ATOM AND INDIVIDUAL IN THE AGE OF NEWTON

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ATOM AND INDIVIDUAL IN THE AGE OF NEWTON

On the Genesis of the Mechanistic World View

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EDITORIAL PREFACE

In this stimulating investigation, Gideon Freudenthal has linked social history with the history of science by formulating an interesting proposal: that the supposed influence of social theory may be seen as actual through its coherence with *the process of formation* of physical concepts. The reinterpretation of the development of science in the seventeenth century, now widely influential, receives at Freudenthal's hand its most persuasive statement, most significantly because of his attention to the theoretical form which is characteristic of classical Newtonian mechanics. He pursues the sources of the parallels that may be noted between that mechanics and the dominant philosophical systems and social theories of the time; and in a fascinating development Freudenthal shows how a quite precise method – as he descriptively labels it, the 'analytic-synthetic method' – which underlay the Newtonian form of theoretical argument, was due to certain interpretive premisses concerning particle mechanics. If he is right, these depend upon a particular stage of conceptual achievement in the theories of both society and nature; further, that the conceptual was generalized philosophically; but, strikingly, Freudenthal shows that this concept-formation itself was linked to the specific social relations of the times of Newton and Hobbes.

The history of the social relations of theoretical science, much discussed and debated these past six decades in German, French, Russian and English works, has been criticized as more promise than achievement, more a matter of asserting what is evident than of explaining what is subtle, original and admirably creative. Who would doubt that social context of utility in peace and war, of belief in myth and religion, would influence the problems chosen and the explanatory metaphors too? Or that the materials and instruments made available by the crafts and resources of a society would be useful to those investigating nature? But Gideon Freudenthal goes much deeper; he has taken the complexity of the interactions among the social, the practical, the philosophical, the ideological, and the autonomous scientific, through a meticulous and documented examination. Far from barren, his result seems to us fruitful, and his method promises much more to come.

Not the least of his achievements is the brief but incisive comparison drawn between the social world of Newton and that which conditioned

Leibniz's philosophical presuppositions. Shall we look for other contrasts, perhaps the world of Gassendi? But what we have here is already extraordinary in Freudenthal's tripartite historical and conceptual analysis of the ways of understanding element and system in the fundamental work of the science and politics of modern society. With the synthesis of knowledge of nature came the 'anti-feudal social philosophy' of Hobbes, and ultimately that same analytic-synthetic method in the establishment of a basis of understanding civil society. We need not decide whether the physical particles, to be our atoms, and the social individuals run together, whether each was idealized along the same standard, to see that the materials for reaching a decision are soundly presented in Freudenthal's work. The decision concerns a far-reaching issue: whether scientific theory may be cognitively conditioned by social relations without abandoning the claim to empirical truth? Freudenthal's response supports the objectivity of scientific theory within a clear-headed social dialectic.

February 1986

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For Rachel
and Our Parents

PREFACE TO THE ENGLISH EDITION

In the study presented here I shall try to reconstruct the genesis of a specific form common to both Newtonian mechanics and some of the social theories and philosophies of Newton's time. This form is the result of applying a particular version of the analytic-synthetic method.

The genesis of the form under examination in this study will be reconstructed with reference to supra-theoretical conditions. I believe that by the method of investigation itself I have succeeded in excluding that kind of relativism which prevents comprehension of the truth content and of the continuity in development of scientific knowledge. I have tried, first of all, to determine precisely which aspects of the theory under examination, Newtonian mechanics, need an explanation that goes beyond the theory itself, and, secondly, to explain why theoretical assumptions, which when considered from today's point of view cannot be sufficiently justified, were nonetheless accepted. The reconstruction of a theory out of its premises, which also include such assumptions, can, I believe, also do justice, both to the historical limitations of a theory and to its still valid cognitive content. This method of investigation and its application are explained at length in the introduction and at various points in the main text itself.

This study was originally published in German in 1982. Since then a number of important works on some of the subject matters treated here have appeared. After examining these publications, I see no reason to modify the theses presented here and have therefore abstained from incorporating references to the most recent literature. A number of minor changes have been made in the original text, and I have have supplemented it in two places: I have pointed more explicitly to the connection between Newton's philosophical views and the physiological theories of his time, a connection which was one of the factors mediating his philosophy with his physics (Chapter XIII). Furthermore, I have attempted in the Afterword to summarize more clearly the interrelationships demonstrated in this study. Despite these additions and Peter McLaughlin's sensitive translation, the book remains in one respect very 'German': a central question is pursued through differing themes and areas, and each succeeding step of the investigation is structured by the result of the preceding step. For this reason, although the results are

summarized at the end of each part of the book as well as in the Afterword, my thesis will probably be comprehensible only to those who follow the entire argument. I believe, however, that this difficulty is grounded in the subject matter itself and could not have been avoided by a different kind of presentation.

I should like at this point to thank Joachim Moebus for his careful reading of and detailed commentary on the original manuscript and my brother Gad Freudenthal for his helpful lessons in physics.

The reworking of earlier drafts of this study or of parts of it has benefited from the criticism and suggestions of Gad Freudenthal, Wolfgang Krohn, Wolfgang Lefèvre, Rachel Livné-Freudenthal, Peter McLaughlin, Joachim Moebus, Friedrich Tomberg, and Michael Wolff.

For mistakes that remain as well as for the theses proposed, however, I alone am responsible.

Finally, I would like to thank the Van Leer Jerusalem Foundation for assuming most of the costs of translation.

GIDEON FREUDENTHAL

I am amazed, Sir, that you say one must agree on the method of philosophizing before one speaks about the philosophy of Mr. Newton: *Is there a different logic in London than in Hanover*? If one reasons in good form from well established facts, or from indubitable Axioms, one will not fail to be right.

(Leibniz to Conti, April 9, 1716, Robinet, 65)

If geometry were so opposed to our passions and present interests as are morals, we would contest and violate it scarcely less, in spite of all the demonstrations of Euclid and Archimedes, which would be treated as dreams in the belief that they were full of paralogisms.

(Leibniz, *Nouveaux Essais*, I.ii.12)

INTRODUCTION

1. PROBLEMS AND METHODS OF ANALYSIS

The analysis presented here takes up two major problem complexes. The first deals with the relationship between philosophy and modern science; the second with the influence of social relations on concept formation in natural science. Both complexes are closely connected here.

The question of the relationship between natural science and philosophy has comparatively seldom been discussed. In the familiar phrase about the 'emancipation' of science from philosophy the answer seems tacitly presumed: namely, that a separation of the two was the prerequisite for natural science. The question as to the reasons for the purported separation thus seems to coincide with the question as to the foundations for the origin of modern science. On the other hand, the question of the possible influence of social relations on concept formation in science has for some years been the focal point of discussions on the methodology of the historiography of science. A systematic problem, I believe, lies at the root of this discussion, which will not be dealt with in more detail here: it is, that if a scientific theory is substantiated, then it can be rationally reconstructed; its origin seems to need no further explanation. If, however, connections are pointed out between a scientific theory and social relations, then, at first, only two courses of argument seem open: on the one hand, the rational reconstruction of the theory can be accepted in principle, but at the same time it can be argued that the possibility and even the necessity of the development of science must be explained through and on the basis of social relations. On the other hand, it can be maintained that what is called scientifically rational is itself affected by social relations. The first possibility leads to the opposition of 'external' (here: social) and 'internal' (cognitive) 'factors' in the development of science. The conceptual structure of the theory under examination is thus not included in the socio-historical explanation of its origin. The second possibility denies the claim to truth of science in general and leads to the position that science must be considered as merely one possible way of explaining nature, in principle of equal value with any other.

Both these positions have the assumption in common that a scientific

theory is already determined unambiguously by the theoretical form (e.g. empirical-mathematical) and by the subject-matter of the science. The present analysis will, on the contrary, attempt to demonstrate that a scientific theory can be rationally reconstructed and nonetheless can be co-determined in its concept formation by the social relations.

A more precise answer to the question, how concept formation in a scientific theory can be influenced by social relations and at the same time meet the 'internal' standards of scientific work, can only be given in the course of the analysis undertaken here. At this point I should like only to present a few deliberations which have determined the course of this investigation.

The proof that a scientific theory was co-determined by motives 'external to theory', itself presupposes the proof that different scientific theories of equal value could be formulated about the same subject with the conceptual tools available at the time. If this proof can be given, then it must be asked further, what were the reasons for the difference between the theories and for the fact that one of them prevailed. The possibility of proposing different theories of the same subject on the basis of empirical research is grounded in the fact that a scientific theory does not consist merely in ascertaining supposedly theory-independent 'facts of experience'. The epistemological question whether it is possible at all to ascertain such 'facts' need not be discussed here. For the purposes of the present analysis, it suffices to show that different theories have been formulated on the basis of the same 'facts', in order to be able to inquire about the theoretical premises which led to this difference. It should however be pointed out that such premises need not necessarily belong to that knowledge that is taken as scientifically well established. "It is often hard to draw a clear dividing line", writes Michael Wolff, "between what appears evident to the supporters of a scientific doctrine and a conviction which they have taken over unnoticed as a prejudice".[1]

With the demonstration that the investigation of the same phenomena could support the formulation of different theories of equal value, the way would be opened up to inquire about motives above and beyond the quest for empirical confirmation and theoretical consistency, which might affect the difference; but a more exact determination of such motives must still be sought after. This analysis will deal particularly with the influence of social relations in the narrower sense, that is, with the influence of socio-political processes, not with that of technological-economic interests or other motives.

Thus we shall not deal with the question whether scientific experience was stamped by an allegedly evident, prescientific 'preconception' of the

objects (Wolff). Such a relationship is imaginable, for instance, between technological experience and scientific mechanics, since their objects – the motion of material bodies and the forces which move them – are the same. However, the objects of the experience of socio-political processes and those of scientific mechanics, for instance, are different.

In so far as an 'evident preconception' (that is, a theoretical presupposition), a preconception which originates in the experience of socio-political processes, has stamped a scientific theory, it must itself be the concept of an object common to (scientific or prescientific) social theory and theory of nature. Thus it must be the concept of an object which transcends both theories. Concepts of such objects are philosophical concepts. The demonstration that social relations can have an influence on concept formation will therefore be so conducted as to show,

(1) that a natural scientific concept was formed on the basis of an 'evident preconception';

(2) that this preconception is a philosophical concept;

(3) that the philosophical concept found application both in a theory of nature and in a social theory and that it relates to the same philosophical object;

(4) that the specifications of this philosophical concept which cannot be drawn from research in natural science originate in the use of the concept in social theory and not in a preconception based on prescientific (technical) experience of nature;

(5) that these specification of the philosophical concept can be explained through social relations (not, for instance through peculiarities of concept formation in social science);

(6) that these specifications of the concept also appeared evident to natural scientists;

(7) that these specification, although they stamped the natural scientific concept, did not destroy its scientific character, that is, were not in contradiction to the empirical results of scientific research.

From these deliberations it should be clear that the two questions posed at the beginning as to the relation between philosophy and natural science and as to the possible conditioning of concept formation in science by social relations, are closely connected, and that the so-called 'emancipation' of science from philosophy is here rather called into question. Furthermore, these deliberations determine the choice of the historical subject matter of the investigation, namely, classical mechanics, which was the first natural scientific discipline to be developed. The attempt to demonstrate the socio-

historical conditioning of concept formation in empirical-mathematical physics will be conducted so as to sketch summarily the social history of England in the age of Newton, on the one hand, and particular aspects of contemporary social and natural scientific theories, on the other. The justification for so extending the subject of investigation must be evaluated by whether the suspected connections between the different areas mentioned can be demonstrated. These requirements determine the course of investigation. It will take a direction which is the reverse of the conjectured sequence of conditions.

The subject of the analysis will be Newton's theory of space and its connection to some other parts of his physics. (The choice of this historical subject will be justified below.)

In the first part of the analysis (Chapters I–III), the 'evident preconception' of the Newtonian theory of space will be uncovered: it involves a particular conception of the relation between phenomena and the properties of the particles out of which material bodies are composed (I). Thereupon, it will be demonstrated that at the same time an alternative physical theory was conceived, that of Leibniz (II), which differed from Newton's in that it started from a different 'preconception'. The following chapter will show that the theory of Leibniz (which did not prevail) is not merely of equal value but also has some advantages. Some references to the later justifications of the Newtonian theory of space (which prevailed in physics) are to show that this theory was not only conceived on the basis of this preconception but also that its later acceptance was based on this preconception. The question of why the preconception appeared 'evident' is thus not confined to the person of Newton nor to short term, temporary conditions but rather must be directed toward fundamental conditions characteristic of an entire epoch.

In the second part of the investigation (Chapters IV–VII) it will be demonstrated that the Newtonian 'preconception' was a philosophical preconception. To this purpose the possibility will first be excluded that this preconception was common property of the tradition of natural science (IV); then it will be shown that it can be discovered in the various disciplines of a contemporary philosophical system (V). Finally, it will be shown (VI, VII) that Newton's presupposition was not taken directly from social philosophy and that the 'Newtonian presupposition' in social philosophy did not result directly from the experience of social relations.

The third part (Chapters VIII–XII) will show that the 'evident' character of the 'preconception' can nonetheless be explained by social relations – although only for social science. The demonstration will be made in three steps: (1) the social-historical background will be discussed (VIII); (2) it will

be shown that the preconception is not to be found in the tradition of social theory or the theory of nature; and (3) it will be indicated how the mediation between social relations and the formation of the preconception can be explained (IX–XII).

In the fourth part (Chapters XIII and XIV) the mediation between the social and the natural scientific 'preconceptions' in Newton's deliberations will be presented (XIII), and thus the argument for the influence of social relations on Newton's theory concluded. To check the argument, the social conditions of Leibniz's differing view will be considered (XIV), and it will be shown that he, too, had a philosophical 'preconception' which stamps his social philosophy, metaphysics, and physics.

2. SCIENCE AND PHILOSOPHY; NEWTON AND LEIBNIZ

The historical example, on which the systematic problems of the relationship between natural science and philosophy and of the socio-historical roots of scientific theory are to be examined in this study, is the discussion between Leibniz and Newton of the concept of absolute space. This discussion is particularly suited for the purposes of this study, both on account of the persons involved and of the subject matter dealt with.

Newton and Leibniz can be taken as representatives of the two lines of development: natural science and philosophy. Newton's works are considered to be the culmination of the above mentioned process of the 'emancipation' of mechanics, the 'leading' branch of science of the time, from philosophy. Newton himself has been considered ever since as 'the' scientist. His contemporary Leibniz, on the other hand, is generally valued as a mathematician and philosopher.

The separation of science and philosophy seemed already advanced by the time of Leibniz and Newton and was sensed and addressed by both of them. Thus, Leibniz had words of recognition for Newton's physics but scorn for his philosophy:

> I believe the metaphysics of these gentlemen [Newton and his supporters – G. F.] *a narrow one* and their mathematics *arrivable* enough; this does not prevent me from estimating very highly the physico-mathematical meditations of M. Newton ... (Letter to Conti, Dec. 6, 1715; Alexander, 185–186; the italicized words are English in the original.)

Leibniz even noted a connection between the growing separation of philosophy from natural science and Newton's theory of space:

> Mere mathematicians, who are only taken up with the conceits of imagination, are apt

to forge such notions [as absolute space – G.F.]; but they are destroyed by superior [philosophical – G.F.] reasons (5th Letter to Clarke, § 29).

Newton, on the other hand, made the accusation, that philosophy is speculative. Leibniz, he wrote,

prefers hypotheses to arguments of induction drawn from experiments, . . . and instead of proposing questions to be examined by experiments before they are admitted into philosophy, he proposes hypotheses to be admitted and believed before they are examined (Newton to Conti, Feb. 26, 1716; Alexander, 187).

Nonetheless, the separation had not so far advanced by the time of Leibniz and Newton, that mutual understanding had become impossible. This advantage applies also to the clarification of the influence of social relations on scientific theories. Leibniz and Newton lived in an age of transition. This circumstance made a discussion possible which would not have been possible between a medieval scholastic scholar and a modern natural scientist.

On the other hand, Newton lived in a society, which was the first to carry out a bourgeois revolution (aside from the Dutch Revolution which was waged as a war of national liberation). This reference should not be understood as if local social relations were to be ascribed a fundamental significance. However, the circumstance that the first bourgeois revolution occurred during the lifetimes of Newton and Leibniz and that each of them took up a different position with regard to the social changes, might at least suggest that, if social relations and partisanship in social controversies have an influence on concept formation in science, we ought to be able to recognize them here.

3. 'ABSOLUTE' AND 'RELATIVE' SPACE

The second general advantage of the Leibniz-Newton discussion for the clarification of these questions is its subject: the concept of space.

The concept of space is, on the one hand, one of the fundamental concepts of physics and, on the other – since all of material reality is spatial – one of the basic concepts of philosophy. In the opinion of one historian, the theory of space is a 'cornerstone' of the system of any philosopher in modern times (Jammer, *Space*, 1).

Schematically, two schools can be characterized into which the various theories of space can be divided: the theory of 'relative' and the theory of 'absolute' space.

Einstein writes:

Those two concepts of space may be contrasted as follows: (a) space as positional quality of the world of material objects; (b) space as container of all material objects. In case (a), space without a material object is inconceivable. In case (b), a material object can only be conceived as existing in space; space then appears as a reality which in a certain sense is superior to the material world (Einstein, Preface to Jammer, *Space*, xiii).

According to this division, Leibniz's conception of space theory would fall under (a) 'relative space' and Newton's under (b) 'absolute space'. The significance of the problem becomes clear when the consequences are taken into consideration. A particular concept of space cannot be evaluated independently of the theory to whose 'conceptual tools' (Einstein) it belongs. These two alternative theories of space in the 17th century will therefore be examined to see if and, if so, to what extent, they could have a function in the most advanced physical theory of the time, in mechanics.

4. NEWTON'S THEORY OF SPACE AND THE SPACE THEORY OF NEWTONIANISM

At the end of the 19th century and the beginning of the 20th, the earlier discussion was repeated in certain regards. This led to a revived interest in the controversies on the theory of space carried on in the 17th century. In his systematic critique of Newton's theory of absolute space, Ernst Mach characterized Newton simply as an 'absolutist'. Others saw in Leibniz the anticipation of the newly developed theory (Cassirer, Carnap, Reichenbach, Weyl).

Once it was recognized that mechanics can dispense with the theory of absolute space, historians of science began to search for the reasons which might have moved Newton to propose this theory. Great stress was laid on showing that Newton coupled the theory of absolute space to metaphysical-religious notions, and the conclusion was drawn, or at least implied, that the theory was influenced by these notions (Burtt, Koyré).

The demonstration that the theory of absolute space had metaphysical-religious meaning for Newton, however, touches only a limited aspect of the problem. For Newton does not justify the introduction of his concept of space with his metaphysical convictions, and leading physicists in the 200 years after Newton retained his theory of space without sharing Newton's metaphysical convictions; they agreed with his physical arguments. For these reasons Newton's theory of space will first be examined without going into the metaphysical-religious aspects. Assuming that Newton's argumentation contains 'preconceptions' whose origins are to be found in the social relations and if, as samples will show, later physicists increasingly used these presuppositions

for support, we shall be able to ask whether the results might not also apply to the 'Newtonianism' of a particular epoch and not just to Newton's own work.

5. THE LEIBNIZ-NEWTON DISCUSSION AND THE LEIBNIZ-CLARKE CORRESPONDENCE

The discussion between Leibniz and Newton on the theory of space was to the greatest extent carried out in an exchange of letters between Leibniz and Samuel Clarke. Historical research has demonstrated that Clarke, at least in particular points, argues as Newton's spokeman and in agreement with him. The correspondence and other related documents date for the most part from the years 1715 and 1716. The discussion ended abruptly with the death of Leibniz. It was carried on approximately thirty years after Newton had published his *Philosophiae Naturalis Principia Mathematica* (1687), the work in which he founded his theory of space, and just as long after Leibniz's first outline of his philosophy in the *Metaphysical Discourse* (1686). From this it should be clear that the original justifications of the different theories do not appear in the exchange of letters.

The correspondence presents some difficulties for the present analysis. Its systematic value is held by many interpreters to be rather small, since to all appearances it is the metaphysical-religious aspects of the space theories which are focused on. An additional failing is seen in the fact that the dialogue rather gives the impression of a series of monologues held in the presence of the adversary, and it seems that neither party takes the least trouble to understand the point of view of his opponent. Such a style of discussion is not surprising; for the discussion of the theory of space is only one of the continuing controversies between Leibniz and Newton, or between their respective supporters. The most bitter quarrel dealt not with scientific problems but with the question of who first discovered the infinitesimal calculus. This 'priority dispute' acquired with time the status of a national affair, in which a choice had to be made between England and Germany. Not only national prestige was involved, but even political differences acquired significance. Leibniz at any rate brings the priority dispute into connection with the controversies over the succession to the throne of England. An attack on himself, maintained Leibniz, who represented the interests of the House of Hanover, must be seen in connection with these controversies.[2]

For these reasons the correspondence between Leibniz and Clarke cannot constitute the starting point of this analysis; an interpretation will be under-

taken only after Newton's theory of space, as presented in his major work, has been reconstructed and after it has been examined whether Leibniz was able to develop his dynamics on the basis of concepts different from Newton's.

Only then will it be possible to demonstrate the inner relationship of the scientific, philosophical, and metaphysical-religious aspects of the discussion and to have a basis on which to discuss the alleged separation of science and philosophy and the influence of social relations on Newton's theory of space.[3]

PART ONE

ELEMENT AND SYSTEM IN CLASSICAL MECHANICS

CHAPTER I

NEWTON'S JUSTIFICATION OF THE THEORY OF ABSOLUTE SPACE

In his *Philosophiae Naturalis Principia Mathematica* Newton presented his theory of absolute space. 'Absolute' means that an immovable space exists independently of the existence of material bodies. Space is conceived as a 'container', in which material bodies are located, but which would also exist even if there were no material bodies located within it. Newton believed that he could prove this theory on the basis of physical experiments. At the end of the 19th century Ernst Mach found Newton's proof unconvincing. In his critique he adduced no facts which would not have been familiar to Newton, rather he rejected the conclusions which Newton had drawn from his experiments. Apparently, it was possible to draw different conclusions from the same established facts. Newton, however, had no doubt that his conclusions were certain. Therefore the first step of our investigation will take up the question of the conditions under which Newton's proof is valid. We shall see that if we accept certain assumptions, the proof is indeed compelling. The reasons which impelled Newton to presuppose these assumptions will be discussed later on. But since Newton does not name the presuppositions of his proof, an analysis of his argument must first be undertaken in order to reveal them.

1. ABSOLUTE MOTION AND ABSOLUTE SPACE; NEWTON'S FIRST PRESUPPOSITION

The purpose of the *Principia*, wrote Newton, is "to obtain the true motions from their causes, effects, and apparent differences, and conversely from the motions whether true or apparent to obtain their causes and effects".[1]

With these words Newton formulates the fundamental step forward in the history of science represented by the *Principia*: it is a systematic presentation of dynamics, and from its laws he derives the "system of the world" (Book III of the *Principia*). For, Newton says, "the whole burden of philosophy seems to consist in this – from the phenomena of motions to investigate the forces of nature, and then from these forces to demonstrate the other phenomena". (*Princ.*, Praefatio Auctoris; Cajori, XVII–XVIII)

To this purpose Newton starts with a series of definitions. He defines the

'quantity of matter' (mass, Def. 1), the 'quantity of motion' (momentum, Def. 2), '*vis inertiae*' (inertia, Def. 3), '*vis impressa*' (force, Def. 4), 'centripetal force' (Def. 5) and its measures (Def. 6–8).

With the exception of inertia and force, the definitions are definitions of the measure, not of the thing measured (that of centripetal force is not really a definition). Matter and motion are not defined. The explanation of the concept of motion presupposes explanations of the concepts of time, space, and place; and these are given in the 'Scholium' after the definitions.

Since, as Newton believes, time, space, place, and motion are in general the most familiar concepts, they are not defined. But it is necessary to forestall the habit of considering space and time only in relation to perceivable objects. He therefore differentiates them into absolute and relative, true and apparent, mathematical and common (*Princ.*, 46; Cajori, 6).

The determinations of absolute and relative time are given first, then those of absolute space:

I. Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external, and by another name is called duration: relative, apparent, and common time, is some sensible and external (whether accurate or unequable) measure of duration by the means of motion, which is commonly used instead of true time, such as an hour, a day, a month, a year.

II. Absolute space, in its own nature, without relation to anything external, remains always similar and immovable. Relative space is some movable dimension or measure of the absolute space; which our senses determine by its position to bodies; and which is commonly taken for immovable space; such is the dimension of a subterraneous, an aerial, or celestial space, determined by its position in respect of the earth. Absolute and relative space are the same in figure and magnitude; but they do not remain always numerically the same. For if the earth, for instance, moves, a space of our air, which relatively and in respect of the earth remains always the same, will at one time be one part of the absolute space into which the air passes; at another time it will be another part of the same, and so, absolutely understood, it will be continually changed (*Princ.*, 46–47; Cajori, 6).

Newton does not carry out his intention of differentiating between "absolute and relative, true and apparent, mathematical and common" concepts to the same extent for time and space. Absolute time is called true and mathematical, while absolute space is not given these determinations. The reason for the difference in the concepts can easily be seen: the measure of time is motion, but "it may be that there is no such thing as an equable motion, whereby time may be accurately measured". All motion could be accelerated or retarded, but the flow of absolute time cannot be changed. The duration of the existence of things is the same, whether the motions are accelerated

or uniform or even if there is no motion at all. Thus duration must be distinguished from its measures (*Princ.*, 48; Cajori, 8). Accordingly, time is completely independent of its measure.

A perfectly uniform periodic motion would be the exact measure of time, the number of motions its standard of measure. However, all standards of measurement used, such as the motions of the planets etc., are merely approximations to a perfectly uniform motion. Thus for the physicist such a motion is an ideal which must guide the choice of a standard of measurement and the introduction of necessary corrections.

'Absolute' time can be called 'true' as opposed to 'apparent', because in the phenomena it is not the duration of the existence of a body that is measured but rather the duration of its motion on a particular path. Since 'apparent' time does not satisfy the condition of 'flowing' perfectly uniformly, absolute time can be called 'mathematical' as opposed to 'common'. If the distance traversed by a moving body is divided into segments of equal length and the time periods in which the body traverses these lengths turn out to be of different durations when compared with another standard of measure, it cannot be determined whether one of the two measures is suitable as an exact measure of uniformly flowing time.[2]

Space is different. 'Relative' space is an arbitary part of 'absolute' space, and since space is homogenous, every relative space is also a mathematically exact measure of absolute space. Any 'standard' can serve as a measure of absolute space. The difference between relative and absolute space is that relative space is movable, absolute space is immovable. Distinguishing between relative and absolute space makes sense, but not between true and apparent, common and mathematical space. Thus the explanation begins merely: "Absolute space, in its own nature, without relation to anything external, remains always similar and immovable"; the determinations 'true' and 'mathematical' are not mentioned here as they were in the explanation of the concept of time.[3]

Nonetheless, the difficulty arises of how to identify absolute, immovable space, since it might be that there are no bodies really at rest, to which it could be related (*Princ.*, 48–49; Cajori, 8). The object investigated in dynamics can, according to Newton, only be determined if a distinction is made between absolute and relative motion. 'Absolute' motion presupposes an absolutely immovable frame of reference. One can however try to distinguish between absolute and relative motion by means of their (1) properties, (2) causes, and (3) effects, without necessarily determining by sense perception their relations to absolute space (cf. *Princ.*, 48–49; Cajori, 8).

(1) A property of bodies absolutely at rest is that they are at rest relative to one another. Should there be a body at rest relative to absolute space, then the motions of other bodies with respect to absolute space could be determined by observing their motions relative to the body at rest (*Princ.*, 49; Cajori, 8). However, since such a body is not known, this possibility can be excluded,[4] and there remain the causes and effects, by means of which we might be able to distinguish between absolute and relative motions and thus between absolute and relative space.

(2) The distinction between absolute and relative motion based on their causes: "True motion is neither generated nor altered, but by some force impressed (*vis impressa*) upon the body moved" (*Princ.*, 50; Cajori, 10). On the other hand, the relative motion of a body can be generated even when it rests absolutely if other bodies change their positions with respect to it. The problem here is that one non-perceptible (absolute space) must be identified by means of another non-perceptible (force). An exception can be made only for those forces which man himself 'impresses' on a body. Even in such cases it can only be determined that a force affects the body, but it is impossible to say whether its motion is the result of this force alone. Thus this criterion, too, is useless for determining absolute motion.

(3) The distinction between absolute and relative motion can also be based on their effects. This procedure finally allows Newton to determine first absolute motion and then absolute space.

The effects which distinguish absolute from relative motion are the forces of receding from the axis of circular motion (*Princ.*, 50–51; Cajori, 10).

To distinguish relative from absolute circular motion, Newton introduces the famous experiment with the rotating bucket. A bucket filled with water and hanging by a cord is wound up. The water and the bucket are at rest relative to one another. When the bucket is released, it begins to rotate as the cord unwinds and at first moves relatively to the water which remains at rest. The surface of the water remains smooth. The motion is gradually imparted to the water until the water is moving just as fast as the bucket, that is, until it is again at rest relative to the bucket. At the same time the surface of the water takes on a concave shape, that is, the water receding from the axis of rotation climbs up the side of the container. It reaches its highest mark when the water is at rest relative to the bucket.

This ascent of the water shows its endeavor to recede from the axis of its motion; and the true and absolute circular motion of the water, which is here directly contrary to the relative, becomes known, and may be measured by this endeavor (*Princ.*, 51; Cajori, 10).

A further experiment is that of two balls connected by a string which rotate around their common center of gravity. The balls are at rest in relation to one another, but the tension in the string (the effect of centrifugal forces) shows their absolute motion: "and from thence we might compute the quantity of their circular motions" (*Princ.*, 53; Cajori, 12). By the application of forces in or opposed to the direction of the motion and by their effects on the tension of the string, the absolute direction of motion can be ascertained.

A proof has unquestionably been given; the only question is, what has been proved. Newton's conclusion is clear:

> And thus we might find both the quantity and the determination of this circular motion, even in an immense vacuum, where there was nothing external or sensible with which the globes could be compared (*Princ.*, 53; Cajori, 12).

The 'absolute' motion which Newton believes he has demonstrated is a motion relative to absolute space. And so, he concludes, the existence of absolute space has been proved.

There are thus two conclusions. The one concludes that there is absolute motion from the appearance of centrifugal forces, the other that absolute space exists from absolute motion.

The first conclusion was criticized by Ernst Mach. "Try", he wrote, "to fix Newton's bucket and to rotate the heaven of fixed stars and then to prove the absence of centrifugal forces" (Mach, 279).

> Newton's experiment with the rotating vessel of water simply informs us, that the relative rotation of the water with respect to the sides of the vessel produces *no* noticeable centrifugal forces, but that such forces *are* produced by its relative rotation with respect to the mass of the earth and the other celestial bodies. No one is competent to say how the experiment would turn out if the sides of the vessel increased in thickness and mass till they were ultimately several leagues thick (Mach, 284).

The fundamental question whether from centrifugal forces the 'absolute motion' of the body on which they are observed may be shown was considered once by Newton himself. In light of the relativity of the motion of the heaven of fixed stars and of the earth, one might think that God could move the fixed stars from east to west and let the earth stand still: "But who will imagine", Newton replied, "that the parts of the Earth endeavour to recede from its centre on account of a force impressed only on the heavens?" (*De Gravitatione*, (1664–1668) Hall and Hall, 96, 128).

In the *Principia* the question is no longer raised. In Newton's interpretation of the experiment with the two bodies rotating around their center of gravity, it is furthermore presupposed that the centrifugal forces would also

appear if the two bodies rotated in an otherwise empty space. Likewise, the question, how a 'motion' of bodies which are at rest with every perceptible point of reference (the respective other body) might be ascertained, is not discussed. Newton also makes no attempt at all to justify these assumptions, or even to designate them as such. They enter as self-evident into the interpretation of the rotation experiment.

But let us assume with Newton that the centrifugal forces which appear on a rotating body depend only on the rotating body itself and that they would therefore also appear in an otherwise empty space. From this, however, it by no means follows that space exists independently of material bodies. From the first hypothetical assumption it cannot be concluded whether or not the existence of space depends on the rotating bodies. Thus from his proof of absolute motion Newton could still not conclude that absolute space exists independent of material bodies.

Newton, however, believed he could prove the existence of a space which existed independently of material bodies – and thus the existence of an empty space – in yet another connection.

2. PROOF OF THE EXISTENCE OF A VACUUM; NEWTON'S SECOND PRESUPPOSITION

Based on careful experiments with pendulums of various materials but of equal weight, which were so constructed that in spite of their different volumes they had the same air resistance, Newton was able to confirm the fact that all bodies fall equally fast in a vacuum.[5] In non-empty spaces, however, a body falls only in media, whose specific gravity is less than that of the body.[6] From this Newton derives the following conclusion:

> And so a vacuum is necessarily given. For if all spaces were full, then the specific gravity of the fluid which fills the region of the air, on account of the extreme density of the matter, would fall nothing short of the specific gravity of quicksilver, or gold, or any other most dense body; and therefore, neither gold, nor any other body, could descend in air; for bodies do not descend in fluids, unless they are specifically heavier (Book III, Prop. vi, Theor. vi, Corol. 3 of the first edition; *Princ.*, 575ff.).

The presuppositions of this assertion are the assumptions, that the particles of all matter are of equal volume and equal mass (and if the force of gravity is equal: of equal weight) and that the difference in specific weight of materials is due to the relation of filled to empty parts of space per unit of volume. Newton introduces this assumption explicitly: "If all the solid particles of

all bodies are of the same density, and cannot be rarified without pores, then a void, space, or vacuum must be granted" (*Princ.*, 575f.; Cajori, 414).

The concept 'density' thus means the relation between the number of solid particles of a body and the pores; with the exception of an absolutely dense body, every body must be conceived as porous. Newton thus concludes, "that Bodies are much more rare and porous than is commonly believed. Water is nineteen times lighter, and by consequence nineteen times rarer than Gold" (*Opticks*, Bk. II, Part iii, Prop. viii, p. 267). The conclusion, that gold is nineteen times less 'porous' than water since it is nineteen times heavier, is only valid if it is presupposed that every 'ultimate' particle of gold has the same mass and the same volume as every 'ultimate' particle of water.

If this presupposition were true, then Newton would have succeeded in demonstrating a vacuum between the particles of matter in a body. Such an 'inner' vacuum, however, is not to be identified with a vacuum existing outside the body, or better: an empty space in which the body is located. The existence of such a vacuum must be shown separately. Before that, however, the consequences of this notion for Newton's concept of 'density' and for his definition of the 'quantity of matter' should be pointed out.

Nonetheless, in the argument thus far Newton's second presupposition can already be detected: all particles of bodies are equal, i.e., of equal volume and equal mass.[7]

3. 'DENSITY' AND 'QUANTITY OF MATTER'

Newton uses the concept 'density' with various meanings: one such meaning, which is different from that discussed above, is expressed in the following definition: "By bodies of the same density, I mean those whose forces of inertia are in the proportion of their bulks" (*Princ.*, 575; Cajori, 414). Density can be determined empirically only as the relation of the masses of two bodies of equal volume. $P_1 = P_2$ if $m_1/m_2 = V_1/V_2$.

The measure of density is: $P = m/V$. A measure of density would then be the mass of the unit of volume of a particular kind of matter. The density of other bodies can thus be expressed as the relation of their masses per chosen unit of volume to the standard (i.e., the unit of measurement). Newton expresses this by speaking of the "*same* density" and thus assuming that two masses are being compared.

From the relation of the masses of the two bodies of equal volume Newton could conclude that a vacuum exists only, because he had presupposed that all particles are of equal volume and equal mass. This assumption could not

be examined empirically since only material bodies could be weighed, accelerated, and measured – not their ultimate elements. While the mass of a body can be determined empirically only by measurement, it can nonetheless be *defined* as the product of the mass of the uniform particle multiplied by the number of particles in the particular body.

The density of a material can be expressed empirically only by the relation of the masses of two bodies of equal volume; it can however be *defined* as the number of particles of equal volume in a volume unit of that kind of matter.

Assuming that all particles are of equal mass, we can then define the mass of a particular body as the product of the 'density' of its kind of matter (the number of particles per unit of volume), the number of volume units in the body, and the mass of a particle.

Compare with these remarks Newton's definition of the 'quantity of matter' (mass): "The quantity of matter is the measure of the same, arising from its density and bulk conjointly."[8] Ernst Mach rightly saw a circle in this definition, "As we can define density only as the mass of unit of volume" (Mach, 237). On the assumption given above, which Newton does not name, the definition follows quite logically.

If the density of a body expresses the relation of the number of particles to the number of equal units of volume in the body, then the particle itself, in which by definition there is no vacuum, must be absolutely dense; a body without vacuum is an absolutely dense body. An 'absolutely dense' medium is thus for Newton 'full of Matter without any Vacuum' (*Opticks*, Qu. 28; 368). The presupposition about the equal mass and equal volume of all particles of matter is thus contained implicitly even in the first definition of the *Principia*.[9]

4. PROOF OF THE EXISTENCE OF EMPTY SPACE

Under the conditions stated, Newton has demonstrated the existence of empty space between particles. He has, however, not proved that empty space also exists where there are no particles, that is, that there is also an empty space which exists independently of the existence of material bodies. One argument of Newton's for the existence of such a space consists in an extrapolation: "An if the quantity of matter in a given space can, by any rarefaction, be diminished", (as the differences in specific gravity clearly show) "what should hinder a diminution to infinity?" (*Princ.*, 575; Cajori, 414). The existence of empty space can also be demonstrated in a strictly empirical way, that is, through a 'deduction' from a phenomenon.[10]

Material bodies can be perceived and offer resistance, as opposed to mathematical bodies, which "are not perceived by touching nor cause a resistance, nor are they usually called bodies" (McGuire, 'Body and Void', 217, 244). The place in which a body can move without resistance is defined as a vacuum (*op. cit.*, Draft No. 3, Def. III; 247). If body is what offers resistance, and if in a vacuum no resistance is met with, then Newton can define a vacuum in the following manner:

> And vacuum I call all space which is destitute of bodies of this kind (that is, material bodies – G. F.) (*op. cit.*, Draft No. 4, Scholium, 222, 247).

And that there really are such empty spaces, can be seen from empirically ascertained facts. At a height of 200 miles, Newton calculated, the air is thinner than that at the surface of the earth in a ratio of $75 \cdot 10^{11}$ to 1, so that the motion of the planet Jupiter would be retarded by a millionth in a million years by the resistance of the medium. And in experiments with bodies falling in a vacuum at the earth's surface no retardation at all can be established.

> And therefore, the celestial regions being perfectly void of air and exhalations, the planets and comets meeting no sensible resistance in those spaces will continue their motions through them for an immense tract of time (*Princ.*, 586; Cajori, 419).

In very distant regions we must thus assume a completely empty space.

The basic principle of Newton's method:

> From the phenomena we know the properties of things, and from the properties we infer that the things themselves exist and we call them substances (Draft to Scholium Generale, in Hall and Hall, 306, 356).

is by no means transgressed here. For, the differences in the resistance of various media, the lack of resistance of others can be ascertained empirically or can be inferred from experience. If we are to infer the properties of 'things' from these phenomena, then we can consequently attribute resistance to material bodies and lack of resistance, as a property of extension without body, to empty space.

5. THE ESSENTIAL PROPERTIES OF A PARTICLE IN EMPTY SPACE: THE PROBLEM OF GRAVITATION

In the *Principia* Newton explicates the methodological rule: "From the phenomena we know the properties of things", as follows:

The qualities of bodies, which admit neither intensification nor remission of degrees, and which are found to belong to all bodies within reach of our experiments, are to be esteemed the universal qualities of all bodies whatsoever (*Regula Philosophandi* III, *Princ.*, 552; Cajori, 398).

Since Newton presupposes that bodies are composed of particles, he adds a further determination:

The extension, hardness, impenetrability, mobility, and force of inertia of the whole, result from the extension, hardness, impenetrability, mobility, and forces of inertia of the parts; and hence we conclude the least particles of all bodies to be also all extended, and hard and impenetrable, and movable, and endowed with their proper forces of inertia. And this is the foundation of all philosophy (Scholium to Regula III, *Princ.*, 554; Cajori, 399).

In this catalogue of qualities which belong to all particles of matter it is apparent that gravitation is missing, although it too is a property of all bodies within reach of our experiments. In the explanation of this same rule Newton remarks that the "argument from the appearances" is even stronger "for the universal gravitation of all bodies than for their impenetrability; of which, among those in the celestial regions, we have no experiments, nor any manner of observation" (*Princ.*, 552ff.; Cajori, 400).

In an unpublished addendum to the first edition of the *Principia* Newton went on to draw the conclusion:

Gravity is a quality of all bodies upon which experiments can be conducted, and, existing in individual bodies in proportion to the quantity of matter, it cannot be intensified or remitted, and consequently by Hypothesis III (= Regula III – G.F.) it is a property of all bodies (Addendum on an interleaf in Newton's own copy of the first edition to Bk. III, Prop. vi, Theor. vi, before Corol. 3; *Princ.*, 575, fn.).

Gravity, then, meets the requirements of a 'universal property' of all bodies, and although it was not mentioned from the start among the 'universal properties', it is now determined to be such.

However, in the third edition of the *Principia* Newton added four sentences at the end of the explanation of Regula III:

Not that I affirm gravity to be essential to bodies. By their *vis insita* I mean nothing but their force of inertia. This is immutable. Their gravity is diminished as they recede from the earth (*Princ.*, 555; Cajori, 400).

The argument seems to be nonsensical; for it is not the 'property' gravity but rather its effect, the acceleration of the gravitating bodies, which diminishes with distance. Let us assume, for instance, that particles A, B, and C are

situated ón a line and gravitate towards one another. Let the distance AB be double the distance BC. How much is the 'property' of gravity in B supposed to have diminished?

A further difficulty lies in the fact that, according to the text of Regula III, qualities which "admit neither intensification nor remission" are the *universal* qualities of all bodies; in the addition to the third edition Newton does not deny that gravitation is a *universal* property of all bodies, but he does think that it is not an *essential* property.[11] Newton does not explain the difference between a universal and an essential property. The difficulty is thus, that it is first of all unclear under what conditions the 'property' of gravitation is diminished, and secondly, it is unclear what the difference between a universal and an essential property is supposed to be.

One criterion for a universal property, namely that it cannot be diminished, was explicated by Newton in the first edition of the *Principia* with the determination: "and such (qualities) as are not liable to diminution can never be quite taken away" (*Princ.*, 553; Cajori, 398).[12] If there is a possibility that a body might lose its gravity, then both Newton's proof of the 'diminution' of gravity and his distinction between 'universal' and 'essential' properties makes sense. This can be shown by comparing his argument on gravitation with his proof of the existence of absolute space.

The existence of empty space independent of matter was supposed to be proven by the fact that at a height of even 200 miles the quantity of matter is infinitesimal in relation to the volume of space, without there being any change in the character of space. If all particles were evenly distributed throughout space, the relation of empty volume to filled would be $686 \cdot 10^{18}$ to 1. But matter is not evenly distributed throughout space; the relation of empty space to matter in the distant regions is thus even incomparably greater, and the attraction of two particles can for practical purposes be neglected.[13]

If we can by extrapolation show the existence of empty space, then we can also consider what would happen if there were only one single particle of matter in empty space. *Vis inertiae* must continue to be a property of the particle, since, according to Newton, it would retain its state of motion and this state is relative to absolute space. Any attempt however to attribute gravitation to a single particle would be absurd, since gravitation can only be conceived as mutual gravitation, that is, it presupposes at least two bodies. Gravity may thus be considered as a property of all bodies in the world (as a universal property) but not as an essential (necessary) property of a body as such.[14]

Newton's distinction between 'universal' and 'essential' properties in the explanation to Regula III makes sense after the following addition: the essential properties of a material body are those universal properties which also belong to a single body in otherwise empty space.

With this addition Newton's argument, that gravity can diminish and consequently can disappear from a body, makes sense; for the property of gravitation can in fact be eliminated, namely in the case that only one particle is located in empty space. The suggested addition also justifies Newton's distinction between 'essential' and 'universal' properties. The contrast between the 'essential' property 'inertia' and the merely 'universal' 'gravitation' shows, moreover, that the assumption that inertia is a property of a single particle in empty space seemed obvious and evident to Newton. The validity of Newton's proof of the existence of absolute space depends on this assumption, which also determines his formulation of the law of inertia; this will be discussed next.

6. NEWTON'S LAW OF INERTIA

In the explanation to Regula III Newton determined that gravitation is not an 'essential' property of matter, but that the 'force of inertia', as an 'inherent force' (*vis insita*) of bodies, belongs essentially to matter. According to the interpretation presented above, essential properties are those which are attributable to a material body independently of the existence of the system of the world, that is, in empty space. Correspondingly, Newton's first law of motion, the 'law of inertia', refers itself to this empty space:

> Every body continues in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed upon it (*Princ.*, 54; Cajori, 13).

In the explication of the law we are not told, in regard to which frame of reference a body is supposed to continue in its "state of rest, or of uniform motion in a right line". The distinction between 'rest' and 'uniform motion' implies, however, an absolutely resting frame of reference, and this can only be absolute space (Scholium to Def. VIII; cf. Jammer, *Space*, 101–103).

Using the criteria of dynamics, one cannot differentiate between uniform motion and rest. For such a distinction, a point must be given that is at rest relative to absolute space. But even such a point cannot be demonstrated due to the dynamical equivalence of uniform ('inertial') motion and rest.[15] This problem may well have been the reason for the following peculiar deliberation of Newton's

Hypothesis I: *That the centre of the system of the world is at rest*. This is acknowledged by all,while some contend that the earth, others that the sun, is fixed in that centre. Let us see what may from hence follow.

Proposition XI, Theorem XI: *That the common centre of gravity of the earth, the sun, and all the planets, is at rest*. For (by Cor. iv of the Laws [of motion]) that centre either is at rest, or moves uniformly forwards in a right line; but if that centre moved, the centre of the world would move also, against the Hypothesis (*Princ.*, 586; Cajori, 419).

The reasoning is of course anything but a proof; nor is it passed off as a proof. For in Newtonian physics it is impossible to distinguish between a system at rest and one in uniform motion. Newton therefore appeals to a widespread conviction. However, the necessity of assuming some point or other to be absolutely at rest follows for Newton from his formulation of the law of inertia, which determines the state of motion of a body in reference to absolute space.

Ernst Mach, who criticized Newton's version of the law of inertia as evidence of his "metaphysical penchant for the absolute", suggested an alternative formulation of the law, according to which "the mean acceleration of the mass μ with respect to the masses m, m', m'' . . . at distances r, r', r'' . . . is = 0." This formulation is interesting because Mach explicitly states the difference between his and Newton's conceptions:

When, accordingly, we say that a body preserves unchanged its direction and velocity *in space*, our assertion is nothing more or less than an abbreviated reference to *the entire universe* (Mach, 286–289).

"Nature", Mach concludes, "does not begin with the elements as we are obliged to begin with them" (Mach, 286–289). The important point of this critique is that Mach sees the decisive difference between his own procedure and that of Newton in Newton's starting with an 'element' that stands in relation to absolute, empty space. It is also in precisely this point that Newton's formulation of the law of inertia differs from that of Descartes, from whom he otherwise borrowed a number of things.

Descartes formulation of the law of inertia was as follows:

The first of these laws [of nature – G.F.] is that each thing, provided that it is simple and undivided, always remains in the same state as far as is in its power (quantum in se est), and never changes except by external causes. Thus, if some part of matter is square, we are easily convinced that it will always remain square unless some external intervention changes its shape. If it rests, it will continue to rest; if it moves, it will continue to move (*Princ., Phil.* II, §37).

The second law of nature is: that each part of matter, considered individually, tends to continue its movement only along straight lines, and never along curved ones; . . . This rule, like the preceding one, results from the immutability and simplicity of the operation by which God maintains movement in matter (*Princ., Phil.* II, §39).[16]

Two points are of interest here. First of all, Descartes introduces inertia not as a property of a body but as a law of nature grounded in the immutable character of God and the simplicity of his operation, that is, in the axiom that nothing happens without a cause. Thus, not only the state of motion of a body but also its unchanged shape are listed as consequences of the law; and the *vis* and *actio*, which can be attributed to a uniformly moving body, can also – due to the relativity of motion – be ascribed to either one of two bodies moved relatively to one another (*Princ., Phil.* II, §29, §40).[17]

Newton proceeds differently: an 'inherent force' of matter is introduced, which a body 'exercises' on impact. A number of peculiar formulations are the result. For instance, the *vis impressa* exercised on impact is an instantaneous *'actio'*, although the force of inertia is supposed to be inherent to matter, i.e., permanently to reside within matter. It is thus not an *'actio'* but a *'potentia'*. But it must also be asked why it is called *'vis'*, when 'force' in Newton's dynamics denotes the cause of a change in state. As Newton put it, this inherent force is given the "most significant name" *'vis inertiae'*, force of inactivity (*Princ.*, Def. III, 40). For Newton, these (and similar) peculiar formulations are necessary: the necessity arises from his presupposition that phenomena must be traced back to the essential properties of particles,[18] to properties which are independent of the existence of these particles in the world system.[19]

As is well known, Descartes limited the task of God to creating matter and to giving it laws of motion and the first push. The equal parts of matter arrayed contiguously, without intervals or spaces between, first become separated with motion, and at the same time their original sizes and shapes are changed (*Princ. Phil.* III; §§46ff.). The individuation of matter into corpuscles with their individual properties thus depends on the laws of nature, which continue to operate. The law-likeness of nature thus precedes the individuation of matter. For Descartes, all phenomen are to be traced back to laws of nature or to the properties of the particles of matter in this world, not to the properties which belong to a single particle in empty space. For Newton, nothing preceded the individual existence of the particles of matter:

. . . it seems probable to me, that God in the Beginning form'd Matter in solid, massy, hard, impenetrable, movable Particles, of such Sizes and Figures, and with such other

Properties, and in such Proportion to Space, as most conduced to the End for which he form'd them (*Opticks*, Qu, 31, 400).

The subsequent interaction of the particles can change nothing in these properties. Impenetrability and mobility of a mass distinguish a particle from empty space; figure and size (which presuppose extension) determine it in relation to space. Inertia (contained in the concept of mass) determines the state of motion (resting or in uniform motion) of a single particle in empty absolute space.

7. A SINGLE PARTICLE IN EMPTY SPACE; NEWTON'S FUNDAMENTAL PRESUPPOSITION

Newton's proofs of the existence of absolute space had two presuppositions:

(1) Inertia and the other essential properties belong to a particle independently of the existence of other particles. These attributes thus also apply to a single particle in empty space.

(2) All particles of matter are of equal volume and of equal mass.

The two assumptions can be combined in the following way: the material world is composed of equal particles, whose essential properties are attributable to every single particle even as the only particle in empty space. This single assumption provides the basis for Newton's proofs for the existence of absolute space, the formulation of the law of inertia, as well as for the apparent circle in the definition of the quantity of matter.

A further consequence of this presupposition is that the analysis, which started out from a system of the world in which the particles of matter gravitate towards one another, leads to the concept of a particle to which gravity is not attributed. This result in turn has important consequences, as we shall see. For, the synthesis which follows Newton's analysis will lead to the result that the cause of gravitation can in principle not be physical.

It is of decisive importance that Newton was not aware of the presuppositions of his proofs. In the explanations to Regula III quoted above, he wrote:

The extension, hardness, impenetrability, mobility, and force of inertia of the whole, result from the extension, hardness, impenetrability, mobility, and forces of inertia of the parts; and hence we conclude the least particles of all bodies to be also all extended, and hard and impenetrable, and movable, and endowed with their proper forces of inertia. And this is the foundation of all philosophy (*Princ.*, 554; Cajori, 399).

Apparently, the proposition that phenomena follow from the properties of particles is assumed as self-evident, just as it was assumed as evident that all

particles are of equal volume and equal mass. The final presupposition that the properties mentioned of the particles would also belong to every single particle in empty space, was never even formulated by Newton; apparently, he was not even aware that it is a presupposition which neither is contained in Regula III nor follows from it.

CHAPTER II

LEIBNIZ'S FOUNDATIONS OF DYNAMICS

The analysis thus far has shown that 'absolute space' in Newton's theory refers not merely to an 'inertial frame of reference' but to a physical reality, which is also responsible – as a vacuum – for the 'density' of various materials and for the lack of resistance in regions distant from the earth. The presupposition of this theory has turned out to be the assumption that the material world is composed of equal particles whose essential properties belong to them independently of the existence of a world system.

It does not of course follow from this demonstration that Leibniz's critique of the theory of absolute space was based on his recognizing and rejecting this presupposition. Furthermore, even the demonstration of an explicit critique by Leibniz of that presupposition would not suffice for the purposes of this analysis. For the purpose of this investigation is not merely to explain why Newton held his proofs for the existence of absolute space to be certain, but also to explain why his theory was retained until the end of the 19th century. As long as no alternative to a scientifically confirmed theory is offered, no critique of the foundations of a theory can lead to its replacement. Thus, if Leibniz's critique were directed only against the above mentioned presupposition of Newton's theory without at the same time pointing out a viable alternative, then the question, why his critique exercised no influence on the further development of physics, would already be answered. Leibniz's critique would then be justified as a 'philosophical' critique, that is, as touching on the principles of science, but it would nonetheless be insufficient for a different development of science. As long as it cannot be shown that there were alternative theories, there is also no occasion for the question whether social factors were the grounds for the ascendancy of Newton's theory. For this reason we shall analyze Leibniz's writings on dynamics to see whether an alternative physical theory is developed there. At the same time we shall investigate whether the difference between the theories of Newton and of Leibniz originate in Leibniz's not sharing the presupposition shown to be at the bottom of Newton's proof of the existence of absolute space.[1]

1. LEIBNIZ'S NEW MEASURE OF FORCE

Leibniz's immediate contribution to mechanics consisted in particular in the introduction of a new principle of conservation, which was later to be designated as the law of conservation of *vis viva* ('living force'). He argued for this principle in a controversy with the Cartesians. Leibniz maintained: not the 'quantity of motion' (mv) but the '*vis viva*' (mv^2) is universally conserved.[2]

In the argument two assumptions, which the Cartesians also accepted, are made:

(1) "That a body falling from a certain altitude acquires the same force which is necessary to lift it back to its original altitude if its direction were to carry it back and if nothing external interfered with it" (GM VI, 117; PPL, 29).

(2) That the same force is necessary to raise the body A of weight 1 to the height 4 as to raise the body B of weight 4 to the height 1. In other words: the force necessary in both cases is four times that necessary to raise a weight of 1 to a height of 1 (*ibid.*).

According to assumption (1) two bodies with the weights 1 and 4, which fall from the heights 4 and 1, will acquire the force necessary to rise to their former heights. According to assumption (2) the forces of both bodies are equal at the end of the fall.

However the quantity of motion (mv) of each of the two bodies is different. In a free fall from a height s, as Galileo showed, $v \propto \sqrt{s}$. Consequently, the body A has a velocity (in the appropriate units) proportional to $\sqrt{4} = 2$ after a fall from the height 4; body B has a velocity proportional to $\sqrt{1} = 1$ after a fall from the height 1. The quantity of motion would thus be $1 \cdot 2 = 2$ for A, and $4 \cdot 1 = 4$ for B. Thus, says Leibniz, it is clear that the 'force' should not be measured by mv but by its effect (*a quantitate effectus*), that is here, by $m \cdot s \propto mv^2$ (GM VI, 118; PPL, 297–298).[3]

2. DESCARTES' ERROR AND THE LIMITS OF THE CONCEPTION OF LEIBNIZ

The universal validity, which Leibniz claims for the law of conservation of *vis viva*, stands in marked contrast to his failure to apply the law to any cases other than the free fall of bodies. He does mention other examples such as the "tension of a spring, the impulsion of a body to motion or the retardation of a body in motion" ('*Brevis Demonstratio*', Scholium to the Supplement,

GM VI, 122; PPL, 301), but nowhere does he carry through an analysis of such a case. The model of the falling body which lifts a weight is the only model for which a demonstration is given.[4]

A second problem occupied Leibniz himself. If his proof consists of nothing but the application of Galileo's law of falling bodies, and if Descartes, as Leibniz remarks in a letter to Arnauld, also considered the possibility of calculating force by the height of fall, then the question arises, why Descartes himself had not already discovered *vis viva* as the measure of force.

In the attempt to answer this question, Leibniz gives a hint as to how his own restriction of the proofs for the law of conservation of *vis viva* to a discussion of the free fall of bodies might be explained. The *'Brevis Demonstratio'* begins:

> Many mathematicians, seeing that velocity and mass compensate for each other in the five common machines, have estimated the force of motion (*vix motrix*) by the quantity of motion or by the product of the body and its velocity (GM VI, 117; PPL, 296).

In simple machines (e.g., lever, windlass) in equilibrium the masses are inversely proportional to the heights and the velocities. The velocities are directly proportional to the distances traversed. It is therefore all the same whether one multiplies the mass by the distance or by the velocity:

> It is therefore merely accidental here that the force can be estimated from the quantity of motion. There are other cases ... in which they do not coincide (GM VI, 119; PPL, 298; cf. also 'Essay de Dynamique', GM VI, 218).

Descartes, when he dealt with statics, had a particular case in mind, in which both measures are accidentally (*per accidens*) equivalent. That this might not hold in other cases, he did not take into consideration.

Leibniz's explanation, that Descartes did not discover *vis viva* as the measure of force because he restricted himself to examining the five simple machines, prompts the question of what kind of machines Leibniz himself had in mind. It is surprising that he mentions the pendulum, with which Huygens had already implicitly discovered the measure mv^2, only as an example of a "physical *perpetum mobile*". He refers in his proof to a machine in which a falling weight produces an 'effect' by descending vertically and expending its entire *'potentia'* to raise another weight so that the *'potentia'* of A ($m_1 s_1$) is equal to the 'effect' on B ($m_2 s_2$).

A further peculiarity lies in the fact that Leibniz first employed the term "*vis viva*" in a later work (*Specimen Dynamicum*, 1695); in 1686 he used the term *'potentia viva'* (as opposed to *'potentia mortua'* = mv).[5]

The machine which Leibniz might have had in mind is thus one in which raised weights represent a 'dead power' and acquire by falling a 'living power'. Practically, such a machine is possible only if the weights are already located at the higher level and if the losses due to friction can be compensated. In Harz between 1680 and 1686, that is, precisely the years before composing the '*Brevis Demonstratio*', Leibniz had a great deal to do with just such machines, for which the major mechanical problem was the conversion of a given 'living power' into a 'dead power' for future use.[6]

In the mines in Harz machines were used to pump water out of the shafts as well as to ventilate them and to raise the ore. The use of machines involved two technical problems which are of interest here:

(1) guaranteeing a regular source of power and

(2) reducing friction in the transmitting mechanism.[7] The natural forces of nature used, which were cheaper than animal or human power, were running water and the wind. The technical problem was, on the one hand, that available water power was insufficient in dry years and, on the other, that wind power was not available with any dependable regularity.[8]

Leibniz had a plan to solve both problems at once: both to supplement the water power and also to guarantee a regular effect. Expressed in a general form and in modern terms, the solution suggested consisted in using the available kinetic energy of the wind to pump water, which when collected in highland ponds constituted a reservoir of potential energy:

> One can save up the power of the wind and so to speak lay it in storage. So it is to be understood, when one brings water into the ponds, which can hold it in storage and can later dispense it to the common advantage of mining for machinery to raise and crush ore (*Künste und Puchwerke*). This eliminates the major objection, namely that one is neither master of the wind nor has it when he wants it (A I, iv, 43).

This stored up 'power' ('Kraft') would not only be available when needed but could also be applied regularly, since

> the primus motor does not immediately move the field or shaft mechanism but only raises a certain load to the top, which then descends by itself and thus turns the mechanism. For in this manner the pull remains constant all the time, because the same weight always encounters the same resistance and always descends with the same speed. On the other hand, accordingly as the wind is weak or strong, one can then raise such a weight swiftly or slowly to the top again (Gerland, 183).

With these practical, technical problems in mind, it is hardly surprising that Leibniz demonstrates the conservation of force on the example of a falling weight that lifts another. Nor is it surprising that he refutes Descartes

with a *reductio ad absurdum*, by showing the absurd consequences of Cartesian measure of force. For according to Descartes' measure, it must be possible to construct a mechanical *perpetuum mobile*, that is, a machine which could not only remain eternally in motion but on top of that also produce a mechanical effect (*effet méchanique*), such as raising water or milling grain (cf. *Dynamique* (1692), Prop. 4, *Démonstration*). If it thus appears as if "Leibniz had only to feed the numbers into Galileo's kinematics of free fall and turn the crank" (Westfall, *Force*, p. 285), in order to obtain his new measure of force, it should not be forgotten that he had for years dealt with real cranks and with the practical conversion of kinetic energy into potential energy. From this it is understandable not only that Leibniz could correct Descartes' mistake but also why he again and again cites the model of this 'dynamic machine' to prove his law of conservation.[9]

3. ACTION MOTRICE

Leibniz's proof for the conservation of the 'true measure of force' showed that the 'living power' of a freely falling body A was equal to the product of its mass and the height of fall. The proof presupposes the assumptions (1) and (2) listed above, which taken together assert the possibility of a 'physical' *perpetuum mobile*. From this assumption it also follows that the effect of the *vis viva* of a body A after the fall is equal to the product of the mass of body B and the height to which it is raised. It is thus assumed that the body B at rest at the 0 level resists upward motion in proportion to its mass.

If one abstracts from the resistance of the mass, then "it would be no more difficult to move a large body than a small one, and hence there would be action without reaction, and no estimation of power would be possible, since anything could be accomplished by anything" (*Spec. Dyn.*, GM VI, 241; PPL, 440).

If bodies did not offer a resistance proportional to their masses, then, for instance, a body of mass 2 falling from a height of 4 could lift a body of mass 4 also to a height of 4. The 'force' would thus have doubled. The world would then be a "pure chaos" (Leibniz to De Volder; March 24/April 3, 1699, GP II, 179; PPL, 517). Since this is obviously not the case, the mass must be included in the equation as a 'passive force', just as it entered into the expression of force as the cause.[10] The conservation of living force (*vis viva*) applies not only to the particular case where the effect is dependent on gravitation: "I do not tie myself down to gravity; rather I think I can obtain the same results whatever effect you take; nonetheless, compared to other

effects, gravity is more convenient to the intellect" (Leibniz to James Bernoulli, March 15, 1697, GM III, 58).

If the law of conservation of *vis viva* is to be universally valid, then the force must be conserved even when it is not consumed, that is, when no *'effet violent'*, as Leibniz called such an effect, occurs. The body to which a living power is attributed must move with a finite velocity. This motion of a body, which does not consume its force in an *'effet violent'*, Leibniz calls an *'effet formel'*. The effect consists in the translation of a mass through a particular distance with uniform velocity. The *vis viva* is conserved (GM IV, 243, 345, 436; cf. Gueroult, 121).

The estimation of the force in an *'effet formel'* can occur in two ways. The *'effet formel'* can be converted into an *'effet violent'*, for instance, by converting a horizontal uniform motion into a vertical retarded motion, so that the familiar methods of measurement can be applied (GM VI, 220). But the estimation can also be done without consuming the force. For this Leibniz introduced a new measure: *action motrice*. This is supposed to be the product of the *'effet formel'* and the velocity.

> We want to transport 100 pounds to a distance from here; that is the formal effect which is demanded. One of us desires to do it in one hour, the other in two hours; I say that the action of the first is double that of the second, being doubly quick with an equal effect (GM VI, 221).

The *action motrice* is thus the product of mass times distance times speed: $msv = mv^2t$.[11]

In the justification of this new measure of force, Leibniz emphasizes that he assumes "always a continual and uniform motion" (GM VI, 221; GM VI, 366f.).

The following consideration forces itself upon the modern reader: in a uniform motion in which no impediments are overcome, no work is performed and no force applied. Therefore, the multiplication of 'living force' by time is senseless. For no matter how long a uniform motion lasts, it needs no application of force to continue. It seems as if Leibniz did not distinguish between cases of 'uniform motion' and such cases where work ($msa = W$) is performed and thus fell far short of the level of physics existing at the time (i.e., Newtonian physics).

4. LEIBNIZ'S LAW OF INERTIA

The criticism, that Leibniz did not distinguish between 'motion' and 'performance of work' and thus wanted to measure 'work' where no 'force' is applied, presupposes the Newtonian law of inertia, according to which force is needed only for accelerations. However, according to Leibniz's own concept of inertia, his determination of *'action motrice'* is justified and fruitful.

In his discussions of the concept of 'inertia' Leibniz never appealed to Newton. For instance, in *De ipsa natura* (1698) long after he had studied Newton's *Principia*, he argues against the geometrical concept of body held by the Cartesians, which implied indifference to rest and motion. Matter, Leibniz believed, resists being moved "by its own natural inertia (*per suam inertiam naturalem*), as Kepler has fittingly named it" (*De ipsa Natura,* §11, GP IV, 510; PPL, 503). Kepler's inertia, however, does not denote the continuance of a body in its state of motion but rather the resistance of matter to motion in general.[12]

Leibniz thus makes the following distinctions: mass (i.e., *materia*) resists motion; 'original motive force' causes motion (not just acceleration!); 'body' is the unity of mass and force.

Uniform motion is thus not a state (*status*) but an action (*actio*), not an 'essential property' of matter but the result of the action of force and the reaction of mass. Differing from Newton's conception, Leibniz distinguishes here not between 'inertial motion' and acceleration but between rest and motion as such. The so-called 'inertial motion' is likewise an activity and presupposes "that inertia also constantly resists the . . . motive force during its motion" (Letter to De Volder, March 24/April 3, 1699, GP II, 171; PPL, 517).

Leibniz introduced inertia in the context of deliberations on the conservation of force in a 'free system'. In the case dealt with there 'motion' and 'acceleration' were the same, since the body to which force was applied had been at rest. From the two resulting possibilities for determining 'inertia' Leibniz chose the resistance to motion as such not resistance merely to acceleration. He thus interpreted a uniform motion as the effect of a constant 'motive force' and an equally constant 'resistance'. Continuance in uniform motion was thus not introduced as an axiom, as it was by Newton, but as a special case of the general law of the conservation of *vis viva*, namely in the hypothetical case in which the 'free system' consists of merely one body. The force given the body is conserved as 'active force in the body' – as long as it

does not collide with another – just as the mass and thus the 'passive force' which resists motion is also conserved.[13]

If uniform motion is to be conceived as a special case of the conservation of force in a free system, and if it is to be formulated for a single body, then the body must be conceived as a system in which the action of the motive force is always equal to the reacting passive force of matter. Compare Leibniz's formulation:

> However, even in this free or formal action of the mobile itself in as much *as it is conceived as acting in itself*, we can in a sort of analogy conceive a real effect which will not be a change of place (which I consider merely as something modal) but will be that the mobile itself proceeds with the given velocity in the following moment .... And in this sense the axiom of the equality of the whole cause with the entire effect is also verified in formal or free action (*actio formalis seu libera*, i.e., uniform motion – G.F.) (Letter to De Volder, 1699, GP II, 191).

A 'genuine' action in a system of material bodies is distinguished from the uniform motion of a single body merely by the fact that in the first case (*effet violent*): "the force is consumed and exercised *upon something external*" (*quelque chose de dehors*; another body is meant, of course) (*ibid.*); whereas in uniform motion, "the effect lies *in the body in motion taken in itself*" (*Essay de Dynamique*, GM VI, 221; my italics – G.F.). This view of things receives its classical formulation in one version of the law of conservation:

> Proposition 7: The power (*potentia*) in any system of bodies not communicating with others is always the same .... Thus *if there is just one body*, it will always retain the same power; if there are many bodies colliding with each other, there will always be the same power in the sum of them all.
>
> Proposition 8: The power in the universe is always the same. For certainly the bodies of the universe cannot communicate with other bodies, which are not contained in the universe. Therefore the *universe is a system of bodies* not communicating with others and hence (by the preceding proposition) always has the same power (*Dynamica*, Part II, GM VI, 440; my italics – G.F.).

For a single body, for a system of bodies, finally, for the universe as a whole, the same law holds since all three are conceived as systems. The subject of propositions in physics is thus the system and not, as with Newton, its supposed ultimate element, a material atom. Not just the subject but also the content of Leibniz's proposition differs from that of Newton's. The motion of each and every element can be determined relative to others. Since, however, the system as a whole is material and every element in principle is movable, no frame of reference must be presupposed as being at rest, relative

to which the motion could be determined as absolute. Every motion considered as such is thus merely relative.

For every subsystem conservation laws can be determined – the conservation of relative velocity before and after a collision, the conservation of the quantity of motion in a particular direction – but they are always relative conservation laws, which are inconsequential for the system of the world as a whole. For this world system, only one conservation law obtains, and it is absolute: the conservation of *vis viva*.

With the demonstration that the '*action motrice*' (*msv*) is conserved in a free system, Leibniz wanted to provide a further proof for the conservation of 'living force' (mv^2). The proof, however, itself presupposes that 'force' is to be measured by the distance (*ms*) not by the velocity (*mv*). Basically, writes Leibniz, 'action' is nothing other than the product of 'force' and time. And since it has already been proved that the *vis viva* is conserved, it follows that the product of this force and the time, mv^2t must also be conserved (cf. *Essay de Dynamique*, GM VI, 222).

The concept of '*action motrice*' is thus of no significance as a measure of force. The basic idea of introducing a measure of force for distance is nonetheless significant, for it takes the first step towards a concept of 'work' (*msa*). It is however characteristic that Leibniz is not interested in the measure of an 'additional force' producing acceleration along the distance. It was important to him to demonstrate the conservation of force in a free system. The reasons for this will become clear in his discussion with Newton.[14]

5. ABSOLUTE MOTION AND ABSOLUTE SPACE

The concept of '*action motrice*' and Leibniz's conception of inertia are both particular conclusions from the fundamental law of the conservation of *vis viva* in a free system. A system of moving bodies can be considered kinematically or dynamically. In kinematics only changes of position of bodies are of interest, and these are completely relative. Dynamics deals with the forces which cause these motions.

Here Leibniz distinguishes 'respective' (relative) and 'directive' forces: the former are the causes of the motions of the elements in a system, the latter are the algebraic sums of the former, by which systems as wholes can act upon one another (*Spec. Dyn.*, GM VI, 238f.; PPL, 439f.). Whether a merely respective or a directive force is attributed to a body depends only upon whether it is considered as an element or as a system. Every body can be taken as a system of particles; the algebraic sum of its respective forces would

give the directive force of the system. If the body is considered as an element of a system of bodies, its directive force is a respective force with regard to the system, etc.

Rotational motion, however, presents a problem. For here Newton was able to prove that, taken dynamically, the motion must be attributed to that body on which centrifugal forces appear. In his correspondance with Huygens Leibniz asserted that in spite of rotational motion "nothing transgresses the universal law of equivalence (of hypotheses – G.F.)".[15]

Twenty years later when Clarke cited rotational motion against Leibniz as a proof for the existence of absolute space (Clarke's 4th Reply, §13), Leibniz responded that he recognized a difference between the "absolute true motion" of a body and a "mere relative change in its situation with respect to another body"; but he insisted that neither in Definition 8 of the *Principia* nor in the Scholium could he find anything "that proves, or can prove, the reality of space in itself" (Leibniz's 5th Paper, §53).

Leibniz's response is thus directed against the second conclusion in Newton's argument for the existence of absolute space. Although we may conclude that there is absolute motion from the appearance of centrifugal forces, we cannot from this show the existence of absolute space. The reason is that the determination of which body moves absolutely presupposes that motion occurs. But every motion consists in a change of position of bodies: while motion is not dependent upon being observed, it is dependent on observability. To say that a body moves absolutely, means nothing more than that only one of the kinematically possible descriptions is also suitable for a dynamical explanation. In the system in question certain bodies move absolutely but all bodies move relative to one another. None of the motions needs to be referred to absolute space.[16]

In his reply Clarke counters that he did not see how from this point of view one could avoid the "absurd consequence", that

> the *mobility of one body* depends on the *existence* of other bodies; and that any *single body* existing *alone*, would be *incapable of motion*; or that the parts of a *circulating* body (suppose the sun,) would lose the *vis centrifuga* arising from their circular motion, if all extrinsic matter around them were annihilated (Clarke's 5th Reply, § § 26–32).

Leibniz did not live to respond to this letter. However, from the views he had already developed, an answer can easily be found without having to develop a relativistic dynamics. If the parts of the revolving sun remove themselves from the center, their motions are observed not with reference to space but relative to each other. This is not a single body but a system, in which the

the relative change of position of the elements can be observed. If, however, the only 'rotating body' is a material point, then neither can 'rotational motion' be observed nor can centrifugal forces be demonstrated, since no parts remove themselves from the center. In both hypothetical cases, therefore, a motion relative to 'absolute space' cannot be proven.[17]

Newton's proof for the existence of absolute space consisted of two arguments. First of all he proved absolute space from absolute motion – this proof Leibniz rightly rejected – but secondly Newton believed he had proved the existence of a vacuum. The differences in the specific gravity of various materials was traced back to differences in their 'density', that is, to the relation of full and empty units of volume in a body. We shall next examine, whether Leibniz accepted this proof or, as the case may be, how he defined the concept of density.

6. DENSITY

The resistance which a body offers to a motive force determines the magnitude of its mass. Equal volumes of different materials provide resistance of different magnitudes and thus have different quantities of mass. The relation of mass to volume is defined as 'density':

> Density (or the intensity of matter) is that, the quantities of which are proportional to the quantities of matter (. . .) contained in equal volumes (in heavy bodies it is called specific gravity).[18]

For every body the density of matter results from its mass – or experimentally more simple: its weight – divided by its volume: density = m/V. 'Density' is a physical measure and denotes a relation of quantities. The units of measurement are arbitrary. Since a constant magnitude or quantity is determined by comparison with the standard of measure, which must be empirically given, an object which is as far as possible unchanging must be chosen as a standard of measurement.[19]

Since 'density' is a concept denoting a relation of two empirical magnitudes, any definition of the concept which contains non-empirical magnitudes is improper. One such definition is Newton's implicit definition of density, upon which his definition of the 'quantity of matter' is based. It has been shown above that Newton implicitly takes 'density' to be the number of equal particles per unit of volume. Leibniz on the contrary sticks to an empirical definition of measure, which is not dependent on a particular philosophy of nature. Therefore, after his definition Leibniz says that he does

not assert "with philosophical rigor that the same quantity of matter can occupy a greater or lesser volume", he even believes the opposite to be the case (GM VI, 297). These considerations can be dispensed with here, and for Leibniz there is no necessity of assuming an empty space (between particles).

On the other hand, Leibniz had reason to deny the existence of absolutely dense and inelastic particles of matter. The reason can be found in the law of conservation of 'force' or rather in its consequences with regard to the laws of impact. (This problem is taken up in the next section.)

7. LAWS OF IMPACT, ELASTICITY, AND THE CONCEPT OF A MATERIAL BODY

Leibniz developed his laws of impact within a critique of the Cartesian laws. Descartes' first impact law states that if bodies A and B of equal 'size' with the same speed but opposite directions (actually: determinations)[20] collide, they both recoil and move with the same original speeds in the opposite direction (*Princ. Phil.* II, 46).

The second law states that if body A is somewhat larger than B and all other conditions remain the same, body B will recoil and both A and B will move with equal speeds in the same direction (*Princ. Phil.* II, 47).

Leibniz's criticism of the laws of impact of Descartes is based on two principles: the principle of continuity and the principle of the equivalence of cause and effect.[21]

"*Datis ordinatis etiam quaesita sunt ordinata*" – if the given (quantities) are ordered, then the quantities sought after are also (proportionally) ordered. From this it follows:

> if two instances (or data) approach each other continuously, so that one at last passes over into the other, it is necessary for their consequences or results (or what is sought) to do so also (*Principe générale*, GP III, 52; PPL, 351; cf. *Principium Generale*, GM VI, 129).

If the 'data' of the first two laws of impact of Descartes are continuously approximated to one another and finally equated, then a discrepancy occurs in the effects asserted by Descartes. Thus the principle of the equivalence of cause and effect would be transgressed.

For, as Leibniz put it, let the difference between A and B be infinitely small. The difference in the effects must likewise be infinitely small. If both laws of impact of Descartes were correct, then an infinitely small increment in the size of A "will make the greatest difference in the effects, in that it

will change an absolute regression into an absolute continuation of motion. And this is an enormous leap from one extreme to another" (*Principe général*, GP III, 53; PPL, 352; cf. GM VI, 131). One can see that Leibniz, unlike Descartes, does not separate motion from direction. In the refutation of the Cartesian laws of impact, the 'general law of nature' concerning the equivalence of cause and effect is confirmed. Leibniz had so far applied this principle only in the special case in which a freely falling, uniformly accelerated body represents the 'whole cause' and the raising of another body represents the 'entire effect'. Leibniz formulates his own laws of impact on the basis of this principle. These laws of impact, however, are contrary to 'experience', and it seems as if Leibniz has fallen into the rationalist error of deriving laws of nature from a theoretical 'principle' without concern for empirical experience. This problem must be examined more closely.

Leibniz formulates three laws of impact (*Essay de Dynamique*, GM VI, 226f.). Let a and b be the masses of two bodies; let v be the velocity of a before impact, x after impact; y the velocity of b before, z after impact; v is positive.

Conservation of relative velocity before and after elastic impact:

I. $v - y = z - x$

Conservation of the 'quantity of motion' in every impact:

II. $av + by = ax + bz$

Conservation of *vis viva* in every impact:

III. $avv + byy = axx + bzz$

The precondition for the conservation of *vis viva* in colliding bodies – and thus for the conservation of *vis viva* in the system of the world – is the perfect elasticity of bodies (*Et nisi Elasticum esset omne corpus, leges motuum verae et debitae obtineri non possent. 'Beilage'* May 1702, GM VI, 103).

It is just this general elasticity of the bodies of the world that Malebranche (against whom Leibniz is arguing here) denied; and Leibniz, like everyone else, knew quite well that the perfect elasticity of bodies cannot be proved empirically; on the contrary, it can seemingly be refuted without much trouble. Thus, after Leibniz's refutation of the Cartesian law of universal conservation of the quantity of motion (mv), it could seem as if there were no force-quantity which is conserved in the world.[22] If this view were to be accepted, then one would either have to refrain from setting up equations – dynamics would have lost its foundations –, or to admit supernatural

intervention to compensate for the respective losses of *vis viva*. With the latter solution, dynamics would be possible, but science would have to rely on a suparnatural presupposition. Leibniz, on the contrary, insisted on the 'principle of general order'. The 'sovereign wisdom' proceeds like a perfect geometrician and according to a perfect harmony (*Principe général*, GP III, 52): Even if the laws of motion are dependent on the *will* of God as Malebranche (following Descartes) believed, "nonetheless this same divine will observes a kind of order and reason in every thing it does, so that they all harmonize with each other" (*Principium Generale*, GM VI, 133).

The presupposition for the conservation of *vis viva* in the universe is thus that all bodies are perfectly elastic. From this the requirements for a concept of material body are derived. First of all, it was shown that the laws of impact contradict the determination of material bodies as indifferent to rest and motion (which Descartes assumes). A resistance to motion must be attributed to matter which guarantees that no resting body can be moved without proportionally reducing the force of the body that moves it. Now, it is possible to retain the Cartesian concept of body and to resolve the contradiction by assuming that bodies do not act upon one another, but that God moves them according to certain laws that are independent of the properties of bodies. This solution is quite possible, but it means that one starts from one unsubstantiated hypothesis (the concept of body) and reconciles it with experience by means of a second unsubstantiated hypothesis (intervention of God).[23]

For the same methodological reasons, the atomistic theory is also to be rejected. The assumption that bodies are composed of indivisible, inelastic particles of matter (elasticity being understood as compression and regaining of the original shape) is incompatible with the conservation of *vis viva*. On the contrary, two atoms of equal mass and velocity with opposed directions of motion must come to rest at collision, that is, lose their force, "since it would seem that it is only elasticity which makes bodies rebound".[24]

If material bodies were compounded of indivisible, i.e., inelastic atoms, then the amount of force in the universe must continually decrease (this was Newton's view, cf. *Opticks*, 398). To justify the law of conservation of force a further hypothesis would have to be introduced. Here, as before in the critique of the Cartesian concept of material body, the point is to derive the attributes of material bodies from scientific knowledge, not to patch up already proposed, deficient hypotheses with supplementary hypotheses.

It is thus necessary to prove that the conservation of *vis viva* holds even if bodies which are not perfectly elastic collide. Leibniz's explanation is based

on the conception of elasticity which he developed in criticism of Huygens. If elasticity is conceived as perfect hardness, then the changes of direction and velocity of two elastic bodies must be instantaneous, without going through all degrees of positive and negative acceleration. But this contradicts the law of continuity, which allows no saltatory changes in nature.

If, however, 'ultimate particles' of matter must be taken as inelastic – since elasticity can only be taken as the result of the internal motion of the particles in a body – then the concept of an 'ultimate particle' must be discarded, all particles must be taken as actually divided, and matter must be taken as divided *in infinitum*. In this manner the conservation of *vis viva* in the impact of inelastic bodies can be explained.[25]

In a collision the force imparted to a body is transferred to the particles and as a consequence of their motion the body as a whole is moved. This applies to elastic collisions:

> One will always find that if bodies should convert their horizontal motion into motion of ascent, they would always raise, in total, the same weight to the same height before or after impact, *assuming that nothing of the force is absorbed during the impact by the parts of the bodies* (*Essay de Dynamique*, GM VI, 220; my italics – G.F.).

Thus in every seeming loss of force during impact, an acceleration of the particles must be inferred. That this acceleration is not transferred to the motion of the body as a whole is due to the fact "that the parts are not sufficiently united to transfer their change to the whole. Whence it comes that during impact of some bodies a part of the force is absorbed by the little parts which compose the mass without the force's being transferred to the whole" (*Essay de Dynamique*, GM VI, 230).

The force absorbed by the 'little parts', "is not lost absolutely for the universe although it is lost for the total force of the colliding bodies" (*ibid.*; cf. also the 5th Letter to Clarke, §99).

Thus both the *grand and beautiful* laws of nature can be reconciled with empirical experience: the law of conservation of absolute force and the law of continuity (*ibid.*, 228f.). The basic law of Leibniz's dynamics, the conservation of *vis viva*, holds even though it seems to be transgressed in the impact of inelastic bodies. However, it also does not refer to single particles as ultimate building blocks of a body; it is valid only on the condition that every particle is in turn conceived as a whole system, which is internally structured.[26]

CHAPTER III

THE DISCUSSION BETWEEN LEIBNIZ AND NEWTON ON THE CONCEPT OF SCIENCE

Our investigation of Newton's dynamics has shown that his proof of the existence of absolute space rested on the presupposition that the system of the world consists of equal particles whose essential properties belong to them independently of the existence of the world-system. Our investigation of Leibniz's dynamics has shown that Leibniz did not share Newton's presupposition and that his dynamics does not need the concept of absolute space. Both investigations dealt with an area which is now called 'physics'. Newton's *Principia* also contains deliberations on the relationship between God and absolute space. These remarks have ever since their publication been the subject of much interest, which, however, has been directed at Newton the 'metaphysician' and not the 'physicist'. In this chapter we shall see that a physical problem lies at the bottom of this metaphysics, although Newton's metaphysics of space does not necessarily follow from his physics. From the connection between Newton's method in physics discussed above and his 'metaphysical' deliberations a concept of 'science' arises which takes on central importance in the discussion with Leibniz. First of all, however, we should examine Newton's reasons for believing that deliberations on God belong in a work on physics.

1. NEWTON'S MEASURE OF FORCE AND GOD'S INTERVENTION

Newton attempted to refute the measure of force (mv^2) which Leibniz had developed in the *Brevis Demonstratio* by indicating that Leibniz had not considered the different *times* of fall of the bodies. In a free fall, Newton argued, the 'impulsive forces' imparted to a body are proportional to its velocity, and since in a free fall acceleration is for practical purposes constant, then the 'impulsive force' applied to the body is proportional to the *time* of fall. However, since the time of fall is itself proportional to the square root of the height of fall, it follows that the impulsive force of a freely falling body of mass 1, which falls from the height 16 (not 4!), is equal to that of a body of mass 4, which falls from the height 1:

$$\text{impulsive force} = (1m) \cdot \sqrt{16} = (4m) \cdot \sqrt{1}.^{1}$$

In this critique, Newton abstracts from Leibniz's argument on the conservation of 'force' in a free system and concentrates on the measure of 'impulsive force' applied to a single body in a moment of time. This view of things is no accident. For Newton does not exert himself to demonstrate the conservation of 'force' in the system of the world; on the contrary, he believes that in every system 'force' (quantity of motion) can increase or decrease, and that in the system of the world as a whole it is more likely to be decreasing. This conclusion follows from Newton's belief that material bodies, like the particles that compose them, are not perfectly elastic. For,

> by reason of the Tenacity of Fluids, and the Attrition of their Parts, and the Weakness of Elasticity in Solids, Motion is much more apt to be lost than got, and is always upon the Decay (*Opticks*, Qu. 31, 398).

Here, too, the different ways of proceeding of Newton and Leibniz can be seen. Newton starts from an assumption about the nature of the elements and derives the result for the system of the world. Leibniz starts with an assumption about the system and derives from it the nature of the elements of the system.[2]

The supposed decrease in the quantity of motion in the universe apparently did not disturb Newton. Nowhere does he attempt to replace the arguments of Leibniz that he criticized, with others that would avoid this consequence. The question, why the assumption that the quantity of motion decreases seemed unproblematical to Newton, can perhaps be answered by the consequences which he drew from it.

Two possibilities result from the view that the quantity of motion decreases. The most obvious conclusion is that the world system would in time lose so much of its quantity of motion that the planets would fall into the sun. This consequence holds for Leibniz's measure of force, too. For, although the same amount of *vis viva* is preserved, the quantity of motion of bodies can nonetheless decrease. Leibniz drew this conclusion. One must assume, he wrote, "that there might come a time when this lovely star with its entire system will no longer exist, at least not in its present form" (N.E., Preface; GP V, 43).

Newton did not draw the same conclusion as Leibniz. Rather, he assumed that the solar system would be preserved and that the lost motion would be replaced. This feat Newton attributed to God or some 'active principles'. In the Latin edition of the *Opticks* (1706), which Leibniz read, he writes:

> Seeing therefore the variety of motion which we find in the world is always decreasing,

there is a necessity of conserving and recruiting it by active principles . . . . For we meet with very little motion in the world, besides what is owing either to these active principles or to the dictates of a will.[3]

Newton repeats the procedure of Malebranche that Leibniz had criticized: an unfounded hypothesis (material bodies are composed of inelastic particles) is asserted and then the consequences are avoided by a second hypothesis. Neither for Newton's first hypothesis nor for Leibniz's (all particles of matter are elastic, i.e., internally structured *ad infinitum*) was sufficient empirical evidence available. However, Newton's second hypothesis not only goes beyond the given state of knowledge but also oversteps the bounds of what is in principle knowable. To explain the conservation of the system, Newton appeals to a force which by definition is supernatural and thus cannot be the object of natural science. Newton's assurance, that while composing the *Principia* he directed his attention to such principles as could support the belief in God, is surely more than an *ex post* interpretation.[4]

Newton's assumption, that God can intervene in the world system and effect phenomena which contradict the known lawfulness of nature, must be distinguished from his assumption that the world system is composed of equal particles whose essential qualities are also attributable to a single particle in empty space: the latter was a presupposition of Newton's approach and affected his concept formation. Upon this assumption depend not only the proof of the existence of absolute space but also the explanation of density, the definition of 'quantity of matter', and the inference that the amount of 'force' in the universe must be decreasing. Moreover, Newton was in no way conscious of this presupposition; rather he considered it identical with the analytic-synthetic method.

Newton is quite conscious of the second assumption. In fact, God's arbitrary intervention in the world is not a presupposition of his research (God's intervention is arbitrary since no laws can be stated as to how often he intervenes to supply new 'force' to the world system). Every phenomenon that is made dependent on God's arbitrary will must *eo ipso* be excluded from the field of investigation of science. However, Newton restricts God's intervention in the world to bridging the gap between his own scientific results and the assumption that the planetary system will eternally retain its present form. The assumption has no influence on his formation of concepts. It is simply grafted on to the completed scientific system. The next section will show that there is nonetheless a connection between the two assumptions.

2. NEWTON'S CONCEPT OF GRAVITY; SPACE AS THE *SENSORIUM DEI*

Newton's proof for the existence of 'absolute space' depends on his first presupposition concerning the essential properties of a particle. Absolute space is denoted by Newton as the *Sensorium Dei* (literally: God's organ of perception). This characterization forms the basis for the explanation of God's intervention in the material world. It thus forms the basis for Newton's assumption that God replaces the force that the world system loses.[5]

It is significant that Newton also includes remarks on the relationship between God and space in the *Scholium Generale* to the *Principia* – that is, in the same place where he also declares that he "feigns no hypotheses". In the *Scholium Generale* Newton wanted to guard against the accusation that he introduced occult qualities to explain gravitation or that he considered God to be the 'soul of the world'. Newton denies the allegation and explains that he does not know what the cause of gravity is, and he *feigns* no hypotheses. However, he adds extensive remarks about God, which he doubtlessly knew would occasion those long discussions which he loathed.

These remarks as well as Newton's characterization of space as God's organ of perception are due to the difficulty of explaining how gravity works.

(a) *Mechanical Explanations of Gravity*

The discovery, that the orbits of the planets could be derived using the law of gravity, leaves the question of the physical cause of 'attraction' open. An action at a distance, that is, a real attraction of material bodies across empty space would imply an action which occurs at a place where the thing acting is not present. Such an action is not accepted by Newton.[6]

Even in his early studies, Newton had left the way gravity works undetermined:

> *Centripetal force* is a certain action or power by which a body is impelled or drawn or in any way tends towards a certain point as if to a centre: of this ilk is the gravity by which a body tends to the centre of the earth, the magnetic force by which iron seeks the centre of a magnet, and that force, whatsoever it may be, by which the Planets are held in their orbits and perpetually restrained from flying off at a tangent (*'De Motu Corporum'*, in: Herivel, 315–317, Definition 5, 316).

In line with these remarks, Newton used two models to reduce circular motion to centrifugal motion and an opposing push: on the one hand, a ball moving

along the inside surface of a cylinder, and on the other, a body that revolves around a middle point to which it is tied.[7]

The model of the ball which circles in the cylinder implies that the ball pushes against the surface of the cylinder and in turn is pushed back. The circular motion would thus be the result of two forces: a centrifugal force in the direction of the tangent and a push in the direction of the center of the circle. The push is nothing but the reaction to the ball, which pushes against the inner surface of the cylinder. In this sense, no 'active force' in addition to inertia would be needed.

The gravitation of the planets towards the sun cannot be the reaction to the planets' pushing against a sphere (for the planets do not revolve in crystalline shells). Moreover, the same gravitation acts not only on revolving but also on falling bodies. In his first studies Newton had had in mind a "matter which caused gravitation", which – since it penetrated bodies and pushed against their particles – caused the fall of bodies independent of their surface areas. In subsequent years he often modified the explanation but always had to acknowledge that none of his explanations satisfied the requirements.[8]

In the *Principia* Newton applies the law of gravity, according to which bodies attract one another in proportion to their masses and inversely proportional to the square of their distances from each other, without specifying how gravity acts. The short and convenient formulation, "the bodies mutually attract each other", can scarcely be avoided even if nothing is supposed to be said about the cause.

To forestall an initially plausible but over-hasty interpretation, Newton remarks in connection with the formulation of the law, that he uses the word 'attraction' for the striving of bodies to move towards each other, whatever may be the reason for the process.[9]

(b) *The Harmony of the World; God or the Sun as the Cause of Gravity*

Shortly after Fatio de Duillier had begun to prepare the second edition of the *Principia*, he wrote to Huygens that Newton believed the Ancients had known the law of gravity (Letter of Feb. 5, 1691/92, *Corresp.* III, 193f.); and in July of 1694 David Gregory could report that most of the changes in the second edition would provide proof that the most ancient philosophers had taught the Copernican world view and universal gravitation (Memorandum by David Gregory, July, 1694, *Corresp.* III, 384–386; here: 384).

In these explanations, which in the end were not published but only hinted at in a footnote to the *Scholium Generale*, Newton maintained that

Pythagoras had discovered the inverse proportion to the square of the distance in the harmony of two strings, whose tensions are inversely proportional to the squares of their lengths. Newton saw in this an intimation of the law of gravity.[10] Although the inverse proportion to the square of the distance is thus expressed as a comprehensive, harmonious law of the world, nothing is said about the way it acts. Newton maintains steadfastly that "plump inanimate matter" cannot bring forth action and that its laws are passive. "And to affirm that there are no others (laws) is to speak against experience. For we find in ourselves a power of moving our bodies by our thought. Life and will are active principles by which we move our bodies and thence arise other laws of motion unknown to us."[11]

Already in the early work, *De Gravitatione* (1664–1668), Newton had declared: "If that (the way we move our own bodies) were known to us, by like reasoning we should also know how God can move bodies" (Hall and Hall, 107, 141). He repeats this same opinion in all his writings. An explanation must be sought for both phenomena at the same time: for the movement of the body by the will and for gravitation.

> Thales regarded all bodies as animate, deducing that from magnetic and electrical attractions. And by the same argument he ought to have referred the attraction of gravity to the soul of matter .... And to the mystical philosophers, Pan was the supreme divinity inspiring this world with harmonic ratio like a musical instrument and handling it with modulation, according to that saying of Orpheus 'striking the harmony of the world in playful song' .... But they said that the Planets move in their circuits by force of their own souls, that is, by force of the gravity which takes its origin from the action of the soul (McGuire/Rattansi, 119).

Of the two possibilities – referring gravity to the 'soul of matter' or attributing it to the action of God – Newton must choose the second explanation. For matter, as he often emphasizes, is "inanimate and plump". It remains to be explained how God moves matter. A first hint at a solution is offered by the insight of the Ancients, who called the sun "King of the seven sounding harmony"; "by this symbol they indicated that the Sun by its own force acts upon the planets in that harmonic ratio of distances" (McGuire/Rattansi, 116). They expressed this by "calling the Sun the prison of Jupiter, because he keeps the Planets in their Orbs" (*ibid.*, 118).

Since it is definite that an activity without substantial presence is impossible, the sun – if it is to be the cause of gravity – must also be present substantially in all bodies: in the form of light particles. This seems all the more plausible since the attraction that these particles exercise is immeasurably greater in relation to their volume than the gravitation of bodies at the

earth's surface. "And so great a force in the rays cannot but have a very great effect upon the particles of matter with which they are compounded, for causing them to attract one another." [12]

(c) *Leibniz's Critique*

For more than fifty years Newton tried to find a physical explanation for the way gravity acts; every attempt failed. In the *Principia* he spoke of the mutual attraction of bodies but declared at the same time that he did not mean a real action at a distance. This declaration did not protect him against attacks.

In the *Theodicy* Leibniz mentions the "excellent Mr. Newton" who had rehabilitated the "direct action at a distance" – which modern philosophers had discarded – and brought this view into connection with that of the "evangelists", who believed in an actual transsubstantiation, "it being not a great step from the immediate operation to the presence (of one body in another – G.F.), and perhaps the one depends on the other" (§19). A year later Leibniz wrote to Hartsoeker that the assertion that gravity is a primitive quality or that it is brought forth by God without any intelligible means can be reduced to the consideration of gravity as an occult quality (Feb. 10, 1711, GP III, 519).

Cotes pointed out Leibniz's letter to Newton (it had in the meantime been published) and suggested that he respond to Leibniz's objections – without of course naming any names (Cotes to Newton, March 18, 1713, *Corresp.* V, 391–393).

Cotes himself replied at length in his preface to the second edition of the *Principia*, and Newton contributed the *Scholium Generale*. Here he wrote the sentence that was later understood as program: "But hitherto I have not been able to discover the cause of those properties of gravity from phenomena, and I frame no hypotheses."

He continued:

> for whatever is not deduced from the phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy (*Princ.*, 764; Cajori, 547).

This is of course not a prohibition of 'hypotheses' – that is, as long as they are 'deduced' from the phenomena. In the text of the *Scholium Generale* Newton begins with a phenomenon, namely the wonderful order of the cosmos, and 'deduces' that it could only have been brought forth by God (*Princ.*, 762–763; Cajori, 546). He closes the paragraph with the remark:

"And thus much concerning God; to discourse of whom from the appearances of things, does certainly belong to Natural Philosophy"[13] (*ibid.*). A metaphysical hypothesis can thus be derived from the phenomena just as can a mechanical one.

(d) *Space: the* Sensorium Dei

Having described the order of the cosmos, Newton concludes:

> This most beautiful system of the sun, planets, and comets, could only proceed from the counsel and dominion of an intelligent and powerful Being . . . . This Being governs all things, not as the soul of the world, but as Lord over all; . . . and *Deity* is the dominion of God not over his own body, [as those imagine who fancy God to be the soul of the world,] but over servants (*Princ.*, 760; Cajori, 544. The words in brackets added to the 3rd edition).

There follows a discussion of God's relationship to space:

> God is "eternal and infinite, omnipotent and omniscient; that is, his duration reaches from eternity to eternity; his presence from infinity to infinity; he governs all things, and knows all things that are or can be done. He is not eternity and infinity, but eternal and infinite; he is not duration or space, but he endures and is present. He endures forever, and is everywhere present; and by existing always and everywhere, he constitutes duration and space . . . . He is omnipresent not *virtually* only, but also *substantially*; for activity (*virtus*) cannot subsist without substance. In him [here a footnote with numerous citations, mainly from the Bible and Greek philosophers – G.F.] are all things contained and moved; yet neither affects the other: God suffers nothing from the motion of bodies; bodies find no resistance from the omnipresence of God. It is allowed by all that the Supreme God exists necessarily; and by the same necessity he exists *always* and *everywhere*. Whence also he is all similar, all eye, all ear, all brain, all arm, all power to perceive, to understand, and to act; but in a manner not at all human, in a manner not at all corporeal, in a manner utterly unknown to us" (*Princ.*, 761–762; Cajori, 545).

God's omnipresence means that all material bodies are 'in him'; this as well as other properties (eternity, infinity, etc.) is attributable to the same extent to God and to space. As a result it is possible to denote space as divine (whether as a property, attribute, or emanation of the divinity). Here Newton believes he can appeal to the authority of tradition and relates a number of times that one of the Hebrew names for God (*Makom*) means 'place'.[14]

In these remarks Newton stresses that God is omnipresent and that the material world is contained in him. To explain gravity, he then relates that the divinity is its cause although God does not move the world as its soul. These considerations lead to the hypothesis that space is God's sensorium.

How do the Motions of the Body follow from the Will, and whence is the Instinct in Animals? Is not the Sensory of Animals that place to which the sensitive Substance is present, and into which the sensible Species of Things are carried through the Nerves and Brain, that there they may be perceived by their immediate presence to that Substance? And these things being rightly dispatch'd, does it not appear from Phaenomena that there is a Being incorporeal, living, intelligent, omnipresent, who in infinite Space, as it were in his Sensory, sees the things themselves intimately, and throughly perceives them, and comprehends them wholly by their immediate presence to himself: Of which things the Images only carried through the Organs of Sense into our little Sensoriums, are there seen and beheld by that which in us perceives and thinks (*Opticks*, Qu. 28, 370).

In a subsequent passage Newton describes first the wonderful harmony of the universe, especially of the animal organism, and concludes:

All that can be the effect of nothing else than the Wisdom and Skill of a powerful ever-living Agent, who being in all Places, is more able by his Will to move the Bodies within his boundless uniform Sensorium, and thereby to form and reform the Parts of the Universe, than we are by our Will to move the Parts of our own Bodies. And yet we are not to consider the World as the Body of God, or the several Parts thereof, as the Parts of God. He is an uniform Being, void of Organs, Members or Parts, and they are his Creatures subordinate to him, and subservient to his Will; and he is no more the Soul of them, than the Soul of Man is the Soul of the Species of Things carried through the Organs of Sense into the place of its Sensation, where it perceives them by means of its immediate Presence, without the Intervention of any third thing. The Organs of Sense are not for enabling the Soul to perceive the Species of Things in its Sensorium, but only for conveying them thither; and God has no need of such Organs, he being every where present to the Things themselves (*Opticks*, Qu. 31, 403).

Material bodies thus stand in the same relation to God as do their Species to the human sensorium. The sensorium of humans is indeed conceived by Newton as extended. In his theory of the composition of species out of the perceptions of both eyes, he speaks of the different sides of the sensorium (Qu. 15, 346f.) and calls it, "the place of Sensation" in the brain (403). With this he subscribes to a widespread notion.[15]

If material bodies in space are considered analogous to species in the human sensorium, then the difficulty of explaining gravitation is inconsequential. For species do not act upon each other like material bodies, but rather are moved by thought or the will. It makes no difference whether species move towards one another or away from each other; in the sensorium one can just as easily imagine a mutual approaching ('gravitation') as a separation (as a consequence of 'impact').

Newton's hypothesis is the attempt to solve the problem of gravitation – in general the action of something immaterial on material bodies – by

dissolving the materiality of bodies. The difficulty of explaining action at a distance is solved by denying all mutual action of bodies whatsoever, as if we were in truth dealing merely with the motion in God's sensorium of species which obey certain mathematical laws.

A subsequent solution pushes the negation of the materiality of the world even farther. In the second edition of *An Essay Concerning Human Understanding* (Bk. IV, Ch. X, §18) Newton's friend Locke wrote, that "if we would emancipate ourselves from vulgar notions, . . . we might be able to aim at some dim and seeming conception how *matter* might at first be made, and begin to exist, by the power of that eternal first Being".

Pierre Coste, the French translator of Locke's *Essay* and of Newton's *Opticks*, asked Newton in a conversation long after Locke's death about the meaning of this statement. Newton replied that it was he himself who had thought up this theory.

> And this is how he explained his thought: We may (he said) form some kind of idea of the creation of matter by supposing that God by his power prevented anything from entering a certain portion of pure space, which of its nature is penetrable, eternal, necessary, infinite; for so long, this portion of space would have impenetrability, one of the qualities essential to matter; and since pure space is absolutely uniform, one has only to suppose that God communicated this kind of impenetrability to another similar portion of space and this would give us some sort of idea of the mobility of matter, another quality which is also very essential to it (The French text is quoted by Koyré, *Studies*, 92 fn.; cf. also Fraser's note to Locke's *Essay*, Vol. II, 321–322).

If material bodies are in reality only parts of space to which God has imparted impenetrability, the question about the way gravity acts can be dispensed with. What appears as gravitation is like every other motion of material bodies nothing but the transfer of impenetrability from one part of space to another.

This latter hypothesis was by no means held by Newton only in his old Age. Already in his youthful work, *De Gravitatione* (composed between 1664 and 1668), he had written that all appearances of the material world would remain unchanged, even if they were nothing but empty space in which God had imparted impenetrability to the respective parts. This property of impenetrability can, however, be transferred from one part of space to another. Since we judge the reality of a substance only by sense perception, these 'bodies' would be no less real than if they were conceived in the usual manner (*De Gravitatione*, Hall and Hall, 106f.).

Both of these hypotheses, with which Newton sought to eliminate the problem of gravitation, failed to satisfy him. This can be seen from his persistent attempts to find a mechanical explanation for gravity as well as from

his admission in the *Scholium Generale* that he did not know what the cause of gravity is. It is important, though, that he was willing to suggest an explanation of gravitation that made it dependent upon God. According to these hypotheses even the laws of motion depend on God's will to move the bodies according to those laws. In this dependence of physical laws on the will of God lies the basis for Newton's belief, mentioned earlier, that God replaces the amount of 'force' lost in the universe.

As soon as it is admitted that all motion in the world is persistently dependent on God's will, there is nothing to prevent him from occasionally moving a body quicker in order to preserve the system of the world. The common basis of Newton's hypothesis concerning the cause of gravitation and that concerning the conservation of 'force' in the system of the world consists in his readiness to use God's intervention to solve open problems in physics.

Newton's theory of space and matter thus occasions two fundamental problems. First, the origin of the presupposition that essential properties belong to an element independently of its system must be analyzed: Newton's physical proof of the existence of absolute space rests on this assumption. Secondly, it must be asked why Newton abandons the positions reached by his predecessors and is ready to admit an intervention by God (or active principles) contrary to the laws of motion. On this assumption rest the above mentioned hypotheses on the way gravity acts as well as Newton's view that God could replace the lost amount of force.

It must, however, first be asked whether these presuppositions were the subject of the discussion between Newton and Leibniz. A good deal of the material cited above was first published in the second half of our century and thus could not have been known to Leibniz. A first glance at the discussion will however show that these problems were indeed central to the discussion and constitute its so-called 'theological' aspect; furthermore, that both problems are intimately connected.

3. LEIBNIZ'S CRITIQUE OF THE UNSCIENTIFIC CHARACTER OF NEWTON'S PHILOSOPHY

Newton's hypothesis to explain the conservation of the 'quantity of motion' in the world allowed two possibilities: the task of replacing the quantity of motion lost could be assigned to God – an immaterial principle – or to 'active principles'. Such principles are not mentioned in Newton's catalogue of the properties of all bodies; they also cannot be introduced formally since

nothing can with certainty be concluded as to their existence or manner of action. Qualities which are introduced ' *ad hoc*' to 'explain' an unexplained phenomenon were traditionally called 'occult'.

Leibniz saw that Newton attributed the replacement of the quantity of motion to God, but he suspected that Newton also appealed to 'occult qualities' to explain gravitation. On the basis of the mechanics of the time, the problem of gravitation, which appears as 'action at a distance', could be resolved in three ways:

(1) by a mechanical explanation, that is, by the impact of particles of a medium between the planets,

(2) by the interpretation of gravitation as a 'real action at a distance' carried out by an immaterial principle,

(3) by suspending the problem as insoluable for the time being.

I have already shown that Newton supported all three solutions: his ether hypotheses present a series of attempts to explain gravity mechanically; his determination of space as God's sensorium and his appeal to the Pythagorean tradition were intended to interpret gravitation as the action of God; finally, Newton's famous declaration, "*hypotheses non fingo*", suspended the problem.

For an interpretation of the Leibniz-Newton discussion it is irrelevant whether Newton preferred one of these solutions to the others and which solution it was. It is of interest, on the one hand, that the positions which Leibniz and Newton took up in their supposedly metaphysical-theological discussions concern the scientific, philosophical question: what kind of hypotheses are in principle admissable; and on the other hand, that Newton's position is connected with his assumption that phenomena are to be explained by the essential properties of individual particles. These questions of principle, which concern the concept of 'science' and that of 'scientific philosophy', will concern us now.

In a letter received shortly before the beginning of the correspondence with Clarke, Leibniz learned from Conti – who went back and forth between England and France just as much as between Newtonian and Leibnizian philosophy – that according to Newton "or rather according to his disciples, gravity (*pesanteur*) is produced by a cause which is not at all mechanical: since every part of matter is heavy (*pesante*), one sees that there is something in each part that acts and that acts with order and consequently with intelligence" (Letter from Conti, June 30, 1715, communicated by Rémond on Oct. 18, 1715, GP III, 653–656; Robinet, 18f.).

That the Newtonians were not inclined towards a mechanical explanation

of gravity, that is, by means of a medium, was already well known. In the preface to the second edition of the *Principia* (1713), Roger Cotes argued at length, why the property of gravity must be attributed to a material body and concludes:

> In short, either gravity must have a place among the primary qualities of all bodies, or extension, mobility, and impenetrability must not. And if the nature of things is not rightly explained by the gravity of bodies, it will not be rightly explained by their extension, mobility, and impenetrability (*Princ.*, 27; Cajori, xxvi).

In the draft of his preface, Cotes even wrote that gravity is an essential property of matter ("essential to Bodies"). After Clarke had indicated that such a characterization would give occasion for unnecessary attacks, Cotes changed the formulation (cf. Letter of Cotes to Clarke, June 25, 1713; *Corresp.* V. 412f.). Newton himself wrote to Cotes that gravity is a property of all bodies and is inferred just as inductively as impenetrability and mobility or as the laws of motion (Newton to Cotes, March 31, 1713, *Corresp.* V, 400). What conclusions are to be drawn from the fact that gravity is merely a universal property of all bodies but not an essential one, Newton does not say.

With the recognition of gravity as a property of matter Leibniz saw in any case a relapse to prescientific positions:

> Mr. Roberval supposed in his *Aristorque* that each part of matter of which the universe is composed has a certain property by means of which they all are carried towards one another and reciprocally attract each other. Mr. Descartes . . . finds this quite absurd and says that to conceive this, one must suppose that each part of the universe is animated . . . and even that these souls (*âmes*) are intelligent and quite divine in order to be able to know what happens in places very distant from them . . . and to exercise their power (*pouvoir*) there.
>
> This supposition of Mr. Roberval is just the same as that of Mr. Newton (Leibniz, Manuscripts Phil. IV, 1, 4f., 38 (1715?); Robinet, 43f.).

Thus, the discussion concerned not the law of gravity but its Newtonian interpretation. In a letter to Conti, after having once again expressly supported 'experimental philosophy', Leibniz wrote that universal gravitation of every part of matter had not been proven by a single experiment (he means gravity as a property of matter):

> And because we do not yet know perfectly and in detail how gravity is produced or elastic force or magnetic force, this does not give us any right to make of them scholastic occult qualities or miracles (Leibniz to Conti, Dec. 6, 1715; Robinet, 41–43; Alexander, 184–187).

At about the same time Leibniz attacked Newton's explanation for the conservation of force. In a letter to the Princess of Wales, which opened the Leibniz-Clarke correspondence, he wrote that Newton and his followers had a rather peculiar notion of God's works:

> According to their doctrine, God Almighty wants to wind up his watch from time to time: otherwise it would cease to move. He had not, it seems, sufficient foresight to make it a perpetual motion. Nay, the machine of God's making, is so imperfect, according to these gentlemen; that he is obliged to clean it now and then by an extraordinary concourse, and even to mend it, as a clockmaker mends his work (Leibniz's 1st Letter, Nov., 1715, §4).

Leibniz, on the contrary, maintains that force (*force et vigeur*) only passes from one part of matter to another and on the whole is conserved according to the laws of nature. Miracles, that is, supernatural effects are performed by God only for the purposes of grace, not of nature.

Both attacks are directed at the same problem: according to Leibniz the world is conceived as a system that is subjected exclusively to natural laws. It cannot be ruled out that the solar system in its present form might not be preserved eternally. Newton, on the contrary, believed that the world is also subject to the extraordinary intervention of God, and that the present form of the solar system is preserved by precisely this means.

The largest part of the ensuing discussion deals with these problems. Recognizable progress is made in the presentation of both positions, but scarcely any at all occurs in the discussion itself. The reasons for this can already be seen in the first reply by Clarke and Newton.

Newton's response to the accusation, that his explanation of gravity is equivalent to introducing 'occult qualities', does not recognize Leibniz's distinction between 'natural' and 'supernatural' law-likeness. In his answer he calls not the cause of gravity but the law of mass attraction itself a quality. In a very carefully prepared answer Newton explains that Leibniz calls such things miracles which create no wonder and calls such things occult qualities which are manifest and whose causes only are occult (Newton to Conti, Feb. 26, 1716; Robinet, 62f.). In a draft to this letter Newton explicates the position, which Clarke, too, in his first four letters persistently takes up, namely that regularly occurring phenomena may not be called miracles:

> For Miracles are so called not because they are the actions of God but because they happen seldom & by happening seldom create wonder.[16]

The answer could not of course dispel Leibniz's reservations. The regularity

of gravitation was beyond doubt; Leibniz insisted only that the ignorance of its cause provided no justification for declaring it to be supernatural:

"I call a *miracle*," he explained in reply, "any event which can only occur through the power of the Creator, its reason not lying in the nature of created things."

If one ascribes such an event not to the intervention of God but to 'qualities or powers' of the things themselves – although the event could in no way follow from the known nature of things – "then I call this quality an occult quality à la scholastic, that is, one that it is impossible to render manifest" (Letter to Conti, April 9, 1716, Robinet, 64f.; Alexander, 187–188).

In Newton's explanation of gravity and of the conservation of 'force' Leibniz saw the same problem, just as he treated both Newtonian answers as of equal value. In both cases the problem is not a particular scientific question but the principle of whether a supernatural and thus unscientific explanation can be admitted. Newton was also aware of the importance of the principle involved in the discussion:

Leibniz, he wrote, "goes upon the Hypothesis of the materialists viz. that all the phaenomena in nature are caused by mere matter and motion and man himself is a mere machine .... And his zeale for his precarious hypothesis makes him rail at Mr. Newton's universal gravity" (Draft No. 10, K/C, 113).

It seems that no mediation between the two standpoints is possible, even no mutual understanding. Newton does not at all deny that the system of the world is subject not merely to natural laws; and Leibniz says clearly that in his opinion God is an *intelligentia supramundana* and his watch is so perfect that it functions without his intervention. Clarke asserts, on the contrary, that the perfection consists in the very fact that his work cannot exist without his "government and inspection". Leibniz's conception of the world as a clock which functions without God's assistance is materialistic and fatalistic, as can be seen in his expression that God is a 'super-mundane intelligence" (Clarke's 1st Reply, §4).

Both Clarke and Leibniz illustrate their views by using the clock as a model. The model seems at first to be unsuitable. First of all it is unclear, what in the clockwork model is supposed to correspond to the conception that material bodies move in God's sensorium. The model seems rather to exclude every action at a distance (whether in God's sensorium or interpreted as the effect of occult qualities). In a clockwork every transmission is produced by direct contact. On the other hand, the clockwork model seems to justify the conception that every system is composed of bodies whose properties belong to them independently of the system. A clockwork is composed

of parts whose essential properties (impenetrability, mass, etc.) belong to them before any composition; otherwise the construction of a clock would not be possible. Thus Leibniz ought no more to have used the model of a clockwork than Newton.

The model seems to be inadequate to both conceptions, but it is questionable whether the same model is meant at all; for Leibniz always says *montre* – a word which Clarke correctly translates as 'watch'; Clarke himself however calls God's work a 'clock'. The choice of word is by no means accidental but points to two very different models, which in turn are borrowed from two kinds of 'clock' of the time. The investigation of the meaning of the two models can shed some light on the relations of natural science and philosophy in the 17th century.[17]

4. THE CLOCK AS A SCIENTIFIC MODEL

The terms *montre* and 'clock' do not by any means refer to every device for measuring time, nor does every 'clock' necessarily serve this purpose. 'Clock' refers to any mechanical automaton and only to such devices. Sun dials, which were widespread in the 17th century, are not to be included. But even among mechanical clocks, from the time of their invention around the beginning of the 14th century and on into the 18th century, two kinds must be distinguished. For the sake of simplicity we shall call the one an 'artisan's clock' and the other a 'scientist's watch'.

'Artisan's clock' refers to the rather simple and bulky tower clocks. Such clocks were fashioned out of iron or bronze and up to the 18th century were built by blacksmiths. It is not surprising that they ran rather inaccurately. In the middle of the 14th century they lost or gained up to 15 minutes a day; this margin of error had been reduced by only 7 minutes by the middle of the 17th century. It was only in the course of the 16th century that these clocks regularly received a minute hand.[18]

On account of the cumbersome mechanism and the inaccurate functioning of these clocks, it was necessary that they be serviced regularly by the keeper or 'governor':

> Often the governor had to wind up the clock twice a day and he had therefore to climb twice a day to the top of the clock tower; he had very frequently to grease the machine, because the gears were not so smoothly and precisely constructed; he had finally to reset the hand (or the hands) of the clock every time this was being wound because the clock lost or gain much time in the course of half a day.[19]

To get an accurate measure of time in order to set the mechanical clock correctly, the governor used a sun dial, whose construction required no scientific training.[20]

The accuracy of the clocks was improved markedly when the pendulum was introduced instead of the balance to regulate the motion. This invention designed by Huygens – was made possible by the cooperation of scientists and learned watchmakers. The interest of scientists in the clock is, however, much older and resulted from the possibility of using it in astronomy to exhibit the motions of the planets or of the sun and the moon. Such models had already been constructed with a water-clock mechanism in ancient Greece.[21]

The invention of the mechanical clock opened up further possibilities. In the middle of the 14th century the famous clock in Strasbourg was constructed, which in addition to the actual clock also contained a number of automatic mechanical figures, and an astronomical clock. At the same time De' Dondi built an astronomical clock, which displayed the circular motions and epicycles of the planets – a feat which presupposed highly developed technical and mathematical knowledge. In the 17th and 18th centuries, mechanical planetaria, or models of the solar system, which were driven by a clockwork ('orreries') were widespread.[22]

The astronomical clocks and mechanical planetaria, it goes without saying, were not constructed by the same 'blacksmiths and clockmakers' who built the simple tower clocks. Giovani de' Dondi and his father, for instance, were '*philosophie, medicine et astrologie doctores*' at the University of Padua; the construction of the astronomical clock in Bologna was supervised by the humanist Cardinal Bessarion (Basil).

> The first great public clocks usually showed more resemblance to gigantic planetaria or orreries than to the modern timekeepers ... [and it might be suspected, that] the mechanical clock indeed owes its origin to the desire to exhibit more complex models, which would demonstrate the glory of God as revealed in the perfection of regularity in the complicated motions of the heavens.[23]

(a) *Clock Construction and Scientific Explanation*

Great importance must be attributed to the construction of these clocks. In the first place they represented the first fruits of the cooperation of scholars and craftsmen.[24] Furthermore, these clocks represented the first material realization of scientific knowledge and proved that the claim to putting material production on a scientific basis could be realized. In Bacon's

formulation this claim became the motto of the progressive forces of the age.

> Human knowledge and human power meet in one; for where the cause is not known the effect cannot be produced. Nature to be commanded must be obeyed; and that which in contemplation is as the cause, is in operation as the rule.[25]

However, before this ideal could be put into practice, further developments were necessary, in which the clock was also to acquire particular significance. In the first place the production of the 'scientist's watch' provided proof that the requirements for an explanation of a phenomenon, namely that the conditions be given from which it follows with necessity, could also be fulfilled in physics: for the motions of the clock are the necessary results of its construction, which was undertaken on the basis of scientific knowledge.[26]

(b) *The Clock as Laboratory*

The clock served not only to demonstrate what had already been achieved but also as a 'laboratory' for the study of mechanical problems. In particular, experiments with the pendulum presented opportunities to study the laws of motion.[27]

The pendulum clock which Huygens constructed in cooperation with a watchmaker was intended for practical use (it was supposed to help determine geographical position at sea). It was not able to fulfill its intended purpose, but it did lead (aside from some important steps towards the establishment of the law of conservation of kinetic energy) to a qualitative leap forward in clock technology. Important success was also achieved by Hooke in his studies on the mechanism of the spiral-spring watch. These successes, achieved with the watch and realized in its improved construction, led to the first application of scientific results in commercial material production. As early as 1759 Adam Smith could confirm that a watch, which runs two minutes fast or slow can be purchased for a few guineas, but a watch that loses no more than one minute a fortnight costs fifty guineas (TMS IV, i, 5; cf. WN I, xi, o. 4).[28]

(c) *Scientist's and Artisan's Clocks, Natural and Supernatural Action*

The importance of clock technology for the development of modern science as sketched above is sufficient to explain why almost all scientists of the time used clock models in their explanations, but it also shows that quite differing 'clocks' may be referred to and consequently quite differing clock models

may be intended. For our purposes, the difference between the 'artisan's clock' and the 'scientist's watch' is of interest.

In Leibniz's opinion, the world must be conceived as a perfect 'scientist's watch' and in no case as an 'artisan's clock': in the latter the motion of the hands is partly the result of the mechanism and partly due to the intervention of the 'governor'. If the possibility is allowed that a governor intervenes in the system of the world to compensate for the difference between the phenomenon and the recognized laws, then a cause is acknowledged, which in principle follows no natural law: in theology such an intervention is called a miracle. For natural science the model of the 'artisan's clock' is thus useless and even harmful.

To conclude. If God is oblig'd to mend the course of nature from time to time, it must be done either supernaturally or naturally. If it be done supernaturally, we must have recourse to miracles, in order to explain natural things: which is reducing an hypothesis *ad absurdum*: for, every thing may easily be accounted for by miracles (Leibniz's 2nd Letter, §12).

"But the truth is", replied Clarke, "*natural* and *supernatural* are nothing at all different with regard to God, but distinctions merely in our conceptions of things" (Clarke's 2nd Reply, §12) (Newton expresses the same opinion in the drafts to the letter to Conti of Feb. 26, 1715/16, K/C, 73f.).

Clarke's reply misses the point since it is precisely human knowledge, science, that is being discussed. Natural and supernatural may well not be different for God, but for humans they mark precisely the difference between science and non-science. Leibniz wrote:

In good philosophy, and sound theology, we ought to distinguish between what is explicable by the natures and powers of creatures, and what is explicable only by the powers of the infinite substance. We ought to make an infinite difference between the operation of God, which goes beyond the extent of natural powers; and the operations of things that follow the law which God has given them, and which he has enabled them to follow by their natural powers, though not without his assistance (Leibniz's 5th Letter, §112).

Otherwise nothing will be easier than to account for any thing by bringing in the deity, *Deum ex machina*, without minding the natures of things (*ibid.*, §107).

The lack of comprehension for the other side is here again perfect. If one admits, Clarke replied, that God created the world, then he cannot understand why so much effort is made to exclude God's "actual government" and why God in his operation is only allowed to let things function just as they would by "mere mechanism" (Clarke's 5th Reply, §§110–116).

The history of clock technology provides the explanation why the diametrically opposed conceptions of Leibniz and Newton on the possibility of divine intervention in the world system could both be illustrated to the same extent on the model of a clockwork. Clarke, who admitted the intervention of God to explain the conservation of 'force' and probably also to explain the way gravity acts, calls God's work 'clock' and ascribes to God "inspection and government". 'Governor of the Clock' was the title of the man whose profession was to wind up, clean, and reset the tower clock. Clarke's 'clock' is thus an 'artisan's clock'; and God as the creator of the world is an artisan or craftsman; as its preserver he is 'Governor of the Clock'. Leibniz, on whose view the world represents a perfect work of God which needs no resetting, refers with the term *montre* to the 'scientist's watch', in whose functioning God does not intervene. God is thus the perfect mechanic: scientist and learned watchmaker in one person.[29]

Although the history of clock technology explains why Clarke and Leibniz could illustrate their different views on the clock model, it of course cannot explain the origins of their conceptions. This problem will be discussed later (cf. pp. 182ff.). The conception of the world on the model of the 'artisan's' or the 'scientist's' clock also provided the opportunity to discuss different conceptions of the analytic-synthetic method on the model of a 'clock'.

(d) *The Clock as a Model of the Object of Knowledge*

In the construction of the mechanical clock it was possible to produce complicated movements by an appropriate disposition of gears and a driving force. The task of science can be interpreted as the attempt to discover in a limited area and to a limited extent the principles of construction of the divine clock. As opposed to a mechanism constructed by humans, a natural system can only be known according to its effects, according to the phenomena. The task of the scientist can be compared with the attempt to draw inferences about the hidden mechanism from the visible motions of the hands and of the mechanical figures of the clock. Using this analogy, we can formulate (with Leibniz) some conditions for a scientific explanation. First of all, the general condition is acknowledged that the phenomenon is to be traced back to a mechanism. It is consequently unscientific to infer 'occult qualities' or 'miracles' as the causes of the phenomena:

> as if pocket watches marked the hours by a certain hour-showing faculty (*faculté horodeictique*) without needing wheels (N.E. Preface; GP V, 61).

But it is just as domatic and sterile merely to assure us that a phenomenon depends on a lawfulness of nature without seeking out and reporting its particular law.

Thus it is not enough in explaining a clockwork, to say that it is moved by a mechanical principle, without further distinguishing whether it is driven by a weight or by a spring (*De ipsa Natura,* §3, GP IV, 505; PPL, 499).

But it by no means follows that the phenomenon can result only from the system of conditions reported. Here, a peculiarity of a natural system must be taken into account which distinguishes it from the mechanical clock. Any knowledgeable person who has access to the mechanism can decide whether a clock is driven by a spring or a weight. The scientist, on the contrary, has no direct access to a 'mechanism' supposedly 'behind' the phenomena; natural natural phenomena are analogues to the face of a clock whose hands and figures are visible but whose mechanism must be inferred by theory. Thus, taking apart a clock's mechanism cannot serve as a model for the process of scientific knowledge, even though the necessary connection between the mechanism and the visible movements of the hands can be compared with the connection between the laws of nature and the phenomena. The process of scientific knowledge can be compared with the attempt to make inferences as to the clock's mechanism from the observed motions of the hands. It thus follows that every scientific theory will be evaluated by how far the natural appearance follows with necessity from the asserted natural laws, without however there being any justification for the dogmatic assertion that the scientific theory proposed is the only possible one. Thus Descartes says about his explanation of the origin of the world system:

And although perhaps in this way it may be understood how all natural things could have been created, it should not therefore be concluded that they were in fact so created. For the same artisan can make two clocks which indicate the hours equally well and are exactly similar externally, but are internally composed of an entirely dissimilar combination of small wheels (*Princ. Phil.* IV, 204).[30]

Leibniz insisted even more consistently than Descartes on the relativity of all scientific hypotheses. Not only are different hypotheses as explanations of the same phenomenon possible, but also different hypotheses are to be used according to the purpose of the explanation. To describe a system of moving bodies, for instance, one can use any kinematic hypothesis whatever, and from the observation of motion "not even an angel could discern with mathematical rigor which of many bodies is at rest and which is the center of the motion of the others".[31]

If, therefore, there is no means of distinguishing one of these possible hypotheses as the true one, then that hypothesis should be chosen which is more intelligible. Herein lies the truth of hypotheses. But since various hypotheses can be intelligible in various regards, the truth of hypotheses consists in choosing the most intelligible with respect to a particular purpose of explanation.[32]

A quite different line is taken by Cotes in his preface to the second edition of Newton's *Principia:*

> The same motion of the hour-hand in an automatic clock may be occasioned either by a weight hung, or a spring shut up within. But if a certain clock should be really moved with a weight, we should laugh at a man that would suppose it moved by a spring, and from that principle, hastily taken up without further examination, should go about to explain the motion of the hour hand; for certainly the way he ought to have taken would have been actually to look into the inward parts of the machine, that he might find the true principle of the proposed motion (*Princ.*, 28; Cajori, xxvii–xxviii).

Cotes does not write that one must pursue observations and conduct experiments, on the basis of which one could infer from the motions of the hand whether the clock was driven by a spring or a weight. One must, he writes, look into "the inward parts"; how this is to be done, he does not reveal.

Cotes obviously interprets the process of knowledge not as observation of the hands in order to learn about the clockwork but as the actual disassembling of the clockwork itself. Thus, he has grasped the technical procedure, which represents the predecessor of the analytic-synthetic method, but not the method itself.[33]

This interpretation of the analytic-synthetic method fits the Newtonian conception that the world is composed of particles with essential properties. The 'artisan's decomposition' corresponds to the 'artisan's composition' of the world out of the particles which God created in the beginning. The "primitive Particles", Newton wrote, are

> so very hard, as never to wear or break in pieces; no ordinary Power being able to divide what God himself made one in the first Creation. While the Particles continue entire, they may compose Bodies of one and the same Nature and Texture in all Ages .... And therefore, that Nature may be lasting, the Changes of corporeal Things are to be placed only in the various Separations and new Associations and Motions of these permanent Particles (*Opticks*, Qu. 31, 400).

Leibniz pointed out another connection between this notion and the 'artisan' conception of the 'world-clock'. Those persons, he wrote, who favor atoms and the void let themselves be more influenced by 'imagination' than by 'reason':

They carry their inquiries no farther than those two things: they (as it were) nail down their thoughts to them: they fancy, they have found out the *first elements* of things, a *non plus ultra*. We would have nature to go no farther; and to be finite, as our minds are: but this is being ignorant of the greatness and majesty of the author of things.[34]

5. SCIENCE AND UNSCIENTIFIC PHILOSOPHY: NEWTON'S CONTRADICTORY VIEWS

On various questions Newton takes the same position: the world is to be conceived as an 'artisan's clock', as a clock put together out of prefabricated components (ultimate particles with essential properties). Only under this 'artisan' conception can be possibility even be conceived that God intervenes in the world, as the governor of the tower clock compensates for the defective functioning of the mechanism by resetting the hands. Epistemologically, this 'artisan' conception affects the interpretation of the analytic-synthetic method as the dissection of the object into its ultimate elements; properties of a system are then to be explained by the 'essential properties' of particles.

The opposition between the Newtonian and the Leibnizian conceptions is at first glance an opposition between a prescientific and a scientific world view. This result could be accepted without further ado, were it not for the fact that Newton was the most important physicist of his time. Since a mathematical natural science is practically impossible on the basis of the notion expressed by Newton that the world is an imprecisely constructed system which is arbitrarily manipulated by God, we must assume a contradiction in Newton's views themselves. This contradiction appears in two forms: on the one hand, as a contradiction between his practical procedure and his comments on this procedure, and on the other, as a contradiction between various remarks concerning his methods of procedure.

An example of the first kind of contradiction is the concept of density already dealt with.

Newton's measure of density consisted in the mass of a body divided by its volume. Empirically, this meant the relation of the mass of a body to the mass of another body of equal volume, which served as a standard of measure. Newton's *definition* of the 'quantity of matter' presupposes a concept of density as the number of 'ultimate particles' per unit of space.

A further example is the law of gravitation: Newton's formulation of the law refers to a *system* of bodies: "In a system of several bodies A, B, C, D, etc. . . ." (*Princ.*, Bk. I, prop. lxix, theor. xxiv, 296; Cajori, 191). This is also expressed in the mathematical formulation of the law: $F = G\, mm'/R^2$.

Newton of course makes no attempt to determine the measure of the gravitation of *one* body. His methodological rule, however, asserts that one must infer from the phenomena the properties of individual bodies, not those of the system.

An example of the second kind of contradiction can be seen in Newton's comments on the analytic-synthetic method. Whereas in his *Regulae Philosophandi* Newton takes the position that analysis consists in reducing the phenomena to the properties of particles, and in his proofs for the existence of absolute space, that it consists in reducing them to the 'essential properties', in the *Opticks* on the contrary, he formulates the task of the analytic-synthetic method as follows:

> to derive two or three general Principles of Motion from Phaenomena, and afterwards to tell us how the Properties and Actions of all corporeal Things follow from these manifest Principles (Qu. 31, 401; cf. 404f.).

Here, Newton does not specify that the 'general Principles' must be propositions about particles with essential properties.

A further example of this kind of contradiction can be seen in the problem, whether the world is to be conceived as a 'scientist's watch' or as an 'artisan's clock'. In his statements about the conservation of 'force' he takes up the standpoint that the world is to be conceived as an artisan's clock that God can manipulate. In the preface to the *Principia*, however, he insists on the difference between the 'imperfect mechanic' (craftsman), who works with lesser accuracy, and the 'most perfect mechanic' (scientist), who works with perfect accuracy. This perfect accuracy is achieved by the use of mathematics, that is, in Newton's *Principia* (*Princ.*, 15; Cajori, xvii–xviii).

These contradictions do not mean that Newton openly held fast to mutually exclusive opinions. While there is in fact in his actual procedure no basis for his interpretation of it, this interpretation could nonetheless not be falsified by his scientific results. It has been shown upon what presuppositions Newton's proof of the existence of absolute space rests. The proof is not compelling if the presuppositions are not admitted, and it cannot withstand a careful analysis. But the theory of absolute space was not refuted because it fulfills the requirements of an 'inertial frame of reference'. For the same reason, his formulation of the law of inertia could also pass muster. Newton's assumption, that God replaces the amount of 'force' lost, was intended expressly to prevent a contradiction between his conclusion, that the amount of force decreases, and his conviction, that the solar system would be preserved. Later developments in physics were able to confirm without assuming

God's intervention that there is no contradiction between Newton's measure of force and the preservation of the solar system.

Finally, the explanation of gravitation would probably have remained an unsolved problem, even if Newton had not traced it back to a property of an isolated body or to the action of God. A further, epistemological consequence follows from Newton's concept of 'essential qualities'. The propositions about the qualities of the elements, which were originally made to explain the phenomena – and thus were hypothetical and able to claim validity only as a part of a successful synthesis – are now posited absolutely by the conception that these properties are essential (necessary) to matter. Phenomena which cannot be explained by the synthesis are thus not an occasion to re-examine, relativize, or reject earlier propositions; on the contrary, these continue to be asserted as absolutely valid. This dogmatism can be seen, for instance, in the fact that Newton does not contemplate whether the conservation of the system of the world could be explained by assuming matter to be elastic (which would contradict the absolutely posited assumption that it is inelastic); on the contrary, he considers the earlier assumptions to be certain and seeks to eliminate the problems that arise through a supernatural intervention by God. Likewise, this dogmatic conception determines the view that all other phenomena can be explained by determining additional qualities.

In contrast to this procedure, Leibniz presented the propositions about the properties of the elements as results of the analysis of phenomena as propositions which are valid only in so far as the synthesis can explain the phenomena. The difference appears clearly in the interpretation of the clock model. Whereas Leibniz and others assumed that only the number dial and the hands of the clock are known to us, and that the asumptions about the mechanism of the clock must be taken as hypotheses, Cotes took the propositions about elements and properties (originally arrived at by analysis) as certain and as independent of the investigation of other phenomena, which can only specify additional properties. For phenomena which have already been explained, Leibniz's conception is hypothetico-deductive, that of the Newtonians is evident-deductive. Newton's conception was one of the worst imaginable interpretations of his physics but nonetheless a possible one. It still remains to be seen, what reasons might have induced him to adopt such an interpretation.[35]

In the discussion between Leibniz and Newton, two pairs of basic principles confronted each other. Leibniz's first basic principle stated that the appearances of a system must be the point of departures for research; from

these appearances simple laws of the system are to be derived. Newton's first basic principle also required that the starting point be the phenomena of the system, from which, however, inferences were to be drawn about the ultimate elements and their properties which are independent of the system.

Newton's second basic principle, that God intervenes in the world system to compensate for the disappearing 'force', was rejected by Leibniz as unscientific. If the hypothesis of such an intervention were admissable, then all phenomena could be explained without further ado; that is, nothing would be explained scientifically.

Between these two assumptions of Newton's there are, however, important differences. In the first place, Newton's assumption that the amount of 'force' decreases – and the consequence that God could replace it – is based in turn on the assumption that all material bodies are composed of inelastic particles. Newton arrived at this conclusion by deriving the properties of the ultimate elements from the impact laws of material bodies (loss of 'quantity of motion' in an inelastic collision). Thus this second assumption is based on the first, that we should infer the properties of ultimate elements from phenomena.

The second difference between the assumptions is at once historical and systematic. The assumption that God intervenes in the world was obviously unscientific, but it served to close a scientific 'gap'. As soon as d'Alembert and Lagrange had closed the gap with a scientific solution, Newton's hypothesis was superfluous and no longer played a role in physics. But Newton's fundamental presupposition, that phenomena are to be explained by the properties essential to every single particle, and the theory of absolute space, which depends on it, were influential up to the end of the 19th century.[36]

The later discussions of the concept of absolute space and absolute motion and of the formulation of the law of inertia need not concern us here;[37] it is, however, important that the basic principle, that phenomena are to be explained by the essential qualities of single particles, was not only implicitly supposed by the theory of absolute space up until the end of the 19th century but could also be introduced expressly as an evident postulate by the supporters of this theory.

Leonard Euler, for instance, argued in 1736 that a single body in empty space would retain its state of motion for lack of any sufficient reason for changing it; this is, however, according to Euler not the physical cause, as can easily be seen in the fact that a body in uniform motion, upon which no external forces act, will continue in uniform motion in real space, although there could very well be reasons for motion in a particular direction:

'The lack of a sufficient reason cannot of course be taken for the true and essential cause of any event; but only proves its truth and does this in a strict manner. At the same time it also indicates that in the *very nature of the thing there is an occult, true, essential cause*, which is not removed when that lack of sufficient reason is removed . . .'[38]

Euler thus distinguishes between the strict proof of the truth of the law of inertia and the physical explanation of the same. The physical explanation which Euler gives is a classical example of the 'Newtonian principle': a phenomenon is to be traced back to a 'true and essential cause', which is necessarily to be attributed to the nature of the body independently of whether the body is in empty space or in the system of the world.

As late as 1870 Carl Neumann justified the introduction of the concept of absolute space by pointing out that we could otherwise not avoid an 'insufferable contradiction': on a rotating star the effects of the centrifugal forces, which are 'completely independent of the other celestial bodies' can be observed; if however these other celestial bodies were annihilated, then – if motion is defined only as change of position with regard to other bodies – the rotating star must be said to be at rest and ought not to display the effects of centrifugal forces.[39]

The fundamental Newtonian presupposition, that phenomena are to be explained by the essential qualities of single particles, can thus not be attributed merely to the early stages of mechanics; rather it was quite widespread in the 'Newtonianism' which set the tone for mechanics up to the end of the 19th century.

6. RESULTS

Newton characterized his method as analytic-synthetic. The analysis consists in inferring the causes from the phenomena investigated; the synthesis takes these causes as principles on the basis of which the phenomena are to be explained. More specifically, the analysis consists in proceeding, on the one hand, "from Compounds to Ingredients" and, on the other, "from Motions to the Forces producing them" (*Opticks*, Qu. 31, 404f.). The presentation above has shown that Newton's interpretation of the analytic-synthetic method is based on the implicit presupposition that the system of the world is composed of primitive particles; each and every particle has essential properties which belong to it even as the only particle in empty space. On the basis of this presupposition Newton concluded that absolute space exists from the centrifugal forces which appear in rotation experiments. On the basis of this assumption he inferred from the experimentally grounded fact

that material bodies lose some of their quantity of motion on impact, i.e., that material bodies are not perfectly elastic, that the primitive particles are not elastic at all. Newton then saw himself constrained to explain the conservation of the world system by a supernatural intervention. The same presupposition forces him to seek a non-physical explanation for gravitation, since gravitation can only be conceived as mutual gravitation and thus cannot be ascribed to a single particle. Newton 'solved' both problems by assuming God's intervention. He imagined this divine intervention as mediated by the 'Sensorium of God', absolute space. The problems, which the assumption of God's intervention was supposed to defuse, had been created by Newton's presupposition that phenomena were to be explained by the essential qualities of single particles; the solution to these problems, which uses the concept of absolute space as the sensorium of God also depends on the same presupposition, since only on the basis of this are Newton's proofs of the existence of absolute space compelling. Finally, this presupposition implies an epistemological dogmatism; for, on the one hand, the system of propositions is no longer interpreted as hypothetico-deductive, and on the other hand, it is pre-ordained that all future research will consist in determining further properties of the elements. Leibniz's foundations of dynamics referred to material systems and stressed the hypothetico-deductive character of scientific theories. In the subsequent development of physics, Newton's theory prevailed, and the theory of absolute space was accepted on the basis of Newton's basic principle that phenomena are to be traced back to the essential properties of single particles. The second part of this analysis will therefore attempt to uncover the origins of Newton's fundamental presupposition.

PART TWO

ELEMENT AND SYSTEM IN MODERN PHILOSOPHY

It has already been indicated that, while Newton's interpretation of the analytic-synthetic method, according to which phenomena are to be traced back to the essential properties of single particles, did not correspond to his own procedure in science, it did indeed correspond to the craftsman's compounding and decompounding. The product of a craftsman, say a clock, is compounded of prefabricated parts and its functioning is due to the properties of the parts and to their disposition. The original qualities of the parts do not change either by their being compounded or by their later being dismantled. This possible origin of Newton's interpretation does not, however, explain why consequences drawn from the artisan procedure should be transferred uncritically to the scientific method of analysis and synthesis, especially since Clarke in his discussion with Leibniz stressed some differences between the product of an artisan and the world system created by God.[1]

On the other hand, the Newtonian interpretation of the analytic-synthetic method was not directly contradicted by his use of it in science. The consequence of this interpretation – Newton's definition of the 'quantity of matter' and his implicit definition of 'density' as well as the theory of absolute space – either went unnoticed or seemed not to present any particular problems. And even if Newton's misunderstanding of Leibniz's proof for the conservation of *vis viva* had likewise been a consequence of this interpretation of the analytic-synthetic method, the conclusion could not have disturbed him. Newton was not concerned with formulating conservation laws for a system of bodies. Finally, it is to be noted that, while Newton's problems with gravitation resulted likewise from his conception of the relation of element and system, nonetheless a physical explanation of gravity would not have been achieved simply by abandoning this basic principle.

Since Newton nowhere justifies his conception of the analytic-synthetic method nor even hints that it is only one of the possible interpretations of this method, it seems that he presupposes that his interpretation is evidently the only one possible. Our first step therefore will be to examine whether and where such an interpretation of the analytic-synthetic method was recognized

in science and how it was justified. Thus, we shall first take up the two schools of mechanistic natural philosophy which dominated discussion in Newton's time: the atomist and the Cartesian forms of corpuscular philosophy.

The mechanistic philosophy of nature, out of which modern science developed, itself also arose in close connection with the tradition of mechanical arts. If the principle, that phenomena are to be explained by the essential qualities of single particles, as machines are explained by the essential qualities of single parts, had been generally accepted in the mechanistic natural philosophy, it could thus perhaps be explained why Newton took this view to be self-evident and to need no justification. And since the mechanistic natural philosophy developed in opposition to the prevailing (scholastic) natural philosophy and drew on the tradition of mechanical arts, it could perhaps also be explained, why at first artisan procedures were taken over for the purposes of science. We shall see that this was not the case.

However, within mechanistic natural philosophy a distinction must be drawn between atomism and corpuscular philosophy. The significance of these alternatives for the basic principle on the relation of element and system lies in the fact that according to the Cartesian corpuscular theory the properties of the corpuscles are the result of the individuation of uniform extended matter, so that it thus seems questionable whether one could speak of essential properties of a particle in empty space. In the atomic theory, on the contrary, it is possible (although not necessary) to assume that each atom in itself has essential properties and that the material world is compounded of such atoms. In the examination of both these schools the main goal will thus be to see whether the 'artisan' interpretation of the analytic-synthetic method was presupposed as evident or, as the case may be, whether Newton's critique of the shortcomings of the theories of his predecessors determined his interpretation of this method or made the concept of absolute space appear necessary.

CHAPTER IV

THE CONCEPT OF ELEMENT IN 17TH CENTURY NATURAL PHILOSOPHY

English atomism just like the Cartesian corpuscular philosophy was developed in opposition to the dominant scholastic natural philosophy. The anti-scholastic thrust of English atomism is clearly illustrated by the circumstance that the English atomists stood at first under the influence of Giordano Bruno, who published no less than five books during his stay in England (1583–1585) and at the end of the century was condemned and executed by the Catholic Church. No less characteristic was it that one of the first English atomists, Thomas Hariot (1560–1621), was sponsored by Walter Raleigh, whose sceptical views on religion were proverbial. In 1590 Hariot, who appealed to the classical materialism of Lucretius and Epicurus, was arrested on charges of atheism. Although Hariot after his release was extremely careful to express his views in such a way that they did not openly contradict theology, the anti-scholastic and atheistic character of atomism was unmistakable.[1]

1. BACON

These traits of early English atomism, its anti-scholastic thrust and the conflict with religion, reached a peak in the work of Francis Bacon; at the same time, his philosophical development reveals a central problem of atomism: its speculative character.[2]

The present, said Bacon is "like a seer with two faces, one looking towards the future, the other towards the past" (*Masc.*, 68). The glance at the past Bacon used to express criticism of the dominant tradition; from the standpoint of today the entire Greek tradition is inferior. In comparison to the present, the Greeks are like children in comparison to adults; the criteria of judgment are the 'works' accomplished in both ages, and the new inventions: printing, gunpowder, and mariner's compass prove the superiority of the mechanical arts over philosophy; in the former many people work in cooperation and achieve a constant progress, but in philosophy one authority supplants the other, and the disciples of the founder of a school achieve nothing new (*Thoughts*, 97).

Nonetheless, this criticism of tradition itself also appeals to tradition: tradition resembles a river – as Bacon later formulated it – in which the light

and puffed up (inferior) swims to the top and the weighty (valuable) sinks (N.O. I, 71, 77). Against the dominant tradition represented by the names of Aristotle and Plato (*Masc.*, 63–68; *Thoughts*, 12f.), Bacon marshals first the Presocratics in general (*Thoughts*, 13) and then Democritus in particular (*Masc.*, 71; *De Princ.*, 456f.).

"The doctrine of Democritus concerning Atoms", Bacon wrote, "is either true or useful for demonstration. For it is not easy to grasp in thought or to express in words the genuine subtlety of nature, such as it is to be found in things, without supposing an atom" (*Cogit.*, 419). An atom is the smallest part into which a body can be divided, or a body without any vacuum whatsoever (*ibid.*), and has the following properties: form, dimension, place, resistance, appetite, motion, and emanations (*De Princ.*, 492). With Democritus Bacon, too, assumes the possibility of a vacuum, not only between the particles of matter but also a 'collected vacuum", i.e., an empty extension (*Cogit.*, 421).

The theory that all natural phenomena can be traced back to atoms endowed with these properties denies any kind of activity to the 'place' of a body. "For place has no forces, nor is a body acted on except by body" (*De Princ.*, 500). The same theory assures the 'unity of nature', for though there are great differences between supra- and sub-lunar bodies, the separation of the two areas would be 'a great hindrance' to the investigation of nature; one ought rather to distinguish between these bodies, which have much in common, than to admit a gap in their investigation (*Confut.*, 437–439). Like Brecht's Galileo Bacon could also have said, '*Himmel abgeschaft*'.

However much Bacon championed atomism at this time, his later critique of atomism is nonetheless intimated here:

> The understanding is endowed by nature with an evil impulse to jump from particulars to the highest axioms (what are called First Principles). This impulse must be held in check; but generalisations lying close to the facts may first be made, then generalisations of a middle sort, and progress thus achieved up the successive rungs of a genuine ladder of the intellect (*Thoughts*, 99).

The criticism of the procedure of jumping over the 'middle causes' applies equally to all speculative philosophies of nature; Bacon, on the contrary, stresses the necessity of uniting the empirical and the rational (*Refut.*, 131; *Thoughts*, 97) and sees the criterion of truth in practice. "For in nature practical results are not only the means to improve well-being but the guarantee of truth .... It is by the witness of works rather than by logic or even observation, that truth is revealed and established" (*Thoughts*, 93).

Some years later appeared Bacon's *Novum Organum* (1620), in which he rejected both the scholastic philosophy of nature and atomism, on account of their seeking first principles instead of middle principles: "Hence it is that men cease not from abstracting nature till they come to potential and uninformed matter, nor on the other hand from dissecting (*secare*) nature till they reach the atom; things which, even if true, can do but little for the welfare of mankind" (N.O. I, 66). Bacon therefore suggests that we do not trace things back to atoms and the void but to the "real particles, such as really exist", that is, to empirically demonstrable elements (N.O. II, 8).

The common error of scholasticism and atomism lies in the search for first principles; the difference between the two lies in the fact that the former goes too far in 'abstracting' nature in thought, and the latter – in analogy to the craftsman – goes too far in "dissecting" it. The dependence of atomism on mechanical arts was formulated explicitly by Bacon:

> Now the human understanding is infected by the sight of what takes place in the mechanical arts, in which the alteration of bodies proceeds chiefly by composition or separation, and so imagines that something similar goes on in the universal nature of things. From this source has flowed the fiction of elements, and of their concourse for the formation of natural bodies (N.O. I, 66).[3]

Bacon's recourse to the tradition of the mechanical arts does not lead to his accepting the method of separating and compounding; on the contrary, by appealing to this tradition he criticizes the speculative consequences for science. By the time Bacon's early atomistic writings were published in 1653, the controversy over atomism had become quite complicated. On the one hand, the atomism of Gassendi had been propagated by English emigrants on their return from France (among them Hobbes) and was taken – against the intentions of Gassendi – as materialism; on the other hand, the natural philosophy of Descartes presented an alternative to atomism, although it, too, was reckoned to the 'mechanical philosophy'; finally, in England itself much exertion was undertaken to cleanse atomism of the stigma of materialism (cf. Kargon, 76–92).

In the following we shall take up the Cartesian corpuscular philosophy in order to be able to evaluate the grounds for the decision made between atomism and corpuscular philosophy in Newton's time.

2. DESCARTES

In his early work, *Regulae ad Directionem Ingenii* (composed 1628/29), Descartes argued that only a mathematical science can be a science of nature.[4]

"All science consists of sure and evident knowledge", he writes, but only geometry and arithmetic are evident (R 2; 362f.). Only mathematics is science, but it is of no use; its problems are non-existent (R 4, 4; 373). Mathematics deals with quantities (figure and number) without concerning itself whether these quantities "have a real fundament in the subjects themselves", whether they express an essential relation of the material object (R 14, 17; 448). The evidence of mathematics, which consists "entirely in consequences rationally deduced", is grounded in precisely this abstraction (R 2, 5; 365). All deception arises from experience (R 2, 4; 365). From this it may not be inferred "that arithmetic and geometry are alone to be studied, but that in our search for the direct road to truth we should not occupy ourselves with any object about which we are unable to have a certitude equal to that of arithmetical and geometrical demonstrations" (R 2, 6; 366). To mathematics belongs everything "in which order or measure is examined" (AR 4, 1; 377); and these can be investigated not only in abstract but also in material objects. The science which investigates these general relations – in a later formulation, the "science of proportions" (*Disc.* II, 11; 21) – can be denoted as *Mathesis Universalis* (AR 4, 1; 378).

The first step towards solving a problem thus consists in transforming it into a mathematical problem. Therefore "the secret to the whole art" consists in finding out the respective necessary, measurable "simple natures" in the object: "among measurable things extension is something absolute" (i.e., simple) (R 6, 5; 382).[5]

Descartes never changed this point of view; in his *Principia Philosophiae* (1644) he wrote:

> Therefore, all matter in the whole universe is of one and the same kind; since all matter is identified solely by the fact that it is extended. Moreover, all the properties which we clearly perceive in it are reducible to the sole fact that it is divisible and its parts movable; and that it is therefore capable of all the dispositions which we perceive can result from the movement of its parts (*Princ. Phil.* II, 23).[6]

Now all "Natural Phenomena" must be demonstrated from these "common notions" (division, shapes, movements) of uniform matter "with such certainty that it (the demonstration – G.F.) must be considered as a Mathematical demonstration" (*Princ. Phil.* II, 64). But just this is not possible. From "mere reason" one cannot deduce "the size of the parts into which this matter is divided, nor at what speed they move, nor what circles they describe. For, seeing that these parts could have been regulated by God in an infinity of diverse ways; experience alone should teach us which of these

ways he chose" (*Princ. Phil.* III, 46). And when Descartes writes that the analogy between nature and a work of art supported him in the formulation of his theory (*Princ. Phil.* IV, 203), he also uses the analogy to explicate the hypothetico-deductive character of his system:

> And although perhaps in this way it may be understood how all natural things could have been created, it should not therefore be concluded that they were in fact so created. For just as the same artisan can make two clocks which indicate the hours equally well and are exactly similar externally, but are internally composed of an entirely dissimilar combination of small wheels .... The same applies to the construction of nature as a whole (*Princ. Phil.* IV, 204).

Such a theory is not evident, but it suffices "for the needs of everyday life" (*ibid.*); and indeed it was at least sufficient to propound a natural philosophical system on a mechanistic model as an alternative to the scholastic system.[7]

Descartes' assertion that his theory about the origin of the particles and their properties was merely hypothetical was based on the fact that corpsucles cannot be perceived. If, however, a theory can be tested empirically, then it is the case that theories which do not agree with experience can be excluded; from this it of course does not follow that a theory which agrees with experience can be taken as absolutely true; but for the 'needs of everyday life' it suffices when such a theory is found.

In the introduction to his physical explanation of the Copernican theory Descartes remarks that his explanation would support the assumption that the earth does not move. The basis of this explanation is the relativity of motion. The earth is unmoved in relation to the surrounding celestial matter and moved in relation to the visible fixed stars. There is no reason to attribute motion to the earth, for motion "is only the transference of a body from the vicinity of those bodies which are immediately contiguous to it, and considered to be at rest, into the vicinity of others" (*Princ. Phil.* III, 28); and since "this transference is reciprocal ... and because there must be as much *force* or action (*vis sive actio*) in the Earth as in the heaven; this transference gives us no reason to attribute motion to the heaven rather than to the Earth" (*Princ. Phil.* III, 38; my italics).

If no proof can be provided for the motion of the one or the other body, the Cartesian hypothesis at least has the advantage that it not only retains the 'simpler and clearer' Copernican theory but also offers a physical explanation which denies "the motion of the Earth more carefully than Copernicus and more truthfully than Tycho" (*Princ. Phil.* III, 19), by introducing place 'in a philosophical sense' and determining the changed situation of the earth to the

immediately contiguous particles of matter. However, the developed physics of the heavens contradicts this appeasing assertion. For the origin of a vortex, in the middle of which lies a fixed star (for instance, the sun) rests on the "law of nature that all bodies which are moved circularly attempt as far as is in their power to recede from the centers around which they revolve" (*Princ. Phil.* III, 55 (54)). The same phenomenon can be observed when a stone is rotated in a sling: "We see, too, that the stone which is in a sling makes the rope more taut as the speed at which it is rotated increases; and, since what makes the rope taut is *nothing other than the force by which the stone* strives to recede from the center of its movement, we can judge the quantity of this *force* by the tension" (*Princ. Phil.* III, 59; my italics). Descartes thus recognizes that circular motion is a compounded motion (cf. also *Le Monde*; AT XI, 43), and lets no doubt arise that in his opinion the earth really moves. Thus, Descartes recognized not only the relativity of all kinematically described motions but also the possibility of determining an 'absolute' motion without having to assume an absolute space. He ascribed absolute motion to the earth; only the Copernican theory could correspond to this cosmology.[8]

The principal failing of the Cartesian cosmology lay in the fact that it assumed the centrifugal motion of the circling celestial bodies but not the centripetal action of gravitation; the vortices circling around a center would thus have to expand out endlessly. "However that your vortices are not split apart and do not flag out seems a clear indication that the world is in reality infinite", wrote Henry More to Descartes (Letter of March 5, 1649; AT V, 304). More did not understand why Descartes wanted to have the world characterized only as 'indefinite' and not as 'infinite', but he indicates the main point: Descartes can give an explanation of the preservation of the world system only in the form of a '*regressus in indefinitum*'. However, the important points to be remembered are that Descartes stresses the hypothetico-deductive character of science and does not introduce the concept of absolute space to distinguish between relative and absolute motion.

3. NEWTON'S CRITIQUE OF DESCARTES; BOYLE'S COMPROMISE

The contradiction between Descartes' assertion that all motion is relative and his cosmology was clearly recognized by Newton:

> For he [Descartes] says that properly speaking and according to philosophical sense the Earth and the other Planets do not move, and that he who declares it to be moved because of its translation with respect to the fixed stars speaks without reason and only in the vulgar fashion (Part III, Art. 26, 27, 28, 29). Yet later he attributes to the Earth

and Planets a tendency to recede from the Sun as from a centre about which they are revolved .... What then? Is this tendency to be derived from the (according to Descartes) true and philosophical rest of the planets, or rather from [their] common and non-philosophical motion? Motion in the 'vulgar sense', Newton concludes, is more useful (*De Gravitatione et Aequipondio Fluidorum* (1664/68); Hall and Hall, 90–121; here: 92f., 124).

This motion is related, Newton continued, to "extension in general (*in genere*)", to space as Descartes conceived it. According to Descartes this space can only serve as a frame of reference for motion as long as "it is of the same size and shape and maintains the same situation among the external bodies which determine that space" (*Princ. Phil.* II, 12). Newton wants to relate motion to space itself (*De Gravitatione*, 104), but he does not say how this is supposed to be possible, since space is not perceptible. Furthermore, Newton thinks it necessary to assume an empty space, inasmuch as the motion of a body which encounters no resistance presupposes a perfectly empty medium (*ibid.*, 112f.). He does not, however, take up or counter the arguments of Descartes, who asserted the possibility of a medium without resistance and nonetheless believed that such a space is 'in a philosophical sense', i.e., taken strictly, not empty (*Princ. Phil.* II, 16–19; III, 60). Newton himself came back again and again to the ether theory, which also presupposed a medium without resistance in a non-empty space.[9] However, from Newton's justified criticism of Descartes no necessity of accepting atomistic systems can be inferred; Newton's critique is also directed much more at the implicit atheism which he suspected in Descartes' opinions (*ibid.*, 109). He suggests as an alternative the hypothesis that space is an '*effectus emanativus*' of God (*ibid.*, 99, 105), that bodies are parts of space to which God has imparted impenetrability (105f.), and that the motion of a body is thus merely the transfer of this impenetrability from one part of space to another of the same size and shape (106). The result of this theory, Newton remarks, is again the 'general' concept of space of Descartes as well as his concept of body (114); for physics nothing is changed. Thus, according to Newton's own admission there was no physical or natural-philosophical reason to prefer atomism to the Cartesian corpuscular philosophy or the 'artisan' interpretation of the analytic-synthetic method to the Cartesian interpretation.

Finally, it also cannot be assumed that, as atomism had prevailed in England, it was simply accepted uncritically by Newton; on the contrary: Newton's contemporary, Robert Boyle, even asserted that a decision in favor of one or the other of the alternatives was not at all necessary. The "Atomical and Cartesian Hypotheses", wrote Boyle, agree in their opposition to the

Peripetetic and other vulgar doctrines; the differences between them seem to concern "rather metaphysical than physiological notions" and rather "the explication of the first origin of the universe" than the explanation of the "phenomena" of its current state. From these and other considerations, but especially because "both parties agree in deducing all phenomena of nature from matter and local motion", Boyle drew the conclusion that both hypotheses could be considered as one philosophy, "which because it explicates things by corpuscules, or minute bodies, may (not very unfitly) be called corpuscular" (*Works* I, 355).

It is not surprising that Boyle cites the clock model, to explain that, just as little as we can by observing a clock infer with certainty whether it is driven by a spring or a weight, can we determine with certainty in science which particles and motions produce a phenomenon (cf. *Works* II, 45). As he adds at another place, this is also not necessary (*Works* IV, 235f.).

Neither mathematical natural science nor the success of mechanistic natural philosophy against scholasticism demanded that essential properties be ascribed to a single particle of matter in empty space. Furthermore, for Newton no 'naive' generalization of artisan experience can seriously be considered due to the various alternative already existing at the time. The equal value of the corpuscular theory of Descartes, which did not share the 'Newtonian' principle on the relation of element and system, and of atomism had practically been recognized by Newton. On the basis of this circumstance, Boyle had pointed out the hypothetico-deductive character of even the theory of matter. However, the basic postulate on the relation of element and system and the atomism connected with it prevailed in England as well as – significantly almost a century later – in France.

Newton's decision for atomism and his interpretation of the analytic-synthetic method in analogy to the mechanical process of assembling and dismantling can in fact appeal to a tradition in natural philosophy, but they cannot be *explained* simply as acceptance of this tradition. For atomism did not represent the only tradition of mechanistic natural philosophy. The Cartesian corpuscular philosophy must have been at least as widespread as atomism. As was shown above, Newton's critique of Descartes did not require a decision in favor of atomism. The reasons for this decision, we may now conclude, are not to be found in natural philosophy. It must therefore be examined whether the 'artisan' interpretation of the analytic-synthetic method was recognized in some other scientific discipline and how it was justified.

CHAPTER V

THE CONCEPT OF ELEMENT IN THE SYSTEMATIC PHILOSOPHY OF HOBBES

Newton's major work bears the title *Philosophiae Naturalis Principia Mathematica*. The expression *philosophia naturalis* points to a system of science which is divided into three main branches: *philosophia prima* (metaphysics), *philosophia naturalis* (natural philosophy), and *philosophia civilis* (social philosophy). This division was in common use in the 17th and 18th centuries.[1]

The *philosophia civilis* can be excluded as the possible direct source of the presupposition which guided Newton's interpretation of the analytic-synthetic method; neither the physical content of the assumption (the system of the world is composed of particles, etc.) nor a general proposition from which the former could be derived can be grounded in social philosophy. A general proposition on the basis of which a physical proposition could be formulated can thus only be contained in *philosophia prima*. If such a philosophical proposition for some reason or other is taken to be evident, then it is also understandable that a physical proposition can be derived from it and can be accepted as long as it has not clearly been falsified.

With regard to the familiar division of the system of sciences into *philosophia prima, naturalis*, and *civilis*, it follows that, if the origin of Newton's basic postulate on the relation of element and system is supposed to lie in *philosophia prima* and if this postulate is not a principle of logic, then it can only be a principle arrived at by generalizing propositions from *philosophia naturalis* and *civilis*. For only propositions which are valid in both *philosophia naturalis* and *civilis* can be taken as universal philosophical propositions and thus can belong to *philosophia prima*. However, it is possible that a principle on the relation of element and system is postulated in *philosophia prima*, which obtains in both the other philosophical disciplines (natural and social philosophy), which however includes some determinations which are generalizations of propositions, say, of social philosophy, determinations which – as long as they are not refuted by natural philosophy – seem applicable in this area, too.

The following analysis will take up the question of whether the Newtonian principle on the relation of element and system was a recognized part of *philosophia prima* and whether this circumstance can explain Newton's accepting the principle. But since there were a number of different philosophical

systems in the 17th century, this analysis will be limited at first to those which had laid claim to being scientific in Newton's sense, i.e., empirical mathematical. To limit the field of investigation still further, we can start with a hint from Leibniz.

"Real absolute space", said Leibniz, "is an idol of some modern Englishmen", 'Idol' he wanted understood in Bacon's sense (Leibniz's 3rd Letter, §2). A month later he made the remark more precise, asserting that the concept of absolute space was an '*idolon tribus*' in Bacon's sense (Letter to Rémond, March 27, 1716, GP III, 673f.; Robinet, 61f.). '*Idola*' in Bacon's sense are 'false notions', prejudices which hinder the advance of science (N.O. I, 38). '*Idola tribus*' are those prejudices which have their foundation in human nature, species prejudices (*Idola tribus sunt fundata in ipsa natura humana, atque in ipsa tribus seu gente hominum*, N.O. I, 41).

'*Idola tribus* of some modern Englishmen' is thus at first sight self-contradictory: general species prejudices cannot be limited with respect to place (England) or time (modern) or number (some). With these considerations Leibniz introduces a new concept for the prejudice of a particular part of society at a particular time. If we limit ourselves to 'modern Englishmen' and then to those who systematically pursued *philosophia prima*, physics, and social philosophy, there is only one philosopher who fits the bill: Thomas Hobbes.[2] His philosophy will be examined to see whether there is an object common to *philosophia naturalis* and *philosophia civilis* which can be examined with the help of the analytic-synthetic method, and, if there is, whether Hobbes likewise infers from phenomena to 'essential properties'. The purpose of the examination is to find out whether a philosophy known in England contained Newton's basic principle on the relation of element and system and perhaps even justified it, so that this principle could seem obvious to later scientists.

It is of course clear from the start that the presupposition sought after cannot be expressed in exactly the same words in both branches of philosophy; the expression in each field corresponds to the particular object and must in each philosophical discipline prove to be the particular formulation of the same general philosophical principle.

Generalized philosophically, Newton's presupposition reads: A system is composed of equal (similar) elements, whose essential properties are independent of their existence in a system.

(a) *Philosophia Prima*

According to Hobbes, "Philosophy is such knowledge of effects or appearances, as we acquire by true ratiocination from the knowledge we have first of their causes or generation: and again of such causes or generations as may be from knowing first their effects" (*De Corpore* I, 1, 2; *English Works* I, p. 3).

From this it follows that anything that is not generated or has no appearances cannot be the subject matter of philosophy (*ibid.* I, 1, 8); the subject of philosophy is the 'body' (*corpus*), that is, either the 'body naturall' as subject of natural philosophy (*philosophia naturalis*) or the 'body politique' as the subject of social philosophy (*philosophia civilis*).[3]

Knowledge must imitate production. The object, which is taken as an artifact, must first be separated into its elements; the properties of these elements must be made known, in order then theoretically to reconstruct the system by compounding the elements in thought. The method is thus analytic-synthetic (*ibid.* I, 6):

> For everything is best understood by its constitutive causes (*ex quibus rebus constituitur*). For as in a watch, or some such small engine, the matter, figure, and motion of the wheels cannot well be known, except it be taken insunder and viewed in parts (*De Cive, Opera* II, 145; *Works* II, xiv).

But, whether the analysis leads to properties of a system-element or to properties of the element, which belong to it independently of the system, is not determined here. The question is to be answered by examining two objects: the essential properties of the elements of the system of the material world as a whole and those of the elements of a subsystem, society.

(b) *Philosophia Naturalis*

That the essential properties of a natural body are independent of the world system, is taken by Hobbes as simply self-evident. His reconstruction in fact begins by abstracting from the system:

> In the teaching of natural philosophy, I cannot begin better (. . .) than from *privation*; that is, from feigning the world to be annihilated (*De Corpore* II, 7, 1; *Engl. Works* I, 91).

Then comes the next step:

"Let us now suppose some one of those things [which were just annihilated – G.F.] to be placed again in the world, or created anew" (*De Corp.*

II, 8, 1; *Engl. Works* I, 102). This newly created thing will take up a part of space, but will also necessarily "have no dependence on our thought" (*ibid.*). As an extended thing it is called a body; and because it exists independently of our thought: "a thing subsisting of itself" (II, 8, 1; *Engl.* I, 102). The essential property of a body is only its extension (and thus its form, too) (II, 8, 3). Other properties such as "to be at rest, to be moved, colour, hardness and the like, do perish continually and are succeeded by others; yet so as that the body never perisheth". They are thus not essential qualities (II, 8, 3; *Engl.*, 104).

While it is not essential to a body whether it be moved or at rest, the body must nonetheless be in one of the two states. Continuing the thought experiment, let it be supposed, "that some finite body exist and be at rest, and that all space besides be empty; if now this body begin to be moved, it will certainly be moved in some way (*per aliquam viam*)"; it also "will always be moved, except there be some other body besides it, which causeth it to rest" (*De Corp.* II, 8, 19; *Engl.*, 115; cf. II, 9, 7; IV, 30, 4; *Leviathan*, ch. 2).

The 'law of inertia' thus applies to the state of motion of a body in empty space. As opposed to Newton's law of inertia, this 'law' is not traced back to a 'property' or 'force' of the body but rather to the axiom that nothing happens without a cause. But since the cause of a change in the state of motion can only be the collision with another body, it follows that the state of motion is conserved in empty space. The question, what exactly the proposition that a body moves in empty space is supposed to mean, is not even considered. Hobbes' presupposition thus reads: the essential properties of a body and the conservation of its state of motion are independent of the system. This presupposition – as was shown with Newton – cannot be grounded. The validity of the thought experiment depends on the assumption that one could destroy the entire world with the exception of one body without changing the properties of the body or the laws of its motion.

(c) *Philosophia Civilis*

To ascertain the laws that ought to hold in a commonwealth, it is necessary first to know which natural laws apply to man before human commandments are introduced. Like every object of science, man and the state are to be taken as artifacts:

> *Art* goes yet further, than just producing automata, imitating that Rationall and most excellent worke of Nature, *Man*. For by Art is created that great LEVIATHAN called a COMMON-WEALTH, or STATE, (in latine CIVITAS) which is but an artificiall Man (*Leviathan*, Introduction, 81).

Here, too the point of departure is a system, and one has to determine by analysis the properties of the elements. The subsequent synthesis will produce the system as it results from the essential properties of the elements. From this it can in turn be known what must be done to construct the system wished for. The laws to be established must have a foundation in the essential properties of the elements:

> so to make a more curious search into the rights of states and duties of subjects, it is necessary, I say, not to take them insunder, but yet that they be so considered as if they were dissolved; that is, that we rightly understand what the quality of human nature is, in what matters it is, in what not, fit to make up a civil government, and how men must be agreed amongst themselves that intend to grow up into a well-grounded state (*De Cive*, Preface, *Opera* II, 146; *Works* II, xiv).

It is thus presupposed that the elements of the state are individual men, whose 'nature' is to be examined. To determine the essential properties of the individual men, there are in principle two possibilities. First of all, one can start with physics, which investigates the properties of material bodies and the laws of motion, and from there advance to the physiology and psychology of man. On the other hand, one can start with the given social system and determine the properties of the elements; the elements are individual men, and anyone can examine their properties by introspection – self-knowledge.[4] The natural property of man that is important here is the appetite or desire for certain things and the aversion to others. This endeavor is the beginning of voluntary motion towards or away from an object; objects of the first kind are called good, those of the latter kind are called bad. The desire (or aversion) which follows upon deliberation is the will, which is immediately connected to the act (*Lev.*, Ch. 6). The means to obtain a sought after good is defined as the power of a man (Ch. 10); this is partly natural, partly acquired.

> And because the power of one man resisteth and hindereth the effects of the power of another: power simply is no more, but the excess of the power of one above that of another (*Elements of Law Natural and Political*, Part i, Ch. 8, Sect. 4; quoted by Macpherson, 36).

The power of a man to obtain a good is thus not an absolute but a relative quantity. It is determined by the relation of his power to that of all others who endeavor to acquire the same good (*Lev.*, Ch. 13, 184).

From this arises a "general inclination of all mankind, a perpetuall and restlesse desire of Power after power, that ceaseth onely in Death" (Ch. 11, 161). The restless striving of everyone for power presupposes that at least some few have such an unlimited desire, by which the others are forced

likewise to strive for it, in order to obtain enough power against the others to appropriate the goods necessary for self-preservation. For "the greatest of goods for each is his own preservation" (*De Homine*, Ch. 11, 6).[5]

With regard to self-preservation all men are alike; for even the weakest is strong enough to kill the strongest, whether by cunning or by alliance with others (*Lev.*, Ch. 13, 183). A mutual mistrust is the necessary consequence.

> And from this diffidence of one another, there is no way for any man to secure himselfe, so reasonable, as Anticipation; that is, by force, or wiles, to master the persons of all men he can, so long, till he see no other power great enough to endanger him (*Lev.*, Ch. 3, 184).

> Hereby it is manifest, that during the time men live without a common Power to keep them all in awe, they are in that condition which is called Warre; and such a warre, as is of every man against every man (Ch. 13, 185).[6]

It is unessential in this connection, how Hobbes has men secure peace through a contract on the basis of one of the natural properties of man – reason (Ch. 13); more important is the procedure by which he determines the natural properties of man. All philosophers who have examined the foundations of society and have thought it necessary to go back to the state of nature, criticized Jean-Jacques Rousseau,

> by speaking ceaselessly of need, voracity, desire, oppression, and conceit have transferred ideas to the state of nature which they have found in society. They spoke of the Savage Man and portrayed the Civilized man (*Disc. sur l'inégalité, Oeuvres Complètes* III, 132).

When Hobbes determines the 'properties' which he ascribes to the natural man and from which he infers the necessity of a war of every man against every man and of a treaty of peace, he presupposes certain social relations. It is presupposed that the relevant constitutive elements of society are individuals (not, for instance, families or classes), that all are free and equal, that the objects of their needs are available only in limited amounts (only because of this does the struggle become necessary), and that men will join together against others but not with others for cooperative labor, etc.

Hobbes's analysis, which was supposed to help comprehend the state of nature, consisted in "setting aside" the laws that held in society "but not the socially acquired behavior and desires of men" (Macpherson, 22). The method is thus the same as that which Hobbes applied in his physics: the laws inferred from the phenomena of the system are attributed to the elements as properties, as if they were valid independently of the system in which the elements are to be found. Hobbes's analysis and his subsequent determination

of the essential properties of 'man' present the same failing which has already been pointed out in Newton's application of the analytic-synthetic method. It is presupposed that the respective systems under investigation are composed of equal elements whose essential properties belong to them independently of the system in which they are elements.

Macpherson has criticized Hobbes's method:

> The temptation was to think that everything could be explained by the necessary motions of the discrete individuals. . . . The resolutive-compositive method did not in itself require this heavy reliance on individual motions. . . . But Hobbes was, after all, pioneering the application of that method to political phenomena, and his less than perfect use of it is understandable (Macpherson, Introduction to *Leviathan*, 57f.).

If this interpretation were accurate and if later social theoreticians applied the analytic-synthetic method without making the presupposition mentioned, then it could no longer be taken in *philosophia prima* as a basic principle. In that case, the conjecture that Newton's assumption was taken from *philosophia prima* would at least have to be modified. Thus, the first step will then be to examine whether this assumption was also made by later theorists.

CHAPTER VI

THE CONCEPT OF ELEMENT IN 18TH CENTURY SOCIAL PHILOSOPHY

The following presentation is intended to demonstrate that the Hobbes-Newtonian assumption, that phenomena are to be traced back to the essential qualities of elements, which are attributable to them independently of their existence in a system, also remained a fundamental assumption of later social theories.

It is of course clear that the investigation must be limited to a few representatives of social philosophy after Hobbes and to the question, whether they accept the Hobbes-Newtonian assumption. As representatives we may take Jean-Jacques Rousseau and Adam Smith. Rousseau is appropriate, first of all, because it was he who first criticized precisely Hobbes's use of the analytic-synthetic method and pointed out that the properties which Hobbes ascribed to 'man' were 'properties' of men under particular social relations, and furthermore, because Rousseau espoused a political theory opposed to that of Hobbes. Smith also seems appropriate for two reasons: his political theory differs both from Hobbes's and from Rousseau's, and, as the first representative of classical political economy, Smith can be considered to be a social *scientist*.

It may thus be supposed that, if both Rousseau and Smith shared the Hobbes-Newtonian assumption, then it was probably generally held by scientists and philosophers of the age. Afterwards, we shall inquire into the reasons for this.

1. JEAN-JACQUES ROUSSEAU

(a) *The Autarchy of Natural Man*

Earlier theoreticians of natural right, criticized Rousseau, "have transferred to the state of nature ideas which they acquired in society".[1] Since Rousseau here expresses his conjecture that the natural man is different from the social, he must pose the question, how he – who himself lives in society – can obtain empirically grounded knowledge of natural man (*Discours*, 122). Rousseau tries two approaches to a solution of the problem: first of all, he draws on reports about peoples at a less advanced stage of development than

the Europeans and draw conclusions about the earlier state of his own society; secondly, he believes he can by observations within his own society infer introspectively the properties of natural man.

The observation of less developed peoples may give important indications, but, taken in itself, it does not suffice to gain adequate knowledge of man in a state of nature, since most of the known "wild peoples" (*peuples sauvages*) "are rather far from the first state of nature" (170). Rousseau relies, therefore, on the second method, on introspection, and attempts, by abstracting from all properties which seem dispensible for the state of nature, to determine the necessary properties of man. His investigation uncovers two original properties: the interest in self-preservation and in one's own welfare and a natural aversion to seeing a sensitive creature, especially one of our own kind, suffer pain or death. He believes he can from these principles "derive all the rules of natural right" (126).

Now, these remarks of Rousseau's do not yet demonstrate that he understood the properties mentioned above to be 'essential' in the sense of Hobbes and Newton, that is, to be properties which also belong to a single person. On the contrary, the properties were determined on the basis of the investigation of a social man and not of one living alone. However, the purpose of the investigation was not to determine the properties of social but of natural man. It must be asked whether, according to Rousseau, the natural man lived in a social grouping or alone. Rousseau's answer is decided: in the state of nature men lived alone scattered around among the animals, and they met each other only by accident; perhaps the same two individuals never met each other twice in their lives (146, 136). Society is not naturally necessary (151), and man feels no need for his own kind; on the contrary, natural man was physically and psychically autarchic, self-sufficient (*se suffisant à lui-même*, 159f.; cf. C.S. II, 7, *Oeuvres* III, 381).

(b) *Division of Labor and the Autarchy of Natural Man*

Neither in the description of 'wild peoples' nor in the reports of solitary human individuals living among animals could Rousseau find any support for his assumption that natural man was autarchic and lived alone in the woods. At no point does he justify this view systematically; the reasons for the assumption can be inferred only indirectly: they lie in the second way he applies the analytic-synthetic method.

Rousseau's critique of Hobbes and Locke is directed against their starting from an age in which there were enough reasons for men to live together and

against their transferring this situation to a condition in which the men had no reason at all to live alongside others (218, n. 12). The reason which necessitated social life is explicated by Rousseau in an important passage:

> ... as long as (men) applied themselves only to works which a single person could do and to arts which do not require the cooperation of many hands, they lived free, healthy, good, and happy as far as they could by their nature and continued to enjoy among themselves the pleasures of an independent commerce (*Discours*, 171).

This changed with the invention of metallurgy and agriculture (the first forms of productive 'labor' as opposed to gathering, hunting and fishing), which represented the first forms of specialized division of labor; from then on the individuals had to rely on one another: the 'smith' on the foodstuffs produced by the 'farmer' and the 'farmer' on the tools fashioned by the 'smith'. As soon as the form of production based on the division of labor was established, social life becomes necessary.

Between the state of nature, in which men lived alone and autarchic, and the developed social relations based on the division of labor, Rousseau places intermediate steps (cf. e.g., 171f.); but more important than these connecting links is the fact that from the developed social relations known to him of peoples in the stage of barbary he extrapolates an original state of nature, in which there were supposedly no social relations at all. Even at the first stage of socialization, a combination of individuals might have been advantageous (for instance, hunting: 166f.) but by no means *necessary*, the solitary individuals remain in principle independent, that is, autarchic.[2]

From these deliberations of Rousseau's the methodological path by which he arrived at the assumption of an unsocial state of nature can be surmised. The empirical object of analysis was contemporary society, the investigation of which – after appropriate abstractions – was supposed to allow inferences back to the state of nature. If then in the society he investigated, the sociality of the otherwise apparently unsocial men was grounded in the division of labor (which in turn was mediated by the exchange of the products of labor), then it follows, after abstracting from the division of labor or by extrapolating to a social state in which no division of labor had yet been introduced, that in the state of nature the individuals could have lived independently of one another.[3]

Based on this and the earlier cited deliberations, Rousseau concludes that the natural man lived alone and attributes to him the 'essential properties' of self-preservation and compassion. The weakness of Rousseau's argument need not concern us in the present connection; what is important is, that he

shares the Hobbes-Newtonian basic principle, that phenomena are to be traced back to essential properties of a single element, and that he, just like Newton, runs into difficulties as soon as he has to do with properties which consist in a relationship. Thus Rousseau can attribute compassion, for instance, to a person living in the woods among animals (154), since he can also feel compassion towards the animals; but Rousseau must also relate compassion "especially to those of his own kind" (*ibid.*), because otherwise after the transition of primitive man to hunting, the life of those of his own kind would not be secure (and Hobbes would be vindicated). This solution, too, is unsatisfying because according to Rousseau the natural man can distinguish neither species nor genera (149); he can scarcely even recognize individuals of his own species as such (219, n. 15). It thus remains unclear why the *pitié* refers especially to those 'of his own kind', nor can it be grounded why the natural man satisfies his sexual instinct with a conspecific and not with some other animal.

2. ADAM SMITH

Adam Smith was hailed in his own lifetime as the 'Newton' of his field, and he himself took 'Newton' as the highest distinction for a scientist.[4] The reason that 'Newton' is a synonym not just for a *natural* scientist (natural philosopher) but for a scientist in general lies in the fact that Newton applied a method which holds for all branches of philosophy; this method maintains that:

> we may lay down certain principles known or proved in the beginning from whence we account for the severall Phenomena, connecting all together by the same chain .... This method which we may call the *Newtonian method* is undoubtedly the most Philosophical, and *in every science whether of Moralls or Natural philosophy* etc., is vastly more ingenious and for that reason more engaging than the other.[5]

Society, which for the purposes of scientific investigation can be considered as a machine,[6] must be considered from two perspectives:

> All the members of human society stand in need of each others assistance, and are likewise exposed to mutual injuries (TMS II.ii.3.1.).

By "each others assistance" Smith means the social division of labor, for

> The unassisted labour of a solitary individual, it is evident, is altogether unable to provide for him such food, such cloaths, and such lodging, as not only the luxury of the great but as the natural appetites of the meanest peasant are, in every civilized society, supposed to require (ED, 562).

With the reference to the danger of "mutual injuries", Smith addresses the necessity of justice:

> "Society, however, cannot subsist among those who are at all times ready to hurt and injure one another"; without justice no society can survive (TMS II.ii.3.3).

The necessary functions of social life are thus the exchange of goods and services and the observation of justice; as such they constitute the two subjects of social science: political economy and jurisprudence. It is to be examined whether Smith explains these functions on the basis of 'essential properties' of a single individual.

(a) *Division of Labor*

Smith wants to explain the so advantageous social division of labor neither teleologically – with reference to its effects[7] – nor by the assumption of different talents.[8] On the contrary, he asks "from what principles in our nature" can the division of labor best be explained (LJ(B), 492), and believes such a principle is

> a certain propensity in human nature . . . the propensity to truck, barter, and exchange one thing for another.[9]

On the basis of this 'principle' Smith then explains how from occasional exchanges a thoroughgoing division of labor was developed. "As right as it is", remarked Karl Marx on Smith's view, "that private exchange presupposes division of labor, it is quite false that division of labor presupposes private exchange. Among the Peruvians, for instance, labor was extraordinarily divided although no exchange of the products as commodities occurred".[10]

(b) *Justice*

Smith also traces the second essential function of society, justice, without which society "must in a moment crumble into atoms" (TMS II.ii.3.4), back to a primitive principle in human nature, "resentment".[11]

Resentment arises from the injured self-love of a man who has been done injustice (TMS II.ii.1.4); that a person feels resentment towards a wrongdoer, who has injured not him but another, rests on the fact that he can sympathize with the suffering of the afflicted person (TMS II.i.3.3; cf. II.i.2.5). Resentment is thus not an original instinct but derived from the self-love of the injured party and from the disapprobation of the motives of the person who

does mischief; for the spectator, resentment is derived from sympathy with the suffering of the injured person and from disapprobation of the motives of the offender (TMS II.i.5.4–5).

These two – self-love and sympathy – cannot be traced back to other qualities of man and are thus original. They, and the sentiment of resentment derived from them, do not change with the development of society; before the institution of 'civil government' resentment is the reason for revenge of one private person on another (TMS II.ii.1.7); the same sentiment is the reason for punishment under civilized relations. In both cases the social phenomenon examined is traced back to one and the same original property of man.[12]

(c) *Autarchy*

Smith maintains not only that the original properties do not change, but also that they belong to every single living person; this is clearly recognizable even in his introduction of the 'propensity to barter' to explain the division of labor. For if this principle is supposed to be sufficient to explain the origin of the division of labor, then the division of labor must be just as eternal as the principle itself; if this is not the case, as Smith shows with examples, then the propensity to barter which he cites is obviously not sufficient to cause the division of labor. The resolution of this apparent contradiction is achieved by assuming a pre-societal existence of men. As soon as the men endowed with the 'propensity to barter' form a society, the process of division of labor begins. Thus Smith traces social phenomena back to essential properties of man, which also belong to him as a single individual.[13]

CHAPTER VII

THE RELATIONSHIP BETWEEN NATURAL AND SOCIAL PHILOSOPHY IN THE WORK OF NEWTON, ROUSSEAU, AND SMITH

Newton's justification of the theory of absolute space presupposed that the material world is composed of equal particles, whose essential properties would belong to each and every particle even as a single particle in empty space. In philosophical generalization, this assumption of Newton's maintains that a material system is composed of equal elements, whose essential properties are independent of their existence in a system. In the chapter above it was shown that the same presupposition also lies at the root of the *prima philosophia* and the *philosophia naturalis* and *civilis* of Hobbes as well as of the social philosophy of Rousseau and Smith. Whereas Hobbes himself had explicitly drawn a connection between natural and social philosophy, Newton did not deal directly with social philosophy and metaphysics; Smith and Rousseau, on the other hand, concentrated precisely on social philosophy and did not concern themselves explicitly with natural philosophy and metaphysics.

Nonetheless, all three theorists believed in a relationship between the theory of nature and the theory of society; Rousseau and Smith seem even to have drawn on insights of natural science in order to be able to explain social phenomena. It will now be shown that, in so far as a relationship can be established between theory of nature and social theory, it is to be done at the level of *philosophia prima*.

(a) *The Supposed Analogy Between Natural and Social Philosophy*

At the end of his *Opticks* Newton sums up once again the results of his investigations using the analytic-synthetic method and concludes:

> And if natural Philosophy in all its Parts, by pursuing this Method, shall at length be perfected, the Bounds of Moral Philosophy will also be enlarged (*Opticks*, Qu. 31, 405).

The duties towards God and towards men will then be grounded in the knowledge of the 'first cause', his power over us, and the benefits we receive from him, which "will appear to us by the Light of Nature". The relationship

between natural and moral philosophy thus consists in the former's bringing to light knowledge about the divine plan of the world, which includes the destiny of the human race – knowledge which must be taken as the basis of any moral philosophy.[1]

Rousseau seems to establish a scientifically usable relationship between natural and social philosophy by drawing on the laws of motion of a system of moving bodies as a model for society.

The social contract, writes Rousseau, becomes necessary because men arrive at a point at which the obstacles to their self-preservation can no longer be overcome by the forces of each single individual:

> Since men cannot create new forces, but merely combine and control those which already exist, the only way in which they can preserve themselves is to form by aggregation a sum of forces which can overcome the resistance by applying them through a single body (*mobile*) and letting them act in concert" (C.S. I. 6, 360).

The constant amount of force of the single individuals guarantees that, with the formation of a political body by the social contract (C.S. II.6, 378), the compounded force of all subjects, which constitutes the force of the government, remains constant ("*Or la force totale du Governement, étant toujours celle de l'Etat, ne varie point*", C.S. III. 2, 400; cf. 401).

Rousseau conceives of these 'forces' as directed, that is, as vectors. Therefore, the ideal situation is one in which the force of the government is equal to the arithmetic sum of the forces of all the subjects, that is, in which "there are no opposed movements, which counteract one another".[2] Rousseau does not merely implicitly employ the analogy between the force of an individual (as part of the sovereign) and a vector – between the force of the government and the vector sum of all – but he also uses an explicitly physical term to designate the sum: '*quantité d'action*', that is, 'work' (*msa* = *W*) (C.S. III.1, 398). The ideal situation is thus the one in which the forces of all individuals act on the compound body which they form in the same direction, parallel to the same line.

The same model of society as a system of moving bodies is also used by Smith. In a metaphor he compared the individual in a society with a chess piece, which

> has a principle of motion of its own, altogether different from that which the legislature might chuse to impress upon it. If those two principles coincide and act in the same direction, the game of human society will go on easily and harmoniously, and is very likely to be happy and successful. If they are opposite or different, the game will go on miserably, and the society must be at all times in the highest degree of disorder (TMS VI.ii.2.17; cf. also VII.iii.1.2; II.ii.3.4).

Smith thus uses the same analogy between society and a system of moving bodies as did Rousseau before him; he can therefore compare explicitly the unchangeable character of the 'governing principles' (or properties – G.F.) of human nature with physical laws of motion (TMS III.5.6; cf. Campbell, 59).

(b) *The Fundamental Analogy Between Natural and Social Philosophy*

The analogy which Hobbes, Rousseau, and Smith saw between the subject of mechanics and the subject of social philosophy consists in the conception of the individuals as moving bodies and of society as a system of such bodies. But it has been made clear that mechanics does not provide a usable model for social philosophy: Although Rousseau does indeed assume the conservation of force of the single individual and uses the metaphor of the compounding of forces for the social contract, he also maintains that the most perfect constitution (*législation*) of society is that in which the force of the entire social body is "equal to *or greater than* the sum of the natural forces of all the individuals" (C.S. II.7, 382). With this, the possibility of using vector addition in mechanics as a model for social science is given up; and it is precisely the increase of force by the compounding of many that is realized by the division of labor, upon which social life necessarily rests.

This possibility, that the force of society could surpass even the arithmetic sum of the forces of the individuals, is the focus of Smith's deliberations. According to Smith it is precisely the fact that in a society with division of labor "the productive power of labour" (WN I.i.1) is greater than the sum of the powers of all the individuals, which constitutes the difference between a 'rude' and a 'civilized' society (WN I.i.11).

The first positive analogy to be established between a society and a system of moving bodies consists in the fact that opposing motions of individuals, that is, the pursuit of opposing interests counteract each other, so that the algebraic sum would be less than the arithmetic sum. This insight is, however, nothing more than what is expressed in the old Latin addage: '*Salutis fundamentum republicae concordia populi*'. The comparison with a system of moving bodies adds nothing new.

There is also a second positive analogy, that maintains that the law-likeness of social life, just as that of a system of moving bodies, depends on the motions of the elements – i.e., here: the individuals – and thus cannot be manipulated arbitrarily.[3] The motions of the elements, as has been shown, depend on their 'essential properties'. From this Rousseau and Smith conclude that the construction according to a plan of a society, which is supposed to be

different from the existing one, requires a change of 'human nature'; Rousseau favors such an enterprise, Smith rejects it (cf. C.S. II.7, 380; TMS VI.ii.2.17).

The basic agreement between Newton, on the one hand, and Hobbes, Rousseau, and Smith, on the other, consists not in substantial determinations of the elements and their properties but in the determination of their respective subjects as systems, which consist of equal elements, to which essential properties are attributed independently of the system. The common ground thus lies in *philosophia prima* and can be formulated both ontologically ("A system consists of . . .") and methodologically ("A phenomenon is to be traced back to . . .").

(c) *Concept of Element and Experience*

The principle which determines the relation of element and system, can (with regard to the scientific work of the above mentioned theorists) represent either a presupposition of research or a generalization of scientific knowledge. The latter possibility was eliminated earlier in this analysis. The first possibility, too, that the principle represents an 'original presupposition' apparently does not hold; in traditional *philosophia prima* no such postulate can be found, and it is not 'evident' in the sense of logic.

A third possibility would be that the principle represented, on the one hand, a presupposition of scientific research and, on the other, a generalization of prescientific experience. In its physical sense the principle could be interpreted as a generalization of the artisan procedure of taking apart and putting together (a clock, for instance). Such an interpretation is, however, insufficient, for in the tradition of natural philosophy such a generalization had been considered and rejected by some theorists. Hence it could not have been adopted simply as a matter of course.

A comparable interpretation in regard to social philosophy seems more plausible: the 'essential properties' such as sympathy and compassion or even the 'propensity to barter' and the hypothetical autarchy of man seem to reflect experiences. For, if the social division of labor is traced back to an original propensity of every individual to barter and exchange, then this could be interpreted as the generalization of that specific form of division of labor which is mediated by the exchange of commodities and which Rousseau and Smith refer to. In this form of social division of labor, the products of the "labor of private individuals independent of one another" (Marx, *Capital*, 1, MEW 23, 57) are exchanged on the market; the exchange of commodities, which, as Smith had stressed, has the form of a contract, presupposes that

the exchanging parties recognize one another as proprietors and, in so far, as freemen and equals.[4]

If this situation is generalized ahistorically, every form of social division of labor then appears to be grounded on commodity exchange between independent producers, and it is intimated that, where there is no division of labor, the independence of the individuals is complete, they are autarchic.[5]

But even if it is admitted that experiences in a commodity producing society are a necessary condition for the assumption that society is composed of independent, in principle autarchic, individuals and that the properties of these individuals belong to them as single beings, nonetheless, this condition is not a sufficient reason for the assumption. To demonstrate that the social relations corresponding to commodity production are not necessary and universally valid, it suffices to draw a comparison to other forms of production. Thus, Marx, for instance, writes:

> Let us now transport ourselves from Robinson's island bathed in light to the European middle ages shrouded in darkness. Here, instead of the independent man, we find everyone dependent, serfs and lords, vassals and suzerains, laymen and clergy. Personal dependence here characterises the social relations of production just as much as it does the other spheres of life organised on the basis of that production (*Capital*, 1, 77; MEW 23, 91).

The reference to social relations can only then be taken as a sufficient explanation of the basic principle on the relation of individual and society if it is assumed that the theorists are familiar neither with different social relations (earlier or coeval) nor with social theories that are grounded on a different relation of individual and society. Only then could it be inferred that their view is a naive generalization of the social relations prevailing in their time. None of these conditions are met. Macpherson, who interprets Hobbes's theory with reference to the social relations of his time, considers the following social conditions for Hobbes's theory to have obtained: the "development of market society" "had created, *or was visibly creating*, an equality before the law of the market"; and secondly, "had replaced, *or was visibly replacing* hierarchical order by the objective order of the market, which did not require unequal rights for different ranks" (Macpherson, 90; my italics).

The restrictions added in each of the quoted passages are revealing: for if the development was 'visibly' leading from a feudal, hierarchical order of society to another, based on equality before the law and at the marketplace, then two social orders must have been 'visible': the feudal hierarchical society

and another one based on freedom and equality. These two orders were in fact not only 'visible' in principle, but also both were known to Hobbes from his own experience. Hobbes's father was a country preacher, his mother was descended from a line of yeomen; the expenses for Hobbes's education were paid by his uncle, a rich glovemaker. Hobbes himself after his studies at Oxford entered the service of the Cavendish family. "The contradiction", writes Christopher Hill, "is apparent. Hobbes, the small bourgeois, the clever boy making good at Oxford, is taken into the service of one of the most conservative of the great feudal families, which still ruled large tracts of the economically backward north of England".[6]

It can also by no means be imputed of Hobbes that he had no knowledge of theories of nature and of society based on a different relation of element and system. During his studies at Oxford (1603–1608) he studied the logic and metaphysics of Aristotle, and his familiarity with the Thomist social theory is evidenced by his critique of Cardinal Bellarmine.[7]

Much the same goes for Newton. It is improbable that he developed his theory as a naive generalization of artisan experience, and furthermore, it is established that he was aware of theories of nature which were based on a different principle of the relation of element and system.[8]

It is thus quite improbable that the assumption, that the appearances of a system are to be traced back to essential (system-independent) properties of the elements, is a naive generalization of everyday experience. On the contrary, with Hobbes the question must be asked, how the circumstance is to be explained that he seems to presuppose the – in reality *non-existent* – prevalence of social relations appropriate to a commodity producing society. With regard to Newton' theory of nature the question arises, why Newton, who had transcended the bounds of all artisan experience, nonetheless retained a principle of the relation of element and system, which was adequate for a craftsman's purposes but not adequate to his own theory.

In the third part of this analysis I shall attempt, with reference to the social history of England at the time of the Revolution, to reconstruct the inception of the basic principle of the relation of element and system; the mediation between this principle in social theory and the corresponding theories in *philosophia prima* and natural philosophy will be taken up in the fourth and last part.

PART THREE

ON THE SOCIAL HISTORY OF THE BOURGEOIS CONCEPT OF THE INDIVIDUAL

In this third part, the investigation turns to the social history of the bourgeois concept of the individual; in the fourth part I shall try to show that Newton's theory of absolute space is in the last analysis dependent on this concept of the individual. The present part will first reconstruct the origin of Hobbes's basic principle of the relation of element and system. After an outline of the social and political history of England on the eve of the Revolution (Chapter VIII), a sketch of the scholastic conception of the relation of element and system will be given (Chapter IX); and in the interpretation of Hobbes's social philosophy, I want to show that it is grounded in his anti-feudal position, and that Hobbes develops a political program for the establishment of civil society as a society of independent proprietors. Hobbes's basic principle of the independence of the essential properties of the elements from the system which they compose will prove to be a necessary assumption for grounding this theory. A further examination of the social history of England after the Revolution (Chapter X) will show that the development led to the establishment of a capitalist society, which could not be comprehended in all regards by Hobbes's model. The subsequent development of social philosophy (Chapter XI) led to a division corresponding to that between the political factions. The bourgeois-liberal social theory (Locke and Smith) introduced the premise that even those wthout property have a property in their persons and held fast to Hobbes's model and to the fundamental principle of the relation of element and system upon which it was based; the bourgeois-democratic social theory (Rousseau) likewise retained the Hobbesian model and demanded that everyone should have property in the means of production. Both theories (Chapter XII) thus applied the model of a society of small commodity possessors and could therefore also retain Hobbes's interpretation of the analytic-synthetic method.

CHAPTER VIII

ENGLAND BEFORE THE REVOLUTION

1. TOWN, COUNTRY, AND THE POOR

"Thomas Hobbes was born in 1588 and lived till 1679. His life thus extends from the defeat of the Spanish Armada to the beginning of the Popish Plot; from the year in which the independence of Protestant England was finally ensured to the period when the threat to restore Catholicism in England was less a political reality than the stunt of a Parliamentary party. The revolution of 1640 occurred after Hobbes was 50 years old, when his main ideas had taken form."[1]

In relation to the history of English absolutism, Hobbes's birth coincides with one of the high points of the progressive absolutism of the Tudors, and his decisive years were spent in the time of the controversies between Parliament and the Stuart monarchy, which succeeded in 1603 – the year Hobbes began his studies at Oxford. In a nutshell, Hobbes experienced the transition from progressive to reactionary absolutism, a development due not to the strengthening of feudalism in England but, on the contrary, to the development of bourgeois relations of production.[2]

At the beginning of the 17th century England was still an agrarian land: approximately 4/5 of the population lived in the countryside, and the towns – aside from London with its 200 000 inhabitants and a few smaller cities – were only sparsely populated.

The English village itself had been in a process of transition since the 15th century: increasing demand for wool on the domestic and export market led to rapid developments in sheep-farming and as a consequence to the 'enclosures' of the 15th and 16th centuries. In the 17th century the enclosures continued, among other things in order to satisfy the growing needs of the towns for foodstuffs by extending cultivation. In the course of this development, the traditional feudal lord, who resided amidst the peasant population and lived off their rents, gave way to the landowner – often a rich citizen from the town – who produced for the market and wanted to be able to dispose of the land unhindered by the feudal rights of the peasants. Those peasants not protected by property titles, the so-called copyholders, were driven from their land and became wage laborers on the newly organized

farms and in the industries of the towns or constituted the mass of 'paupers', who remained unemployed in the towns or vagabonded on the highways. The latter were gruesomely persecuted by special laws.

This development was however essentially confined to the Southeast of England; in the Northwest – and even more in Scotland – the feudal property relations were scarcely affected:

> We must be careful, however, not to antedate these developments, nor to exaggerate their extent: they are significant as the dominant tendency. Similarly the new progressive landowners and farmers catch the eye as the rising and expanding class perhaps more than could be justified statistically. The improving landlord was not typical before 1660 (Hill, *English Revolution*, 21).[3]

In the towns a rapid development of commodity production took place at the beginning of the 17th century. Favored by a long period of peace and the use of water-ways which eased transportation, trade flourished along the southern coast. The dominant branch of production was cloth production, which, although no technical revolutions occurred, passed from the small independent masters into the hands of capitalists, who in the form of the 'putting-out system' employed up to 1000 spinners and weavers working at home. In this development a key role was played by London; by 1600 London handled 7/8 of English trade; in the course of the next forty years London's exports increased five times over. London, where the royal court now resided permanently, constituted the largest domestic market for agricultural and industrial products.

All those who themselves had no commodities to sell were afflicted by the development of commodity production and the inflation prevalent from the middle of the 16th century onward. On the one hand the feudal lords who lived off their rents, but to a much greater extent the wage laborers, whose numbers increased and whose real wages – which were fixed by the Justices of the Peace, who were identical with the landowners – fell so much that they scarcely sufficed for survival. Even worse off were the masses of expelled and unemployed peasants. Despite all the laws binding them to their rural home parishes, despite all prohibitions of enclosures, the number of unemployed laborers, beggars, and criminals in the towns continued to rise. And although until the Revolution there were no organized revolts, nonetheless, there were sporadic uprisings by the peasants threatened by enclosures or by the unemployed in the towns. The fear of a possible uprising influenced the politics of both the parliamentary majority and the royal party.[4]

2. THE POLITICS OF THE STUARTS

In light of these developments, the Stuart kings (James I and Charles I) were forced into contradictory policies. Like all feudal landlords the King, too, ran into financial difficulties due to the rise in prices. The King was compelled again and again to sell estates and thus to lose influence as a feudal lord; on the other hand, he had to secure sources of income in the developing trade and industry by selling monopolies and instituting taxes. Although the sale of monopolies was pursued extensively – in 1621 the number was estimated at 700 – and damaged the free entrepreneurs and tradesmen as well as the mass of paying consumers (arousing hostility towards the crown) nevertheless the King profited relatively little, since the greatest part of the proceeds seeped off along the way.[5]

The monopoly system was completely discredited when the 'Cokayne Project' (1614) ended in a fiasco causing many bankrupcies and mass unemployment in cloth production.

Direct taxation was more remunerative than the sale of monopolies, but it involved the King in disputes with Parliament. Parliament, whose consent was needed, made its approval of taxes conditional on the fulfillment of certain demands. Taxes were passed only for short periods of time thus keeping the King in a state of dependence; and they were only granted on the condition that Parliament could oversee their expenditure and thus attain control over the executive. When Parliament was dissolved in 1625 and 1626 without voting the King the money he wanted, he tried to raise it by forced loans. Parliament answered with the 'Petition of Right' in 1628, which laid down that only taxes and loans consented to by Parliament could be raised, that no free man might be arrested without cause (that is, not by a 'special command of the King'), that no forced quartering of soldiers was to be allowed, and that all martial law commissions were to be revoked. These measures, which were to prevent the financial independence of the King as well as the establishment of a standing army, would have taken from the King all possibility of ruling absolutely. The open struggle for sovereignty had begun. Parliament was dissolved by the King in 1629.

In this struggle between Parliament and the King, Parliament was supported by the free tradesmen and entrepreneurs in the towns, by the modern landowners and the yeomen in the country. The King, on the other hand, was compelled, the more dependent he became on Parliament, to consolidate his power with the aid of the feudal lords and the Church hierarchy.

3. THE CHURCH

'No Bishop – no King.' On this epigram of James I, Charles I expanded: "People are governed by the pulpit more than the sword in times of peace. As the Church can never flourish without the protection of the crown, so the dependency of the Church upon the crown is the chiefest support of royal authority" (Quoted by Hill, *Century*, 74).

The importance of the Church for political order is to be attributed both to the social and state functions which it exercised as well as to its dominant role in the ideological sphere. Church officials were not only responsible for the care of the poor, they also assumed those administrative functions which were not exercised by the 'official informers' or the Justices of the Peace and which could not be exercised by the crown, which possessed no bureaucracy of its own. Officials of the Church were thus at the same time officers of the state.

It thus hardly comes as a surprise that "the abuses and extravagances of preachers in the pulpit have been in all times suppressed in this realm . . ." as James I reported in 1622, when he introduced a number of new regulations for sermons, which among other things forbade preachers from advocating restrictions on "the power, prerogative, jurisdiction, authority or duty of sovereign princes".[6] Furthermore, the preachers had the duty (as they had had since the days of the Tudor monarchy) to preach the divine right of kings – on at least one Sunday per quarter as the Congregation of 1640 determined.

Besides the constant though often unsuccessful attempt to determine the content of the sermons, the Stuart kings and the Church hierarchy, too, tried to stop preaching altogether. In 1622 James I ordered that instead of Sunday afternoon sermons the Catechism should be expounded; in 1633 Charles I ordered them stopped. Laud, the former Bishop of London (and since 1633 Archbishop of Canterbury) and Charles's right hand, wanted to emphasize "the beauty of holiness" – by which he meant a ceremony similar to that of the Catholics – instead of sermons. By means of the ministers, who were nominated by a patron – a lay or clerical lord of the manor – and appointed by the bishop, to whose authority they were subordinated, the Church could exercise extensive control. On the other hand, the 'lecturers' were not subject to episcopal authority; these were preachers who were paid by wealthy persons or by the parish and who occupied vacant minister posts – in 1603 according to an episcopal estimate more than a third of the positions were vacant. They preached the opinions of their patrons, who as a rule were

'modern' landlords or rich citizens of the towns. In addition to this consequence of vacant positions, the Church hierarchy was also confronted with another problems, namely, the increasing influence of the Jesuits: "It was this universally admitted lack of competent protestant preachers that made the invasion of England by learned, well-trained and wholly devoted Jesuits so dangerous to the precariously balanced Elizabethan settlement. The Jesuit martyrs formed a marked contrast to the average rude and uneducated English parish priest" (Hill, 'The Preaching of the Word', 54).

In light of this development, the Church hierarchy and the bourgeoisie had a common interest in relieving the lack of ministers. But just as much as their ideas on the preachers they wished for diverged, so too did their suggestions differ on how to relieve the lack of ministers. While the bishops sought to have the monastical estates returned or to have the present owners pay for the preachers, the bourgeoisie demanded that they be paid for from the revenues of the bishops. In some places, especially in Scotland, Laud was able to force the episcopal solution, however, only by injuring the property rights of the possesors thus contributing to the identification of Puritanism and defense of property as well as to the identification of his own and the King's policy with feudal 'papism'.

4. PROPERTY AND PROTESTANTISM AGAINST FEUDALISM AND PAPISM

"Protestantism, patriotism, and property were closely linked. The association of ideas was strong and popular. The danger from Catholicism was both real and imaginary. Few English Catholics were Spanish fifth columnists. . . . Yet the Jesuits certainly wanted a forcible reconversion of England, and if the Catholic cause had prevailed in the Thirty Years' War they might have got it" (Hill, *Century*, 58).

Originally, the separation of the English from the Roman Church was the expression of England's development to a nation state. But ever since the Stuart kings had begun a policy of reconciliation with Counter-reformation Spain, the defense of the English national interests became the task of Parliament and grew to be identical with anti-Spanish, Protestant politics on the continent. When Parliament in 1621 demanded war against Spain – to prevent the victory of the Counter-reformation on the continent and especially to free England's trade from Spanish constraints and to win colonies for England – James I dissolved it; and the Spanish ambassador Gondomar, who had become one of the most influential advisors to the King, could remark

with satisfaction that this action of the King's was "the best thing that has happened in the interests of Spain since Luther began to preach heresy a hundred years ago". In 1623 Prince Charles attempted to negotiate a marriage with the Spanish Infanta; his offer included extensive concessions to English Catholics, concessions which were in fact made when Charles finally married the likewise Catholic Henrietta Maria of France.

Besides the disadvantages in foreign policy and trade which were to be feared from a policy amicable to Catholicism and Spain, the interests of those landowners who had acquired the estates of the dissolved monasteries during the Reformation were threatened. Whether it was the attempt to re-catholicize the country, the alliance with Spain, the agreement with Louis XIII to crush the Protestant fortress of La Rochelle, or the domestic and Church policy of Stuart kings and Anglican bishops, from the point of view of the bourgeois entrepreneurs, merchants, and landowners, the Counter-reformation, feudal rule, monopoly, support of feudal monarchies in the Thirty Years' War were one and the same policy of a feudal and papist monarchy. The Grand Remonstrance of Parliament counted in the same breath among the protagonists of this policy: the bishops, 'Jesuited Papists', and such councillors and courtiers who for private advantage support the interests of 'foreign princes or states'.

5. PRACTICAL AND THEORETICAL STRUGGLE FOR SOVEREIGNTY

From this brief overview of the period preceding the English Revolution, we can see that bourgeois relations of production can by no means be looked upon as the predominant relations. Undoubtedly, commodity production was relatively developed, but this development was more or less confined to the Southeast of England and was hampered by state regulation. There can be no talk of a 'market society' (Macpherson) in prerevolutionary England, not even that the development was 'visibly creating' a market society. What was 'visible' to sharp-sighted contemporaries was that the struggle for a bourgeois social order lay behind the day to day political controversies; the outcome of these controversies was not at all 'visible'.

Much the same goes for the ideological sphere, both for the moderate form of Anglican Protestantism and for the more radical varieties. On the Catholic attempts at restoration, Hill writes: "On a world scale [i.e., in Europe] two ideologies were in conflict, and it was by no means clear that Protestantism was not going to be driven under, as so many heresies had been before. In the sixteen-twenties and -thirties the outlook was perhaps even blacker than one

or two generations earlier" ('The Preaching of the Word', 50). With regard to the political controversies in England he confirms a similar state of affairs: "Looking back, we describe the early seventeenth-century conflicts as a struggle for sovereignty. Who was to be the boss, the King and his favourites, or the elected representatives of the men of property? Contemporaries did not see it in this light. Only Royalist thinkers had a clear theory of sovereignty" (Hill, *Century*, 62).

This situation is not surprising, for although restricting the power of the King was practically necessary in the twenties and thirties in order to foster the interests of the bourgeoisie, it was not irrevocably certain that absolutism must necessarily pursue a feudal policy. The politics of the early Tudor monarchy, just as the later politics of Cromwell (to whom the crown was offered), show that such an evaluation was thoroughly justified. The bone of contention between bourgeois and feudal supporters of absolutism was thus not the *form* of government but the question to whose advantage power should be exercised. Looking back in 1653, the republican Albertus Warren wrote, "The question never was whether we should be governed by arbitrary power, but in whose hands it should be."[7]

In the political theories the opposing interests are expressed in the differences of function intended for the monarchy, and the function in turn is derived from the quite differently grounded necessity of the office of King. On this point the feudal and the bourgeois theories differ fundamentally. On a European scale there are thus three forms of theory to be considered: the feudal-Catholic, the feudal-royal, and finally the bourgeois.

This theoretical discussion will concern us only in so far as it deals with the relation of element and system. Only if we can find a basic principle different from that of Hobbes in the feudal theories of the state we will be able to speak of a significance of social history for the questions dealt with here. Nonetheless, it should already have become clear, that the possible *importance of bourgeois relations for the theory formation of the time cannot consist in their being an overpowering fact which these theories simply reflect but rather that the various theories arose within a discussion which was an element of the social struggle*. The basic flaw in the interpretation of Macpherson and others is thus: assigning theories to this or that model of social relations blocks one's view on the essential points of the epoch – the struggle that led to the transition from one form of society to the next and the partisanship in the theoretical controversies which these struggles involved.[8]

CHAPTER IX

THE ANTIFEUDAL SOCIAL PHILOSOPHY OF HOBBES

The first thinker for whom the basic principle of the independence of the essential qualities of an element from its system could be demonstrated was Thomas Hobbes. In order to interpret his position on the background of the political and theoretical controversies of his time, we must first take into consideration the dominant conceptions against which he took the field. Among the better known scholastics of his time, Hobbes himself mentions the Jesuits, Francis Suarez and Cardinal Bellarmine; he dealt extensively with the latter in the *Leviathan*.

In the history of science Cardinal Robert Bellarmine (1542–1621) made a name for himself through his role in the trials of Giordano Bruno (1599) and in the first trial of Galileo (1616). His own scholarly work was dedicated primarily to philosophy of right and to grammar; he published no systematic writings on natural philosophy. Bellarmine belonged to the Thomist school and was an advocate of the philosophy of Thomas Aquinas. With the exception of a few theorems, Thomas was to be taken as '*ordinarius et communis auctor*', and the exceptions were then limited to the most minor theorems.[1]

For the analysis of the relation of element and system in scholastic natural philosophy, we shall therefore turn first to the work of Aquinas; afterwards, some modifications of Aquinas's theory of the state which Bellarmine undertook and their importance for the debates at the beginning of the 17th century will be discussed.[2]

1. THOMAS AQUINAS' DOCTRINE OF NATURE AS A HIERARCHICAL ORGANISM OF UNEQUAL ELEMENTS

(a) *Unequal Elements*

According to the Thomist conception, tangible bodies exist only in the sublunar sphere. These bodies consist either of one of the elements (fire, air, water, earth) or of a compound of different elements. Every material body consists of matter and form. Matter is passive and capable of receiving various forms, but it can only exist in unity with a form (*Quaestiones de Quodlibet* III, Art. 1).

The substantial forms of the elements are determined according to the primary qualities to which all other qualities are to be traced back. The primary qualities are passive or active. The passive ones are the wet and the dry; the active ones are the hot and the cold (*De Generatione et coruptione*, II, Lect. 2). Out of these four qualities result four possible combinations of opposed qualities and, correspondingly, four elements: dry heat (fire), wet heat (air), wet cold (water), and dry cold (earth). Should one of the qualities take the place of another, then the element transforms itself into another. From fire (dry heat) – when the dry is changed to wet – there arises air (wet heat); from air – when the hot is changed to cold – there arises water (wet cold); and from water – when the wet is changed to dry – there arises earth (dry cold).

Since the greatest warmth is derived from the quickest motion of the outermost moving sphere, the place most distant from it (the center of the earth) is the coldest. The elements in these most distant places are dry: in the highest sphere, because fire dries; in the earth because great cold draws material bodies together and squeezes out the wetness; between these two extremes the wet elements are to be found: the warmer (air) above the colder (water). Even from these elementary effects it can be seen that the distance from the outermost sphere is decisive for the qualities attributed to the (in itself) uniform matter. The place of a material body on the radius of the spheres, that is, on the line up-down, is not only what contains the body but also what 'conserves and forms' the body.[3]

It can easily be seen on the basis of this sketch that Aquinas' view of the relation of element and system is very different from that of Hobbes, indeed quite the opposite of it: the world consists of unequal, dissimilar elements whose primary qualities depend on their own peculiar place on the radius of the world system.

(b) *Hierarchical Organism*

The hierarchy of all beings is connected to this necessary relationship between the place of a body on the radius of the world system and its primary qualities. Since the extemes are, on the one hand, the immaterial, the one God, the most perfect being (*ens perfectissimum*), the pure activity and being itself (*actus purus*; "*Deus est ipsum esse per se subsistens*"; *Summa Theologica* I, Qu. 4, Art. 2) and, on the other hand, matter as mere possibility and passivity, thus all species of entities, which are composed of possibility and reality, are to be arranged in a series between these two extremes, whose order is

determined according to the degree of participation in God's being, unity, and activity.[4]

The hierarchy leads from God down through the pure forms (*formae separatae*) to the forms which exist only in conjunction with matter (*formae inhaerentes*). Man participates in both worlds, the material and the immaterial; for his soul, due to its reason (*anima intellectiva*), forms the lowest step of the *formae separatae*, and as animal soul it forms the highest step of the *formae inhaerentes* (*anima sensitiva* and *anima vegetativa*). Beneath man are those creatures which have no *anima intellectiva*, and beneath these are the plants, which are endowed only with an *anima vegetativa*; and below the plants are the inanimate material bodies whose substantial forms make up the lowest step of the scale.

On each of these steps the same principle of unity (*principium unitatis*) prevails; multiplicity has its source in unity (*multitudo derivatur ab uno*) and is traced back to the One (*reducitur ad unum*). This order of the universe appears especially in the order of the whole and in the order of man who represents a microcosmos:

> Just as all bodily motion outside of man can finally be traced back to the motion of the celestial spheres, so, too, the motion of all organs and parts of the body to the motor force of the heart. Just as the heavenly spheres are moved by angels, so the heart is moved by the intellective soul as the form of the body; just as the whole universe is moved by God, so the whole man with all his powers is moved by the commanding will of the reasonable soul.[5]

The conception of every substance as a unity of passive matter and an active fom in analogy with the unity of the parts of the body and the soul in a living organism necessitates a more precise determination of the relation of element and system: Every being in the material world represents a part or member of the world organism, a part whose primary qualities depend on its place in the hierarchy of the world system.[6]

2. THOMAS AQUINAS' DOCTRINE OF SOCIETY AS A HIERARCHICAL ORGANISM OF UNEQUAL ELEMENTS

(a) *Hierarchical Organism of Society*

The relation of a part to an organism which is governed by its head holds especially for human society. For, although the universal law of the world

permeates all creatures, only man, due to his participation in the "eternal (divine) reason", recognizes and consciously carries it out.[7]

"And so if it were fitting for man to live alone, as do many animals, he would need no other guide [than the 'light of reason' – G.F.] to reach his end, but each would be a king unto himself" (I, 1). But since nature has not given man food and means of defense like the animals but rather has endowed him with reason and determined him to obtain the necessities of life by labor, and since the power of an individual does not suffice for this purpose, it is natural that he live with others, that is, in society.

"If therefore it is natural for man to live with many others in society, then it is necessary that there be something among men by which the multitude is governed" (*De Regimine Principum*, I, 1). "Thus in the universe of bodies the other bodies are governed by the first body, namely the heavens, according to the order of divine providence, and all bodies by the rational creature. Also in a single man the soul governs the body, and among the parts of the soul the passions and desires are governed by reason. Similarly, among the parts of the body one is principal and moves all the others, whether this be the heart or the head. Therefore, in every multitude there must be something which governs" (I, 1). "In the multitude of parts (of the body) there is one that moves all the rest, namely the heart; among the parts of the soul one principal force presides, namely reason . . . and in the whole universe there is one God, creator and ruler of all. . . . For all plurality derives from unity" (I, 2). All social groupings are instituted according to this law (*ordinatio ad unum*): the family, the village community, the town, the kingdom; the king, who rules a city or a state thus has a similarity not only to the father of a family (*paterfamilias*; I, 1) but also to God whom he represents in the state (I, 12).

Looking back from a later viewpoint, we can recognize two basic principles in these deliberations: on the one hand, the natural necessity of social life, which does not represent a combination of individuals (elements) but rather an organism whose parts or members could not exist separately; on the other hand, the natural necessity of a hierarchy, of a governing of the organism by a unified, superior power. For Aquinas both principles are the same: A society, consequently, represents a naturally necessary, hierarchical organism, which is ruled by a governing organ.[8]

(b) *Pope and King*

The structure of human society just discussed is attained on the basis of the reasonable nature of man; the goal is a virtuous life. On account of his

participation in divine reason man also has a final goal located beyond his life on earth: the supreme happiness which he hopes for in the sight of God after his death (I, 14).

Man cannot reach the goal through virtue but only with the help of 'divine government'. Therefore, "such a government belongs only to that king who is not only man but also God, that is, to our Lord Jesus Christ, who, making men to be sons of God, has led them into heavenly glory" (I, 14). "The ministry of this kingdom is entrusted not to worldly rulers but to priests, so that spiritual things may be kept distinct from worldly, and in particular to the Highest Priest, the successor of Peter, the Vicar of Christ, the Roman Pontiff . . ." (I, 14).[9]

The Church, like every human community, is thus taken as an organism, as a 'mystical body', whose head is Christ and whose members are all the faithful.[10]

But since the otherworldly goal is higher than that of this world, "those who are concerned with antecedent ends ought to be subordinated to him who is concerned with the final end and to be directed by his command"; therefore, "all the kings of Christian people should be subject (to the Pope) as to the Lord Jesus Christ himself" (I, 14), or as the body to the soul.[11]

On this point too, Aquinas employs the basic principle, that every system represents an organism, which is governed by one organ, and whose hierarchy is constructed according to the nearness to God as the head of the world organism.

3. CATHOLIC CHURCH AND NATION STATE IN THE 17TH CENTURY

(a) *Cardinal Bellarmine's Theory of the State*

When Bellarmine at the beginning of the 17th century undertook to renew the theory of natural right of Thomas Aquinas and to present a new justification of the supremacy of the Pope, he had to take the changed situation into account. Among the decisive factors for the final formulation of his theory of the state were "the struggle of the Curie with the Republic of Venice and its state theologians (1606–1607) and especially the controversy with the absolutist English King James I and his court theologians (1607–1609) as well as with Gallicanism, which was aggressive towards Bellarmine".[12]

The controversy with James I had this 'decisive importance' for Cardinal Bellarmine and for the Catholic Church as a whole, because the liberation

from the dominion of the Pope was carried out most decisively in England and was coupled with the rejection of his ecclesiastical supremacy as well. A number of other events had occurred before James I's exclusive claims to dominion, which limited the power of the Pope and contributed to influence the work of Bellarmine: the restriction of papal rights over the Church in France by Charles VII (the so-called 'Gallican liberties', 1438), the Reformation, the recognition of the principle '*cuius regio eius et religio*' even by Catholic princes (a principle which derives spiritual authority from worldly authority), and finally, the revoking of papal privileges by the Venetian republic, against which Pope Paul V could only proceed with an inconsequential interdict (1606).

James I, who took the final step, had propounded as early as 1598 in the (anonymously published) *Trew Law of Free Monarchies* and in *Basilikon Doron* the theory (which will be discussed below) that kings have received their offices directly from God, a direct appointment, which the Pope claimed for himself alone in the line of succession from Peter.

The outstanding achievement of Bellarmine in his dispute with this claim lies in seeking a compromise which took the changed power relations into account and in defending it against out-of-date Catholic theories which laid claim to the entire spiritual and temporal power for the Pope as the representative of God on earth. By such an assertion, remarked Bellarmine, "ecclesiatical authority is without reason made odious to the secular rulers".[13]

Against such futile demands Bellarmine maintained that the Christian princes were not vassals of the Pope, "but true kings and princes . . . state and Church are different powers. They can be separated from one another or joined together. The state can exist by itself without the Church and the latter also without the former. So purely are the two areas separated in Bellarmine's mind that he considers it better, taken absolutely, that the Popes take care only of the spiritual and the kings only of the temporal" (Arnold, 104). However, it would be mistaken to conceive the relation of the Church and the state as that of two independent states. For, in so far as it is a Christian state (and a state can be Christian only as a Catholic state; Protestant and heretical states are simply 'infidels') in which the people have temporal and eternal ends, these ends cannot be separated from one another, and consequently, the powers responsible for them can also not be separated. The secular power, the state, is independent as far as its affairs "do not oppose the spiritual purpose of men or those ends which are necessary to achieve this goal".

"In the latter case the spiritual authority can and must coerce the temporal

in everyway which seems necessary (*coercere temporalem omni ratione ac via, quae ad id necessaria videtur*). The Pope has no ordinary (*ordinarie*) right to intervene in the affairs of state; but he does, as the highest spiritual prince, have an extraordinary highest authority over the worldly affairs of all Christians in regard to the *bonum spirituale*. His right to intervene in the jurisdiction of the state is founded in and limited by the necessities called forth by the care for the salvation of souls.

"By this 'indirect' power the Pope cannot overturn the political order or confound it with the spiritual regime .... The Pope can however by his spiritual and apostolic power direct and correct the political power and, when it is necessary for the spiritual end, transfer it from one prince to another. This power was given him as the shepherd of all Christendom, as superior of the whole Christian family, and as representative of the head of the entire body, to which kings and emperors also belong".[14] Against James I Bellarmine stresses that he has "allowed the unrestrained people no authority at all nor has he loosed the reigns or paved the way for rebellion and regicide"; the people have only the right to depose the king on the basis of a judgement by the Pope, who has the right to condemn heresy (cf. Arnold, 249).

The compromise which Bellarmine suggests to the King consisted in the abdication by the Church of direct temporal power (which it also no longer possessed in England) and in the obligation of the subjects to obey the King without restriction. In return the King was to submit to the 'spiritual' dominion of the Pope with all the consequences for domestic and foreign policy of such an action. Should the King refuse to accept this compromise, the Pope reserved the right to call upon the Catholics to depose the heretical King. The increasing activity of the Jesuits in England showed that this was no empty threat.

For the theoretical controversies of the 17th century it is also of importance that Bellarmine conceived the state and the Church as organisms each of which was governed by a dominant organ, and that this hierarchy is constructed according to the nearness to God as the head of the world organism.

(b) *The Theory of the State of James I*

Bellarmine's attempt to justify the supremacy of the Pope rests on two pillars: first, the spiritual end of men is higher than their material end, which is in the care of the king; secondly, the office of king is grounded in natural right and thus indirectly God-given, while the office of Pope was founded directly

by God. The position of the king as head of the social organism and of the Pope as head of the Christian total organism remains unaffected.

The Stuart position was summarized by James I in a speech to Parliament as follows:

> The state of monarchy is the supremest thing upon earth; for kings are not only God's lieutenants upon earth, and sit upon God's throne, but even by God himself they are called gods. There be three principal similitudes that illustrate the state of monarchy: one taken out of the word of God, and the two other out of the grounds of policy and philosophy. In the Scriptures kings are called gods, and so their powers after a certain relation compared to the divine power. Kings are also compared to fathers of families, for the king is truly *parens patriae*, the politic father of his people. And lastly, kings are compared to the head of this microcosm of the body of man.[15]

In these three comparisons of the dominion of kings over the state with God's dominion over the world, with the dominion of a father over the family, and with the dominion of the head over the body, Bellarmine and James I are in agreement. The difference occurs only in the determination of the adequate analogues to the world, the family, the human body (the state, Christendom, with which the precedence of the king or the Pope is justified). The differences concerning the consequences of the theories which are supposed to ground the supremacy of the king or the Pope do not affect their common foundations. Both theories presuppose hierarchical-organic natural and social relations (in a word: feudal relations). When the parliamentarians in 1614 attacked Anglican bishops, Jesuits, and courtiers in the service of foreign powers as being responsible for the 'papist' politics of the King, they were not pointing out a conflict of interests between (feudal) King and (feudal) Pope; on the contrary, they saw and clearly articulated the common interests of the two feudal lords and the opposition of these interests to their own. And so long as the bourgeoisie did not see its own interests joined to a form of state different from absolutism, its political struggle concentrated practically on the attempt to employ the absolutist power in its own interests and, where this was not possible, to thwart its engagement in the interests of the feudal lords by restricting its power. The limiting of absolutist power was not, however, the primary aim of the bourgeoisie but rather a means to an end. This circumstance, as well as the fundamental opposition of interests between bourgeoisie and feudal lords was expressed theoretically not in the question of the form of government but in the question of whether the King is, or should be, the proponent of feudal society or the proponent of civil society.

On this background, Hobbes's political philosophy will now be interpreted.

4. HOBBES'S THEORY OF THE STATE AS A CONTRACT OF EQUAL AND AUTARCHIC INDIVIDUALS

The common foundation or the royal and the papal versions of feudal ideology consisted in the conception of society as a hierarchical organism that is governed by a natural head. This conception was supported by the analogy drawn with the order of nature, in which every subsystem, just like the wold as a whole, forms a hierarchical organism, which is governed by a head and in which the properties of each member or part are determined by its rank in the hierarchy.

If one takes the prevailing social conditions as well as the prevailing interpretation of those conditions into consideration, it becomes clear that the basic principle of Hobbes, that a system consists of equal elements, to which essential properties are to be attributed independently of the system, is directed in its thrust against the feudal ideology and that due to the dominance of that ideology, it could be developed and advocated only in the full consciousness of that opposition.

Hobbes wrote not merely as the representative of antifeudal interests, he also claimed to be practicing science. As long as his basic conception can be sufficiently justified by his scientific procedure, it is not of interest whether it was affected by his dispute with feudal theory or whether, just the reverse, his dispute with feudal theory was necessitated by the results of his researches. This question need be posed only if it should turn out that Hobbes's conception cannot be grounded by his scientific analysis; this will now be examined.

(a) *The Equality of Men in the State of Nature*

Hobbes's intention was to analyze the system of the absolutist state or on the basis of the analysis to demonstrate its necessity based on the constitution of the elements themselves. A scientific analysis could not abstract from the fact that this state had really arisen out of the struggle of feudal lords and was also supported by the bourgeoisie. The presupposition that the state consists of equal elements, taken consistently, means that it must be proved that the differences among the nobility, the bourgeoisie, and the poor are in regard to the state not essential differences.

Hobbes grounds the necessity of absolute rule in the necessity of preventing the war of every man against every man for the sake of the preservation of each one (*Leviathan*, Ch. 13). This war was explained by Hobbes with the 'restless desire' of every man for more power, which in the last analysis is

necessary for self-preservation (Ch. 11 and 12). In general, Hobbes explains, the power of a man consists in "his present means, to obtain some future apparent Good" (Ch. 10, 150) – a definition which remains neutral vis à vis a feudal or a bourgeois social order. It is however peculiar and inappropriate to a bourgeois form of society that the largest part of the chapter is dedicated to determining the power which consists of honor.

In addition to 'natural' honor, there are in a commonwealth, where the highest authority determines what is to be taken as a sign of honor, particular honors: "A Soveraigne doth Honour a Subject with whatsoever Title, or Office, or Employment, or Action, that he himself will have taken for a signe of his will to Honour him" (Ch. 10, 154). To this kind of honor belong such things as magistrate functions, offices, titles, "and in some places Coats, and Scutchions painted" (*ibid.*). The latter kind of honor "commonly called Gentry" (157) as well as the titles of nobility – Duke, Count, Marquis, and Baron – are hereditary and firmly anchored in feudal society. The Gentry, wrote Hobbes, "has been derived from the Antient Germans", and Germany, "*as all other Countries* in their beginnings [was originally] divided amongst an infinite number of little Lords, or Masters of Families, *that continually had wars one with another*" (Ch. 10, 158; my italics; cf. Ch. 17, 224).

The titles Duke, Count, Marquis, and Baron originally designated military leaders, as Hobbes shows on the basis of etymology. The 'honor' which constitutes power consists either in the command or the dominion of the person honored over an area which he was to defend. 'Honor' (*honos*) – one might add to Hobbes's presentation – had even in ancient Rome not only the meaning of 'worth' or 'dignity' but also of 'office' (e.g., *cursus honorum* as the career path of public office), and in feudal society it also designated a '*beneficium*', whether in the form of tenures of offices or money.

Thus, Hobbes does indeed take the origins of absolutism in the war of the feudal lords against each other into account; however, he does not fall in with the feudal ideology, which represented the hierarchy as natural: "Nobility", he remarks, "is Power, not in all places, but onely in those Common-wealths, where it has Priviledges: for in such priviledges consisteth their Power" (Cf. 10, 151). Just as noble descent is not sufficient to give power, it is also not necessary to be of noble descent in order to acquire privileges from the sovereign and thus to belong to the 'nobility': nobility depends on the will of the sovereign, and titles were conferred on "rich or otherwise deserving people" and "men were made Dukes, Counts, Marquises, and Barons of Places, wherein they had neither possession, nor command" (159; cf. the Latin version of the same passage). The circumstance that many rich burgesses

bought titles in the 17th century and that much of the nobility organized their estates on a capitalistic basis made it possible for Hobbes to subsume privileges and wealth under one concept: power.[16]

In the concept of 'power' the supposed difference in principle between feudal privileges and bourgeois riches disappears, and Hobbes obtained at the same time a standard of measure with which feudal lords and citizens could be measured in the same way: "The *Value*, or WORTH of a man, is as of all other things, his Price; that is to say, so much as would be given for the use of his Power: and therefore is not absolute; but a thing dependent on the need and judgement of another" (Ch. 10, 151–152).

The reduction of the significance of titles to the power that they actually represent and the introduction of the same measure for the power of the nobility and the power of the wealthy citizens enable Hobbes to assert their equivalence. The first proposition of his basic principle, i.e., that a system is composed of equal elements, is not yet justified; for that, the men without property must also be included. However, the concept of power proves to be general enough in principle to achieve this as well.

The first kind of power is the natural power, that is, "the eminence of the Faculties of Body or Mind"; in these properties all men are in principle equal (Ch. 10, 150). The given "difference between man, and man, is not so considerable, as that one man can thereupon claim himselfe any benefit, to which another may not pretend, as well as he" (Ch. 13, 183). And since the kinds of power already discussed are acquired through the 'natural power' or by 'accident' (Ch. 10, p. 150), all men are in principle equal in the struggle for more power. Men are equal, not in the sense that their starting positions are equal – it is, for instance, advantageous to be descended from "conspicuous Parents" since one more easily acquires assistance and also inherits the friends of the ancestors (Ch. 10, 156) – but they are equal in the sense that no one is excluded from taking part in the struggle. And from this equality arises an equality 'of hope' of attaining the projected goals (Ch. 13, 184).

The equality of all men is grounded not only in this equality in principle; the struggle of all against all for more power arises in the last analysis because it is necessary for self-preservation, and in the endeavor to preserve their lives all men are, as natural creatures, equal. Basically, all men are equally threatened, for even "the weakest has strength enough to kill the strongest, either by secret machination, or by confederacy with others, that are in the same danger with himselfe" (Ch. 12, 183). In the possibility of being killed the rich and the penniless are equals, and therefore everyone, whether noble, bourgeois, or propertyless, must fear for his life. All men also have an equal

possibility of acquiring the greatest of human powers by founding parties. From this Hobbes infers the necessity of setting up the "Greatest of humane Power", which is composed of the powers of the most men, the state, which can enforce peace (Ch. 13, 150). In the end it is in this function of the state that the general reasons lie which move even the propertyless to subject themselves to the absolute state in spite of all disadvantages that might arise for them in such a state (cf. Ch. 20, 260).

Hobbes's broad concept of power thus justifies his view that a system consists of equal elements; moreover, this concept allows him to neglect the differences between the feudal and the bourgeois society, so that the determination of the essential qualities of the elements (the men) can be undertaken independently of a *particular* social system.

(b) *The Equality of Men in the State*

As soon as the state is established and the danger of being killed ceases to be the dominant social reality as in the state of nature, the physical equality of men loses its importance, and the actual differences in their power can no longer be levelled by referring to the, in principle, equal possibilities of acquiring power. The equality of men seems thus to hold for the state of nature but not for life in the commonwealth: the now existing inequality was introduced by civil laws, writes Hobbes (Ch. 15, 211). Thus Hobbes cannot assert the equality of all men in the state as an actually existing equality; but he does foresee measures to bring it about.

The specific power of the nobility, Hobbes explains, consists in its access to state offices, in its function as military commanders, and finally in its privileges. Hobbes rejects the inheritance of claims to office by the nobility and demands that offices be filled by the most capable (Cf. 30, 391f.); the same applies to command of the army (393f.). The legal privileges of the nobility Hobbes also wanted to see dissolved; he celebrates the abolition of special courts for the nobility in England (Ch. 23, 292) and demands equality before the law as well as the impartiality of the courts (Ch. 27, p. 385).

Hobbes likewise demands that riches – whether of the nobility or of the bourgeoisie – do not become a power in the state; he warns against the wealth of the towns, which suffices to finance an army (Ch. 29, 374f.) and also wants to limit the number of servants of private persons, so that they cannot dispose of a private army (Ch. 22, 287). He even denies the unconditional validity of the right to property and reserves the sovereign the right to confiscate and distribute property (Ch. 29, 367f.; Ch. 24, 297; Ch. 30, 376).

Hobbes's regulations culminate in a general prohibition of all 'systems', thereby depriving nobility, bourgeoisie, as well as the propertyless of the possibility of forming a power of any kind whatever, which could approach the 'greatest human power' – that of the state – a power which arises from the union of many and depends on the will of a private person, the power of a party (Ch. 10, 150).[17]

Hobbes's philosophical principle, that a system consists of equal elements, is thus of twofold significance for social philosophy: in the theory of the origin of the state, it allegedly represents the result of the analysis of society; with regard to the form of the state recommended by Hobbes, however, it represents a goal, which is to be realized by appropriate measures. These measures are to prevent the development from the minor natural inequalities of men to a more extensive inequality, so that the equality of all men can still be acknowledged. This is to be achieved by equipping the state with so much power and depriving the subjects of so much power that they can all be taken as equals with regard to the state (cf. Ch. 30, 385f.); the fundamental equality of all men in the commonwealth, just as in the state of nature, consists in powerlessness. Hobbes's state thus has the primary function of securing the continuation of the 'state of nature': the equality of all men in the struggle of all for more power. The condition for the continuation of this struggle is that it be carried out peacefully and not be decided and ended through the concentration of power in one private person.[18]

It is thus clear that Hobbes's basic principle of the relation of element and system cannot be explained simply by a particular (artisan) interpretation of the analytic-synthetic method, especially since it is also easy to see that even the determination of the elements in the state of nature cannot be explained without reference to Hobbes's political program; for, from his description of the war of the feudal lords against each other and of the war of the wealthy burgesses for more power – a struggle in which allegedly the propertyless also participate – one could just as well trace the state back to unequal elements, which, moreover, need not even be individuals but could also represent families. Hobbes's reduction of the state back to the struggle of equal individuals with one another thus seems partly determined by his intention to represent a commonwealth in which every supra-individual association of private persons is forbidden as the 'natural' one.

This conjecture is supported by the circumstance that the knowledge that the state is compounded out of individuals is not the result of an analysis but is presupposed: in accord with the analytic-synthetic method, writes Hobbes, he began with "the very matter of civil government, and thence

proceeded to its generation and form, and the first beginning of justice". And so,

> to make a more curious search into the rights of states and duties of subjects, it is necessary, I say, not to take them insunder, but yet that they be so considered as if they were dissolved; that is, that we rightly understand what the quality of human nature is, in what matters it is, in what not, fit to make up a civil government, and how men must be agreed amongst themselves (*inter se componi*) that intend to grow up into a well-grounded state (*coalescere*) (*De Cive*, Preface, *Opera* II, 146; *Works* II, xiv).

Hobbes thus begins not with the analysis of the state and the determination of its elements but rather presupposes that the state is composed of individuals, and the analysis already refers to the elements (individuals) and leads to the determination of the psycho-physical endowments of man.

(c) *The Autarchy of Man in the State of Nature*

Hobbes's deduction of the necessity of the state from the war of every man against every man by no means implies that logically or historically a condition must be assumed in which independent, autarchic individuals lived alongside one another and that the determination of essential properties must refer to such single individuals. For Hobbes refers the war of all against all to the war of families with one another, which embraced all individuals, and he says that cities and kingdoms are nothing but "greater Families" which "endeavour as much as they can, to subdue, or weaken their neighbors, by open force and secret arts" (Ch. 17, 224; cf. Ch. 22, 287, and Ch. 10, 158). Hobbes seems to intimate that he wants to explain the origin of the state by the war of families or the social forms derived from them and not by the struggle of autarchic individuals. It must therefore be asked whether Hobbes's theory of the origin of the state presupposes the autarchy of men in the state of nature and whether such an assumption can be justified.

Hobbes considers two principal possibilities of founding the commonwealth: *acquisition* and *institution* (Ch. 17, 228). The first form of founding by acquisition is a contract between conqueror and conquered and is of no interest here: a lasting subjugation presupposes some kind of society on the side of the conqueror, because it requires a lasting, superior power which a single man cannot have over another. The second form of founding by acquisition, the lasting subjugation of children also cannot explain the original transition from the state of nature to the commonwealth: Hobbes argues that the child owes its life to its mother, who nourishes it and could have exposed

it, and therefore – as compensation – it must be her subject (Ch. 20, 253f.). Assuming the subordination of the mother to the father, then the father is – before the founding of the state – the absolute sovereign over his children and his children's children (Ch. 22, 285); and after the state arises, the father deserves the honor and friendship of the children (Ch. 24, 301; Ch. 27, 352; Ch. 30, 382).

These latter determinations cannot be reconciled with the conditions of contracts which Hobbes sets; for "Covenants, without the Sword, are but Words, and of no strength to secure a man at all" (Ch. 17, 223). Therefore, "the Validity of Covenants begins not but with the Constitution of Civill Power, sufficient to compell men to keep them: And then it is also that Propriety begins" (Ch. 15, 203). If the family preceded the state it is not clear what force could be supposed to move grown up children to fulfill their duties to their fathers: on the contrary, the father would have to enforce fulfillment with a war. The conclusion of peace would legally be the equivalent of the institution of a sovereign, and the stability of a family would presuppose the commonwealth by institution.

To explain the origin of the state by institution, that is, by covenant, without assuming any already existing family or other social relations, means that we

consider men as if but even now sprung out of the earth, and suddenly, like mushrooms, come to full maturity, without all kind of engagement to each other (*De Cive*, 8.1; *Works* II, 109).

The theory that the state is instituted by contract thus presupposes the autarchy of each man, not only in the sense that he supports himself (for the contract follows not from the necessity of social labor according to Hobbes, but from the desire for security from attack), but also in the sense that every man has from nature all the necessary human properties – including, alongside the physical properties, also the mental ones such as reason and language, without which no contract can be entered into. Hobbes was aware of this presupposition "Justice, and Injustice", he wrote, "are none of the Faculties neither of the Body, nor Mind. If they were, they might be in a man *that were alone in the world* as well as his Senses, and Passions. They are Qualities, that relate to men in Society, not in Solitude" (Ch. 13, 188; my italics). However, all physical and mental properties which are necessary for an autarchic existence and for concluding contracts must be ascribed to a man "that were alone in the world". Here too, lies the reason why eight chapters on the psycho-physical properties of man as such without any relation to

society had to precede the doctrine of the state in the first part of *Leviathan* ("Of Man").[19]

One can scarcely believe of Hobbes that he ever seriously thought that men had "sprung out of the earth, and suddenly, like mushrooms, come to full maturity, without all kind of engagement to each other". Furthermore, Hobbes maintained that even if one were to assume the existence of such ready-made autarchic individuals, they would never be able to institute a state by agreement. In case the state dissolved at the death of the sovereign (if the sovereign is a king), the "multitude" would be unable to agree on the institution of a new state, that is, on the choice of a new sovereign (Ch. 19, 249).

Hobbes thus does not put much faith in the ability of autarchic men, peacefully to agree on instituting a sovereign at the present time, and it is not clear why men should have had more insight in the past than they do now. Indeed, Hobbes never supposed that a meeting of autarchic individuals in reality founded the state by instituting a sovereign; his examples always refer to subjugation by conquest, most often to the subjugation of many feudal families by a single family. His institution theory is intended neither to explain the historical origin of the state nor to suggest a new form of the state; rather it points out the possibility of how the existing relations of subjugation in state and family can be *interpreted* as contractual relations and how subjugation can be grounded in a contract.

(d) *The State as a Contractual Relation*

Hobbes's intention of interpreting relations of domination as contractual relations is served equally well by both the institution and the subjugation theory. For the state which is established by acquisition – whether by conquest or by subjugating children – differs from the state which is established by the institution of a sovereign "onely in this, that men who choose their Soveraign, do it for fear of one another"; while in the case of the founding of the state by acquisition, "they subject themselves, to him they are afraid of. In both cases they do it for fear: which is to be noted by them, that hold all such Covenants, as proceed from fear of death, or violence, voyd" (Ch. 20, 252). The sovereignty of the actually existing state, which arose out of the war of the feudal lords, must be recognized just as well as the sovereignty of the state which could have been established by a contract of the individuals among themselves.

In both cases the prerequisite for a contract – the freedom and equality of the contracting parties – are guaranteed. They are free, since freedom can

be reconciled with fear (Ch. 21, 262f.); just as men are free to remain in a state of war instead of instituting a sovereign, so too, are they free to resist the conqueror or father. Their subjugation in both cases is the result of a free decision to their own advantage.

The equality of contracting parties consists in the fact that a reciprocal transfer of rights constitutes the contract (Ch. 14, 194). This requirement is met both by the contract of institution (Ch. 17, 227) and also by the contract of the conquered with the conqueror or parent, in which the loser submits to the winner and in return retains his life (Ch. 20).

The question as to the origin of Hobbes's basic principle, that a system consists of autarchic elements, is thus the question as to the purpose of this interpretation of the contract.

(e) *Hobbes's Refutation of the Feudal Theory*

The importance (although not the main purpose) of Hobbes's attempt to trace all social relations back to contractual relations and, accordingly, of his basic principle that society consists of autarchic individuals can be understood if one confronts it with the conception that was dominant in his time; for Hobbes's views represent a radical repudiation of all feudal justifications of the state. It is radical in so far as not every argument is refuted one by one but in so far as the feudal basic principle, that a system represents a naturally necessary hierarchical organism, is ignored, and a theory is developed which *eo ipso* excludes the feudal theory. The basis of this is Hobbes's taking the autarchy of man as his starting point: man, who unlike socially living animals is not social by nature but rather on the basis of willful, conscious, and reasonable actions enters into society.[20]

Using this principle, Hobbes refutes the three analogies with which the feudal theoreticians supported the claim to power in society. Against the assertion, that kings rule the state as God rules the universe, Hobbes remarks: "But to call this Power of God, which extendeth it selfe not onely to Man, but also to Beasts, and Plants, and Bodies inanimate, by the name of Kingdome, is but a metaphoricall use of the word. For he onely is properly said to Raigne, that governs his Subjects, by his Word, and by promise of Rewards to those that obey it, and by threatening them with Punishment that obey it not" (Ch. 31, 395f.).

Against the preference of monarchy over every other form of state because of the analogy with the family, Hobbes argues, as has already been mentioned, with the construction of the family as a contractual relation, and furthermore,

he does not justify the right of the king to dominion with that of the father but, just the reverse, that of the father with that of the king. The father has power over his children not as their progenitor but as sovereign; paternal power is a variety of state power and not the other way around. Accordingly, the authority of the father is limited by the state (Ch. 22, 285), and the instruction of the children to obedience towards their parents is placed within the framework of instruction to obedience towards the sovereign (Ch. 30, 382).

The third analogy, too, with which the feudal theorists justified the social order, the analogy between the human body, which is governed by the head, and the state with a monarch at its head, is given no consideration by Hobbes. The state instituted by contract is analogous to a mechanical clock, not to a natural organism.[21] Thus Hobbes subjects the state to the measure of human reason as opposed to that of an allegedly natural, organic, hierarchical order.

5. HOBBES'S POLITICAL PROGRAM

The deficiency of Hobbes's contract theory as an explanation for the historical origin of the state and its function as a refutation of the feudal theory of society and the state do not have the consequence that his theory has no claims to science. For Hobbes does not attempt to trace social relations back to a form which he simply made up and which did not exist in social reality; rather he attempted to ground social reality on the contract, which did indeed lie at the bottom of social relations in so far as they were exchange relations. Hobbes's procedure thus consisted in generalizing the contractual relation which the analysis of market relationships had uncovered, and – as a political program – declaring them to be the form of social relationships as such. His claim to be pursuing political science can thus not at all be judged according to his success at representing the actually dominant form of social relations, but rather according to whether a society based on contractual relations is possible and whether he succeeded in drawing from his theoretical construction practical consequences, whose implementation would lead to the establishment of such a society.

The theoretical consequence of Hobbes's justification of the state is that the starting point of political theory has been transformed: equality instead of hierarchy, self-interest instead of common good (*bonum commune*), ability instead of hereditary right, reason instead of tradition, power instead divine right. The practical consequences which Hobbes himself draws correspond to these premises: he hales the abolition of the special courts for the

nobility in England (Ch. 23, 292) and demands equality and impartiality of jurisprudence; he denies the hereditary claim of the nobility to state functions and demands that offices be given to the most competent (Ch. 30, 391f.); and finally, he rejects the justification of law by tradition: a law should only then take effect when the sovereign has assented to it, and all contracts are legally binding which are entered into in accord with the laws that the sovereign has assented to it, and all contracts are legally binding which are entered into in accord with the laws that the sovereign has made, and only such contracts.[22]

With these determinations Hobbes opposes the traditional feudal notions of law, in which even Parliament at first remained trapped (cf. Hill, *Century*, 64–67), and thus takes a position on the central problem of the time:

> The burning question of the day was the position of the small proprietor, the copyholder or cottager, whose holding was frequently an obstacle to consolidation of estates, enclosure, racking of rents, and all the familiar methods by which one section of the gentry was enriching itself and sharing in the commercial and industrial boom of the century before 1640. The attack on the security of tenure of these small men, the mere idea that customary rents could be raised and that peasants unable to pay might be evicted, had seemed in the sixteenth century a breach with all that was right and proper, a gross violation of equity even when the letter of the law was observed. For most copyholders and cottagers held by customary right, at customary rents, not automatically enforceable at common law. There was no contractual basis for their claims. The aim of the improving landlord was to replace copyholds by leaseholds, copyholds for lives by copyholds for a fixed term of years; to substitute precise, limited, and determinable contracts for the indeterminate, traditional, customary rights of the medieval peasantry; to pass from status to contract. It had been a moral as well as an economic revolution, an intrusion of the alien standards of the market into a sphere hitherto unaffected by them.
>
> ... But now here was Hobbes making contract the basis of morality! Justice is the keeping of covenants: no contract, no injustice. Nowhere is the fundamentally 'bourgeois' nature of Hobbes's approach to the state and to morality more apparent than in this, the foundation of both (Hill, 'Thomas Hobbes and the Revolution in Political Thought', in: *Puritanism and Revolution*; 274).

It has already been indicated that the enclosures, which Hobbes justified with the equation of justice and contract, were a precondition of the development of capitalism in England, in that they freed the poor peasants from feudal dependency and at the same time separated them from their means of production thus forcing them to wage labor. This development, which was to lead to a new class opposition between capitalists and wage laborers, was not foreseen by Hobbes.

Hobbes did indeed see that a host of unemployed poor people had arisen,

but his suggestions for a solution to the problem show that he had no premonition of the actual later development of capitalism and therewith of the rapid expansion of production. On the one hand, Hobbes recommended fostering such existing branches of production as "Navigation, Agriculture, Fishing, and all manner of Manufacture that requires labour"; and on the other hand, if the "multitude of poor, and yet strong people" continued to grow, he suggested transplanting them to sparsely settled countries. "And when all the world is overcharged with Inhabitants, then the last remedy of all is Warre; which provideth for every man, by Victory, or Death" (Ch. 30, 387). Just as Hobbes had no idea that the development of capitalism would solve the problem of apparent overpopulation – the population of England, by the way, was under six million – he was also unable to foresee the rise of a class of wage-dependents. Whether Hobbes wanted to exclude the laborers in manufactures, navigation, and agriculture from civil society or whether he conceived of them as contract partners with equal rights is not important here. Civil society in any case is composed of free and equal commodity possessors, who only exchange that part of their product which goes beyond their own immediate needs.[23]

Just as Hobbes did not yet have a concept of wage labor, he also had no concept of capital. Hobbes sees the use of money as "the reducing of all commodities, which are not presently consumed, but reserved for Nourishment in time to come, to some thing of equal value" (Ch. 24, 300). The function of money as a measure of value, as a means of circulation, and as a means of accumulating treasure are known to Hobbes; but he knows nothing of the function of money as productive capital, money which the owner of capital exchanges for means of production and for labor power and which he receives again at the sale of the product – increased by the money amount of the surplus value created.

Hobbes's assertion that all social relations are based on contract thus brought to clear expression and affirmed one aspect of the dominant development – the replacement of all personal, naturally arising dependency by reasonable, contractual relations of independent individuals; his scientific achievement thus consisted not in representing the dominant social relations but rather in recognizing the development of bourgeois relations as the most important social phenomenon and in devising a social theory, which not only pointed out the basis and the result of this development but also suggested appropriate political measures for the establishment of this new form of society. The other side of this achievement is Hobbes's failure to recognize that the replacement of the naturally arising feudal relations of dependency

would lead not to a classless society of free commodity producers but to a capitalist class society mediated by a contract entered into by capitalists and wage laborers as free citizens.

The necessity of advocating bourgeois relations against the prevailing feudal theory corresponded to the circumstance that the political program of the bourgeoisie could only be implemented in a struggle against the feudal lords; the heart of this theoretical controversy was that the feudal theoreticians represented all social relationships as 'natural', political institutions as 'organisms' and personal rule as a natural principle of order. Hobbes, who with political intent undertook to interpret the existing form of society based on personal dependency as already a civil society based on contractual relations, saw himself compelled in principle to interpret all natural relations, in particular the family – which in his view, too, is the seminal form of all society – as contractual relations. He supported this conception, although – taken strictly – it implied the absurd consequence that men popped out of the ground like mushrooms.[24]

The inadequacy of Hobbes's theory, the reason for which lies in his one-sided concentration on contractual relations, is to be seen not in his hypothesis on the origin of the state nor in his conception of the family as a contractual relation – he was probably aware of these flaws – rather it should be seen in the fact that he recognized only the development of bourgeois relations but not that these relations could only arise on the basis of capitalist relations of production with the appropriate class relations. Hobbes opposed the feudal social order with the program of a classless society of commodity producing independent individuals which never became reality.

Hobbes's fruitful one-sidedness – fruitful because it enabled him to see the contractual relations, which were just developing, as the decisive relations for the future – is the reason both for his significant scientific achievement and for the inadequacy of his theory; and this one-sidedness is conditioned by the controversy with the feudal view.

6. THE CONTROVERSY WITH FEUDAL THEORY AND THE ANALYTIC-SYNTHETIC METHOD

In conclusion, we must consider the consequences of this one-sided interpretation of all social relations as contractual relations for Hobbes's conception of the analytic-synthetic method. It has already been shown that Hobbes's determination, that society is composed of individuals was not obtained by analysis but was rather the presupposition of the analysis; the analysis

itself applied only to the properties of single individuals. These individuals had to be taken as capable of entering into contracts, that is, free, independent, and rational. And since in Hobbes's opinion a society is possible only when an absolute rule has already been established, the prerequisites for entering into contracts, independence and reason, must be attributed to men before and outside of society. Thus, the assumption of autarchic individuals, to whom all properties are attributed that are necessary for self-preservation and for closing contracts, was a necessary condition of Hobbes's contract theory.

This does not mean that Hobbes's analytic-synthetic method was obtained merely by abstraction from his theory of the state; but it does mean that it is dependent on this theory. For even if Hobbes should have conceived his method on the model of the artisan's procedure of compounding and decompounding, his partisanship for the bourgeois grounding of the state and against the feudal organism theory provides the reason for the form of its application in social philosophy. It is striking that Hobbes carries out no analysis at all but presupposes that the decisive elements of society are individuals (and not, for instance, families); on the other hand, it is inconsequential for the artisan method, whether the essential properties are ascribable to each and every element in empty space: important is only the circumstance that they belong to each independently of the connection into which they are to be placed. Hobbes, however, presupposes that the essential properties belong to every single element and, although he recognizes and states openly the absurd consequence for social philosophy, that ready-made men pop out of the ground like mushrooms, he corrects neither his presupposition nor the corresponding interpretation of the analytic-synthetic method. For it is precisely this absurd consequence which is the foundation of his theory of the state and of his refutation of the feudal theory.

The suggested interpretation applies to Hobbes's basic principle and to his interpretation of the analytic-synthetic method only with regard to social philosophy; with regard to natural philosophy there are some other possibilities for an explanation. For instance, it could be possible that Hobbes was compelled to ascribe essential properties to a single body in empty space in order to oppose the feudal 'organism' conception, which dominated natural philosophy. In this case his interpretation of the analytic-synthetic method in natural philosophy would likewise, in the last analysis, have to be seen as part of the social controversies. It could just as well be assumed that Hobbes arrived at this interpretation of the method on the basis of his experience with social philosophy and – since its consequences in natural philosophy

were much more plausible – allowed it general validity; in this case, too, it would have been conditioned by the social controversies.

Hobbes's assertion of the equality and independence of all citizens became increasingly problematical in as much as the historical developments led to massive expropriation of the small producers and to a concentration of land in the hands of a few. This development is of interest for the subsequent course of this analysis: for if civil society can no longer be taken as a society of equal and independent individuals, then a reinterpretation of Hobbes's basic principle of the relation of individual and society would be necessary, a reinterpretation of that principle upon which his conception of the analytic-synthetic method was based.

Before the problem of the determination of the new society as 'civil' or 'capitalist' was posed in social philosophy, it had been the object of social and political controversies, which broke out in the course of the Revolution. In order to interpret the development of social philosophy after Hobbes and its conception of the analytic-synthetic method, it is therefore necessary to consider the social struggles which were fought out in the time between the publication of Hobbes's *Leviathan* (1651) and that of Locke's *Two Treatises on Government* (1689/1690).

CHAPTER X

THE RISE OF CIVIL SOCIETY IN ENGLAND

1. THE LEVELLERS

In 1651, when Hobbes's *Leviathan* was published in London, the question, whether civil society was composed of independent, free, and equal citizens, was a political question of decisive importance. The reason for this lies in the fact that the victory of Parliament over the King had been attainable only by recognizing people in the parliamentary army as free and independent whose 'freedom' and 'independence' had to be called into question at the end of the revolution.[1]

When the Civil War began in 1642,

> A very great part of the knights and gentlemen . . . adhered to the King . . . . Most of the tenants of these gentlemen, and also most of the poorest of the people, whom the other called the rabble, did follow the gentry and were for the King. On the Parliament's side were . . . the smaller part (as some thought) of the gentry in most of the counties, and the greatest part of the tradesmen and freeholders and the middle sort of men, especially in those corporations and counties which depend on clothing and such manufactures (Richard Baxter (1615–1691), quoted by Hill, *Century*, 114).

After the defeat of the Royalists in 1645/1646 the decisive question was, who was actually the victor: the gentry and the merchants, or the 'middle sort of men', who had equal rights in Cromwell's army? "Is this the liberty which we claim to vindicate by shedding our blood?" asked the Earl of Essex, commander of the parliamentary army, in 1644. "Posterity will say that to liberate them from the yoke of the King we have subjugated them to that of the common people" (Quoted by Hill, *Century*, 117).

The 'common people' saw quite different dangers. In 1647 the conservative Presbyterian majority in Parliament wanted to dissolve the army (in which the more radical Independents were in the majority) without pay and negotiated with the King on a compromise. The regiments thereupon elected agitators, most of whom are to be reckoned to the radical 'Levellers', and when Cromwell and the majority of the officers sided with the soldiers, the General Council of the Army was formed and the King was taken into the custody of the army. The generals then began to negotiate with the King on the establishment of a limited monarchy (Heads of Proposals), and the

Levellers countered by drafting the 'Agreement of the People'; both drafts of a constitution were discussed in the Council of the Army (Putney debates). The decision to be made was which of the two should replace the old constitution destroyed by the Civil War; the question of sovereignty had already been decided – practically. It was impossible for Parliament to wage war against the King and at the same time assert his sovereignty: the sovereign was to be the people whom Parliament represented.

Since Parliament was supposed to represent the 'people', the question which was to be debated was: who belonged to the people, or who had the right to vote. Those who were unwilling to make any compromises with the King and with the feudal classes, the Levellers, appealed to the natural equality of all men and demanded the same right to vote for all free Englishmen who were willing to enter into the contract establishing a civil society. Only those who had fought on the side of the King and thereby demonstrated that they had no interest in such a contract – and of course those who abided by no contract: the criminals – were to be excluded from the right to vote.[2]

All remaining freeborn Englishmen were to enjoy the same right to vote, in so far as they were capable of entering into a contract, that is, in so far as they had not lost their freedom by a previous contract freely made. Thus, the following persons were also excluded from the right to vote: children – who were under the jurisdiction of their parents –, all women, servants, and those in receipt of alms: "now I see no reason", formulated Thomas Reede, "why any man that is a native ought to be excluded that privilege, unless from voluntary servitude". "I conceive the reason", said Maximilian Petty, a Leveller spokesman, "why we would exclude apprentices, or servants, or those that take alms, is because they depend upon the will of other men and should be afraid to displease (them). For servants and apprentices, they are included in their masters, and so for those that receive alms from door to door . . .".[3]

The view that the Levellers had demanded universal male suffrage thus seems to be a legend which arose from the contradictory statements and unclear notions of the Levellers (Macpherson, 142–159).

The reasons for the apparently contradictory views of the Levellers as well as for their connection to the communist 'Diggers' become clearer, when one takes not only the texts of the suffrage debates into consideration but also the social program of the Levellers as it is presented in their writings and practice. Shortly after the suffrage debate a Leveller petition was published: *The Remonstrance of many Thousands of the Free People of England* (Sept. 21, 1649) which had been signed by almost a hundred thousand men. In this

petition it was demanded, "that every free commoner shall be put into a way and enabled with means for his natural subsistence".[4]

After the suppression of the Levellers the fourth *Agreement of the People* was published; the §18 demanded that "all servile tenures of lands as by copyholders and the like to be abolished and holden for naught" (quoted by Brailsford, 449). Looking back, Cromwell characterized the Leveller position accurately: "What was the design but to make the tenant as liberal a fortune as the landlord? . . . That this thing did extend far is manifest, because it was a pleasing voice to all poor men and truly not unwelcome to all bad men" (Opening speech to Parliament, Sept. 4, 1654; quoted by Brailsford, 417).

The conditions under which universal manhood suffrage and the suffrage of independent small proprietors could be supported at one and the same time should by now be clear: namely, that all men be small proprietors. This program of the Levellers seemed to have good prospects for success. Two things were necessary: (1) to prevent enclosures and (2) the distribution of property or money to provide those without property with an independent existence as farmers or craftsmen.[5]

(1) The resistance of the Levellers to enclosures scarcely needs to be stressed; this can almost be taken as the essence of the Leveller movement. The name 'Levellers' was first coined during the uprisings against enclosures in the Midlands in 1607; and as late as 1724 the rebels against enclosures in Galloway were called Levellers. Throughout the course of the Civil War up to the suppression of the Leveller movement in 1649, large scale enclosures were prevented; immediately afterwards began a wave of enclosures. At first the Levellers had attempted to base their demand for small parcels of land on an appeal to the Anglo-Saxon tradition; when they realized how tenuous such arguments were, they began to argue that all men were by nature not only free and equal but that they also had a natural right to property. Overton was thus compelled to deviate from Hobbes, to whom he was otherwise indebted for many things (cf. Macpherson, 141f.), and – like all Levellers in the Putney debate (*ibid.*, 139) – to attribute to man a right to property prior to any social contract.[6]

(2) The time seemed also more favorable than ever before for the creation of small property. For, since the beginning of the 1640s, local committees had begun to confiscate the estates of royalists and papists and to collect rents to pay the soldiers of the parliamentary army; Parliament supported this action in order to be able to pay the army's suppliers and the creditors of the government. However, the estates of private persons were not sold until the end of 1648: the members of the House of Lords and conservative

parliamentarians successfully warded off such measures since they saw in them the beginning of the end of private property. The ordinance of Nov. 17, 1646 allowed the immediate tenants for thirty days the first option to purchase lands sold from the episcopal or Church estates; it seemed that measures had been taken to transfer feudal possessions into the hands of the immediate holders. However, the government desparately needed money, so that half of the payment had to be delivered eight weeks after the sale was contracted. It is obvious that the peasants could not exercise their options to buy; the land passed into the hands of the merchants from the City, who also arranged the whole transactions.[7]

Since the sale of estates was not sufficient to support the army and parts of the army had at the end of 1646 and in 1647 taken to satisfying their needs on their own by force, the government issues debentures, which could be exchanged for land but were not to be sold. Here again it seemed possible for the simple soldiers, among whom the Levellers played a decisive role, to become small proprietors. Thus one regiment acquired together an entire manor with such debentures; however, two and a half years later the major and five other officers bought up the shares of all the other soldiers; the reasons that the debentures helped only the officers to acquire land were always the same: the simple soldiers, who needed money to live on, had to sell their debentures – despite the initial prohibitions – while the officers, who were financially independent, could speculate. Most of the estates sold after 1649 went to the merchants of the City, higher ranking officers, and affluent citizens.[8]

At the end of the Civil War the oppositions in the parliamentary camp were clearly visible; those in the army were especially visible during the Putney debates between the Levellers and the officers. The struggle for the same demands of freedom and equality threatened to turn into a struggle within the same faction over the realization of the different possible interpretations of these slogans.

2. THE SUPPRESSION OF THE LEVELLERS

To the Independents, who wanted no limitations on property rights, who were thus proponents of large holdings, and who accordingly denied the property rights of the peasants (copyholders, tenants), the Leveller program represented an attack on property as such. The Levellers had to be suppressed before they could bring the army under their control. The opportunity soon made itself available: on the first of November (that is, during the Putney

debate) the King escaped from his imprisonment, and royalist uprisings began. Unity in the face of the enemy was necessary; Cromwell had one of the Leveller agitators shot, others were sent back to their regiments, rebellious regiments were suppressed.

In July 1648 the King invaded England with a Scottish army but was decisively defeated. The Presbyterian majority nonetheless favored a compromise. The army occupied London, excluded the most conservative members from Parliament, and installed a court to try and sentence the King; the King was executed on January 30, 1649. One month later Cromwell wrote that there was no other way to deal with the Levellers but 'to break them to pieces'. In May of 1649 he suppressed the most dangerous revolt of the Levellers in Burford; in the same month Parliament passed an ordinance calling for the drainage of the moores. Enclosures, which had been avoided during the Civil War due to massive resistance, were now carried out regularly along with the sale of the estates of the royalist nobility. After the suppression of the Levellers Cromwell and Fairfax received honorary degrees from the traditionally royalist university at Oxford. "Henceforth the Revolution had turned conservative" (Hill, *Century*, 121).

In the 1650s the resistance of the Levellers and of the tenants with insecure titles became completely hopeless. In 1656 the last attempt to halt enclosures and to protect the copyholders failed in Parliament; in 1661 when the military duties which had once been connected with feudal tenures were abolished, the act of Parliament expressly stated that no change in the position of the copyholders was implied; the landlord had become a landowner, the peasant had become propertyless and could be set free. Out of the revolution against feudalism there did not arise a civil society of independent producers but rather a civil society with capitalist relations of production, in which the means of production became the property of a minority of capitalist proprietors upon whom the majority of citizens were dependent.

Nonetheless, the further development of capitalism in England was still dependent on the army, and therefore a few years later another favorable situation occurred for the Levellers. In the middle of 1652 the conquest of Ireland was practically completed, and the ordinances of the Long Parliament on the confiscation of the estates of 'delinquents' and 'papists' also applied to the Irish 'rebels', and just as in England these estates fell into the hands of the great landowners. With the proceeds from the sale of royalists' estates or by rigorously taxing them, it was possible to finance the building up of the fleet. The Navigation Acts of 1650 and 1651, which Holland was forced to recognize after losing a war, secured for the English the trade with their own

colonies, and the treaty with Portugal (1654) secured that with the Portuguese colonies overseas.

When these tasks were completed, conflict between Parliament and the army was inevitable. The power of the leaders of the army depended on the existence of a large standing army; the affluent citizens represented in Parliament had neither any interest in financing the army nor in relinquishing executive power to it. When the generals attempted to finance the executive by heavy taxation of former royalists, an alliance of the affluent was created. At the end of 1659 the taxpayers in the City went on 'strike', the army had to be supported by forced quartering, plundering became an everyday event; radical pamphlets were published, in which all the Leveller demands reappeared; an alliance between the unpaid army and the radicals, i.e., a repetition of the events of 1647–1649 seemed to loom after Cromwell's death.

"Nor will the largeness of the governor's power", wrote John Locke at the time, "appear dangerous or more than necessary if we consider that as occasion requires it is employed upon the multitude that are as impatient of restraint as the sea, and whose tempests and overflows cannot be too well provided against .... To whom are we most likely to be a prey, to those whom the the Scripture calls Gods, or those whom knowing men have always found and therefore call beasts." In light of the threat from the beasts and of the necessity of equipping the authority with sufficient power, Locke could contemplate with indifference the question "whether the magistrate's crown drops down on his head immediately from heaven or be placed there by the hands of his subjects".[9]

The danger was, however, quickly removed. The commander of the army in Scotland, Monck, marched on England, The army of General Lambert, which was sent to stop him, could not be paid and melted away along the way. At the beginning of 1660 Monck arrived in London. A new conservative-royalist Parliament met in April; the Upper House was restored. Baxter, who had advocated the abolition of episcopacy in 1640, told Parliament: "The question is not, whether Bishops or not, but whether discipline or none" (Hill, *Century*, 153). Parliament was of the same opinion; it accepted the 'Breda Declaration' of Charles II. Charles returned to England in May, 1660, and the compromise between former feudal lords and bourgeoisie was concluded: the so-called Restoration began.

3. RESTORATION: WHIGS AND TORIES

First of all the institution of King was restored; thirty 'regicides' of 1649 were sentenced to death, eleven were executed. Also restored (at least in theory) were the property titles of the Crown, the Church, and the royalists to their estates in so far as they had not themselves sold them. Finally, the Anglican Church was also restored: public offices could be held only by Anglicans (Corporation Act, 1661); uniform church services were enforced; and those ministers who did not publicly acknowledge the *Book of Common Prayer* *'ipso facto'* lost their positions (Uniformity Act, 1662). The Archbishop of Canterbury and the Bishop of London acquired the power of censorship over the press.

It was decisive, however, that feudal property relations were not restored. The last feudal duties connected with the possession of land were abolished by Parliament as well as the protections of the small holders; enclosure and cultivation of the forests areas was made possible. The practice of strict settlement guaranteed that land was not divided up among the heirs. Large landowners drove off the small holders; the capitalist mode of production came to dominate agriculture, too.

It is characteristic of the changed power relations between bourgeoisie and King that, when the King ran into financial difficulties, he did not even make the attempt to raise taxes on his own; instead he entered into a secret treaty with France (1670) which brought him considerable sums of money, for which he offered to re-catholicize England and to wage war on Holland. On March 15, 1672 Charles II issued the Declaration of Indulgence which ended the persecution of Catholics. In the same year a stop of the Exchequer had to be declared, since the King could not pay his debts to his creditors in the City; Parliament approved 1.2 million pounds for the third war against Holland (1672–1674), but in return the King had to repeal his Act of Indulgence and to accept the Test Acts (1673), which excluded Catholics from public office.

The secret treaties between Charles II and Louis XIV enabled the latter to achieve the great successes of his war against Spanish Flanders and Holland. In 1677 the English Parliament demanded an alliance with Holland, and Charles had to consent under pressure to the marriage of the daughter of his Catholic brother, James, to William of Orange.

In 1678, after the peace of Nymwegen, France was at the height of its power. In the same year the former Anglican chaplan Titus Oates uncovered an alleged Papist-Jesuit conspiracy to murder Charles II and to place his

Catholic brother, James, on the throne and finally to promote the Counter-reformation in England.

At the same time the correspondance between the secretary of James's wife, Coleman, and Père Lachaise, the confessor to Louis XIV, became known, in which they negotiated on the re-catholicization of England. The 'papist' danger had never seemed so great; the elections in February, 1679 were dominated by this theme. For the first time elections were carried out on the basis of party formations, and the 'Whig' opposition won an ovewhelming victory. At a demonstration in London at which the Pope was burned in effigy, 200 000 people are supposed to have taken part. As had happened in 1640, the controversy had again gone from Parliament into the street. Shaftesbury, the leader of the Whigs, had at first encouraged this development; he founded the 'Green Ribbon Club' (green was the color of the Levellers) and built up an extended party organization; mass agitation was practiced in London: in the country the Whigs put up candidates to oppose the established functionaries. It seemed as if an attempt by the King to dissolve the third Parliament within two years would be the signal for an uprising. The probability seemed all the greater since close to half the population of England lived at or below the existence minimum and wages had been falling since the first year of the Restoration.

Lord Halifax warned the parliamentarians that the events of the 1640s could repeat themselves: "the gentlemen, the knights of the shires, may be kicked out by mechanics, by citizens and burgesses, for he who practiseth disobedience to his superiors teacheth it to his inferiors" (quoted by Hill, *Century*, 203). When the King called Parliament to meet in Oxford, where it was secure from the pressure of the 'mob', the Whigs' threat of an uprising turned out to be a bluff. Charles II prevailed with the help of the Tories; in 1682 the designated successor to the throne returned to England; in 1683 the 'Rye House Plot' was uncovered and a number of Whigs were arrested and sentenced.

4. THE THEORETICAL CONTROVERSIES BETWEEN WHIGS AND TORIES: LOCKE AND NEWTON AS WHIGS

(a) *Locke*

The concern that the events of the years 1679–1681 could take the same course as they had from 1640 to 1649, led in both parties to increased exertions in the realm of theory. The controversies engaged in at this time are of

interest because the Whigs, whose opponents, the Tories, had fallen back on the feudal-absolutist theoretician, Filmer,[10] could not simply take the position that society is an association of equal and independent private proprietors, for it was precisely the development of the civil society they favored which led to the mass expropriation of the small peasants and to concentration of private property in the hands of a few. The implementation of the Leveller program, that is, the parceling out of land and of the great fortunes, was the last thing that crossed the mind of a Whig theoretician like John Locke.

The dilemma of the Whigs consisted in the fact that they upheld the bourgeois standpoint against the Tories, who now denied (in theory) every liberty of subjects, but at the same time had to fear that the 'mob' that they were mobilizing could attempt to put the slogans 'liberty' and 'equality' into action in the sense of the Levellers. Freedom and equality, thus, had to remain the basis of social theory – but in a form which excluded a Leveller interpretations. John Locke attempted to fulfill these requirements by starting from a state of nature, in which – in accord with the bourgeois conception – men lived as free and equal, autarchic producers, and then by showing how from this natural condition a civil society might have arisen in which, in spite of there being great landowners and wage laborers, all men can be taken as equal and free private proprietors.

In a state of nature, so Locke argued, all men are equal as members of the same species (II, 4), at least as far as jurisdiction is concerned. All are likewise perfectly free "to order their Actions, and dispose of their Possessions, and Persons as they think fit" (II, 4). Every man has a natural property right to his own person. "This no Body has any Right to but himself" (II, 27). The justification of property in goods is derived from this, since the property of a man in his person justifies the property in the "*Labour* of his Body and the *Work* of his Hands": "Whatsoever then he removes out of the State that Nature hath provided, and left it in, he hath mixed his own *Labour* with, and joyned to it something that is his own, and thereby makes it his *Property*" (II, 27); he has thereby removed it from the common right of other men. However, a man may appropriate a natural object in this manner only "where there is enough, and as good left in common for others" (II, 27). A further restriction lies in the fact that everyone must take care to consume the objects "before they spoiled; else he took more than his share, and robb'd others . . . the *exceeding the bounds of his* just *Property* not lying in the largeness of his Possessions, but in the perishing of anything uselessly in it" (II, 46).

The ownership of land, which is now the "chief matter of Property", is acquired in the same manner as property in the product of labor: "*As much*

land as a Man Tills, Plants, Improves, Cultivates, and can use the Product of, so much is his *Property*. He by his Labour does, as it were, inclose it from the Common" (II, 32). The limitation that no one may be injured applies here, too; for when the land was appropriated, "there was still enough and as good left; and more than the yet unprovided could use" (II, 33).

One can easily see that all requirements that can be made on a society of independent, indeed even autarchic families of producers (II, 105) are fulfilled here. Such a society would still be possible in principle, "since there is Land enough in the World to suffice double the Inhabitants" (II, 36), but only in principle. The limitation of a man's property to that which he himself can use, says Locke, would still hold today "had not the *Invention of Money*, and the tacit Agreement of Men to put a value on it, introduced (by Consent) larger Possessions, and a Right to them" (II, 36). But since gold and silver, which do not spoil (II, 37, 47), can be hoarded, men have practically consented to inquality of property (II, 48, 51) and thereby also consented to the appropriation of goods even supposing that "enough and as good" do not remain for other men.

However, even in this case the determination still holds, that only the mixing of one's own labor grounds property; thus, the rich man must be able to dispose of more labor than he himself expends; and this is not only possible but also permissable, since every man has a property in his 'person' and in the "labor of his body" and the "work of his hands" (II, 27), which like every property can be exchanged or sold. The 'mixing' of this 'labor' with a natural object grounds the right of its owner to the product of the labor; the buyer and owner of the 'labor' of another can as a consequence appropriate and use more products or land than he could by the labor of his body alone. For the grounding of property by labor, Locke gives the following example:

> Thus the Grass my Horse has bit; the Turfs my Servant has cut; and the Ore I have digg'd in any place where I have a right to them in common with others, become my Property, without the assignation or consent of any body. *The labour that was mine*, removing them out of that common state they were in, hath fixed my Property in them (II, 28; my italics).

The introduction of money thus leads to a situation, where property in the product of one's own labor and in the land cultivated can develop farther to property in great estates and to wage labor – without however changing anything in the justification of property through labor or in the natural rights of man. It is in this connection not of significant interest that (or how) Locke derives the inequality of intellect as well as political inequality in capitalist

society on the basis of this inequality of possessions (on this cf. Macpherson, 221–251). For Locke's social philoosphy it is nonetheless important that, according to him, the origin and continuance of a capitalistic class society is only possible because this society is still essentially a society of independent private proprietors. Thus, Locke not only has no reason to revise his opinion that society is composed of independent (formerly autarchic) private proprietors, but he must also retain this view in order to be able to represent capitalist society as 'civil'. Thus, Locke also has neither reason nor opportunity to revise the bourgeois conception of the relation of element and system or the Hobbesian interpretation of the analytic-synthetic method.

It is, furthermore, important that Locke has achieved the political goal of his treatise: whoever, he wrote, "will not give just occasion, to think that all Government in the World is the product only of Force and Violence . . . and so lay a Foundation for perpetual Disorder and Mischief, Tumult, Sedition and Rebellion (things that the followers of that [Filmer's – G.F.] Hypothesis so loudly cry out against) must of necessity find out another rise of Government, another Original of Political Power, and another way of designing and knowing the Persons that have it, then what Sir *Robert F.* hath taught us" (II, 1).

The "other original of political power" is the agreement of free, equal, and independent men to leave the state of nature, where the "enjoyment" of property is "very uncertain", and to found civil society: "The great and *chief end* therefore, of Mens uniting into Commonwealths, and putting themselves under Government, *is the Preservation of their Property*" (II, 123, 124). The "great instrument" for securing property is the law, and therefore the legislative is the "Supream Power" of the commonwealth (II, 134, 135). From these determinations it follows that "*Absolute Monarchy* . . . is indeed *inconsistent with Civil Society*, and so can be no Form of Civil Government at all"; for the absolute monarch is not subject to the law and is therefore in a state of nature with respect to his subjects (II, 90ff.; cf. 211–243 and the allusions to James II in II, 205).

Locke's theory thus legitimizes the bourgeois-capitalist society in opposition to two political positions: the freedom of all citizens as private proprietors is maintained not only against absolute monarchy but also against the Leveller program.

(b) *Newton*

When Locke's *Two Treatises of Government* was published near the end of

1689, James II had already lost his throne to William III of Orange. James, who had succeeded to the throne in 1685, attempted after the suppression of Monmouth's rebellion (June, 1685) to establish his own power base with an alliance of Catholics and Nonconformists. He raised a Catholic army in Ireland, filled key government posts and local offices with Catholics, and attempted with the newly established 'Court of Commissioners' to force Catholics on the universities at Oxford and Cambridge. When Cambridge was being forced to accept a Benedictine monk as Master of Arts, Newton wrote:

For all honest men are obliged by the Laws of God and Man to obey the King's lawfull Commands. But if his Majesty be advised to require a Matter which cannot be done by Law, no Man can suffer for neglect of it (Letter of Feb. 16, 1686/1687, *Corresp.* II, 467–478; cf. Locke, II, 210).

In 1678 and 1688 James II issued Declarations of Indulgence which prohibited the persecution of dissenters and repealed the Test Acts. With these measures he launched a direct attack on the power of the Tories and the Anglican Church. The Bishops thereupon refused to follow his directives and have the second Declaration of Indulgence read from the pulpit. "If the King", said the spokesman of the bishops, "may suspend the laws of our land which concern our religion, I am sure there is no other law but he may suspend; and if the King may suspend all the laws of the kingdom, what a condition are all the subjects in for their lives, liberties and properties! All at mercy!" (quoted by Hill, *Century*, 208).

The alliance of Whigs and Tories was quickly made; on the 30th of June, the day the bishops were acquitted and released, an invitation to invade England, signed by seven Peers (three of them Tories), was sent to the Protestant William of Orange, who was willing to accept the crown on Parliament's terms; his army encountered no serious resistance. In February, 1689 William III and Mary II were declared joint rulers by Parliament. On Feb. 21 Newton wrote to the vice-chancellor of Cambridge University offering arguments, why one could swear allegiance to King William in spite of the oath of allegiance to James II:

Fidelity and Allegiance sworn to the King, is only such a Fidelity and Obediance as is due to him by the law of the Land. For were that Faith and Allegiance more then what the law requires, we should swear ourselves slaves and the King absolute: whereas by the Law we are Free men notwithstanding those oaths.

Moreover,

Allegiance and Protection are always mutuall and therefore when K. James ceased to

protect us we ceased to owe him allegiance by the law of the land. And when King W. began to protect us we began to owe allegiance to him (Newton to Covel, Feb. 21, 1688/1689, *Corresp.* III, 12f.).

On account of his role in the resistance of the university against the illegal measures of the King in 1687, Newton was elected in 1689 to represent the university in Parliament; in 1701 he was re-elected. From 1699 up till his death (1727) he was director of the Mint; from 1703 onward he was President of the Royal Society. In 1705 he was knighted.[11]

5. THE REIGN OF THE 'PLUSMAKERS'

In the third edition of the *Two Treatises*, which appeared in 1713, Locke added to his explanation of how the inequality of fortunes could justly develop. In the first edition he had simply maintained that there was still enough land for double the current population of the earth (II, 36) and pointed out that wherever land is not worked, the people "have not one hundredth part of the Conveniencies we enjoy: And a King of a large fruitful Territory there feeds, lodges, and is clad worse than a day labourer in *England*" (II, 41). In the third edition he added:

that he who appropriates land to himself by his labour, does not lessen but increase the common stock of mankind. For the provisions serving to the support of humane life, produced by one acre of inclosed and cultivated land, are (to speak much within compasse) ten times more, than those, which are yielded by an acre of Land, of equal richnesse, lyeing wast in common (II, 37).

At first glance nothing more is said than in the comparison between the King in an uncultivated land and the wage laborer in England; the point is that England was not an uncultivated country but rather was tilled by small peasants, who were, however, dependent on the use of the commons. The comparison of the commons with land lying waste had thus been inaccurate. In his new argument Locke places the emphasis on the assertion that the cultivation of the commons even in an already cultivated country produces as great a quantity of foodstuffs as if 'mankind' had been given ten times as much land for common use, and thus that the expropriation of the peasants, who now became wage laborers, seems beneficial to 'mankind' and can be welcomed because the existence minimum of even the unemployed poor would be secured (II, 41–42). Locke argues, in other words, that the accumulations of large fortunes in a few hands does not necessarily lead to the impoverishment of the rest of men.

Thus in 1713 Locke traced the economic progress of England agriculture back to enclosures. With this he does in fact hit the mark; for the development of agriculture at this time rested on the transformation of agrarian relations not on technological innovation. The turning point in the development, the appointment of William III of Orange in the year 1689, brought "the landlord and capitalist plus-makers to power. They inaugurated the new era by practising on a colossal scale thefts of state lands, thefts that had been hitherto managed more modestly. These estates were given away, sold at a ridiculous figure, or even annexed to private estates by direct seizure".

"The advance made by the 18th century shows itself in this, that the law itself becomes now the instrument of the theft of the people's land .... The parliamentary form of the robbery is that of 'Bills for Inclosures of Commons', in other words, decrees by which the landlords grant themselves the people's land as private property, decrees of expropriation of the people". These replaced "the independent yeomen" with "tenants at will, small farmers on yearly leases, a servile rabble dependent on the pleasure of the landlords ... ". "About 1750, the yeomanry had disappeared, and so had, in the last decade of the 18th century, the last trace of the common land of the agricultural labourer" (Marx, *Capital* 1, 722–725; MEW 23, 750–753). Marx, comments Hill, "may have oversimplified and foreshortened a complicated process ... but taking the long view that is precisely what happened" (Hill, *Industrial Revolution*, 271; cf. also Kulisher, II, 70–72).

The immediate consequences for the peasants 'set free', who had to buy food and clothing etc. on the market, must have been catastrophic. But thereby a demand was created for the commodities of manufacture, which now produced for mass consumption, and the freed peasants constituted a reserve of laborers upon which the manufacturers could call whenever need arose. The other great market for manufactured goods was export, especially to the colonies. The profits which flowed from the colonies back to England derived not only from trade in manufactured goods; the most profitable branches were slave trading and the systematic plundering of the colonies. The complicated causes and the various details of the economic boom in England up to the industrial revolution can be neglected here; but it is important to note that the standard of living of the working population rose steadily. Crop rotation, which had already begun in the 16th century and improved transportation (waterways) reduced the fluctuations in the prices of foodstuffs; basic foodstuffs became cheaper, and wages increased; better nourishment of the working population and the decrease in epidemics since the beginning of the centtury lowered the mortality rate; the birth rate climbed.

This development of course benefited most of all the ruling class, which became increasingly unified. The enormous profits from trade were invested above all in land; the traders of yesterday became the landowners of today. Landowners began to mine coal and iron, and agriculture introduced capitalistic management. In spite of the tendency to unity, differences between City capitalists and rural landowners can be recognized. The former favored an aggressive policy of war to conquer new markets; the latter, whose taxes financed the wars, favored peace. The opposition of interests, however, had quite a different dimension than it had a century before: neither City capitalists nor great landowners were now interested in changing the form of society or the form of government. The acrimony of controversies in social theory also belonged to the past; the theories on the divine authority of kings or on the social contract were 'speculative systems', with which Tories and Whigs legitimated their practical programs – as one cynical contemporary detachedly noted (Hume, 452).

The bourgeois social philosophers still had two possibilities: they could describe the existing society or they could demand a 'Leveller republic'. Both views, however, – this will be shown in the next chapter – assume that civil society is composed of independent private proprietors.

CHAPTER XI

ALTERNATIVE CONCEPTIONS OF CIVIL SOCIETY

1. THE CAPITALISTIC COMMODITY PRODUCTION OF INDEPENDENT PROPRIETORS: ADAM SMITH

(a) *The Savage and the Worker*

Adam Smith, who had a thorough knowledge of the economic development of England sketched above, favored this development and maintained it would benefit all – even the poor. In principle his social philosophical views scarcely differ from those of Locke.[1] Smith, too, cites the comparison between a society of "savages", among whom "every individual enjoys the whole produce of his own industry", and a "civilized" society, in which the "poor provide both for themselves and for the enormous luxury of their superiors"; but he points out "in the midst of so much oppressive inequality ... the superior affluence and abundance commonly possessed even by this lowest and most despised member of civilized society, compared with what the most respected and active savage can attain to" (Ed, 563f.). Unlike Locke, Smith traces the wealth of civilized society back to the advanced division of labor, which also effects the "difference of genius and talents", whereas in a society which has seen little division of labor a "perfect uniformity of character" will be found (Ed, 573).

Smith is nevertheless aware that the poor themselves are less convinced of the advantages of capitalism and would more likely wish for equality of fortunes: "Laws and governments", he writes, "may be considered in this and indeed in every case as a combination of the rich to oppress the poor, ... who if not hindered by the government would soon reduce the others to an equality with themselves by open violence" (LJ(A), 208; cf, WN V.i.b.1–4, 12).

Smith himself also does not overlook the seamy side of the form of subdivided production with which he is familiar. He observes that as a result of uniform activities in manufacture the worker "becomes as stupid and ignorant as it is possible for a human creature to become (WN V.i.f.50); and he also notes that the worker decays morally (WN I.viii.48; V.i.g.12). In a society with advanced division of labor, development leads to "great abilities" of a

few but also to a situation where "all the nobler parts of human character *may* be, in a great measure, obliterated and extinguished in the great body of the people" (WN V.i.f.51; my italics).

However, this development is not necessary. For the degeneration of the working population in moral, intellectual, and social respects arises from their poverty, that is, from the circumstance that they are forced to send their children to work instead of to school; furthermore, it is the result of the increasing decay of the school system. Both problems are, according to Smith, solvable through an improvement in general welfare and through legislative mandate and state support of sufficient education (WN V.i.f.52–57). This responsibility indeed lies in the interest of the state, since the better instructed the lower ranks of society are, "the less liable they are to the delusions of enthusiasm and superstition, which, among ignorant nations, frequently occasion the most dreadful disorders" (WN V.i.f.61).

On the other hand, the care for the welfare of the masses does not fall directly within the jurisdiction of the state – for reasons of principle and also of economics.

(b) *The Society of Private Proprietors*

Like John Locke before him and based on the same arguments, Adam Smith, too, is of the opinion that civil society is composed of independent private proprietors:

> The property which every man has in his own labour, as it is the original foundation of all other property, so it is the most sacred and inviolable. The patrimony of a poor man lies in the strength and dexterity of his hands; and to hinder him from employing this strength and dexterity in what manner he thinks proper without injury to his neighbour, is a plain violation of this most sacred property (WN I.x.c.12).

On the basis of this conception, Smith distinguishes between those societies in which the independence of all private proprietors is realized and those in which the poor are dependent on the rich. In the age of shepherds – the age in which there were differences in wealth but still no luxury production – the rich kept the poor in dependency by providing them with the means of subsistence (LJ(A), 202, 208, 215, 217); the same dependency was produced by the feudal lord by letting out land at favorable terms (LJ(A), 261f.). After the "introduction of arts, commerce, and luxury", the power of the feudal lords diminished. To satisfy their need for luxury, they were compelled to demand an increase in the rent of land; but those dependent on them paid

only on condition that the durations of the leases were extended, by which the tenants gradually became more independent (*ibid.*).

As far as the independence of the private proprietors is concerned and on the basis of the view that the wage laborer is a private proprietor (of his labor), it is unimportant whether the dissolution of feudal society leads to a society of small proprietors or to a bourgeois-capitalist society. Even the living conditions of the poor would not be affected; for the great landowners consume only a little more of the necessaries of life than the poor, and "though the sole end which they propose from the labours of all the thousands whom they employ, be the gratification of their own vain and insatiable desires, they divide with the poor the produce of all their improvements. *They are led by an invisible hand to make nearly the same distribution of the necessaries of life, which would have been made, had the earth been divided into equal portions among all its inhabitants . . .*" (TMS IV.i.10).

(c) *The System of Natural Liberty*

The non-interference of the state in the economic activity of the citizens is to be haled not only because it does not restrict their 'natural liberty', but also because it secures prosperity; for "no human wisdom or knowledge could ever be sufficient [for] the duty of superintending the industry of private people, and of directing it towards the employments most suitable to the interest of the society" (WN IV.ix.51). The decision on how to employ his own labor power or capital must thus be left to every private person. For since every individual endeavors to employ his capital where the greatest profit is to be expected, and since, if too much capital is employed in certain areas of production, the rate of profit sinks in these areas while rising in others, thus "the private interests and passions of men naturally lead them to divide and distribute the stock of every society, among all the different employments carried on in it, as nearly as possible in the proportion which is most agreeable to the interest of the whole society" (WN IV.vii.c.88; cf. IV.ii.9).

Smith conceived of all citizens as not only private proprietors but also capitalists, who employ their capital (means of production and 'labor') in order to obtain the highest profits, and he demanded equal freedom for all. In addition to his critique of mercantilist economic policy (WN IV), Smith therefore argued for the abolishment of the privileges of corporations, of the statutes of apprenticeship – "both which are real encroachments upon natural liberty" – and of the 'Act of Settlement', which prevented the

unemployed from finding work (WN IV.11.42; cf. I.x.c). Smith also opposed the attempt by the state to set wages, and supported measures to prevent masters from combining to hold down the wages of their workers (WN I.x.c.61).[2]

The expectation, that his political recommendations would be followed, enabled Smith to contrast two 'natural' societies in which the independence of the individuals is realized: the barbarous and the civilized society. Whereas civil society due to its capitalistic mode of production is a more perfect form of commodity producing society than that existing among savages, because it is richer and because it encourages the 'humanity' of the citizens, barbarous society is the more perfect form of a society of commodity producers in so far as all individuals develop their personality to the same extent and are capable of taking part in political life.

The society of 'savages' with its division of labor forms not only the historical point of departure for development but at the same time represents an aspect of that social condition, to which capitalist society must advance according to Smith, in so far as appropriate state measures can be initiated. In this perspective, the savage represents both the origin and the ideal of the citizen of the future, who, to be sure, also develops 'humanity' on the basis of affluence.[3]

Both forms of society, the 'barbarous' before the institution of government, and the 'civil', whose development in the ideal case is no longer guided by the government, are thus 'natural', and in both the individuals are free and independent. The 'barbarous' form of society already presupposes a division of labor among the independent producers. To explain the origin of the division of labor Smith extrapolates to a likewise 'natural' 'rude state of society' and concludes, that this society consisted of independent and autarchic individuals. The origin of the division of labor is explained by way of the motives of the autarchic and freely acting individuals, by a 'propensity' to barter. This 'propensity', which is attributable to every individual as an essential property, acts as soon as individuals come together. Thus, Smith's conception of civil society and of earlier social forms as 'natural' necessitates the reduction of social phenomena to essential properties of individuals, which belong to them independently of their existence in society.

(d) *The Value-form and the Value of a Commodity*

A central problem of Smith's political economy, the labor theory of value, depends on the conception of the analytic method as the resolution of an

object into independent elements and on the view behind it that civil society consists of independent private proprietors. This problem has two aspects. First of all, the value of a commodity cannot be reduced to a property of a single product; and secondly, – taking, on the one hand, all citizens as equal private proprietors and 'labor' as a commodity, and assuming, on the other hand, the exchange of equivalents – the origin of surplus value (and thus of profits) cannot be explained.

Like other economists before him, Smith does not analyze the 'value-form' of the commodity, that is, the form in which the products of labor are exchanged as commodities; on the contrary, he takes it as natural just as he takes civil society as a society of private proprietors to be natural.[4] On the basis of this assumption no consistent labor theory of value can be developed.

"Labour alone", writes Smith, "therefore, never varying in its own value, is alone the ultimate and real standard by which the value of all commodities can at all times and places be estimated and compared. It is their real price; money is their nominal price only" (WN I.v.7). On the other hand, Smith wants this measure of value to be applied only to the "early and rude state of society which precedes both the accumulation of stock and the appropriation of land" (WN I.vi.1). This measure cannot be applied if some people have have accumulated capital which they employ "in setting to work industrious people, whom they will supply with materials and subsistence, in order to make a profit by the sale of their work, or by what their labour adds to the value of the materials" (WN I.vi.5). A second part of the value produced by labor pays the "rent of land" (WN I.vi.8), and only the remainder will constitute the price of labor, that is, the wages. When the value (or price) of a commodity is considered as the source of income for the various classes in society, it is divided into three components: "Wages, profit, and rent are the three original sources of all revenue as well as of all exchangeable value" (WN I.vi.17).

The contradiction is apparent. On the one side, Smith says that labor alone creates value; but since all commodities, including 'labor', are sold at their values, Smith cannot discover the source of profits and rents of land and wants therefore to limit the validity of the theory of value to pre-capitalist times. To explain the origin of profit and rent, Smith then says that the value of a commodity is composed of three components: the value of labor, capital and land. With this, the labor theory of value is abandoned, and what 'value' is remains unexplained.

The contradiction arises from the following problem: if the exchange relation between owners of capital and owners of labor power differs in no

respects from the exchange between two owners of any commodities whatever, then it is unfathomable whence profit is supposed to arise. But if it is maintained that the worker sells not the commodity 'labor' but 'labor power', and if the introduction of this distinction is sufficient to explain the possibility of creating profit without abandoning the labor theory of value,[5] then it follows that labor power is different from other commodities and that the owner of labor power is different from the owner of other commodities and, finally, that capital can exist only when one of the exchangers owns commodities while the other owns only labor power: that capital thus consists in a relation.[6]

Adam Smith cannot agree with this conclusion. The worker is in his view a private proprietor like any other commodity owner and the exchange of a commodity for labor power is the same as the exchange of any commodities whatever; otherwise Smith could not have maintained that civil society consists of equal and independent private proprietors. But since he supported precisely this view, he could neither admit the distinction between owners of labor power and owners of other commodities nor could he recognize that ownership of capital consists in a relationship and thus cannot be attributed to a single individual.[7] Smith's assertion, that civil society consists of equal and independent private proprietors, is thus also the reason for his failure to formulate consistently his labor theory of value and for his interpretation of the analytic-synthetic method as resolving an object into its equal and independent elements and compounding them again.

2. THE SIMPLE COMMODITY PRODUCTION OF INDEPENDENT PRIVATE PROPRIETORS: JEAN-JACQUES ROUSSEAU

Hobbes had not surmounted the artisan conception of the analytic-synthetic method – the determination of essential properties of each single element – because its absurd consequence, the autarchy of every man, represented a necessary condition for his contract theory, and a contractual relation was the only real alternative to the relations of personal dependency of feudal society. Rousseau, too, faced the same alternative, as had Locke before him, although he carried on the ideas of the Levellers rather than those of Locke.[8]

The original contract, which is entered into by all regardless of the inequality of possessions, the contract between the rich and the poor, whose equality consists in the fact that all are exposed in equal measure to a violent death, was judged by Rousseau – on the basis of its results (the inequality

of property protected by the state) – to be a fraud, a cheating of the poor by the rich.[9]

On the example of the contract of the rich with the poor, Rousseau showed that even an 'equitable' contract, in which the same rights are conferred by each side on the other (abstention from the use of force), can perpetuate inequality, lead to the domination of the rich over the poor, and in the end destroy the freedom of the contracting parties. The social contract which Rousseau proposes, "far from destroying natural equality substitutes, on the contrary, a moral and lawful equality for whatever physical inequality that nature may have placed among men; . . . men become equal by covenant and right" (C.S. I.9, 367). This contract presupposes that "all possess something and none has too much" (C.S. I.9n., 367) and that in civil society "no citizen shall be rich enough to buy another and none so poor as to be forced to sell himself" (C.S. II.11, 391f.). But since the division of labor (private property assumed) leads inevitably to differences in possessions and thus to dependency (*Disc.*, 172), the prerequisite for a society in which real freedom and equality prevail is a contract between autarchic or at least personally independent small proprietors.[10]

This autarchy of the private producers is, however, essentially distinct from the original autarchy of the natural man roving through the forests. The men who enter into the social contract already live in family groupings: "the oldest of all societies, and the only natural one is that of the family" (C.S. I.2, 352). The contract entered into by the autarchic producers is thus a contract between heads of families; the founding of families and the social contract do not coincide historically; but both kinds of socialization occur on account of an external necessity and therefore do not compromise the original non-social nature of the autarchic subject.[11]

Deriving both forms of socialization, the family and the state, from external necessity while retaining the assumption of the non-social nature of man enables Rousseau to comprehend the family as a 'natural society' and still to reject the consequence drawn by feudal theoreticians, that relations of personal dependency are natural. The family, Rousseau argues, is indeed a 'natural society' but the children "remain tied to their father by nature only so long as they need him for their preservation. As soon as this need ends, the natural bond is dissolved", and "both parties equally regain their independence. If they continue to remain united, it is no longer nature, but their own choice, which unites them; and the family as such is kept in being only by agreement. This common liberty is a consequence of man's nature" (C.S. I.2, 352). If therefore the family is a 'model' of 'political societies', the only thing

that can be inferred is the natural 'freedom and equality' of all (C.S. I.2, 352f.). In this is to be seen the primary function of Rousseau's theory on the origins of the family and on the autarchy of the natural man for his political theory.[12]

Just as Rousseau's theory of the origin of the family is a prerequisite for his refutation of the feudal theory of royal-paternal rule, so too it enables him to reject the conception of society as a natural organism and instead to interpret the relationships of the citizens to one another as contractual relations. For, according to Rousseau, the relationship between children and parents is necessary, but the relationships among the children themselves are not. Grown-up children, that is, all citizens, are independent of each other, and their relationships are voluntary, i.e., contractual relations. The independence in principle, which is grounded in economic autarchy, is a major condition for the social contract and at the same time a goal that is to be realized. The theoretical task which Rousseau sets himself thus consists in finding a form of socialization, which

> defends and protects the person and goods of each member with the collective force of all, and through which each individual, while uniting himself with the others, obeys no one but himself, and remains as free as before (C.S. I.6, 360).

The freedom of each after the contract must be considered in two respects: from the point of view of the 'body politic' and from that of the relation of each individual to each other. The socialization transforms each individual from a 'perfect and solitary whole' to a 'part of a larger whole' from which the individual receives 'his life and being' (C.S. II.7, 381); the greater the dependence of the subject on the laws passed by him as part of the sovereign, the greater is his freedom and the more secure is his 'perfect independence' of all other private persons (C.S. II.12, 394). Rousseau's theory of the formation of the family by free and independent natural men due to external necessities turns out to be a necessary condition for his claim that the republican social contract (and thus popular sovereignty and the independence of private persons from one another) rather than the feudal conception of a hierarchical organism is the form appropriate to human nature. In light of this political goal Rousseau had to tolerate the absurdities of his theory of the original state of nature. The point of departure for his social philosophy consisted in the assumption of the autarchy of natural man. Since this assumption was represented as the result of a social analysis, there was neither necessity nor possibility for Rousseau to grasp the analytic-synthetic method otherwise than as the resolution of an object into primitive elements, whose essential properties belong to them independently of the system.

CHAPTER XII

CIVIL SOCIETY AND THE ANALYTIC-SYNTHETIC METHOD

1. SOCIETY AS AN AGGREGATE OF AUTARCHIC INDIVIDUALS

All the social theories analyzed above, to which (as Smith had already recognized) the theory of Mandeville can be added (Letter, 250), have in common the view that civil society is composed of independent individuals who enter into relations in contract form and only for their own advantage.

Determining his own point of departure at the beginning of the *Grundrisse* ('Foundations of the Critique of Political Economy'), Karl Marx makes explicit reference to these notions:

> Individuals producing in society – hence socially determined production of the individuals is of course the point of departure. The individual and isolated hunter and fisherman, with whom Smith and Ricardo begin, belongs to the unimaginative conceits of the eighteenth-century Robinsonades, which by no means express merely a reaction against over-sophistication and a return to a misunderstood natural life, as cultural historians imagine .... It is, rather, the anticipation of 'civil society', in preparation since the 16th century and making giant strides towards maturity in the 18th. In this society of free competition, the individual appears detached from the natural bonds etc. which in earlier historical periods make him an appendage to a definite and limited human conglomerate. The prophets of the 18th century, on whose shoulders Smith and Richardo still squarely stand, envisioned the individual of the 18th century – the product, on the one hand, of the dissolution of feudal social forms and, on the other, of the new forces of production developed since the 16th century – *as an ideal, whose existence lay in the past*. Not as a historic result but as history's point of departure. As the *Natural Individual* appropriate to their notion of human nature, not arising historically, but *posited by nature*. This illusion has been common to each new epoch to this day (*Grundrisse* (=GR), 5f.; my italics; Engl. adapted from *Grundrisse*, p. 83).

In a number of places Marx stresses the relative justification of the view he criticizes, which has its basis in the fact that in the "developed system of exchange" "the ties of personal dependency (are) in fact burst apart and torn asunder" (GR, 81; (163–164); cf. 542f. (649f.)), and that the process of exchange is the "real basis" of the mutual recognition of individuals as private proprietors as well as of their equality and freedom in so far as it is contained in the concept of juridical person (GR, 155f. (243f.); 915f.). On the other hand, he emphasizes that the individuals appear independent only to those

"who abstract from the *conditions*, the *conditions of existence* under which the individuals come into contact" (GR, 81 (163–164); cf. *Capital* 1, 175f.; MEW 23, 189f.). At another place, where Marx criticizes the views of Proudhon, who "wants to reduce the exchange between capital and labor to the simple exchange of commodities as exchange values, to the moments of simple circulation", who thus repeats the already presented view of Smith, Marx formulates a conception, which is of interest here as the contrary to all the conceptions of the 17th and 18th centuries discussed above:

> Society does not consist of individuals, but expresses the sum of interrelationships, the relations within which these individuals stand to one another (GR, 176; (265)).

Twelve years earlier Marx had already formulated the corresponding conception of the individual: the 'human essence' is not an abstraction inhering in the single individual. "In its reality it is the ensemble of social relations" (6th Thesis on Feuerbach, MEW 3, p. 6).[1]

2. ANALYSIS AS DETERMINING THE PROPERTIES OF SINGLE INDIVIDUALS

On the basis of the presentations above, the general relationship between the development of civil society and the 'artisan' interpretation of the analytic-synthetic method in all branches of social science can be summed up. In the controversy with feudal theory, which conceived society as a naturally necessary, hierarchical organism, bourgeois theoreticians of the 17th and 18th centuries based their arguments on the analysis of exchange relations, in which individuals appear as independent private proprietors. They generalized these contractual relations and declared them to be the only natural and thus legitimate form of social relations. Finally, they traced the existence of society back to an original contract. From the terms of the contract the slogans against feudal rule were then coined: equality instead of hierarchy, freedom instead of dependency, reason instead of tradition, self-interest instead of the good of the organism, right instead of privilege, etc. These are not principles that came from nowhere; feudal society was in fact eroded by the spread of market relations; freedom (from personal dependency) and equality (before the law) were realized.

The contract to found civil society could be traced back to the equality, self-interest, reason, and passions of the single individuals. However, this view did not necessarily presuppose an original, pre-contractual condition in which the individuals lived alone and unsocial but had to possess all properties

necessary to enter into contracts. It was also not necessary to assume that men had 'sprung out of the earth, and suddenly, like mushrooms, come to full maturity, without all kind of engagement to each other" (*De Cive*, 8.1, 161; *Works* II, 109). Considered theoretically, this absurd consequence must urge the recognition that society, cannot be comprehended as an artifact, as a contructed contractual relation and, accordingly, that social phenomena can be traced back to simple relations or to properties of social individuals within particular relations. This conclusion was, however, not drawn: the contract theory was extended to the constitution of society itself. It seems as if the controversy with feudal theory, according to which society represents a naturally necessary, hierarchical organism, (a controversy in which the bourgeoisie supported the demand for freedom and equality) affected the extension of the contract theory.

This is certainly the case for some of the exaggerated formulations (of Hobbes). But that this is not the sufficient reason for conceiving the analytic-synthetic method as the resolution of a system into primitive elements and the subsequent compounding of them again in social theory, is shown by the fact that Smith subscribes to the same interpretation but no longer holds the theory of a social contract.

The pervasive motive, which conditioned the artisan interpretation of the analytic-synthetic method in the social sciences, and on the basis of which the negative demarcation to the feudal theory became possible, lies in the determinate affirmation of civil society. This affirmation is determinate in that it refers to the determination of this society as being composed of independent and free private proprietors. This conception of civil or bourgeois society is in turn conditioned by the advocacy of the realized freedom and equality of the private proprietors, and thus of social relations as contractual relations. As long as a real alternative to the freedom and equality of private proprietors consisted only in abandoning these achievements, not in expanding them to apply to social equality, the affirmation of freedom and equality coincided with determining man as a private proprietor and of society as bourgeois society. Furthermore, this affirmation is determinate in that it does not refer to civil society as a capitalistic class society. In so far as capitalism is advocated, then not as a class relation but as the most effective form of social production; and in so far as the relation between this form of production and social relations is considered, then from the viewpoint, that the inequality loses significance due to the increasing wealth of the society as a whole.

Experience did not contradict this view. For, although civil or bourgeois

society represents a class society, the equality and freedom of the private proprietors were increasingly realized in it. This is the reason, why the determination of civil society as composed of private proprietors pervades the differing political positions of the social scientists. On the question of the realization of material freedom and equality, the various theoreticians differ: Rousseau contemplated a 'Leveller' republic and referred in his political programs to pre-capitalist societies;[2] Smith, on the contrary, maintained that, although the progress of production based on the division of labor would not produce equality, it would nonetheless increase wealth so much that no primary importance would be attached to the question of its equal distribution. Here, too, there seemed to be no contradiction between the determination of bourgeois society as a society of private proprietors and as a capitalistic class society, if the tendency of historical development is taken into consideration. In this circumstance lies the reason that a pervasive motive can be recognized in the differing political views: they deal with the freedom and equality of men as private proprietors.

To the general concurrence from Hobbes to Smith, that bourgeois society is a society of independent private proprietors corresponds the agreement in the interpretation of the analytic-synthetic method: all social phenomena are to be so analyzed that they are traced back to 'essential Properties' of individual men, to properties which the individuals possess independently of the society in which they live; the synthesis is nothing other than the reconstruction of those social phenomena which result from the combination of these individuals, a combination which is supposed to have been arranged by an original contract.

It has been shown that the theoreticians of feudalism conceived society as a naturally necessary, hierarchical organism and generally saw the properties of an element as being conditioned by its position in the hierarchical system. Marx, whose brief characterization of society and of social man has been cited, also by no means shares the views of the theoreticians of the 17th and 18th centuries. The conception of society as composed of independent individuals and the corresponding conception of the analytic-synthetic method in the social sciences can thus be determined exactly: it is peculiar to bourgeois society and can in this sense be called 'bourgeois'.

3. RESULTS

The results of the analysis carried out so far can now be summed up. The following points may be taken as substantiated:

(1) Newton's proof of the existence of absolute space rests on the assumption that the world system consists of equal elements, whose essential qualities would also belong to them as single particles in empty space. In Clarke's argument, that it would be absurd to assume that centrifugal forces would not appear on a single rotating body in empty space, this presupposition is directly expressed. Leonhard Euler and Carl Neumann, likewise, made the same assumption.

(2) Newton neither tried to justify this assumption, nor was he even aware of it. He believed he was simply applying *the* analytic-synthetic method. Clarke and Neumann believed it would be absurd to assume that centrifugal forces could depend on the existence of other bodies.

(3) One of the most important achievements of Newton, the discovery of the universal law of gravitation cannot be formulated so as to correspond to the presupposition mentioned in (1). In the formula $F = G(mm'/r^2)$ a single particle is not the point of departure. Newton's formulation thus reads: "In a system of several bodies *A, B, C, D,* etc. . . ."

(4) In spite of this formulation, Newton clings to the assumption mentioned in (1) and therefore must introduce the distinction between 'essential' properties (which are attributable to a single particle) and 'universal' properties (which are attributable to all bodies in the world).

(5) The 'mechanical philosophy' and the analytic-synthetic method were interpreted in analogy with the experience of the craftsman's separating and compounding. In this procedure it is justified to assume that the properties belong to the elements before as well as after the composition. However, the distinction between 'essential' and 'universal' properties (as interpreted above) is senseless in the workshop.

(6) The generally employed model of the clock was used by some scientists to present an interpretation of the analytic-synthetic method different from the above mentioned interpretation: natural phenomena, they said, are analogous to the face and hands of a clock; natural scientific theories refer to systems, not to single elements. The theories are to be taken as hypothetico-deductive, that is, even the determination of the properties of the elements is part of a theory to explain the phenomena of the system.

(7) The 'mechanical philosophy' was developed in a controversy with feudal philosophy; the basic principle of the latter – every system represents a naturally necessary, hierarchical organism, and the determinations of the parts depend on their ranks in this organism – had to be overcome.

(8) The 'organism'-principle was overcome in both natural and social philosophy; the result: the principle on the independence of the properties

of the equal elements from the system in which they are to be found prevailed in both natural and social philosophy.

(9) In natural philosophy the mechanistic conception prevailed; the basic principle of the independence of the properties of the elements from the system was, however, never explicitly formulated. This principle was also not necessary for the development of mathematical natural science.

(10) The case in social philosophy is different. Here, too, the mechanistic model of a society composed of elements (individuals) was propounded against the organism-conception of feudalism; but here the properties of the individuals were determined from the start as existing outside of every social system. This was necessary in order to be able to ground bourgeois social theory.

(11) According to the different stages of development of society and the various political views of the bourgeois social theorists, different 'essential' properties were attributed to the independent individuals; the view that society consists of independent individuals and the corresponding necessity of ascribing them properties as solitary unsocial individuals remained the same.

(12) The view of the bourgeois social theoreticians was based on experiences with bourgeois exchange relations, which formed at the same time the only form of the realization of freedom and equality that seemed possible.

(13) The generalization of this principle, namely, that in every system the elements are to be attributed properties independently of their interrelationships, also determines the limitations both of social philosophies and of special disciplines such as, for instance, political economy.

Newton's equation of determining the properties of a particle in a system with determining these properties as belonging to every particle as a single particle in empty space can be interpreted as a generalization of the artisan procedure. Of the two possible interpretations of this procedure, whose difference was probably not clear to him, Newton accepted the one which undertook to determine the properties of singly existing particles. In his own scientific work he encountered no obstacles on account of this interpretation. It compelled him to differentiate between 'essential' and 'universal' properties of each and every particle; but even if he had limited himself to determining 'universal' properties, he still would not have had a physical explanation of gravitation. Newton's circular definition of 'quantity of matter' and his implicit definition of 'density' are likewise results of this view, but for empirical research they had no significance. A second necessary consequence of this view of Newton's was his proof for the existence of absolute space. The

theory of absolute space, while not necessary for Newton's physics, nonetheless satisfied the requirements placed on an inertial frame of reference and could thus be retained. The philosophical difficulty pointed out by Descartes and Leibniz, that the concept of empty space would imply that nothingness (the void) could have a property (extension), could not shake Newton: he conceived of space as the emanation of God (*effectus emanitivus*) and he considered the theory of absolute space as an argument to refute materialism and atheism (cf. *De Gravitatione*, Hall and Hall, 99, 103, 105, 109f.). It is furthermore quite possible that Newton's view of the relation of element and system aided and abetted his own lack of comprehension for the principle of conservation of mechanical energy. This last was, however, not systematically necessary since the conservation principle was accepted in the subsequent development science without necessitating explicit changes in the Newtonian conception of the relation of element and system.

It has been shown how, based on a generalization of (1) the physical proposition on the properties of a particle in a system of material bodies and (2) the social-philosophical proposition on the properties of man in society, a philosophical proposition (3) on the properties of an element in a system can be obtained. It has furthermore been shown, how from this philosophical proposition on the universal properties of the elements in a system and from the proposition which expresses the bourgeois conception of the relation of an individual man to civil society (as it is systematically presented in bourgeois social philosophy), the general philosophical proposition on the essential properties of an isolated element can be obtained.[3] If one then derives a physical proposition from this philosophical one, he obtains the proposition which has been demonstrated to be the presupposition of Newton's proof for the existence of absolute space:

> The system of the world is composed of particles whose essential properties are attributable to them independently of their existence in this system.

Granted that this or a similar philosophical generalization of the propositions of natural and social philosophy actually was the source of Newton's physical basic principle, then the question arises, whether and how such a connection could be demonstrated. It is clear that such a connection cannot be supported with explicit pronouncements by Newton; for 'evident' propositions are not argued for or proved. This becomes clear if one compares the conflicting views of Newton, Clarke, and Neumann, on the one side, and Einstein and Infeld, on the other.

To refute the objections of Leibniz, Clarke employed the method of *reductio ad absurdum* by showing that if one does not infer the existence of absolute space from the appearance of centrifugal forces, then the 'absurd consequence' cannot be avoided that the motion of a single body in space is impossible and that on a single rotating body in empty space no centrifugal forces would appear (Clarke's 5th Reply, §§26–32). Carl Neumann called these consequences an 'insufferable contradiction' (HS I, 220n.). Einstein and Infeld, on the other hand, have maintained that the assertion, that one cannot speak of the motion of a single body in empty space, can appeal to 'common sense' (211–212). It can be seen here not only that what is taken to be 'evident' apparently changes with history but also that the reasons why a proposition is held to be 'evident' are normally not explicated.

This general reconstruction of the argument given so far shows which steps are still missing and have to be supplied: (1) The demonstration of a connection between Newton's philosophical and physical concept formation, and (2) the demonstration of a connection between Newton's conception of 'element' and 'system' in nature and society (human individual and particle of matter; civil society and system of the world): a connection which would first make possible the formulation of a general philosophical principle on the relation of element and system.

The demonstration of these connections will be given in the concluding part of this analysis.

PART FOUR

ATOM AND INDIVIDUAL

In the first part of this analysis I traced Newton's proof of the existence of absolute space back to the assumption, that inertia as well as other properties are attributable to a single particle independently of the existence of other particles, that is, even in an otherwise empty space. Such properties Newton called 'essential' and distinguished them from merely 'universal' properties, which can be attributed to all bodies in the world but not to a single particle alone in empty space. Later supporters of the theory of absolute space likewise assumed that inertia was an 'essential property', thus accepting not only Newton's results but also his justification of them. If this assumption is admitted, then Newton's conclusions from the experiments with rotating bodies are compelling; if the assumption is rejected, then Newton's theory of absolute space cannot be considered as empirically grounded. In the second part I argued that Newton's presupposition, that phenomena are to be traced back to the essential properties of individual elements, cannot be taken as a naive generalization of artisan experience; and I showed that, although it was in dispute within the tradition of mechanistic natural philosophy, in the various tendencies of bourgeois social philosophy it was dominant.

In the third part of this analysis I tried to reconstruct the origins of this assumption in bourgeois social philosophy and argued that it corresponds to the concept of civil society as a society of independent private proprietors. While this conception is appealed to to justify various political standpoints, the interpretation of who exactly is an independent private proprietor and of what kind of social conditions are to be realized differs from one opinion to the next. Nonetheless, the concepts of civil society and of the free private proprietor remain unchanged. Likewise unchanged was the motive behind these theories, namely the attempt to substantiate the freedom of the individual; this freedom was conceived as independence from all other individuals, as autarchy.

As far as my argument is convincing, Part Three has reconstructed the origins in social relations of the assumption that essential properties are attributable to an individual independently of the existence of others. As far

as my argument in Part One is convincing, I have reconstructed the genesis of Newton's theory of space (and his definition of the quantity of matter) from the assumption that essential properties belong to every particle independently of the existence of others. In the following chapter (XIII) I want to demonstrate the genetic dependency of Newton's assumption that essential properties would belong to a single particle upon the assumption of social philosophy that essential properties would be attributable to a single individual; this will conclude the reconstruction of the mediated dependency of Newton's theory of space on social relations.

The second chapter of this part (XIV), which deals with Leibniz's philosophy, can be considered as a first test of these results. Leibniz's dynamical theory was used in Part One to show that an alternative theory of Newton's was formulated but was not accepted, and that it differed from Newton's precisely in the fact that Leibniz referred the propositions of physics to systems of material bodies but never to single elements. In this final chapter it will be demonstrated that this procedure is also based on a fundamental postulate on the relation of element and system, which permeates the entire philosophy of Leibniz. It will be shown that Leibniz in his social philosophy consciously sets himself off from the social philosophers discussed here (Hobbes and Locke), but no attempt will be made to reconstruct the genesis of his postulate in the manner undertaken with Newton, since this would necessitate a full scale study of Leibniz.

CHAPTER XIII

THE BOURGEOIS INDIVIDUAL AND THE ESSENTIAL PROPERTIES OF A PARTICLE IN NEWTON'S THOUGHT

1. PASSIVITY AND ACTIVITY AS ESSENTIAL PROPERTIES

Newton's assertion that particles of matter have essential properties – here for instance, the property of inertia – is inadmissable according to his own methodological principles; only the determination, based on induction, of universal properties is admissable. Newton's distinction between 'universal' and 'essential' properties was introduced to differentiate between properties of matter which can be eliminated and those which cannot. Gravitation – so the reconstruction of Newton's deliberation – would be eliminated if there were only one particle; but this particle could still be ascribed inertia. This consideration however fulfills no purpose in physics, and the determination of inertia as a 'universal property' is completely sufficient for deriving trajectories of motion in the world. The determination of inertia as an 'essential property' is thus for Newton's physics neither necessary nor admissable.

Since according to Newton's theory of induction the determination of an 'essential property' is inadmissable, it must be asked whether Newton had other reasons to attribute inertia to matter as an essential property. In what follows I want to demonstrate that Newton believed he could determine inertia as an essential property because he identified 'inertia' with 'passivity' and held the proposition that matter is passive to be just as certain as self-evident propositions. Since Newton considered the proposition, that passivity is an attribute of matter, to be evident, he could determine this property as essential because the proposition that passivity is not an attribute of matter implies a contradiction. Physical propositions, however, cannot be self-evident. The question of the plausibility of the concept 'essential property' in physics can thus be formulated as follows: Which propositions, from which a determination of matter may be inferred, are so certain according to Newton that they can be considered evident?

2. NEWTON'S '*EGO SUM ET COGITO*'

As is known, the question of an evident starting point for knowledge played a central role in the founding of modern philosophy. Descartes methodological

doubt ended with evident knowledge: '*Cogito, ergo sum*' – I think, therefore I am. The negation of the consequent, as Descartes emphasized, implies a contradiction (*Princ. Phil.* I, 7). On the basis of this evident knowledge, and after introducing further premises, Descartes believed he could infer the existence of a '*res cogitans*', a thinking substance. This problematical conclusion need not concern us here; it is however important that the evidence is limited to the existence of the 'ego' as a thinking thing. Propositions about the 'external world' including one's own body were not considered evident; Descartes believed that these too could be made secure, but his deliberations on the hypothetico-deductive character of his natural philosophy show that he drew the consequences from the difference between evident and empirically grounded knowledge.

The problem of 'evident' knowledge occupied Newton to a lesser extent than Descartes. He never doubted the dependability of sense perception; he doubted only the theoretical conclusions derived from sense perception. In the course of decades and in numerous works he insisted that scientific knowledge must start with the 'phenomena', whose cognition seemed to him certain, and by means of induction must advance to theoretical conclusions. Therefore, Newton introduced the Cartesian 'Cogito'-argument in a modified form: one's own existence is denoted as a 'phenomenon', and the certainty of numerous other phenomena is placed on the same level of certainty as one's own existence. One of these phenomena justifies the proposition that passivity (and thus inertia) is necessarily attributed to matter and thus is an essential property. But first, Newton's cogito-argument should be examined:

> Phenomena I call whatever can be perceived, either things external which become known by the five senses, or things internal which we contemplate in our minds by thinking. As fire is hot and water is wet, and gold is heavy, and sun is light, *I am and I think*. All these are sensible things and can be called phenomena in a wide sense; but those things are properly called phenomena which can been seen, but I understand the word in a wider sense.[1]

The allusion to Descartes's cogito-argument ('I am and I think') can no more be overlooked than can the difference between the two arguments: sense perception and the certainty of one's own existence are equally certain for Newton; the proposition 'I am' – in contrast to Descartes – precedes the proposition 'I think' and is not dependent on it.

Newton's cogito-argument is the basis for his critique of Leibniz' theory of pre-established harmony, in so far as the latter is concerned with the relationship of body and soul. To Leibniz's accusation that Newton had a limited conception of God because he believed God's clock would in time run down

if God did not occasionally wind it up by an 'extraordinary hand', Newton replied that, using the same argument, one could maintain,

> that God was able to endow matter with an active and self moving principle, and enable it to think, and therefore has done it because he is wise and good. (Draft No. 10, K/C, 114)

Newton rejects this consideration with the argument: matter is passive and has no 'principle' of self-movement; the will, however, is such a principle as the 'daily experience of all mankind' proves:

> everyman finding in himself a power of seeing with his eyes and moving his body by his will (Draft No. 4, K/C, 108; cf. Draft No. 7, 111).

Leibniz, by denying this power of the will, asserts that "man himself is a mere machine" (Draft No. 10, 113) and contradicts himself when he maintains (against Newton) "that God cannot be in the world without animating the world tho a mans soul according to his Philosophy doth not animate his body" (Draft No. 7, 109).

The important point in these remarks of Newton's is that he makes a connection between what we would call a 'philosophical' question (i.e., freedom of the will) and a physiological question (i.e., the cause of animal motion) and thus carries the Cartesian position on to materialist consequences which Descartes himself denied. For Descartes – as well as for Leibniz – there was never any question whether a man moves himself when he wills it; what was debated was how this movement is caused. Both Descartes and Leibniz believed they experienced two things (1) that they willed and (2) that they moved. Both things were considered phenomena; their causes and the cause of the agreement between the phenomena needed to be explained. It was even one of the major concerns of Descartes to dissolve the connection between the philosophical question of freedom of the will and the physiological question of the cause of motion – a question which left its mark on the traditional concept of the soul, to which the powers of sensation, motion, and thought (*facultates sentiendi, movendi et intelligendi*) were ascribed.[2]

As the following deliberations of Descartes show, his '*cogito ergo sum*' is not only the 'Archimedian point' of his epistemology but also of his materialist, mechanistic physiology:

> But because ever since our childhood we have always found that many of its (the body's) motions obey the will, which is one of the powers of the soul, this has disposed us to believe that the soul is the principle of all (motions) . . .

> Instead, when we attempt to understand our nature more distinctly, we can see that our soul, in as much as it is a substance distinct from the body, is known to us solely by the fact that it thinks, that is to say, that it understands, that it wills, that it imagines, that it remembers, and that is senses, for all these functions are species of thoughts. And since the other functions which some have attributed to it, such as moving the heart and the arteries, digesting food in the stomach, and such like, which do not contain in them a single thought, are only bodily motions and since it is more common that a body be moved by another body than that it be moved by a soul, we have less reason to attribute them to a soul than to another body.
>
> . . . ; that is why I attempt here to prove it and to explain the whole machine of our body in such a manner that we would have no more occasion to think that it is our soul that excites in it (the body) the motions that we do not at all experience as being conducted by our will, than we would have occasion to judge that there is a soul in a clock which makes it show the hours. (AT XI, 224–226)

In order to justify his criticism that Leibniz rejected 'active principles' because "out of zeale for the Hypothesis of the Materialists" he wanted to explain everything by matter and motion and to reduce man to a mere machine (K/C, 113f.), Newton introduces a modified cogito-argument clearly alluding to Descartes. His argument has two interesting aspects. First of all, he rejects Descartes' mechanistic physiology, which was prepared for by separating the philosophical question of freedom of will from the physiological question of animal motion. With the concept of active principles he subsumes once again under one concept the faculties traditionally ascribed to the soul including those differentiated by Descartes. Secondly, Newton argues using allegedly Cartesian tools: applying them to the 'active principle' instead of the mere '*cogito*', he can claim the same certainty that Descartes claimed for his '*Cogito ergo sum*' for the experience of willful self-movement and at the same time for its *cause* (everyone knows that he moves his body by his will).

It is significant here that neither Descartes' nor Newton's reasoning can legitimately claim the status of immediate certainty without any presuppositions. Both arguments are based on physiological, physical, and philosophical assumptions and imply consequences of the same kind. It is furthermore clear that Newton's argument is only plausible if what is to be proved is already presupposed, namely, that the soul (or the will) is active and can act upon the body, and that matter is passive but movable. These assumptions could only have been tested if there were matter without an active principle or an active principle without matter. The first case does not exist in the real world: material bodies gravitate towards one another and gravity, according to Newton, is an active principle. The case of a single particle in empty space, which behaves only in accord with its passive property (inertia), is

quite imaginable, but the third Regula Philosophandi allows inferences only about the universal properties of matter in the world not about properties of a single particle in empty space. The second case, the existence of a free and active principle without matter was the focal point of the discussion between Leibniz and Clarke on the concept of freedom.[3]

3. FREEDOM AND SPONTANEITY

The accusation by Newton and Clarke, that Leibniz denied the freedom of the will and reduced man to a machine, refers to two arguments of Leibniz': Leibniz had denied that the total amount of 'force' in the world could be increased by willful actions. Secondly, he had asserted that a freely acting will is always determined to action by motives: there must be a sufficient reason to act in one way rather than in the other; from indifference no action can arise. From this Leibniz does not conclude that Buridan's ass must necessarily starve to death between two equal and equally distant piles of hay; rather he denies that two perfectly equal choices can exist.

As I have said, Clarke and Newton accused Leibniz of reducing man to a machine with this point of view and of denying his freedom. To illustrate this, Clarke cites the example of the balance, with which Leibniz had demonstrated the necessity of the principle of sufficient reason in physics (Leibniz' 2nd Letter, §1), and turns it against the assertion that an action can be determined and at the same time free: Leibniz' view

> leads to universal necessity and fate, by supposing that motives have the same relation to the will of an intelligent agent, as weights have to a balance; so that of two things absolutely indifferent, an intelligent agent can no more choose either, than a balance can move itself when weights on both sides are equal. But the difference lies here. A balance is no agent, but is merely passive and acted upon by the weights; so that, when the weights are equal, there is nothing to move it. But intelligent beings are agents; not passive, in being moved by the motives, as a balance is by weights; but they have active powers and do move themselves, sometimes upon the view of strong motives, sometimes upon weak ones, and sometimes where things are absolutely indifferent. (Clarke's 4th Reply, §1 and 2)

Leibniz saw no reason to reject Clarke's comparison in so far as it concerned the determined character of the will: "It is true", he wrote, "that reasons in the mind of a wise being, and motives in any mind whatsoever, do that which answers to the effect produced by weights in a balance" (Leibniz's 5th Letter, §3). The difference, however, lies in the fact that, strictly speaking, it is

the mind that acts by virtue of the motives, which are its dispositions to act. And therefore to pretend, as the author does here, that the mind prefers sometimes weak motives to strong ones, and even that it prefers that which is indifferent before motives: this, I say, is to divide the mind from the motives, ... as if the mind had, besides motives, other dispositions to act, ... Wherefore, if the mind should prefer a weak inclination to a strong one, it would act against itself, and otherwise than it is disposed to act (Leibniz's 5th Letter, §15).

It is easily seen that the discussion cannot be carried on in this form: the fact of human freedom is, as Newton remarked, known to everyone from his own experience. Consequently, the discussion deals with the reasons for a particular action. While Leibniz maintains that a motive can always be found for this or that decision, Clarke maintains that the reason could lie simply in the 'active Powers' of the will itself. The question to be decided is thus whether the will can act in cases of indiscernable alternative choices, that is, even if the motives balance each other out. However, this case, too, cannot be the subject of the discussion; for Leibniz asserts that there cannot exist two perfectly identical particles of matter. Thus the motives would be different even if there were only a free will and two particles of matter in the world. A common basis for discussion would thus exist only in the case where there is no motive at all to act. According to Clarke's opinion the free will would have to be able to act due to its 'active powers'. If there is to be no motive, then nothing may exist to which the free will might relate itself, not even two particles of matter. The thought experiment to be undertaken must then pose the following question: Would a free will in empty space be able to act on the basis of its 'active Powers'?

It is admittedly easier to imagine a single body that rests or moves uniformly in empty space, than to imagine a 'will' that acts freely in empty space. The difficulty is encountered, however, only when one attempts to imagine a human will acting freely in empty space. The genus of 'agents', to whom a free will is attributed, contains not only man but also God. The notion of a freely acting God, who creates the world in empty space, is no stranger to religious thought, and Newton emphasizes God's freedom to create worlds at will, i.e., with perfect freedom: God could not only choose an arbitrary point in uniform space for the purpose but also determine the nature of the elements and the resulting laws of the respective worlds.[4] Even this freedom of God's does not satisfy Newton; God is also free not to create a world, and he can nonetheless be active:

[God has] a propensity to action, that he should never and nowhere be idle especially concerns his glory and majesty; though what God did before the creation of this visible work and outside its limits, we cannot think.[5]

It is precisely this position that Clarke takes up in his discussion with Leibniz on the concept of freedom.

The question by means of which the notion of a free will in empty space is concretized concerns the possibility of God's creating two similar particles of matter and placing them at different points in empty space. With this thought experiment, Clarke believes his view can be proved: here, there are no (external) reasons to act one way or the other, and the sufficient reason for God's action is thus his mere will, that is, the sufficient reason to act lies in his "original principle or power" (Clarke's 3rd Reply, §§5, 7, 8). Leibniz, in turn, does not consider his position endangered. He sees himself compelled neither to admit that God is determined by external things not that God could not act if there were no external things. For "the ideas of external things" are in God, who is therefore "determined by internal reasons, that is, by his wisdom" (5th Letter, §72). The ideas of all possible things are contained in God's understanding, whether they exist outside of it or not. In his fifth and last letter Leibniz accuses Clarke of wanting "to divide the mind from the motives" (§15). Clarke confirms the allegation: the motive, he writes, is "something extrinsic to the mind"; the freedom of the will consists in the fact that the ability to act (i.e., the "active powers"), the spontaneity, lies in the will itself. (Clarke's 5th Reply, §§1–20).

The arguments, which Leibniz and Clarke offer in support of their various conceptions of freedom need not concern us here. What is important is, first of all, that Clarke is only willing to ascribe freedom to the will if it acts in the world as if it were alone in empty space; freedom means independence from motives. Secondly, it is significant, that freedom is identified with the power to move in the concept of 'active power' or 'active principle'. It remains to be seen how Newton from these assumptions determines the concept of matter.

4. WILL AND BODY; ACTIVE AND PASSIVE PRINCIPLE

Newton's conception of the free and active will is, I believe, the premise of the argument he did not carry through, which would justify the proposition that passivity must necessarily be attributed to matter. Newton's deliberation can be summarized as follows: in nature phenomena are observed which cannot be explained by inertia. The best examples are the self-movement of animals and gravitation; from 'inner experience' every man knows that his free will moves his body. Theoretically, the phenomena in question could be traced back to properties of matter or to the action of God. In both cases however – Newton thinks – the presupposed freedom and activity of the

will would have to be rejected; but since these are evident, then matter must be attributed passivity (inertia) and the will must be ascribed activity (freedom); moreover God's activity must be restricted so as not to interfere with human liberty. Newton's reasoning will be presented briefly.

"Bodies" he argues are "passive":

> By their *vis inertiae* they continue in their state of moving or resting . . . ; but they cannot move themselves; and without some other principle than the vis inertiae there could be no motion in the world. (And what that Principle is and by (means of) laws it acts on matter is a mystery or how it stands related to matter is difficult to explain) . . . We find in ourselves a power of moving our bodies by our thoughts (. . .) and see the same power in other living creatures . . . And by this instance and that of gravity it appears that there are other laws of motion (unknown to us) than those which arise from *Vis inertiae* (unknown to us) which is enough to justify and encourage our search after them. We cannot say that all nature is not alive.[6]

The observation of nature shows that not all phenomena can be explained by inertia; the inference that matter is passive and that activity is attributable to "active principles" different from matter is based on the fact that the existence of at least one such immaterial 'active principle' is already certain: the existence of the human will, which moves the body. Were the existence of the will, which by 'thought' moves the body, not presupposed, then no refutation of materialism could be derived from the observations so often cited by Newton of phenomena which could not be explained by inertia.

By appealing to the experience that the will moves the body, Newton also wanted to refute Leibniz's theory of pre-established harmony. However, simply pointing to the existence of an immaterial will would not have been sufficient, since Leibniz had not denied this. Nonetheless, Leibniz believed that all motions of material bodies were subject to strict laws and could not be caused by the will. He explained the agreement between the will and the movement of the human body by a pre-established harmony, which is only possible if the will does not decide without reasons or motives, that is, only if its decisions are foreseeable (although not determined) given a perfect knowledge of all circumstances. In this Clarke saw the affirmation of 'fatalism', and Newton the reduction of man to a machine. From the point of view of Newton and Clarke, who identified freedom with unmotivated, spontaneous action, the reproach is justified; and if freedom is identified with the ability of an immaterial, active principle to move matter, then the rejection of the Leibnizian theory (which denied the possibility of this action) is necessary. But even if Newton's assertion, that the will is an 'active principle' and can move matter, is accepted, the Newtonian position is not

yet grounded. For, with this very assertion as the premise of an argument by analogy, Newton argues for God's ability to move all bodies in the world; from the assertion that human and divine wills are analogous 'active principles', it follows that the occasionalist theory is possible and that it could be God who moves not only the inanimate bodies of the world but also the bodies of animals (including humans).

Newton's certainty that it is the active human will that moves the body is understandable only if man in his willful actions is conceived as an independent system not even influenced by God; then man is a system which consists of an active and a passive principle, and from these principles all phenomena of willful action must be explained.[7] Based on this presupposition, the proposition that matter is a passive principle is just as certain as the proposition that the will is free and active. Newton asserts both of these interdependent positions at the same time when he cites the experience known to 'everyone' that the (active) will moves the (passive) body. If however passivity is attributed to matter by necessity (and not based on induction), then it is also impossible to deny it this property; Newton could thus attribute passivity (inertia) to a single particle in empty space. That these considerations do in fact correspond to Newton's chain of thought, I shall try to show on the basis of the consequences of this conception.

Let it be remarked here that the conception that the body is moved by the 'will' or the 'soul' as well as the proof for human freedom based on this ability was quite widespread. To give some examples: Descartes, for instance, introduces his impact rules with the remark that they deal only with changes whose causes themselves are corporeal, "for I am not here enquiring into what kind of power the minds of men or Angels may perhaps have to move bodies" (*Princ. Phil.*, II, 40).

In the *Encyclopédie* D'Alembert lists as examples of '*force motrice*': gravity (*la pesanteur*) as well as "the faculty of our soul by which we put the limbs of our body into motion".[8]

Finally, we find notions analogous to those of Newton in the writings of Euler: among other things, thinking and willing are properties "incompatible with the nature of bodies". These as well as freedom are, however, just as essential to spirits "as are extension and impenetrability to bodies". Since the souls of humans and animals can move their bodies, "thus the system of the world is no longer purely a machine, and events are no longer all necessary"; thus was determinism supposed to be refuted.[9]

5. THE SYSTEM OF 'NATURAL FREEDOM' IN THE STATE AND IN THE WORLD SYSTEM

In the discussion above I have attempted to reconstruct the origins of Newton's view, that a natural system consists of elements, to which activity of passivity are attributed as essential properties, from the 'certain' experience that the human will moves the human body. I have indicated that Newton's argument, that God moves the bodies of the world as the human will moves the human body, is only intelligible if it is so interpreted as Newton intended it: as an argument by analogy. Difficulties arise only when one takes into consideration that the 'system', 'man', is itself a part of the 'world'. The difficulty consists, put generally, in the fact that at least two 'active principles', the will of living creatures and the divine will, must be assumed in the 'world', and that it thus remains unclear which effects are to be ascribed to which of the two active principles.

Newton's assumption of a 'regulating' activity of God seemed at first intended to remove the contradiction between the two propositions: that the quantity of motion decreases and that the system of the world nonetheless remains in its present shape. Thus, to 'regulate' meant to supply new quantities of motion to the bodies of the world system, that is, to 'wind up' the world clock. In light of Newton's remarks on the ability of animals to introduce new motion into the world, this function of God's must be reinterpreted. For, if the quantity of motion decreases due to the inelasticity of matter but also increases due to 'active principles', it can no longer be asserted that the quantity of motion in the universe decreases: rather, it could just as well increase as decrease. Clarke draws this conclusion:

> Action is the beginning of a motion where there was none before, from a principle of life or activity: and if God or man, or any living or active power, ever influences any thing in the material world; and every thing be not mere absolute mechanism; there must be a continual increase and decrease of the whole quantity of motion in the universe (Clarke's 5th Reply, § §93–95).

God's regulating activity does not necessarily consist in supplying new quantities of motion, for it is not certain whether the world loses more motion due to the inelasticity of matter than it gains due to the active powers of living creatures. God's government is indispensible because there is no connection at all (and thus no quantitative relation) between the increases and decreases in the quantity of motion. The system of the world can fall into disarray both on account of the inelasticity of matter and on account of the

active powers of animals. The present shape of the world system can of course also remain constant if the opposing effects accidentally cancel each other out.

At this point the connection between Newton's philosophical basic principle on the relation of element and system and his hypothesis about God's government and possible intervention in the world becomes clear. The connection consists not merely in the fact that a physical assumption on the decrease in the quantity of motion in the world is to be brought into accord with the continued existence of the world, but rather, in principle, in the fact that if the attribution of properties to elements is not based on the analysis of an ordered system, then there is no reason to assume that the compounding of these elements will yield an ordered system. If, however, it is assumed that the system is an ordered one – in this case that the system of the world represents a cosmos – and if this assumption is not justified by the methodical procedure of analysis, then this assumption must be presented either as an arbitrary presupposition or as a consequence of divine government.

The same problem arises in social theory,[10] where it also takes on a practical political form. For, if individuals are attributed properties, and if the continuence of civil society does not necessarily follow from the properties ascribed to the individuals, then the continuation of the society must be secured by a power (the state) which exercises government over them. The analogy between these problems of natural and social philosophy had from the beginning been distinctly pronounced by Clarke:

> And as those men, who pretend that in an earthly government things may go on perfectly well without the king himself ordering or disposing of any thing, may reasonably be suspected that they would like very well to set the king aside: so whosoever contends, that the course of the world can go on without the continual direction of God, the Supreme Governor; his doctrine does in effect tend to exclude God out of the world (Clarke's 1st Reply, §4).

Clarke's view, wrote Leibniz, is just as if one were to say:

> that a king, who should originally have taken care to have his subjects so well educated, and should, by his care in providing for their subsistence, preserve them so well in their fitness for their several stations, and in their good affection towards him, as that he should have no occasion ever to be amending any thing amongst them; would be only a nominal king (Leibniz's 2nd Letter, §11).

Clarke countered that this 'king' would indeed be a real 'creator' but a 'governor' in name only (Clarke's 2nd Reply, §11).

These remarks are sufficient to determine Clarke's concept of government. Government is ascribed to God in so far as it is necessary to preserve the system, which is composed of elements equipped with unchangeable properties. Newton held the same view with regard to God's government; and he insisted, too, that the English king might govern only in accordance with the laws of civil society. The power which is conceded to God and (theoretically) to the king is only supposed to guarantee that the uncertain stability of the respective systems are secure in an emergency: no emergency – no government. Above all however, no government which might be connected with 'creation', that is, with influence on the properties of the elements, and no government which exercises direct influence on the actions of the citizens. The functions of the 'governor of the clock' are kept strictly separate from the function of the 'clockmaker'.

6. SYSTEM OF PHILOSOPHY

In the sections above I have shown that Newton derived the proposition, that matter necessarily has the property of passivity (inertia), from the certain experience that the active will of man moves his passive body. A property which is attributed with necessity to a subject cannot be denied it. The activity of the will and the passivity of the body can therefore be determined as essential properties, and they can thus also be ascribed respectively to a single will and a single particle. Furthermore, both properties and their effects are realized in a pure state only when their subjects are really alone in empty space: only in empty space does a particle perservere in its state of rest or uniform motion, and only when a single will is alone in empty space and has no motives to relate to, is its freedom (indifference) certain.

Finally, it is to be shown that Newton's concept of the autarchic individual depends on the bourgeois concept of the individual as it was developed in social philosophy. The evidence for this has already been cited; it also contains hints as to the reasons, why Newton does not appeal to the special autarchy of man (*vis à vis* other individuals) asserted by social philosophy but rather presupposes a more general autarchy of man (*vis à vis* the entire external material reality and even God) as far as willful action is concerned. These deliberations also show the relationship between Newton's physical and his philosophical concept formation. Recall Newton's argument that his notion, that the passive human body is moved by the active will, is certain, for, in case this notion were denied, the absurd consequence would follow that matter has not only the power of motion but also 'life' and 'power of thought'. 'Life', 'power of motion', 'power of thought', and

'freedom' are taken by Newton as determinations of one and the same 'active principle' (a concept which comprehends the concepts 'will', 'soul', 'mind'). When Newton proves the existence of an active principle in man – and to this purpose his argument about the property of a 'power to move' is best suited because it can be supported by the fact known to everyone that man can move his body – he believes he has proved the existence of a principle with all its properties. The question of the freedom of an individual only socially autarchic need no longer even be posed, since the more comprehensive freedom (identified with power of motion) from the entire external reality has already been demonstrated. It is thus, I believe, easy to see that the discussion between Newton and Clarke on the one side and Leibniz on the other about the power of man to move his body is at base a discussion about human freedom and that the attempt to demonstrate this freedom was the motive for Newton's conception. In as much as Leibniz does not recognize the 'active principle' of the will – so argues Newton – he reduces man to a mere machine; and in as much as he denies God's intervention, he banishes God from the world and makes of him a being "that's *nusquam*" (nowhere) (K/C, 114). Atheism and the denial of freedom make up together the "hypothesis of the materialists", for which Leibniz shows so much "zeale", and which Newton undertakes to refute.

While Newton undertakes a refutation of materialism with physical arguments, he is nonetheless compelled, every time a physical phenomenon cannot be explained by the 'passive laws' of inert matter and an 'active principle' must be assumed, to ascribe to this principle all the properties of such a principle. Motions that cannot be traced back to the principle of inertia indicate that nature is 'animated'; the assertion that matter has the power to move is equivalent to saying that matter can think; and the freedom of an individual means that he must be able to increase the quantity of motion in the world. This is also the reason, why the contradiction, that could occur between Newton's conception of the autarchic individual and the rule of God over the world of which the individual is a part, must take place on the level of natural philosophy (who moves the bodies?) and not on the level of moral philosophy (how is God's foresight to be reconciled with human freedom of will?). The very possibility of identifying the freedom of the individual with the power of moving his body, the motion of the body with the supplying of force, and both assumptions with that about God's government over the world presupposes the concepts of 'active' and 'passive' principle, which comprehend all these objects of theology, moral and natural philosophy. From the status attributed them, these are philosophical concepts. As far as the determinations of the concepts

are concerned, there is a mixture of those of natural philosophy with those originating in moral philosophy or theology, which in turn are all attributed to the objects of the respective disciplines in as far as these are taken to be 'active' or 'passive' principles. Precisely those conditions are met which I have cited for the influence of social relations on concept formation in natural science – mediated by way of concepts of social philosophy and *philosophia prima*.

Finally, it should be stressed, that this explanation applies only to the origin of the determination of inertia as an 'essential property' and has nothing to do with the principle that a particle maintains its state of motion in the absence of external forces ('law of inertia'). For, from the 'evident' knowledge that the will can move the body, it could just as well have been inferred that matter also resists uniform motion in a straight line even when no external forces act on the body (*inclinatio ad quietem*). Thus it has been demonstrated only that the determination of inertia as an 'essential' property, as opposed to its determination as a 'universal' property of matter, is physically both unnecessary and inadmissable. This seemingly minor difference is, however, the basis of Newton's proof for the existence of absolute space.

7. NEWTONIAN IDEOLOGY

From the various possibilities of explaining the self-movement of humans – materialism, pre-established harmony (or occasionalism), and the action of the will on passive matter – Newton decided for the last mentioned possibility; Newton's specific version of the dualism, which includes the action of God in the world, as well as the socio-historical background of this position were touched on in the correspondance between Leibniz and Clarke. These will be taken up in conclusion.

Against Newton's appeal to God in his function as 'Governor of the Clock', Leibniz conceded that the system of the world need not necessarily continue in its present state; on the other hand, he had had to draw radical and quite inopportune conclusions with regard to human freedom:

> Whatever is performed in the body of man, and of every animal, is no less mechanical, than what is performed in a watch. The difference is only such, as ought to be between a machine of divine invention, and the workmanship of such a limited artist as man is (Leibniz's 5th Letter, §116).

"In a word", wrote Leibniz elsewhere, "so far as the details of phenomena are concerned, everything takes place in the body as if the evil doctrine of

those who believe, with Epicurus and Hobbes, that the soul is material were true, or as if man himself were only a body or an automaton. . . . Those who have tried to prove the contrary have, by persisting in this bias, merely dishonored themselves and prepared the basis for error to triumph" (Reply to Bayle's objections, GP IV, 559; PPL, 577).

Leibniz objects to an appeal to God: "Otherwise nothing will be easier than to account for any thing by bringing in the deity, *Deum ex machina*, without minding the natures of things" (5th Letter, §107).

It is striking in these deliberations by Leibniz, that the idea does not even occur to him, that one might, on the one hand, pursue research in a strictly scientific manner and, on the other, appeal to God – when no scientific explanation is found and when the appeal to God's activity does not contradict any already established scientific laws.[11] His incomprehension on this point is not an attitude taken up merely for purposes of the discussion with Newton; it can be seen just as well in his own attempts to substantiate human freedom without transgressing the laws of mechanics and also in the attempt to reconcile the freedom and the determined character of the will. In the discussion carried on with Clarke on this point, he formulated what he considered most important:

> Those great principles of a *sufficient reason*, and of the *identity of indiscernibles* [principles which from the start exclude God's groundless and "free" choice between indifferent things – G.F.], change the state of metaphysics. That science becomes real and demonstrative by means of these principles; whereas before, it did consist in empty words (4th Letter, §5).

Clarke designated this 'scientific metaphysics' as fatalism and rejected it maintaining against it the existence of 'active principles' of the will. Leibniz in turn considered such 'active principles' to be mere 'occult qualities', which no scientist could accept or support. For the same reason he refused to accept a 'property' of gravity, at the same time giving an interesting hint as to the socio-historical background of this new willingness to appeal to unscientific instances, whether to God or to occult qualities:

> "In the time of Mr. Boyle, and other excellent men, who flourished in England under Charles II, [in the early part of his reign] no body would have ventured to publish such chimerical notions . . . . Mr. Boyle made it his chief business to inculcate, that every thing was done mechanically in natural philosophy . . . . What has happened in poetry, happens also in the philosophical world. People are grown weary of rational romances, such as were the French *Clelia*, or the German *Aramene*; and they are become fond again of the tales of fairies" (5th Letter, §114). Thirty years earlier, Leibniz added, this "attraction à la scholastique" would only have been mocked at (*ibid.*, §128).

The systematic reason for the fact that Newton pursued research in a strictly scientific manner and nonetheless appealed to God, has already been discussed at length: it is the result of his basic postulate on the relation of element and system. The historical background, however, which let such a position appear not only possible but also desirable (recall Newton's remark that he always had an eye open in his research for principles which supported religion) was directly indicated by Leibniz. In light of the social history of England in the century of revolution, we can interpret Leibniz reference to the reign of Charles II as follows: as long as the bourgeoisie struggled against the feudal state it supported, according to the standards of the time, a strictly scientific philosophy; as soon as it succeeded to power itself after its compromise with the feudal classes, this support was abandoned, without of course abandoning the natural sciences. It was now the Newtonian philosophy of nature which was supposed to help prop up (bourgeois) theology and bourgeois rule. In the century after the English revolution Newton's natural philosophy became a cornerstone of the sermons of the moderate Anglican clergy.[12]

CHAPTER XIV

ELEMENT AND SYSTEM IN THE PHILOSOPHY OF LEIBNIZ

The explanation suggested above for the origins of Newton's fundamental postulate, that a system consists of equal elements whose essential properties are attributable to each single element independently of the system, forms the conclusion to an analysis which began with the discussion between Newton and Leibniz on the concept of absolute space and with the differing structures of their physical theories. The presentation of the basics of Leibnizian dynamics was intended to prove that the development of physical theory along other lines than Newton's was possible in the 17th century. However, the thesis suggested as a result of the analysis also prompts some questions regarding Leibniz's position and its origins; thus it seems problematical, on the one hand, to assert that Newton's basic postulate on the relation of element and system had its roots in social history, and on the other hand, to demonstrate by the example of Leibniz that a different conception was apparently possible at just the same time. A further difficulty lies in the fact that Leibniz's philosophy has traditionally been characterized as a 'philosophy of individuality', and his well known formulations that a 'monad' is a 'world to itself' and has no 'windows' etc. could even appear as classical examples of the 'Newtonian' postulate of the relation of element and system. But if both of them start from the same basic principle, then it seems mistaken from the first to oppose their principles to one another and to analyze this opposition.

To check the soundness of these objections, we shall first take up Leibniz's social position as well as his social theory and then his theory of monads, in order to determine whether he has a 'basic postulate' of the relation of element and system, and, if so, whether it is the same as Newton's. No attempt will be made systematically to present Leibniz's social position or his theory of the state or of monads; only some basic characteristics will be presented, which clarify Leibniz's relation to his English contemporaries and to Newton's basic principle. I should also point out that Leibniz's own systematic presentations of his philosophy, in which the connections between social and natural philosophy as well as those between these two and his metaphysics are expressly formulated, will not be used. These presentations attempt to systematize, and the various formulations are chosen for this

purpose; Leibniz's social philosophy will be discussed independently of his adaptation of it to his system.

1. THE 'OPPRESSED COUNSELLOR'

The first of the difficulties mentioned consists in the following: with regard to Newton it was argued that the controversy with feudal theory and the affirmation of bourgeois social relations, in short the partisanship for the developing bourgeois society, was sufficient reason for accepting the 'Hobbes-Newtonian' principle of the relation of element and system; on the other hand, with regard to Leibniz it was shown that he did not assent to this principle. Assuming the validity of this thesis, then Leibniz may not be taken as a 'bourgeois' philosopher but also not as a feudal-scholastic philosopher since he also did not subscribe to the 'organism' principle.

It is first of all clear that none of the social conditions, which were presented as decisive for the acceptance of the 'Newtonian' principle, apply to Leibniz; no detailed investigation of the social history of Germany after the Thirty Years War is needed to maintain that in Germany with its division into small states no open struggle between the bourgeoisie and the feudal nobility can be ascertained and by no means an ascendancy of the bourgeoisie. Leibniz's position consisted in the attempt to mediate between opposing positions. "Everywhere", writes Ludwig Feuerbach, "whether in politics or science or in the religious sphere, we see him mediating between the extremes".[1]

Leibniz's social situation and his conception of it can best be characterized by his own remarks:

> Disdained though reasonable counsellors [– and such was Leibniz at the court of Hanover –] should *ultra consilia* undertake nothing, but rather consider that God reserves the good intention for better times and therefore out of his hidden wisdom has not given them power equal to their understanding; and thus they should also by no means seek to acquire such power by forbidden machinations which bring the state into turmoil or by word and deed seek to carry out even good suggestions.

Leibniz observed this prescription; the right "proportion between understanding and power", which is the foundation of justice and of the "form of the republic", was not granted him. He continued:

> If power is greater than understanding, then he who has it is either a simple minded sheep, if he knows not how to use it, of a wolf and a tyrant, if he knows not how to use it well. *If understanding is greater than power, then he who has it is to be deemed as oppressed.*[2]

It would be false to equate the mutually opposing positions: power without understanding versus understanding without power, with the opposition between 'unreasonable' feudal rule and 'reasonable' bourgeois rule; for Leibniz's social and political views can scarcely be called bourgeois in the strict political sense. There is no doubt that he supports bourgeois demands – above all that the state power should be bound by laws, that science should be furthered and practically applied; but at the same time Leibniz speaks out against a capitalistic development, and his social views are very different from the bourgeois conceptions supported in England. The difference between the views of Leibniz and those of Hobbes and Locke can be shown on three points:

– Leibniz's conception of the state of nature (a),
– his justification of right (b), and
– the limitation of the right to private property (c, d).

2. ON THE SOCIAL PHILOSOPHY OF LEIBNIZ

(a) *Animal Sociale*

The fundamental difference between Leibniz's conception and that of his English contemporaries with regard to the state of nature was that, although Leibniz considered it to be stateless, he did not consider it to be non-social:

> I am pleased, [he wrote on Locke's observation that man is a 'social creature'] to see you far removed from the sentiment of Mr. Hobbes, who did not agree that man was made for society, conceiving that one is only forced to it by necessity and by the viciousness of those of his own kind. But he did not at all consider that the better men, exempt from all viciousness, would unite to obtain better their goal as birds flock together to travel better in company and as beavers join together by the hundreds to build great dams where a small number of these animals could not succeed (N.E. III.i.1).[3]

Leibniz thus accepts the traditional notion of man as a 'social animal' and also accepts its traditional justification: the necessity of social labor. Society is taken not as an 'artifact' but as natural; likewise the 'Church of God' and the 'community of saints' which embraces the entire human race.[4]

(b) *Right, Power, and Property*

Since the state of nature was not unsocial, there must also have been right there, for there could have been "no purely natural state of man beyond any republic" (Letter to Hobbes, July 13/22, 1670; GP VII, 572). On this point

Leibniz inclines to the view of Filmer, who "recognized rightly that there is a right, even a *jus strictum*, before the foundation of states". The right of acquisition by labor "is a *jus strictum* which even equity approves" ('Meditation sur la notion commune de la justice', Mollat, 66f.; PPL, 572).

Hobbes's error, according to Leibniz, consisted not only in assuming an unsocial condition but – confusing justice and law – also in assuming that in a pre-state situation there could be no injustice (*ibid.* 47; PPL, 564). However, if right were dependent on might, then in a pre-state situation in which only God's justice holds this justice would be dependent only on the will of God; that is, it would be just, not because God is bound to eternal truths, but because he wills it so (*stat pro ratione voluntas*): this would be the "motto of a tyrant" (*ibid.* 41; PPL, 561; cf. *Theod.*, II, §§121, 124, 176; cf. also GM VI, 95f.).

Just as little as Leibniz agrees with Hobbes that might makes right, can he agree with Locke that there can be no injustice where there is no property – a principle which Locke took to be as certain as a proof by Euclid. Leibniz wrote:

> Ordinarily, one uses the word *property* a bit differently; for one understands a right of the one to a thing to the exclusion of the right of another. Thus, if there were no property at all and all were in common, there could nonetheless be injustice (N.E. IV.iii.18).[5]

(c) *Private and Communal Property*

The reference to the possible existence of property in common is not accidental; for Leibniz subscribes to the traditional conception of an original communal property, which furthermore serves him as an ideal:

> In a perfect republic (*in optima re publica*) the *jus strictum* of property would be annulled, but in its place the *jus strictum* of the community would be introduced (Mollat, 15).

The law of this best republic is the 'natural right', the ideal, which one should as far as possible approach. But "due to the imbecility of human affairs" and "because most men are so poorly educated", the ideal is nowhere realized; with regard to private property, that is, in that sphere about which society does not concern itself, men remain "in that rude state of nature outside of order and society" (Mollat, 13, 9, 10).

In this perspective of communal property on the one hand and in the demand for the "promotion of arts and sciences" on the other, Leibniz's dilemma is clearly revealed. While he demands the vitalization of crafts and

manufacturing, he rejects, in a conservative, humanistic attitude, the consequences of the private economic form of this vitalization, namely, that "deep-going failing in many republics", "which consists in letting everyone sustain himself as he can and will, whether he grow rich on the destitution of a hundred others or whether he fall and take a hundred others with him, who trusted him and were sustained by him" ('Societät und Wirtschaft', (1671?). A. IV.i. 359–361; Holz II, 127–130). Holland – "the capitalist model nation of the 17th century" (Marx) – is for Leibniz the land, "where the precept of the merchants is always to keep the craftsmen in poverty and labor" (*ibid.*). Leibniz, on the other hand, outlines the vision of "public workhouses" in which "no one works alone but all together, if one has too much and the other too little, then it is transferred to the other", so that the labor "will always be roughly the same". The artisans, whom one "will provide with all necessities", will "then do more with joy than they now do of necessity" and also have the "heart" "to undertake something new and real" (*ibid.*). The welfare of the laborers will thus be joined to the improvement of "arts".

How seriously Leibniz took such plans is not essential in this connection; the important point is that his tuopia here takes the form of a 'cooperative', whereas those of Locke and Smith have the form of a society of commodity producing, independent proprietors. Secondly, it is decisive that Leibniz insists that the *justitia commutativa* ("to do no one harm") constitutes only the lowest level of right, above which the *justitia distributiva* ("to give each his due" in the sense of: "to give each as much as befit him or as much as he deserves") is to be placed.[6]

Leibniz determines the duties of the state accordingly: its purpose is above all the "common safety", without which there could be no "good"; but it would be desirable,

> that one could procure for men something more than security, namely happiness, and one ought to apply oneself to this; but at least security is essential and without this the good ceases (Letter to Mr. de Falaiseau, July 8, 1705; Klopp IX, 143).

The concern for the happiness of man is, however, not an additional duty alongside the strict property right (and here Leibniz's concept of "security" differs, for instance, from that of Locke); rather it can suspend this *jus strictum*: for the purpose of community of goods, for the purpose of common external security; but also private property may be eliminated in the interest of a "great common good" – assuming of course this is carried out in a legal manner and is not left to the arbitrary will of the rulers (cf. Mollat, 13, 14f.).

(d) *The Kingdom of God: Justitia Universalis and the Right of Property*

The *justitia distributiva* is, according to Leibniz, the middle degree of right, a justice which stands above the *justitia commutativa* but below the *justitia universalis*, which includes all virtues, within which everything honorable is beneficial and everything base is harmful; this "highest degree of right" is realized in the kingdom of God.[7]

The further determinations of this perfect republic, of the kingdom of God, need not concern us here; important is merely that the *justitia universalis* suspends the right of property (over slaves) which is admissable according to the *jus strictum*.

The difference to Hobbes is interesting in two regards: according to Leibniz, the property right to a slave rests on the natural inequality of men. Leibniz thus does not share the view of Hobbes and Locke on the natural equality of men (Locke derived the right to slaves from victory in a just war; cf. *Two Treatises*, II, 85). On the other hand, Leibniz sees this property right as superceded by the *justitia universalis*. The third "natural community", that between master and servant, is conformable to nature "when a person lacks understanding but does not lack strength to nourish himself", "for everything a servant is, he is for the sake of his master, since all other powers exist for the sake of the understanding. But understanding is in the master, the other powers are only in the servant".

> Since such a servant exists for the sake of his master, his master owes him only his maintenance, and that for his own sake, so that he does not lose him, just as with cattle. This might be understood if there were no hope of bringing the servant himself to understanding; otherwise the master would be obligated to advance his servant's freedom through education, at least as far as this is necessary for the happiness of the servant.
>
> To confess the truth, I doubt whether an instance can be found of a servitude such that the servant exists entirely for the sake of the master, *especially since souls are immortal* and hence can sometimes achieve understanding and the blessedness of a life based upon it. In my opinion, therefore, this society exists only between men and cattle .... But if souls were only mortal, this servitude might occur in entire races which are almost as dumb as cattle, and so could be kept in this stupidity for the advantage of their masters – at least to the extent that children can be reared not to advance beyond cattle. *Now since the universal rules of justice are taught here, and even atheists must accept them, it seems that a natural servitude of men can be dealt with*, provided, that is, such a servitude were to be found. Even if such a servitude is not to be endured in its full force among men, something similar and approaching it sometimes conforms to nature. (Ms. on natural societies (1678) Grua II, 602; Holz, 138f.; PPL, 428–429; Loemker's translation has been amended to correspond to Grua's and Holz's version of the German original).

From the point of view of natural right there is thus a right to slavery; but this right is suspended because every immortal soul is a citizen of the kingdom of God.

> This is the right of reasonable souls, which are naturally and inalienably free. It is the Law of God who is the sovereign master of bodies and souls and under whom masters are the fellow-citizens of their slaves, since slaves have the right of citizenship in the kingdom of God as well as their masters. So it can be said that a man's body is the property of his soul and ought not to be taken from him as long as he lives. Since a man's soul cannot be acquired, neither can ownership of his body be acquired, so that the right of a master over his slave can be in the nature only of what is called servitude to another, or a kind of usufrucht. But usufrucht has its limits; it must be practiced without destroying itself, *salva re*, so that this right cannot be extended to the point of making the slave evil or unhappy (Mollat, 68; PPL 572).

At a time in which up to a fifth of the slaves died on the way from Africa to the plantations (cf. Hill, *Reformation to Industrial Revolution*, 228f.; to this slave trade Locke owed a great part of his fortune), Leibniz's attitude was anything but 'bourgeois'.

(e) *Equality and Freedom; Element and System*

Leibniz's view, that men are from nature unequal and therefore that the master-servant relation is natural, as well as his hint that inequality could be the product of education also determine his conception of the state. He wrote:

> Nature, which destines men to civil life, let them be born with different qualities, some to command and others to obey (Klopp IV, 461).

On the other hand, Leibniz believed in the perfectibility of men and did not assert that the inequality was necessary. The state bears responsibility for the health and means of subsistence of the citizens. At the same time however, "to contribute truly to the happiness of men, one must enlighten their understanding; and one must fortify their will in the exercise of virtues, that is, in the habit of acting according to reason; and one must, finally, try to remove the obstacles which keep them from finding truth and following true goods" ('Memoire pour des personnes éclairées et de bonne intention', §12; Klopp X, 11; Riley, 105). One must see to it "that men are prudent, endowed with virtue, richly supplied with faculties, and of course that they know how to do the best, that they want and can do it" (Mollat, 87).

In as much as this kind of measure has the equality of men as a goal,

equality is not presupposed as naturally given but is made an obligation which the state must fulfill.

Leibniz held a similar position with regard to freedom; against Locke he distinguished between legal and factual liberty (*liberté de droit et liberté de fait*):

> according to liberty of *law*, a slave is not free at all, a subject is not entirely free, but a poor man is just as free as a rich man. Liberty of fact consists either in the power to do which one wills or in the power to *will* what one ought . . . *Generally*, he who has more means is freer to do what he wills (N.E. II. xxi. 8).

The "factual liberty", which was not dealt with explicitly in the characteristically bourgeois social theories, is also taken by Leibniz as an obligation; but the preconditions for the fulfillment of this obligation must first be created (by the *justitia distributiva*).[8]

It is in this connection unnecessary to present the consequences which Leibniz draws from his deliberations or to develop his theory of the state; it is, however, important that in all central questions Leibniz did not subscribe to the classical bourgeois position. He subordinates private property to the needs of society as a whole and to Christian morals; he also does not think that all men are equal by nature or as free citizens equally free. For the question of the relation of element and system, it is decisive for Leibniz that he takes the state of nature to be already a social condition and that he does not see the contemporary society as composed of equal and independent individuals. Leibniz's starting point in social philosophy is, accordingly, the human society, a society which has always existed; Leibniz's starting point in physics is a system of material bodies. With regard to the relation of element and system, there is no opposition between Leibniz's procedure in physics on the one hand and his procedure in social philosophy on the other.

3. THE DOUBLE SENSE OF REPRESENTATION IN MECHANICS AND METAPHYSICS

(a) *The Various Models*

The central problem that the philosophy of Leibniz presents for the thesis, that Newton's principle on the relation of element and system was affected by the development of civil society, is the concept of the monad as a world to itself. It seems to prove that Leibniz – at least in the monad theory – suscribes to the same principle as did Newton on the independence of the

properties of elements from the system. Since Leibniz (in physics) however took systems as his point of departure, it would thus follow that he proceeded differently in physics than in the theory of monads. The relationship between Newton's procedure in physics and his social views would not be affected by this, but the relationship between physics and philosophy would have to be reconsidered. A special problem for the following analysis is grounded in the circumstance that it must be left undecided here whether the theory of monads is to be understood as an ontology, as a theory of dynamics, as an epistemology, as a theory of logic – or as a synthesis of all these. Leibniz's terminology in his systematic presentations of the monad theory encourages considering it as ontology; but for the purposes of the following analysis, a discussion of this point can be dispensed with.[9]

The heart of the problem lies in the apparently contradictory determinations which the monad receives: the monad is a world in itself (e.g., *Monadology*, §7f.) but also a representation of the world (e.g., 'Principles of Nature and Grace', §§3, 13, 14).

It should first of all be remarked that the contradiction between these two determinations of the monad or between the two principles on the relation of element and system is not restricted to the theory of the monad; it also applies to the world of material bodies. In analogy with the monad, wrote Leibniz, one can say that a material body is not pushed but that it moves after impact on account of its own elasticity (cf. above, pp. 40–43). Taken 'strictly' one can thus say that every material body already has all the force that it will ever have. The impact with another body only 'determines' this force (GP II, 116, fn.; II, 251, 506; VII, 513; VI, 103). This determination is analogous to the determination of the monad whose change results from an 'internal principle'.

On the other hand, Leibniz says that every body is an exact mirror of the universe in which past, present, and future of the entire world are recognizable (Reply to Bayle, GP IV, 557; PPL, 576). This determination is justified by maintaining that the motion of one particle in the world acts on all other particles in the world. The mutual effect, says Leibniz, 'symbolizes' the representation of the monads (*Monadology*, §61; cf. GP VI, 617; II, 112). The possibility that a body could exist alone is expressly denied by Leibniz (GP III, 457f.).

Such examples suffice to make clear, that the difficulty of conceiving the element as a 'closed' world or as a representation of the world arises not because a hiatus exists between a system of material bodies and a system of monads. Rather the problem lies in the relationship between two apparently

contradictory determinations of an element (monad, body) and of the 'system' or the 'world' in general.

The problem is brought to a head in two kinds of models which Leibniz uses for representation. In a letter to Arnauld Leibniz wrote that God was able to create substances, which by means of their own laws and according to the natural changes of their thoughts and representations express everything that occurs in the universe of bodies without any influence of one monad on another; to illustrate this, he uses an analogy between a monad and the mechanical model of the solar system (on such models, cf. above, 60f.) that mathematicians use, just as it is said of Archimedes:

> The just order of the heavens, the trustworthy ways of things, and the laws of the gods. All this together the old man of Syracuse represented by his art (GP II, 115; PPL, 341, 349, fn.).

The model of a mechanical device, whose motions represent those of the planets without any causal relation between the two motions, corresponds to the determination of the monad, whose change results only from an internal principle (e.g., *Monadology*, §11) without any external influence (e.g., *Monadology*, §7; Couturat, 14).

For the opposing conception, representation as an actual 'reflection' of the world, Leibniz uses the example of a view of a city (*Disc. Met.*, 9; a representation which is only possible because the city really exists and because light rays hit the eyes) or the concentration of light rays by a lens. These models imply that the representation is based on a real relation between each individual monad and the totality of all others.

Both conceptions – the element is a world in itself, and the element stands in relation to the world as a whole – thus apply both to the system of the material world as well as to the system of monads.[10]

(b) *Inertia, Extension, Impenetrability*

The assertion that the basic postulate on the relation of element and system applies in equal measure to the monads and to material bodies has been substantiated with general propositions of Leibniz's, that is, with propositions about the determination of the 'force' of each body. Before we examine this principle more closely, it must first be demonstrated that the other properties of material bodies which Newton took to be 'essential', namely, extension, impenetrability, and inertia, are likewise not attributed by Leibniz to a single body independently of other bodies.

It is of course clear that 'inertia' (in the Newtonian sense) could be taken by Leibniz neither as an essential property of material bodies nor even as a primitive property; for according to Leibniz's interpretation of Kepler's 'inertia', uniform rectilinear motion is the result of two forces, the passive force that "constantly resists during motion" and the active, motive "force of action" (Letter to de Volder, March 24/April 3, 1699, GP II, 171; PPL, 517; cf. above, 35ff.)

The other properties taken as essential by Newton, extension and impenetrability, were also interpreted by Leibniz as the result of 'passive force':

> I should always distinguish between extension and the attribute to which being extended, or diffusion, a relative concept, is referred. This would be situation or locality . . . . Thus extension, when it is an attribute of space, is the diffusion or continuation of situation or locality, just as the *extension of a body is the diffusion of antitypy or materiality* . . . [Matter] is in a point as well as in a body, and its diffusion in simple length makes a material line. ('Entretien de Philarète et d'Ariste', GP VI, 585; PPL, 622; cf. GP IV, 394; VII, 328).

It need not concern us here to what extent this reduction of extension, impenetrability, and inertia to 'passive force' can be justified; what is important is, that the possibility of a physics of the 'point mass' is opened up, and that extension and impenetrability are not primitive properties and thus cannot be attributed to a single body.[11]

(c) *Inertia; Monad and Possible World; Element and System*

Leibniz's reduction of all properties which Newton considered essential to two – the active and the passive force – does not exclude the possibility of his taking the latter to be essential and believing that they could be ascribed to a single body. As to his view of the relation of element and system, the question is thus far not yet decided.

However, Leibniz did not think that 'inertia', understood as resistance to motion, must be ascribed to a material body. In his youthful work '*Hypothesis Physica Nova*' (1671) Leibniz had supported the Cartesian view, that matter is indifferent to motion and rest. Three decades later he judged as follows:

> And such a world in which matter at rest would obey the moving body without any resistance, could indeed be imagined as possible, but such a world would actually be a pure chaos (Letter to de Volder, March 24/April 3, 1699, GP II, 170; PPL, 516–517).

Resistance is therefore not necessarily attributable to bodies because the laws of motion, which depend on the resistance, are themselves not necessary. When he discovered the 'true laws of motion', for whose justification it had to be assumed that material bodies have resistance – Leibniz wrote – he also discovered:

> that the laws of motion, which are really to be found in nature and are verified by experiments, are in truth not absolutely demonstrable, as a geometrical proposition would be: but it is also not necessary that they are.

One can in fact justify (*rendre raison*) these laws by supposing that 'the effect is always equal in force to its cause" or the "action is always equal to the reaction".

> These suppositions are very plausible and succeed happily in explaining the laws of motion ... but one finds no absolute necessity which forces us to accept them as one is forced to accept the rules of logic, of arithmetic, and of geometry (*Theod.* III, 345, 346; cf. Letter to Bourguet, April 11, 1710, GP III, 550).

Leibniz thus distinguishes necessary truths or "truths of reason" from "truths of fact": "Truths of reason are necessary, and their opposite is impossible. Truths of fact are contingent, and their opposite is possible" (*Monadology*, §33; cf. also GP III, 400). The physical laws, like all contingent truths, arise "not from the mere will of God but from considerations, directed by the intellect, of the optimal or the most convenient" (Letter to Bourguet, April 11, 1710, GP III, 550).

Since, according to Leibniz, there can be no relations and thus, too, no laws of nature that do not have their basis in the nature of things, the choice of the best laws of nature is inseparably bound to the choice of things. Every individual substance can exist so long as its concept contains no contradiction; but since the concept of an individual substance must contain all the predicates which belong to it, it follows for every substance that all predicates which can ever be attributed to it must already be contained in its concept. From this it follows that not all individual substances can exist in the same 'world', that is, can be 'compossible' with each other. Some possibilities "are incompatible with others not just with respect to the same time but also to the same universe, since the future is involved in the present" (GP VII, 289).[12]

God, whose understanding is conceived as a 'metaphysical calculator' (*Mechanismus Metaphysicus*) (GP VII, 304), combines from the concepts of the infinitely many possible substances an infinity of possible worlds. Of

the possible worlds, "God has chosen that world which is the most perfect, that is to say, which is at the same time the simplest in its hypotheses and the richest in phenomena, as might be a geometric line whose construction would be easy but whose properties and effects would be very remarkable and of a wide reach" (*Disc. Met.*, §6, PPL, 306). This is because only this "series of things" is determined, "as of lines the straight, of angles the right, of figures that which contains the most, namely, the circle or sphere (GP VII, 290).[13]

For the question of the relation of element and system, these deliberations of Leibniz's produce the following result: To each possible substance, and consequently to each real substance as well, all predicates must be attributed independently of all others; that is, not only the 'essential properties' but also all of their states in the sequence of time. Every single substance is in a possible world, and consequently every real substance is too, assuming that it harmonizes with all other single substances in the same world and with their states in the sequence of time. For the real (and every possible) world, it follows that every single substance is independent of all other substances as far as its own possibility is concerned, but that it *is* only because it represents the entire world. As opposed to Newton's God, Leibniz's God creates *no atoms* (which he then compounds): he creates (chooses) an entire world. On the occasion of the question, whether God could have created two identical material bodies and have put them in two different places (in space), Leibniz wrote that

> properly speaking, there is but one decree for the whole universe, whereby God resolved to bring it out of possibility into existence (5th Letter to Clarke, §66).

This conception finds its counterpart in a challenge put to human knowledge:

> In my opinion there is nothing in the whole created universe which does not need, for its perfect concept, the concept of everything else in the universality of things, since everything flows into every other thing in such a way that if anything is removed or changed, everything in the world will be different from what it now is (Letter to de Volder, July 6, 1701, GP II, 226; PPL, 524–525; cf. GP II, 239, 249, and N. E. II. xxv. 10).

The same applies to the ideal influence of monads on one another; thus when Leibniz says, that whoever knows the complete concept of a substance can know all its states in the sequence of time, even the state of the entire world (since the single substance is a *representatio mundi*), this applies to God alone. For scientific research it means that properties may be attributed to

a subject in order to explain the relations of phenomena, just as Leibniz ascribed resistance to bodies in order to ground the laws of motion; independent of a theory about the entire system, no properties can be ascribed to any subject whether as essential properties or as contingent ones. Thus the two models of the monad as a 'world to itself' and as 'representation of the world' are not contradictory.[14]

(d) *Clock Simile, Law of Inertia, and Freedom*

The double determination of the monad – as the complete concept of every possible individual substance on the one hand, and as existing substance in the realized possible world (and as concept of the possible substance in every possible world) on the other – is the basis for the much maligned simile of the two clocks.[15]

In this simile, which Leibniz developed especially for the question of the connection between body and soul, but which can hold for any pair of single substances, Leibniz compares two substances with two clocks or watches (*horloges ou montres*) which are in perfect agreement with one another:

> Now this can happen in *three ways*. The *first* is that of natural influence . . . . The *second* way of making two clocks, even poor ones, agree always is to assign a skilled craftsman to them who adjusts them and constantly sets them in agreement. The *third* way is to construct these two timepieces at the beginning with such skill and accuracy that one can be assured of their subsequent agreement" ("Second Explanation" to the *Système Nouveau*, GP IV, 498; PPL, 459–460).

Leibniz rejects the first possibility, since "it is impossible to conceive of material particles or of immaterial species or qualities which can pass from one of these substances into the other". The second possibility (supported by the occasionalists) he also repudiated, because one thereby introduces a '*Deus ex machina*'. The third possibility consists in the system of 'pre-established harmony', which presupposes that in so far as each of these substances "follows only its own laws which it has received with its being, each agrees throughout with the other." (*ibid.*, 498; PPL, 460).

The pre-established harmony means, in this version of the theory which draws much on problems of physics,[16] that in the process of selection among possible substances (clocks) God chose those which could form with others a 'compound clock'. Of the possible 'compound clocks' (possible worlds) the most perfect was suffered by God to exist.

Now this hypothesis, as Leibniz later added, explains just as much (or

just as little) as the theory that lets God constantly produce the agreement between the clocks. The difference lies in the fact that the latter makes God a perpetual supervisor (*'système de surveillant'*; remember the Governor of the Clock) and appeals to a miracle: miracle "in the philosophical sense", that is, an effect that "exceeds the powers of created beings" (Reply to Bayle, GP IV, 520; PPL, 494). In the same paper Leibniz equates such a conception with the theory according to which God has given "natural and primitive gravities to bodies". The connection between Leibniz's criticism of the occasionalists and of Newton is easy to see: all things must "be explained through the nature which God gave to things", and not by supernatural intervention, which *eo ipso* cannot be the subject matter of science. Science must proceed as if the 'evil doctrine' of the materialists were true.

In this proceeding as if the 'evil doctrine' of the materialist were true, Clarke saw the denial of human freedom, which in his opinion could only be rescued if the human will were allowed the possibility of breaking the laws of nature. Leibniz, however, believed he could at the same time assert human freedom and the law-likeness of nature. This conception of Leibniz's is of interest here because it sheds additional light on his conception of the law of inertia. Since we must forego a discussion of Leibniz's concept of freedom, I shall quote some determinations of the concept, to give an indication of the connection of the subsequent remarks with Leibniz's theory of liberty:

Freedom is an intelligent spontaneity; so that what is spontaneity in beasts of other substances deprived of intellect is elevated in men or other intelligent substances to a higher level of perfection and is called freedom.

Spontaneity is contingency without coercion, or spontaneous is what is neither necessary nor constrained . . . .

Constrained is that whose principle is external . . . .

All actions of single substances are contingent. For it can be shown that no contradiction is implied should things happen otherwise . . . .

The more substances are determined by themselves and the remoter they are from indifference, the more perfect they are. For since they are always determined, either they have the determination from themselves – and are the more powerful and perfect – or they are determined from outside and are constrained proportionately to serve external things.

The more one acts according to reason, the greater is one's freedom, and the more one acts according to the passions of the soul, the greater is one's servitude. For the more we act according to reason, the more we follow the perfection of our own nature. And to the extent that we let ourselves be carried away by our passions, we are slaves to external things which make us suffer.[17]

In the present connection we are concerned only with how a 'non-intelligent substance' can be spontaneously active. For Newton and Clarke believed that, if there were no 'active principles', i.e., immaterial principles, then everything would be passive and necessary. The solution to this problem is given by Leibniz's law of 'inertia':

> For do we not conclude [wrote Leibniz in reply to Bayle's objections] from this axiom [that everything perserveres in its state, unless it is forced to change it – G.F.] not only that a body at rest always remains at rest, but also that a body in motion will always retain its motion or its *process of change*, that is to say, the same speed and direction, if nothing occurs to impede it? Thus a thing not only remains *in the state* in which it is, insofar as it depends on itself, but also continues *to change* when it is in a *state of change*, always following one and the same law. But in my opinion it is in the nature of created substance to change continually following a certain order which leads *spontaneously* (if I may be allowed to use this word) through all the states which it encounters . . . (GP IV, 518; PPL, 493; last italics Leibniz's; others mine).

If one compares these remarks with Leibniz's version of the 'law of inertia' – the expression 'inertia' directly contradicts Leibniz's intention – according to which uniform rechtilinear motion is not a 'state' but an 'activity' (*actio*) (or as he formulates it here a 'state of change', in which the 'active force' acts and the 'passive force' resists), then it becomes clear why he found Kepler's concept of 'inertia' so opportune. Inertia, understood as resistance, demands in return a constant action of the active force. To avoid fatalism, Leibniz offered his conception of substance and of material body, in which activity and spontaneity are already contained, and he thus countered the introduction of supernatural 'active principles'. It is unimportant in this connection how Leibniz justifies his concept of freedom as the spontaneity of an intelligent substance; but it is important that, in his attempts to ground the possibility of human freedom, he at no point suspends the laws of nature. Philosophy must presume that in nature everything happens as if the materialists were right.[18]

AFTERWORD

The examination of the genesis of Newton's theory of space developed into an investigation of the genesis of the theory of bourgeois individualism; I hope the results have justified the expanded form. From the explanation of the origin of Newton's theory of space presented here, a number of consequences can be drawn for the questions posed in the Introduction as to the socio-historical determination of scientific concept formation and the relationship between philosophy and natural science.

I

Newton's theory of space – this was the result of the investigation – depended on the principle that a system consists of elements whose essential properties belong to them independently of the system. Newton's concepts of 'density' and 'quantity of matter', the origins of which research on Newton up to now has not been able to explain, are dependent on the same principle. This principle, in turn, was based on experience in the most advanced scientific-technological field, namely the construction of machines, especially clocks. The fact that scientists held on to this conception even where it was apparently useless, e.g., in determining properties which can only be formulated as relations, has been interpreted as an aspect of the development of bourgeois social relations, albeit mediated at many levels.

The study concluded here examined a number of different fields in which the principle that essential properties of an element are independent of the system was influential. Also, some areas were examined in which Newton used the concept of 'force'. I shall now give a sketch of the connections between the two aspects of the investigation.

Newton's interpretation of the analytic-synthetic method drew on the procedure of 'compounding and decompounding' used in practical mechanics. Newton's success in defining the basic concepts of his mechanics ('density', 'quantity of matter', 'vacuum') as well as in interpreting physical phenomena (the difference between relative and absolute motion, which he was able to demonstrate in the rotation experiment) by means of the atomism determined

and specified by this method provided the scientific basis for extending the method from practical to theoretical mechanics. Furthermore, the characterization of the concept 'force' as an immaterial 'active principle' depends on this method – mediated by way of the concept of 'passive' matter. The use of this method in social philosophy was abetted by two interrelated factors. It made possible a scientific investigation of social laws (although merely in a vague analogy to the procedure of mechanics); it also fit in with explicit, ideologically and politically significant assumptions concerning the composition of a society out of autarchic individuals. The agreement in the basic assumption with regard to the independence of the essential properties of a particle from the system of matter and of the individual from the social system allowed an ontological and methodological generalization which made the so-interpreted analytic-synthetic method appear to be the universal scientific method as such. It is thus not surprising that the assumptions behind this method were retained even when some of the consequences of applying it were not so fortunate. These consequences could be interpreted within the theory determined by the method: for instance, Newton's distinction between essential and universal properties, which takes into account the circumstance that gravitation cannot be attributed to a single particle; or the attempt of social philosophers to interpret the state of nature as the real point of departure and still existing basis of civil society, on the one hand, and on the other as a merely hypothetical, possible prerequisite for the developing civil society. This connection between social and natural philosophy, mediated by the specific analytic-synthetic method cited, is thus to be found on a methodological-ontological level.

The second connection, mediated by the concept of 'force', is to be found at the level of individual scientific disciplines. If mechanics is to be a universal science valid for all motions of material bodies, then not only the motion of machines and of inanimate material bodies occurring in nature but also the motions of living creatures must be explained in a unified manner. A connection between the movements of organisms and of machines (and therefore of inanimate bodies in general) was given in fact because the power transmission mechanisms in general use could be driven just as well by a force of nature (wind, water) as by man or an animal. The concepts 'force' and 'matter', 'active' and 'passive principle' were exceedingly well suited for such an interpretation. Applied to the machines of the time, which always had to rely on a natural, human, or animal force which acted on them from without, the distinction between active and passive principles was just as self-evident as it was in physiology at the time. But this unified interpretation could also

be turned around, as for instance, in Descartes' explanation of animal motion based on the principles of mechanics.

The connection with social philosophy resulted immediately from the fact that the possibility of free motion represented the necessary precondition of real freedom (existing not merely in thought). Physiology could thus constitute the connecting link between natural, moral, and social philosophy since it comprehended the force moving the body as a soul, which included both thought and free will, and since the preconditions of freedom of the will were investigated by philosophy (including social philosophy).

The two levels at which the connections between natural and social philosophy are to be found are closely interrelated. The concept of force as it was applied in practical and theoretical mechanics, in physiology, and in moral philosophy also displays characteristics in each of these areas, which we separate today, which are primarily attributable to its application in other areas. Seen from our perspective, the concept of 'force' in Newton's mechanics is not merely a technical term of a particular discipline; it contains specifications derived from other individual sciences (e.g., physiology) or derived from philosophical disciplines (moral and social philosophy) or from the application of a general philosophical method. On the other hand, concepts and methods specified by an implicit or explicit philosophy do not exist independently of their application in the sciences: they determine the individual investigations and are accordingly developed further in these investigations.

The distinction between these two levels, the philosophical and the scientific, is nonetheless meaningful. For, the relative independence of philosophy and the individual sciences can have the result, that for a long time concepts and methods generalized in philosophy can be applied in new scientific investigations without its being known in what specific discipline these concepts were developed and justified; moreover, the developments within a particular science need not lead immediately to a modification of existing philosophical concepts. The distinction between the levels of philosophy and individual sciences can be of great importance for an investigation of how the interpretation of the analytic-synthetic method examined here was handed down and modified – a problem only mentioned in passing in this study.

The connections among the individual sciences and between them and philosophy have the result that concepts are joined together in systems at any given point in time. Single concepts can therefore be derived both with regard to the experiences they define and by means of deduction from other concepts; as a result, the genesis of any particular concept is hard to

explain. The foregoing study, therefore, has tried to uncover a basic principle of the system construction by beginning with the analysis of certain concepts which could not be integrated smoothly into the system and thus could not be deduced from it. The circumstance that the construction principle for these concepts (that is, the specific interpretation of the analytic-synthetic method discussed above) can also explain the formation of other fundamental concepts reinforces the supposition that we are dealing here with an essential aspect of the genesis of this theory.

Using the connections among individual sciences and those between these sciences and philosophy, I have attempted to point out a connection between these and social relations. The relation of social philosophy to social relations consists, on the one hand, in the fact that the former interprets the latter and thus is dependent on it for its content and – mediated through the content – for its method, too; on the other hand, the social philosophies examined constitute implicitly, and sometimes even explicitly, the basis of a political program. The perspective in which these theories are constructed is dependent on the social relations themselves and on partisanship in the social struggles.

Mediated by way of social philosophy, natural philosophy is connected on both levels to social relations – on the level of philosophy and on that of the individual sciences. At both levels concepts are used that are common to the theory of nature and to that of society or even mutually interdependent: whether it be the predominantly scientific concept of 'force' or the already more general concepts 'active' and 'passive principle' or finally, whether it be specifically philosophical concepts like 'element' and 'system'.

Based on these results, the question posed by Leibniz and quoted at the beginning of this study can be put more precisely and answered: Leibniz asked whether there was "a different logic in London than in Hanover". With logic Leibniz also reckoned the art of invention (*ars inveniendi*) in general and even the "art of interrogating nature itself and so to speak of laying it on the rack, *Ars Experimentandi*" (GP VII, 518). If one relates the opposition between Newton and Leibniz and between London and Hanover to the historical situation described above, then we can interpret Leibniz's question as the question, whether social relations which differ in essential respects can condition differing 'evident' assumptions as to the research methods (logic) to be applied and thus lead to the conception and establishment of differing scientific theories.

This question can in my opinion be given an affirmative answer as a result of this study; the answer, however, needs a few clarifications. The point of

departure of this investigation was the demonstration that more than one scientific theory could be formulated about the same object. The circumstance that Newton's theory received confirmation is therefore not sufficient to explain why both theories (Newton's and Leibniz's) were conceived and why the Newtonian theory prevailed. On the other hand the demonstration that alternative theories offered equally satisfying scientific explanations already implies that the grounds sought after for their conception and attempted establishment by no means disqualify them from a claim to truth; however, such a demonstration does indeed invalidate the claims of any one of the theories to exclusive possession of absolute truth.

Leibniz's assertion that the axioms of geometry would be controversial if they opposed our interests, was also quoted at the head of this study. Although it expresses an insight into the possible influence of interests on knowledge, it is neither testable nor does it contain any hint as to what such an influence could consist in and how it could be demonstrated; conjectures about a relationship between interests or social relations and scientific theories ought to be examined with some skepticism. Leibniz's conjecture or J. D. Bernal's remark that Newton was "in unconscious harmony with the economic and social world of his time" (342) are thus quite welcome as exhortations to further research (to reconstruct the conjectured connection). Such conjectures using parallels between social relations and scientific theories can designate a problem to be investigated, but they can by no means be taken as an explanation. The error of taking the 'parallel' which is to be explained for the explanation itself is, I think, the basic error of most previous attempts to solve the problem; moreover, it is an error that leaves the gate wide open for arbitrary constructions.

These remarks should be measured against my examination of Newton and Leibniz; my theses on the origins of Newton's theory of space must, however, also be measured against previous attempts at an explanation. It can, I believe, be ascertained that the historiography of science up to the present has been able sufficiently to explain neither Newton's opinions nor their opposition to those of Leibniz.[1] Here we can see the basic flaw of all 'internalist' interpretations; the 'internalist' historiography defines its object in such a way that it can follow the rational path which leads from one historical position to another. But it cannot explain why out of all the rational developmental possibilities, this particular one and no other was realized. The historiography of 'ideas' that also studies those aspects of a theory and its genesis excluded by 'internalist' historiography, for its part,

cannot explain why these factors should be considered as belonging to the history of science. The opposition of 'internal' and rational to 'external' and supposedly irrational 'factors' has led to the result that none of the studies presented so far can claim to have provided a satisfactory explanation for the genesis of Newton's theory of space (and connected with this, his theory of matter), although a number of prominent historians of science have attempted it.

A few representative interpretations should be mentioned here: first, the interpretations that emphasize Newton's 'metaphysics' (Burtt, Koyré). These interpretations share the assumption that Newton's concept formation, at least with regard to absolute space, was determined by metaphysical convictions. They do not take into account the fact that Newton introduces his theory with a physical argument. A second school of interpretation (Fierz, Toulmin, Perl, Stein) is less unified. These interpretations have in common that they recognize the scientific value of Newton's theory of space and stress its importance, but they neither investigate Newton's proof of the existence of absolute space nor do they explain the connection with his metaphysics. Fierz deals briefly with the significance of the concept of space for mechanics, and with the remark that Newton considered his theory of space to be satisfactory "for philosophical and theological reasons" (Fierz, 68), he then moves on to extensive remarks on the metaphysical tradition of the concept of space. Physics and metaphysics are left unmediated one next to the other. Precisely this result appears to Toulmin to be the goal sought for (Toulmin II, 223); and he distinguishes between the 'physical' and the 'metaphysical' theory of space and accordingly between what Newton "personally" thought and what he thought "as a scientist" (Toulmin II, 215). Toulmin has without a doubt the merit of having reminded us again that Newton's concept of space fulfills a scientific function. This function is, however, ascribed by Toulmin to the proposition, "inertial frames of reference can actually be identified in nature", (Toulmin I, 25), and not to the theory proposed by Newton, that absolute space exists. Those aspects of Newton's space theory which Toulmin considers dispensible he characterizes as 'extra-scientific' and as theological 'decorations' (225f.), which became more important to Newton as he got older. Toulmin, of course, (his paper appeared in 1959) could not have been familiar with Newton's juvenile writings (published only in 1962) in which he adhered to the same views with the same intensity; but his interpretation nonetheless also has the fundamental flaw that it does not explain why the physically valid content of Newton's theory of space was accepted by numerous scientists

not in the general form formulated by Toulmin but rather in the specific form of the theory of absolute space.

II

As for the second question posed in the Introduction – the question of the relationship between philosophy and modern science –, only a few aspects could be dealt with in this study. It seems to me established that one cannot properly speak of a 'separation' of science from philosophy.[2] I should like to substantiate this assertion.

If my presentation of the conception of dynamics in the work of Newton and Leibniz is even approximately correct, then it must be conceded that scientific research was dependent on philosophical presuppositions. However, the assertion that a separation of philosophy and science occurred in the seventeenth century seems most often to apply to the difference between philosophical 'systems' and empirical research. This view seems to me to be favored by an illusory perspective. It is a historical fact that Newton, for instance, did not expound a philosophical 'system' and was the greatest physicist of his time; furthermore, it is a historical fact that Leibniz propounded a philosophical 'system' and that his procedure in dynamics found few adherents. But this implies nothing in a stringent sense about a necessary connection between Newton's achievements in physics and his supposed abstinence from philosophy, nor is any connection demonstrated between the fact that Leibniz was a 'philosopher' and the lack of success of his physics.[3]

Furthermore, the fact that Newton did not propound a philosophical system needs a closer look. Newton's conception, according to which phenomena are to be traced back to essential properties, implies a philosophical dogmatism, which I have illustrated with the analogy between the process of scientific inquiry and the explanation of the functioning of a clock. The conception is dogmatic because it implies that a scientific theory is not an explanation of phenomena (the movements of the hands) but rather a description of the ultimate elements of nature itself (the mechanism of the clock). From this it follows that (1) the results of natural science so far are absolutely certain and thus that they can be added to but never relativized, and (2) that these additions would be of the same kind as Newton's insights, that is, that all phenomena could be explained by determining further properties of the individual elements. Newton did not want to restrict the knowledge acquired so far or that still to be acquired to the area we now

call natural science; on the contrary, Newton believed that the results already achieved could support certain propositions about God and that future knowledge would also benefit 'moral philosophy'. It should be stressed, on the one hand, that Newton did not speculatively anticipate this program; on the other hand, it should not be overlooked that he recognized in principle the limits of mechanistic philosophy and fell back on irrational interpretations to explain those phenomena which could not be given such an explanation. It should be remembered that the assumption of arbitrary interventions by God in the world system was not rejected by Newton as appealing to a 'miracle', and that he speculated in the style of the Cambridge Platonists on physical space as God's sensorium attempting to show that the intervention of God in the physical world is possible.

Finally, the connection between Newton's dogmatic conception of his mechanics and his conception of human liberty should be pointed out. It is first of all clear that the mechanistic view could only conceive of a freedom from nature (either by transgressing its laws or transcending them); a freedom in nature seemed inconceivable. It seems to me that there is a close connection among the various aspects of Newton's thought: his program for a mechanistic philosophy, his restricting himself to the scientifically confirmed, his seemingly mystical speculation on space as God's sensorium, and finally his intensive preoccupation with apocalyptic writings. This connection lies in the fact that Newton did indeed seek a comprehensive world picture but realized that such a picture could not be mechanistic. But since Newton's analytic-synthetic method let none other than a mechanistic science seem conceivable, those phenomena for which in principle no explanation might be expected from further progress in mechanics were comprehended not as the subject matter of scientific research but were turned over to irrational speculations, which at the same time offered a 'foundation' for human freedom.

Finally, it should be remarked that the specifically bourgeois conception of human freedom as the undetermined arbitrary will of an isolated Robinson Crusoe, which Newton shared, could not be reconciled with the concept of necessity arrived at by generalizing the scientific concept of law – and not just the mechanistic concept of law. Just as Newton's basic principle of the relation of element and system determined the further development of physics up to the second half of the nineteenth century, so too was the incompatibility of the bourgeois conception of freedom with the scientific conception of laws of nature of great importance for the development of philosophy in this period; this conception is still influential today. If one

considers the common origins of the 'Newtonian' basic principle of element and system and the bourgeois conception of freedom which I have attempted to point out in this study, then it also seems no accident that Mach's critique of Newton stands at the end of the 'classical' bourgeois epoch, nor does it appear irrelevant that Mach's critique was coupled with the philosophical endeavor to reformulate the concept of the individual. It seems to me furthermore just as little an accident that at the same time a Leibniz-Renaissance began, that three leading philosophers (Russell, Couturat, Cassirer) almost simultaneously prepared books on Leibniz. A detailed examination of these interrelationships would be extremely welcome.

NOTES

INTRODUCTION

[1] Wolff, 35. Wolff has in my opinion succeeded in demonstrating that the concept formation as well as the success of the impetus theory was affected by social relations, and even by the interests which were pursued in social controversies. The end of the impetus theory, however, coincides with the high point of the 'scientific revolution' in the work of Newton. But in the replacement of impetus theory by classical mechanics – so it could be argued – it can be seen that a theory influenced by social relations is in fact not a scientific theory. This objection can only be refuted if the demonstration of such an influence is presented for a theory generally recognized as 'scientific'.

[2] A detailed presentation of the controversy about priority can be found in A. R. Hall, *Philosophers at War. The Quarrel between Newton and Leibniz*, Cambridge, 1980.

On the suspected political background of the quarrel over priority, Leibniz wrote to Caroline, the Princess of Wales:

> A journalist . . . said about this that it seems not to be a quarrel between Mr. Newton and me but between Germany and England. But a learned man wrote me from England, that the sentiments of some stubborn persons (*l'esprit de quelques Rigides*) not favorable to the party of Hanover both from Cambridge (whence Mr. Newton came to London) as well as Oxford (where his supporters are to be found) have had a large part in it (May 10, 1715; Robinet, 17f.).

At the time of the philosophical discussion, all parties involved were in the service of the House of Hanover: Leibniz, as is well known, was in Herrenhausen; Newton had been director of the English mint since 1696; Clarke had been chaplain to Queen Anne since 1709 and afterwards to Princess Caroline of Wales, who acted as go-between for the exchange of letters.

The Hanoverian King of England (George I, 1714–1727) had access to the correspondence between Newton and Leibniz (by way of Conti); cf. K/C, 122. And Leibniz could report that "the King has more than once joked about my dispute with Mr. Newton" (to Caroline, Aug. 18, 1716; Robinet, 120).

[3] In the text itself all quotations will be in English. Minor corrections of translations used have not been indicated. Where no English edition is listed in the bibliography, the translation was done by the Translator taking the author's German translations into account.

If more than one work by an author is cited, these are distinguished by a shortened form of the titles. A list of abbreviations is given at the end of the bibliography.

CHAPTER I

[1] *Philosophiae Naturalis Principia Mathematica*, 3rd edition, 1726, 53; *Mathematical Principles of Natural Philosophy*, translated by A. Motte 1729, revised by F. Cajori, University of California Press, 1934, 12.

The Latin will be cited from the critical edition of A. Koyré and I. B. Cohen, Harvard University Press, 1972.

[2] On the use of 'mathematical' to mean 'exact' cf. *Princ., Praefatio Auctoris*; Cajori, xvii. Cf. also the following remarks by Leibniz: "But if there were nothing uniform in nature, time would still not cease to be determined. . . . However, knowing the rules of difform motion, one can always relate them to intelligible uniform motions and, by this means, foresee what will happen when various motions are joined together. And in this sense time is the measure of motion, that is to say, uniform motion is the measure of difform motion" (Leibniz, N.E. II. xiv. 16).

The question remains open, whether absolute time "without relation to anything external" is supposed by Newton to be independent of any particular motion or of the existence of things in general as well; the formulation on p. 48 implies the first possibility, that on p. 46 the second. The question is by no means new. In the 17th century it was discussed extensively by Henry More and Descartes among others: If God were to destroy the world and create a new one, would any time have passed 'when' there was no world? Cf. e.g., H. More to Descartes, March 5, 1649, AT V, 306; Descartes to More, April 15, 1649, AT V, 343f.

[3] Astonishingly, this difference has not been noticed as far as I can see. Toulmin writes, for instance, "that for Newton the contrast between 'absolute' and 'relative' time, space, place and motion is one and the same as that between 'mathematical' and 'sensible'" (Toulmin, I, 13).

Similarly, to cite a much later state of research, Henri Laboucheix in a paper read in Edinburgh (1977) 'Physique et metaphysique chez Newton' writes: "Or, L'espace 'absolu' est un concept purement mathématique . . ." (p. 1, quoted from the typescript).

[4] Newton by no means excludes the possibility of one day finding an absolutely resting 'body alpha'. Cf. *Princ.*, 49; Cajori, 8f.

[5] *Princ.*, Bk. III, Prop. VI, Theor. VI, 573; Cajori, 411. An extensive discussion of these and related problems can be found in McGuire, 'Body and Void'.

[6] Cf. Prop. XL, Problem IX: "Globi, in medio fluidissimo compresso progredientis, invenire resistentiam per phaenomena" (*Princ.*, 495–509; Cajori, 353–366).

[7] A. R. and M. B. Hall arrive at a similar conclusion: "Newton seems to have believed that all the ultimate particles of matter – whether of gold or water – were of the same density . . ." (Hall and Hall, 316, n. 2). The authors refer to an unpublished text from the 1690s, in which Newton writes that if gold were "wholly solid" and if water were likewise compressed into a perfectly dense state, the latter would take up only 1/19 of its former volume; 18/19 would be a vacuum. The authors do not bring these conclusions into connection with Newton's definition of the quantity of matter, which will be discussed below.

Furthermore, my interpretation is confirmed by K. Figala's demonstration that Newton conceived of the various materials as compounded of such equal particles and vacuum units in different proportions. Cf. Figala, pp. 162–173.

[8] "Quantitas materiae est mensura ejusdem orta ex illius densitate et magnitudine conjunctim" (Def. I, *Princ.*, 39 Cajori, 1).

[9] All assumptions mentioned presuppose, themselves, the existence of ultimate particles of matter, atoms. This could not be demonstrated empirically, but Newton hoped to be able to observe the largest particles with a microscope (Cf. *Opticks*, Bk. II, Part III, Prop. VII, 261).

In Newton's first work, *Quaestiones* (ca. 1664) he writes: "Whither it [the first matter – G.F.] be mathematical pointes: or Mathematical points and partes: or a simple entity before devision indistinct or individualls i.e., Attomes" (Westfall, *Force*, 327). Newton opts for the last conception.

I. B. Cohen believes that the circle in Newton's definition of the quantity or matter arose because Newton confused 'density' with 'specific gravity' (Cf. I. B. Cohen, 'Isaac Newton's *Principia*,' 542, n. 2.). This explanation does not of course change the fact that the circle remains a circle and implies, moreover that Newton had two concepts of density.

[10] 'Phenomenon' is defined in this context as what can be perceived with the senses (Cf. MS to the 3rd edition of the *Principia*, Def. I, McGuire, 'Body and Void', 238f).

Material body is defined in accord with the definition of a phenomenon: "Body I call everything tangible in which there is a resistance to tangible things" (Draft No. 2, Def. I, McGuire, *op. cit.*, 245; Engl., 218).

[11] Newton denied repeatedly that he considered gravity to be an 'essential property' of matter; however, he never denied that he considered it to be a 'universal Property' of matter. This would indeed have been somewhat peculiar since one of Newton's central achievements consisted in fact in demonstrating universal gravitation.

"You sometimes speak of gravity as essential and inherent to matter," Newton wrote to Bentley: "pray do not ascribe that notion to me, for the cause of gravity is what I do not pretend to know, and therefore would take more time to consider of it" (Jan. 17, 1692/1693, *Corresp.* III, 240). In a later letter Newton attributes to Epicurus the notion that gravity is "essential and inherent" to matter (cf. Letter to Bentley, Feb. 25, 1692/1693, *Corresp.* III, 253f.). Cf. also Advertisement II of the *Opticks*.

[12] On the theory of qualities that can be intensified and remitted by degrees, cf. McGuire, 'Essential Qualities', 240ff.

[13] The figures for the relation of matter to empty space were given by Bentley, cf. *Corresp.* III, 248. Newton then tripled the diameter of the system of the world which Bentley used for his calculations, but he also believed that either of the figures was good enough to prove that matter had minimal significance in the world. Cf. *Corresp.* III, 253.

[14] The problem is expressed with admirable clarity in Locke's *Elements of Natural Philosophy*: "Supposing then the earth *the sole body in the universe*, and at rest; if God should *create the moon*, at the same distance that it is now from the earth, the earth and the moon would presently begin to move one toward another in a straight line by this motion of attraction or gravitation" (*op. cit.*, in: *The Works of John Locke*, 10 vol., London, 1823, II, 303–330, here: 305; italics – G.F.).

[15] "If space is conceived as something real, and if it is possible through dynamic criteria to ascertain a motion with respect to space, then it must also be possible to characterize one of the uniform motions as a state of rest" (Reichenbach, 64). Reichenbach believes that Newton was not "aware" of this inconsistency; Newton's arguments cited below seem to me to indicate just the opposite.

[16] Newton adopts from Descartes the concepts '*status*' for motion and rest, '*in directum*' for the rectilinear motion in which a body moves, and '*quantum in se est*' for the situation when no external forces operate on it. All three expressions are taken word for word from Descartes. Cf. Koyré, *Studies*, 67–69.

[17] The relationship between Newton's theory of space and his formulation of the law of inertia, which differs from that of Descartes, is discussed by G. Böhme, 'Die kognitive Ausdifferenzierung', in G. Böhme, et al., *Experimentelle Philosophie*, 244–245. Böhme does not however take the presuppositions for the inference of 'absolute space' from 'absolute motion' into consideration.

[18] Newton does of course trace some phenomena back to gravity, which is not an essential property. The Problems that arise from this and Newton's attempted solutions will be discussed at length in the third chapter.

[19] Decades earlier in *De Gravitatione* Newton had already determined the concepts somewhat more extensively yet in the same sense. There, 'force' is defined as the "causal principle of motion and rest". 'External principle' corresponds to '*vis impressa*'. 'internal' to inertia. Three more definitions follow: '*conatus*' is force in so far as it encounters resistance, 'impetus' in so far as it is 'impressed' on another body; 'inertia' is an internal force whose effect is that the state of motion of a body is not easily changed by an 'external force' (Hall and Hall, 114). There is however no reason to introduce a definition of the force of inertia itself. Since it is already contained in conatus and impetus as an effect of force. The concept '*vis inertia*' is only plausible when it is presupposed that '*actio*' (conatus and impetus; and since *actio* = *reactio: vis impressa*) is the effect of a 'force' already present in the body. Since the only 'effect' in uniform motion is the continuance of the body in its state, the force in this state is a 'passive force'.

For a discussion of this view of Newton's, which displays traces of the older impetus theory as well as of practical mechanics, cf. M. Wolff, *Geschichte der Impetustheorie. Untersuchungen zum Ursprung der klassischen Mechanik* (Frankfurt/Main, 1978), 322–340.

CHAPTER II

[1] An example of a 'philosophical' critique, astonishing in its pinpoint accuracy, can be found in John Toland:

> As for your alledging (to infer the Inactivity of Matter, as well as a *Vacuum*) the *one Body is heavier or lighter than another of equal Bulk*; you must suppose that Levity and Gravity are not mere Relations, the Comparisons of certain Situations and external Pressures; but that they are real Beings, or absolute and inherent Qualities ... [It is clear] that these Qualitys wholly depend on the Constitution and Fabrick of the Universe; which is to say, that they are the Consequences of the World in actual Being, and the necessary Effects of its present Order, but not essential Attributes of Matter ... (*Letters to Serena*, 5th Letter §14, 183–184).

G. H. R. Parkinson, for instance, believes that Leibniz's critique of Newton was such a 'philosophical' critique:

> There was conceptual confusion in that part of it [Newtonian physics – G.F.] which refers to absolute space and motion, and Leibniz was right in pointing this out; yet

Newton and his successors were justified in continuing to use and develop this physics confusion and all ('Science and Metaphysics in the Newton-Leibniz Controversy', 110).

[2] Leibniz's argument will be presented as it is given in the *Brevis Demonstratio* of 1686 since this essay became the object of the '*vis-viva* controversy'. A few years later, Leibniz presented the same problem much better. The later paper, *Essay de Dynamique* (1692), was sent to the French Academy but not published. Cf. P. Costabel, *Leibniz and Dynamics*, Methuen: London, 1973, where the *Dynamique* is published as Appendix I.

It is inconsequential in this connection whether Leibniz's criticism of Descartes does him justice. Only after writing the *Brevis Demonstratio* did Leibniz learn that Descartes was aware of the difference between measuring 'force' by the velocity (*mv*) and by the distance (*ms*) (cf. Arnauld to Leibniz, Sept. 28, 1686, GP II, 67f.). Leibniz remarks that he has in the meantime read in Descartes' letters, that he wanted to consider not merely velocity but also the height of fall. "If he had remembered that when he was writing his principles of physics, he might perhaps have avoided he errors into which he fell regarding the laws of nature" (Leibniz to Arnauld, Nov. 28 (Dec. 8), 1686, GP II, 80; cf. 'Essay de Dynamique', GM VI, 218). This last paper is not identical to the identically named but earlier *Dynamique*.

[3] In the *Dynamique*, Leibniz explains that it does not matter whether *mv* or mv^2 is called 'force'. It is enough that one admit that what he calls 'force' is conserved and not the quantity which others call 'force'. The assumption (1) mentioned above means that, presupposing a perfectly elastic impact, the absence of all friction or effects of external forces, a *perpetuum mobile* is possible. Leibniz calls this a 'physical' *perpetuum mobile*. In as much as a physical *perpetuum mobile* is asserted, a 'mechanical' one, in which external influences occur or work is performed is *eo ipso* excluded. (Cf. *Dynamique* [1692], *Remarques*.).

[4] "*Vis viva* played the central conceptual role in Leibniz's dynamics, but he never effectively based the quantitative measure of *vis viva* on any other foundation than the kinematics of free fall" (Westfall, *Force*, 296f.).

[5] "I understand here such an effect as itself constitutes a natural force (*vis naturae*) or one by whose production the impetus is diminished" (*Brevis Demonstratio, Scholium* to the Supplement, GM VI, 122; PPL, 301).

Leibniz deals with the similarities and differences between the problem of the pendulum and the water mill in a fragment, '*De usu impetus Concepti in Mechanicis*' (Ms. LH XXXVIII, Bl. 216), published and translated into German by M. Wolff, App. I, 349–355.

[6] "For Leibniz is now almost more at home in Harz than in Hanover: we count 31 trips to the mountains and, all told, 165 weeks (out of 365) spent there in the seven years from 1680 to 1686. He works on his windmills and other plans for the mines . . ." (A, I, III, xxix–xxx).

[7] Basically, all machines of the time were mere transmitting machines (on the terminology, cf. Marx, MEW 23, 393f.; *Capital* Vol. 1, 373f.). On the large share of patents for the channeling of water out of mines compared with the sum total of new patents, cf. Merton, 144, Table 12. On the technical problems involved, cf. Hessen, 159–162 and Wolf, Chapt. XXII, passim. Leibniz's technical practice and its connection to his dynamics is discussed at length by Elster, 77–96.

[8] "It is certain that the mining industry often lacks motive power", wrote Leibniz (*Promemoria* for Duke Ernst August, March (?), 1684, A, I, IV, 41).

> that although we have two great motive powers or motors, namely, wind and water, up to now we have used only falling water to drive the pumps and machinery in the mines but not the wind, since one is not sure how to remedy the obstacles lying in the way, especially the uneven power of the wind and consequently worrisome breakdowns, and other inconveniences. (Leibniz to Duke Ernst August, Spring 1680, A, I, III, 34; Leibniz had expressed the same thought a year earlier. Cf. Leibniz to Duke Johann Friedrich, Feb. (?), 1679, A, I, II, 127.)

[9] "The study of friction and thus the investigations on the mathematical form of gearworks, gear-teeth, etc. all done on the mill; ditto here the study of measuring the degree of motive power, the best way to apply it, etc. Almost all great mathematicians since the middle of the 17th century, in so far as they take up practical mechanics and develop theories about it, start from the simple water-driven grain mill. In fact for this reason, too, the name *Mühle* or *mill*, which originated in the period of manufacture, is used for every kind of mechanical engine designed for practical purposes" (Marx to Engels, Jan. 28, 1863; MEW 30, 319–323; here: 321.).

[10] "*Porro tó dynamikón seu potentia in corpore duplex est, Passiva et Activa. Vis passiva proprie constituit Materiam seu Massam . . . Duo insunt Resistentiae sive Massae: Primum Antitypia ut vocant seu impenetrabilitas, deinde resistentia seu quod Keplerus vocat inertiam naturalem . . . ut scilicet novum motum non nisi per vim recipiant corpora adeoque imprimenti resistant et vim ejus infringant . . . quo fit ut virium quantitas augeri non possit*" (Supplement to a letter to H. Fabri, May, 1702, GM VI, 98–106; the same text is in GP IV. 393–400, here: 395).

The concept of mass follows from the concept of acceleration. If a mass offered no resistence, then any finite velocity could be imparted instantaneously and the conatus could not be taken as the differential of impetus (Cf. Gueroult, 44f., 75f.).

[11] Leibniz also introduces the measure *'action motrice' a priori*. Cf. *'Dynamica de potentia et legibus naturae corporae*,' Part I, sect. III, GM VII. 345–367. An extensive analysis can be found in Gueroult, 123–144.

[12] Kepler defined the inertia peculiar to matter as resistence to motion in proportion to the quantity of matter: "*Materiae enim . . . proprie est inertia, repugnans motui, eaque tanto fortior, quanto major est copia materiae in angustum coacta Spatium*" (*De Causis Planetarum, Opera Omnia*, ed. C. Frisch, Vol. VI, 174–175, quoted by Jammer, *Mass*, 56).

Kepler's justification is somewhat similar to the later argument of Leibniz: "If the matter of celestial bodies were not endowed with inertia, . . . no force (*virtus*) would be needed to move a body" (*ibid.*, quoted by Jammer, *Mass*, 55).

Jammer points out that for Kepler "the concept of inertia refers exclusively to the impossibility of spontaneous motion or the resistance to a transition from rest to motion (acceleration)" (*ibid.*, 57). The complementary terms 'force' (*anima motrice*) and 'mass' (*moles*) derive from the traditional doctrine of forma and materia.

[13] The difference between Newton's and Leibniz's laws of inertia is of particular importance. Not only does the interpretation of concepts like *'action motrice'* depend on this difference; but the conception of a moving body (and no body is absolutely at rest

for Leibniz) as a unity of 'force' and mass is the scientific basis for Leibniz's renewal of the concept of 'substantial form' and thus for the connection between his physics and his philosophy. Cf. e.g., '*Specimen Dynamicum*,' Part I (1695), GM VI, 234–246, esp. 236; PPL, 435–444, esp. 436.

The determination of inertia as resistance to motion (and thus also to acceleration) is to my knowledge without exception: cf. e.g., Letter to De Volder, March 24/April 3, 1699, GP II, 170f.; PPL, 515f.; Theod. I, 30 (GP VI, 119); N.E. II. iv, 1.

The difference between Newton's and Leibniz's concepts of inertia must have been clear to contemporaries. Clarke, at least, reprimands Leibniz as follows: *vis inertiae*, he writes, "is that passive force, not by which (as Mr. Leibniz from Kepler understands it,) matter resists motion; but by which it equally resists any change from the state 'tis in, either of rest or motion" (Clarke, 5th Reply, §99, note a).

In Appendix No. 7 to his edition of the correspondence, Clarke added a list of passages in which Leibniz formulates his 'false' concept of inertia.

Newton himself added a note in his own copy of the second edition of the *Principia* to clarify his definition of inertia: "*Non intelligo vim inertiae Kepleri qua corpora ad quietem tendunt sed vim manendi in eodem seu quiescendi seu movendi statu*" (*Princ.*, 40, fn.).

According to I. B. Cohen, 'Newton and Keplerian Inertia,' this remark of Newton's was added on account of the preceding discussion with Leibniz.

As far as I know, Ernst Cassirer is the only scholar to have noted that Leibniz's law of inertia is derived from the law of the conservation of 'force'. It is the first attempt, he writes, "to regard the first basic law of mechanics as a special case of a comprehensive principle of energetics" (*Leibniz*, 317). He, too, however fails to see that it is Keplerian and not Newtonian inertia that Leibniz has in mind.

In his own copy of Newton's *Principia* Leibniz underlined the phrase '*vis inertiae*' but makes no further remark (cf. *Marginalia*, 26).

[14] Two different interpretations of the significance of '*action motrice*' ought to be mentioned. Both have in common that they misunderstand Leibniz's concept of inertia and thus work on the assumption that '*action motrice*' not only represents an error but also contradicts Leibniz's physics.

M. Gueroult maintains that Leibniz did not distinguish between 'work' and 'uniform motion'; and that while this is a mistake in physics, it is nonetheless justified from the point of view of Leibniz's metaphysics (p. 144). The 'force' of a uniformly moving body is physically one and the same from one moment to the next. If time is not absolute, that is, if the moments can be distinguished only by their contents, then two such moments in which one and the same force subsists would be merely one. The conservation of force is thus conceived by Leibniz as a continual generation; the force in one moment stands in a causal relation to the force in the next. But since the forces are – metaphysically – different, the points of time are also different. "One obtains, as it were, a series of pulsations, each of which has a distinct reality and designates a different moment of time" (*op. cit.* 148, cf. the whole argument: 144–153).

As I have already remarked, I believe the whole interpretation works with false assumptions. (All quotations, which Gueroult cites to support the 'generation' of one force by the previous force, refer to a 'body'; according to Leibniz's theory of uniform motion, force does in fact act in a uniformly moving body in 'pulsations' which 'inertia' resists. There is no mention of a continual generation of force.)

Moreover, Gueroult's sudden transition from physics to metaphysics is questionable; Leibniz himself is always very exact in pointing out such transitions.

Finally, the indiscernability of two moments of time presupposes the perfect equivalence of two states of the world; such an equivalence (if only the relative positions of the bodies are taken into consideration – which is inadmissable in any case) would only exist if the world as a whole were translated in space. But then the metaphysical criterion, too, would not be of much help. Leibniz insists very often (e.g., in the correspondance with Clarke) that the assumption of such a translation is meaningless, because two such states would be indistinguishable. Consequently, they could also not be differentiated metaphysically.

From the same assumption of an apparent error by Leibniz, J. Elster suggests a completely different interpretation. First he argues that the economic views of Leibniz waver between those of the mercantilist economists and those of industrial capitalism (according to the former wealth is increased by mere circulation, according to the latter by reproduction on an extended scale). In a similar manner in the area of dynamics Leibniz confuses simple circulation (i.e., uniform motion) and production (i.e., work). "The two problematics [the economic and the dynamic – G.F.] were thought together by Leibniz in a general theory of 'forces' productive or dynamical. Or, to put it more precisely, in two distinct theories, both of which found application in the area of economics just as in the area of dynamics" (Elster, 171; cf. also 169–171). Elster believes that the "precision and objectivity" of this analogy and its interpretation are assured by the fact that Leibniz himself introduces the analogy between money and force – indeed in texts that deal with *action motrice*.

Elster's interpretation would be convincing if it had been proven that Leibniz in principle continually considered 'circulation' as 'extended reproduction'. The classical example of this is the opinion that a *perpetuum mobile* is possible. Leibniz, on the contrary, uses the mechanical *perpetuum mobile* as his primary example of an absurdity.

Even if the equation of continual circulation with extended reproduction (uniform motion with work) is not generally valid for Leibniz, the question still does arise, why it seems to be valid in the case of action motrice. Thus the question still remains the same even after the interpretation, namely, why 'uniform motion' is interpreted as 'activity' by Leibniz.

Finally, it should be examined whether the analogy between 'money' and 'force', which Elster shows in Leibniz, is a model or merely a metaphor. Cf. below p. 227, fn. 17.

[15] Leibniz to Huygens, June 10/22, 1694, GM II, 184; PPL, 418. Cf. also Leibniz's letter of Sept. 4/14, 1694, GM II, 199; PPL, 419. Leibniz does not say what relativistic explanation he was thinking of. A presentation and critique of Huygens' solution can be found in Reichenbach, 63–66.

[16] "*Je repons que le mouvement est independent de l'observation, mais qu'il n'est point independant de l'observabilité. Il n'y a point de mouvement quand il n'y a point de changement observable. Et même quand il n'y a point de changement observable, il n'y a point de changement du tout*" (Leibniz's 5th Letter, §52). Cf. Cassirer in HS I, 158–159, fn. 104.

[17] For a different interpretation, cf. Cassirer, in HS I, 219–221, fn. 158.

[18] *Dynamica*, Sect. I, Chapt. II, Def. 2, GM VI, 296f. Elsewhere Leibniz formulates: "*densum est, cuius major est quantitas in minore spatio. Rarum contra*" (Couturat, 486).

[19] Leibniz considered this point very important: "thus it is impossible for us to know what a *foot* or a *yard* is unless we actually have something to serve as a measure which can be applied to successive objects after each other" (*'Initia Rerum Mathematicarum Metaphysica'*, GM VII, 18; PPL, 667). Cf. GM VII, 275f.; N.E. II. xiii, 4.

[20] Leibniz like most of his contemporaries as well as later commentators overlooked the fact that Descartes differentiated between 'direction' and 'determination' of motion, and that he referred to determination in the impact laws. For Leibniz's critique of the impact laws, however, this distinction is not significant. On the problem of these concepts in Descartes' writings, cf. A. Gabbey, 'Force and Inertia in the 17th Century: Descartes and Newton', in: *Descartes: Philosophy, Mathematics Physics*, ed. S. Gaukroger (Sussex, 1980), 230–320; esp. 248–272.

[21] Leibniz presents the argument in two works: *'Exstrait d'une lettre à M. Bayle sur un principe général utile à l'explication des loix de la nature'* (1687), GP III, 51–55; and Latin: *'Principium quoddam generale non in Mathematicis tantum sed et physicis utile etc.'*, GM VI 129–135. The former is translated in PPL, 351–354, Cf. also *'Über das Kontinuitätsprinzip'*, HS II, 74–78, where the French original is also printed, 556–559.

Leibniz's critique is actually directed at Malebranche's impact laws, but they are criticized according to the same approach and with the same results in the course of the essay as are Descartes' laws at the beginning, so that the first argument suffices to illustrate Leibniz's approach.

[22] "Mais il en est arrivé un inconvenient, c'est qu'on s'est trop jetté dans l'autre extremité, et qu'on ne reconnoist point la conservation de quelque chose d'absolu, qui pourroit tenir la place de la Quantité de Mouvement." (*'Essay de Dynamique'*, GM VI, 216; the critique is intended for Malebranche in particular.)

[23] "Et en effect ceux qui sont pour le systeme des causes occasionelles se sont déja fort bien appercús que la force et les loix du mouvement qui en dependent, ne peuvent estre tirées de la seule etendue, et comme ils ont pris pour accordé qu'il n'y a que de l'entendue dans la matiere, ils ont esté obligés de luy refuser la force et l'action, et d'avoir recours à la seule cause generale, qui est la pure volonté et action de Dieu. En quoy on peut dire qu'ils ont tres bien raisonné *ex hypothesi*. Mais l'hypothese n'a pas en encor esté demonstrée, et comme la conclusion paroist peu convenable en Physique, il y a plus d'apparence de dire qu'il y a du defaut dans l'Hypothese . . ." ('Extrait d'une lettre de M.D.L. pour soutenir ce qu'il a y dans le Journal des Sçavans du 18me Juin, 1691', GP IV, 466f.; here: 467).

[24] Leibniz to Huygens, Nov. 16/26, 1692, GM II, 145; PPL, 416. This argument against atomism seemed to Leibniz to be "one of the strongest" (Leibniz to Huygens, March 10/20, 1693, GM II, 157; HS II, 46).

[25] *'Essay de Dynamique'*, GM VI, 229; on pp. 228f. the various possible outcomes of the impact of absolutely hard bodies is also discussed.

> "Mais on peut prendre les corps naturellement pour Durs-Elastiques, sans nier pourtant que l'Elasticité doit toujours venir d'un fluide plus subtil et penetrant, dont le mouvement est troublé par la tension ou par le changement de l'Elastique. Et comme ce fluide doit estre composé luy même à son tour des petits corps solides, elastiques entre eux, on voit bien que cette Replication des Solides et des Fluides va à l'infini" (*ibid.*, 228).

[26] The law thus applies to a material system, no matter whether it consists of many

'bodies' or of one single body, which itself is an aggregate of material particles; likewise every particle can also be conceived as an aggregate. Cf. '*Spec. Dyn.*', GM VI, 238.; PPL, 439; where *vis viva* is related to an 'aggregate of bodies'. "Lesser minds," remarks Ruben on Leibniz's solution, "take panic when a philosophical proposition seems to contradict certain 'facts' . . . Leibniz, on the contrary, dealt with the contradiction as a means of raising knowledge to a higher level and thus demonstrated what productive reasoning consists in" (Ruben, 31).

CHAPTER III

[1] The argument is presented by Clarke in a note to his 5th Reply (§§93–95, Robinet, 200ff.; Alexander 121ff.); but it was formulated by Newton. Newton's drafts have been published by Koyré/Cohen, (Appendix 2) 116–122.

[2] The entire controversy on the measure of force is characterized by these different approaches:

> The controversy referred to the relationship between the mechanical quantities impulse and energy, which only acquire importance in the treatment of *systems*. Thus the mechanics of the free point mass could not provide the basis or the starting point for the controversy (P. Ruben, 17).

[3] "*Vel ex his principiis actuosis vel ex imperio voluntatis oritur.*" (Quoted by Alexander, XVIII. In the second English edition (1717) Newton – probably as a reaction to Leibniz's criticism – mentions only the 'active Principles' (cf. *Opticks*, Qu. 31, 399).

God's intervention to preserve the system of the world is also necessary, according to Newton, to prevent the fixed stars from falling onto one another and to compensate for irregularities in the motions of the planets when a 'Reformation' of the system becomes necessary (cf. *Opticks*, Qu. 28, 369f.; Qu. 31, 402).

[4] "Sr. When I wrote my treatise about our Systeme I had an eye upon such Principles as might work with considering men for the beliefe of a Deity and nothing can rejoyce me more then to find it usefull for that purpose" (Newton to Bentley, Dec. 10, 1692, *Corresp.* III, 233).

[5] The determination of space as the sensorium of God had been developed by the Cambridge Platonists (R. Cudworth, H. More). It has been maintained repeatedly that Newton was "doubtlessly influenced by More" (K/C, 88; cf. also Fierz, *passim*; both works cite a number of text passages from Raphson and More). It must, however, be remarked that borrowing an expression does not of itself demonstrate an 'influence'. It must be examined whether the expression has the same function and thus the same meaning in both theories. Furthermore, the explanatory value of an 'influence' is rather doubtful. On the contrary, the question must then be asked, why Newton was influenced by More and not by Descartes or Berkeley or some other philosopher.

[6] God "is omnipresent not *virtually* only, but also *substantially*; for activity (*virtus*) cannot subsist without substance" (*Principia*, Scholium Generale, 762; Cajori, 545).

In the *Lexicon Technicum* of the Newtonian John Harris this postulate is listed as an example of an axiom – even before the law of non-contradiction. Under the entry for 'Axiom' we read: Axiom is "such a common, plain, self-evident and received Notion, that it cannot be made more plain and evident by Demonstration; because 'tis its self

much better known than any thing that can be brought to prove it; as, *That nothing can act where it is not: that a thing cannot be and not be at the same time . . .* "

[7] Herivel, Ms. IId, 140–150, here: 146f.

[8] Newton first identified this matter with the air ('*De Aere et Aethere*' (1673–1675), Hall and Hall, 214–220). But the fact that gravitation occurs in a glass vessel in which no air can penetrate compelled him to assume an even finer medium. This is called 'spirit of air' (*spiritus aere*) (*op. cit.*, 220). Later, he differentiated between the main body of 'phlegmatic aether' and an 'aetherial spirit' diffused within the former, which consequently is a sort of 'spirit of spirit' (cf. 'A Hypothesis explaining the Properties of Light discoursed on in my several Papers,' letter to Oldenburg, Dec. 7, 1675, *Corresp.* I, 362–386, here: 365f.). The quandary, which led to the introduction of ever more subtle media, was noticed by Newton himself:

> . . . and the other kind of less dense particles which have to be the cause of the gravity of the denser ones but themselves have no gravity. Lest their gravity might have to be explained by a third kind, and then again by a fourth and so on to infinity (McGuire, 'Body and Void,' 210, fn. 17).

Newton sketched another version of his ether theory in a letter to Boyle, Feb. 28, 1678/1679, *Corresp.* II, 288–295.

There is an extensive literature on these ether theories. Cf. e.g., Jourdain, 'Newton's Hypothesis of Ether and of Gravitation etc.', *The Monist 25* (1915) 79–106, 233–254, 418–440; L. Rosenfeld, 'Newton and the Law of Gravitation', *Arch. Hist. Exact Sci., 2* (1962/1966) 365–386; and 'Newton's Views on Aether and Gravitation', *Arch. Hist. Exact Sci., 6* (1969/1970) 29–37; E. J. Aiton, 'Newton's Aether Stream Hypothesis and the Inverse Square Law of Gravitation', *Annals of Science, 25* (1969) 255–260.

[9] "*Vocem attractionis hic generaliter usurpo pro corporum conatu quocunque accedendi ad invicem: sive conatus iste fiat ab actione corporum, vel se mutuo petentium, vel per spiritus emissos se invicem agitantium; sive is ab actione aetheris, aut aëris, mediive cuiuscunque seu corporei seu incorporei oriatur corpora innatantia in se invicem utcunque impellentis*" (*Princ.*, 298; Cajori, 192).

"*Vis autem omnimodo quo corpuscular distantia in se invicem ruunt, sermone populari attractio appelari solet. Nam cum vulgo loquor vim omnem qua corpuscula distantia vel impelluntur in se mutuo vel quomodocunque coeunt et cohaerent attractionem vocans*" (Unpublished conclusion to the first edition of the *Principia* from the spring of 1687, Hall and Hall, 320–339, here: 322).

[10] The so-called 'Classical Scholia' to Propositions IV to IX of the third book of the *Principia* have been published in exerpt by McGuire/Rattansi, 'Newton and the "Pipes of Pan"', *Notes and Records of the R. S. of London, 21* (1966) 108–143. "By what proportion gravity decreases by receding from the planets the ancients have not sufficiently explained. Yet they appear to have adumbrated it by the harmony of the celestial spheres, designating the Sun and the remaining six planets, Mercury, Venus, Earth, Mars, Jupiter, Saturn, by means of Apollo with the Lyre of seven strings, and measuring the intervals of the spheres by the intervals of the tones." There follow numerous sources from ancient writings, that show that Apollo's lyre with its seven strings holds the key to explaining the motions of the celestial bodies (McGuire/Rattansi, 115f.).

[11] McGuire/Rattansi, 118. The authors remark that there are numerous other references

to life and will as active principles which act harmoniously upon matter. The knowledge of these principles is attributed to the ancients (*ibid.*, 140, fn. 23).

[12] Ms. for the second edition of the *Opticks*, quoted by Westfall, *Force*, 389. Cf. Qu. 30, 374.

This identification of God with the sun may have been an additional reason for Newton's assumption that the center of the world system, the sun, does not move.

[13] *"Et haec de deo, de quo utique ex phaenomenis disserere, ad philosophiam naturalem pertinet."*

This sentence has been often and controversially interpreted. It must, I think, be taken literally: we must speak of God in the same manner (*ex phaenomenis*) as we speak of other things, namely, scientifically.

On hypotheses in Newton's work, cf. I. B. Cohen, *Franklin and Newton* (Cambridge, 1956), chapt. V, 113–150, and Appendix I, 575–589.

[14] The 'predicaments' omnipresence and eternity are to be understood as "consequents of the Existence of a Being which is really necessary and substantially Omnipresent and Eternall. So when the Hebrews called God MAKOM place . . . (they) did not mean that space is God in a literal sense" (Draft E, K/C, 101; cf. Draft D, 99; cf. a further manuscript cited by Westfall, *Force*, 420, fn. 184).

The fundamentals of this Jewish tradition are handed down in a commentary on Genesis from the second century A. D. Starting with the question of the reason for the designation of God as Makom (place), all three participants in the discussion agree "that the Lord is the place of His world, but His world is not His place" (Midrash Rabbah, *Genesis II, LXVIII*, 9). On the connection of this tradition to Greek notions on the relation of the container to the contained, cf. I. Beer, 'On the Clarification of Eschatology at the Time of the Second Temple (2): The upper and the lower world', (Hebrew) *Zion, 23/24* no. 3/4, 25–34. For further sources of the Jewish tradition, cf. Jammer, *Space*, 30–33.

On similar gnostic notions, cf. W. R. Schoedel, 'Topological Theology and some monistic Tendencies in Gnosticism', in: *Essays on the Nag Hammadi Texts in Honour of Alexander Böllig*, Leyden, 1972, 88–108.

H. More appeals likewise to the designation '*Makom*' for God. Cf. W. A. Schulze, 'Der Einfluß der Kabbala auf die Cambridger Platoniker Cudworth und More', *Judaica 23* (1969) 75–240; in particular on the theory of space: 119–126. It must however be doubted that Newton owes the expression to the study of More's writings: in two manuscripts of Newton's (reproduced by K/C, 98–99) he writes '*Makom*' in Hebrew letters but with an orthographic mistake not to be found in More.

A survey presentation has been given recently by Brian P. Copenhaver, 'Jewish Theologies of Space in the Sceintific Revolution: Henry More, Joseph Raphson, Isaac Newton and their Predecessors', *Annals of Science, 37* (1980) 489–548.

[15] "*Sensorium Commune*, or The Seat of the common Sense, is that part of the Brain in which the Nerves, from the Organs of all the Senses, are terminated, which is the beginning of the Medulla Oblangata." "Medulla Oblangata . . . is call'd also the Common Sensory, because the Original of the Nerves being there, it is the common place or receptacle of all that comes to the Brain by the external Senses" (Harris, *Lexicon Technicum*, vol. I (1704)).

In the first edition in which these queries appeared (Latin, 1706), it read "in his sensorium". After printing, the word 'tamquam', "as if", was added by hand. Cf. Koyré/

Cohen, 'The Case of the Missing Tamquam', *ISIS, 52* (1961) 555–566. A 'tamquam' changes the theory just as little as does the question form of the Queries, which always begin with the words "Do not . . . ? and only allow a positive answer.

[16] Draft of a letter to Conti, K/C, 74. No less than 12 drafts to this letter have been preserved. Cf. *ibid.*, 72–77, and Appendix 1, 104–115.

[17] The following discussion of the 'clock model' does not touch on the question of whether models are admissable or even useful in scientific research today. It is a fact that models – especially clock models – were used in the 17th century.

Some examples of the use of this model will be given below. Cf. also K. Maurice, *Die deutsche Räderuhr*, Munich, 1976, I, 5–16; Maurice, however, does not distinguish between an analogy and a metaphor. Cf. also O. Mayr, 'Die Uhr als Symbol für Ordnung, Autorität und Determinismus', in: *Die Welt als Uhr* (exhibition catalogue), Bavarian National Museum, Munich, 1980, 1–9.

The requirement to be met by the use of a model is that the positive, negative, and neutral analogies between the model and the object under investigation be enumerated. The positive analogies make the use of the model possible in the first place; the negative analogies limit the scope of its application. The neutral analogies are those properties of the model for which it has not yet been decided, whether they are positive or negative. One can propose such a property of the model positively or negatively as a hypothesis and evaluate it on the object under investigation. This can be one of the uses of the model. For a thorough discussion of this question, cf. M. B. Hesse, *Models and Analogies in Science* (London and New York, 1963).

In the following, 'analogy' is meant as 'positive analogy' and is understood in the sense of Kant's formulation as a "perfect similarity of two relationships between quite dissimilar states of affairs". Such an analogy must be distinguished from a 'metaphor', a figurative expression and an informal, associative connection. The difference between an 'analogy' and a 'metaphor' is not due to the fact that certain expressions are in themselves 'analogous' or 'metaphorical'; the same expression can be used as an analogy or as a metaphor accordingly as unequivocal relations between the corresponding objects are specified or not.

One pecularity of the question examined here lies in the fact that normally one scientific theory is used as a model for a new theory; but since mechanics represents the first scientific theory of physics, it had to use either geometrical or technical models. The reason why the clock played the dominant role will become clear in the presentation below.

[18] The data on the margin of error as well as on clockmakers, their guilds, training, etc. are taken from Carlo M. Cipolla, 'Clocks and Culture', in: *European Culture and Overseas Expansion* (Pelican Books, 1970), 113–174, Tables: 134. The slow development in the mechanism of these clocks is perhaps best documented by the errors in dating which historians of technology have been led into. Clocks from the 16th and 17th centuries have often been attributed to the 14th century.

[19] E. Gélis, *L'Horlogerie ancienne*, Paris, 1949, 48; quoted by Cipolla, *op. cit.*, 117, fn. In the 15th century Froissart rhymed: "li orloge ne poet aler de soi / se il n'a qui le garde et qui en songne / pour ce il faut à sa propre besongne / un orlogier qui tart et tempre / diligamment l'administre, et attempre / le plons relieve et met à leur devoir" ('Li Orloge amoureuses', quoted *op. cit.*). As late as 1641 the public clocks in Dijon had to be brought into agreement with one another by hand (*op. cit.*, 119).

[20] For instance, in 1677 Joseph Moxon published his pamphlet, *Mechanick Dyalling: Teaching any man tho' of an ordinary capacity and unlearned in the Mathematicks to draw a true Sun-Dyal on any given plane, however scituated etc.*

[21] Representations of the heavens are known to have been made even in the third century B.C.: both immovable (*sphaera solida*) as well as movable such as the spheres of Archimedes. In late antiquity such mechanisms were probably quite common. Pappus of Alexandria (fl. A.D. 320), for instance, counted among the mechanics those "who practice the construction of globes and produce a representation of the motions of the heavens by the uniform circular motion of water" (Klemm, 41).

[22] A short overview of the development of such models of the world from the amillary sphere to the mechanical planetarium is given by E. Zinner, *Deutsche und niederländische astronomische Instrumente des 11.–18. Jahrhunderts*, Munich, 1967, (2nd ed.) 31–46, 168–175, with pictures of some spheres and planetaria, Tables 58–62, 4–6; cf. especially K. Maurice, *Die deutsche Räderuhr*, Munich, 1976, vol. I, 35ff., and the numerous pictures in vol. II.

[23] D. J. de Solla Price, 'Precision Instruments: to 1500', in: *A History of Technology*, ed. Charles Singer *et al.* vol. III (Oxford, 1956), 582–619, here: 616.

[24] No one has more emphatically than E. Zilsel, in his papers from the 1940's, supported the thesis that modern science arose from the synthesis (in Zilsel's presentation, rather, the mechanical compounding) of the theoretical knowledge (especially mathematics) of scholars and the empirical knowledge and procedures of engineers (*virtuosi*). The thesis, which seemed to be generally accepted, has again been questioned by Thomas Kuhn (cf. 'Mathematical vs. Experimental Traditions in the Development of Physical Science', *Journal of Interdisciplinary History*, 7 (1976) 1–31). For a critique of Kuhn's position, cf. Wolff, 48–58. The connection between the origins of modern science and the more highly skilled crafts seems to me to be indisputable, at least for the production of scientific instruments.

The clock is of particular importance because it was both a scientific instrument and was soon to become an object of general use.

[25] "Scientia et potentia humana in idem coincidunt, quia ignoratio causae destuit effectum. Natura enim non nisi parendo vincitur: et quod in contemplatione instar causae est, id in operatione instar regulae est" (Bacon, N.O., I, 3). On the interpretation of this thought of Bacon's, cf. P. Rossi, 'Truth and Utility in the Science of F. Bacon', in: Rossi, *Philosophy*, app. II, 146–173. Cf. Hobbes, *De Corpore*, I, 1, §8.

That the new 'practical' philosophy, as opposed to the old 'speculative' one, could make men the "masters and possessors of nature" (Descartes, *Discours*, VI, §2) is expressed by almost allscientists of the time.

[26] In his explanation of the heart mechanism Descartes, for instance, writes that its movement "follows as necessarily from the mere disposition of the organs . . . as does that of a clock from the power, the position and the shape of its counterweights and its wheels" (*Discours*, V, §6; 68; cf. *Discours*, V, §9, and *Passions de l'âme*, §§6, 7, 16).

There are two important points here: the break with the Aristotleian tradition, according to which the 'science of the necessary' did not apply to things that come to be and thus can be produced (cf. Aristotle, *Metaphysics* I, 1; *Nichomachean Ethics*, VI, 3–6). Secondly, the possibility of applying mathematics to the investigation of material objects is presupposed. The requirement of explaining an object by giving the conditions, under which it would result with necessity, seemed at first to apply only to geometry.

An often cited example is that of the circle, which is not to be defined as the figure in which all lines drawn from the center to the periphery are equal. The correct constructive definition determines that the circle is a figure drawn by the moveable end point of a straight line whose other end is fixed. Cf. e.g., Spinoza, *Tractatus de Intellectus Emandatione*, *Opera* II, 34f.; cf. Hobbes, *De Corpore*, I, §5.

M. Wolff points out two reasons why the mechanical clock could appear especially suited as a model for the solar system. First, one could learn from the clock that a circular motion with a constant speed of revolution could be the result of an accelerated falling motion (of a weight) and of a resistance (escapement mechanism); secondly, the clock and the mill represent the first devices, in which a 'natural motion' (falling weight) replaces an 'artificial motion' (human labor). (Cf. Wolff, 242f.)

[27] From Leonardo Da Vinci to Galileo to Hooke and Huygens there is scarcely a scientist to be found who did not concern himself with some aspect of clock-making. Huygens' *Horologium Oscillatorium* (1673) is the classic example of the use of the (pendulum) clock as object of physical investigations. For Newton's use of pendulum experiments, cf. e.g., *Princ.* III, prop. vi, theor. vi; Cajori, 411; cf. also the remarks by Grossman, 212f.

[28] "The clock is the first automaton applied to practical purposes and the whole production of uniform motions was developed on it . . . . There is no doubt that in the 18th century the clock provided the first idea of applying automatons (driven by a spring) to production" (K. Marx to Engels, Jan. 28, 1863, MEW 30, 321). "Clockmaking was the first industry to put into practice the theoretical findings of physics and mechanics" (Cipolla, 134).

P. Mesnage gives the same judgment, 'The Building of Clocks', in: M. Daumas (ed.), *A History of Technology and Invention*, vol. II, Paris, 1964, 283–305, here: 290.

[29] The difference between the 'scientist's' and the 'artisan's' clock was used by Walter Charleton to elucidate his views on the size of atoms:

> Consider we, first, that an exquisite Artist will make the movement of a Watch, indicating the minute of the hour, the hour of the day, the day of the week, month, year, together with the age of the Moon, and the time of the Seas reciprocation; and all this in so small a compass, as to be decently worn in the pall of a ring: while a bungling Smith can hardly bring down the model of his grosser wheels and balance so low, as freely to perform their motions in the hollow of a Tower. If so; well may we allow the finer fingers of that grand Exemplar to all Artificers, Nature, to distinguish a greater multiplicity of parts in one Grain of *Millet seed*, then ruder man can in that great Mountain, *Caucasus*; nay, in the whole *Terrestrial Globe* (*Physiologia* etc., 1654, 114).

[30] The comparison of the process of scientific inquiry with the observation of the face of a clock or of its mechanical figures and the attempt to infer the hidden mechanism was used by a number of scientists in the 17th century. Robert Boyle, for example, wrote:

> Many Atomists and other Naturalists, presume to know the true and genuine causes of the things they attempt to explicate; yet very often the utmost they can attain to, in their explications, is, that the explicated phenomena may be produced after such a manner, as they deliver, but not that they really are so. For as an artificer can set all the wheels of a clock a going, as well with springs as with weights . . . so the same

> effects may be produced by diverse causes different from one another; and it will often times be very difficult, if not impossible, for our dim reasons to discern surely, which of those several ways, whereby it is possible for nature to produce the same phenomena, she has really made use of to exhibit them (*Works*, 1772, vol. II, 45).

The analogy with a mechanical puppet show was used by Fontenelle. Cf. *Entretien sur la pluralité des mondes* (*Oeuvres de Fontenelle*, vol. II, Paris, 1818, 10f.), quoted by Cassirer, *Philosophy of the Enlightenment*, p. 50.

The relationship between this analogy and the rejection of a dogmatic interpretation of scientific theories is stressed by Laurens Laudan, 'The Clock Metaphor and Probabilism: The impact of Descartes on English methodological thought, 1650–1665', *Annals of Science* **22** (1966), 73–104.

The analogy is even used by Infeld and Einstein:

> In our endeavor to understand reality we are somewhat like a man trying to understand the mechanism of a closed watch. He sees the face and the moving hands, even hears its ticking, but he has no way of opening the case (Infeld/Einstein, 31).

[31] *Phoronamus seu de Potentia et Legibus Naturae*. As far as I know, the work has not been published. Gerhardt published excerpts ('Zu Leibniz's Dynamik', *Arch. f. Gesch. d. Phil.* I (1888), 566–581), and Couturat published the preface, 590–593, here: 590.

With this work Leibniz hoped to induce the Catholic Church to allow the Copernican theory. The words of Descartes quoted above were also written with an eye to the censors. But both views cannot be interpreted only as attempts to outwit the censorship. Leibniz, for instance, also supported the same point of view in his letters to Huygens. Cf. GM II, 177, 184f., 199; PLP, 418, 419.

[32] "Et respondendum est eam Hypothesin eligendam esse, quae est intelligibilior; neque aliud esse veritatem Hypotheseos, quam ejus intelligibilitatem." "Ut proinde veram esse Hypothesin nil aliud sit, quam recte adhiberi" (Couturat, 591).

[33] The artisan origins of this conception of the analytic-synthetic procedure as well as the difference between the scientific and the artisan procedures had already been stressed by Bacon:

> But even in this kind (i.e., in bodies of uniform structure – G.F.), human industry has not been altogether wanting; for this is the very thing aimed at in the separation of bodies of uniform structure by means of distillations and other modes of analysis (*solutionum*); that the complex structure of the compound may be made apparent by bringing together its several homogeneous parts.

But since the structure (*schematismum*) of the compounded body is rather destroyed than known by an analysis, if follows:

> Therefore a separation and solution of bodies must be effected, not by fire indeed, but by reasoning and true induction, with experiments to aid; . . . we must pass from Vulcan to Minerva if we intend to bring to light the true textures and configurations (*Schematismos*) of bodies . . ." (N.O. II, 7). On this problem cf. also Lefèvre, 106–114.

[34] P.S. to a letter to Caroline on May 12, 1716 (Robinet, 76; Alexander, 54; first italics

mine). Leibniz often stressed the inexhaustible character of scientific knowledge. Cf. e.g., N.E. IV. 6, 4.

[35] An important contribution of Toulmin's is his insistence on the significance of the concept of absolute space for Newtonian physics, even though it takes the form: "Inertial frames of reference can actually be identified in Nature" (cf. esp. I, 25–29; II, 206, 220). With this he countered those historians (Burtt and above all Koyré) who represented Newton as a 'Cambridge Platonist', whereby it remained quite unclear, why Newton wrote the *Principia* and not the *Enchiridion Metaphysicum* of Henry More. In a paper published later, Westfall suggested that Newton needed the concept of absolute space above all to regain the "psychological security", which had disappeared with the 'shattering' of the finite medieval cosmos. The rather emphatically described anxiety which Newton must have felt (Westfall, 'Space,' 126) is 'supported' with a quotation from Pascal about his own anxiety.

As justified as Toulmin's critique is, he nonetheless follows the historians he criticizes, inasmuch as he neither analyzes the physical content of Newton's metaphysical-theological determinations nor takes into account the proof for the existence of empty space (vacuum). He is therefore compelled to correct Newton's formulations and then to clap a 'decorative theological superstructure' onto this – now scientifically satisfying – concept.

[36] H.-H. Borzeszkowski and R. Wahsner have stressed the role played by Voltaire for a mechanistic interpretation of mechanics, an interpretation which consists in the fact that "a distinction is made between active principles and matter" and that single particles are ascribed properties "which they can have only in relation to one another" (cf. *Newton und Voltaire*, (Berlin [GDR], 1980), 37f.). On this point my interpretation agrees with that of the authors; however, I do not share their view that Newton himself "did not found classical mechanics mechanistically" (*ibid.*, 40).

[37] Cf. the short sketch by Ernst Mach, 305–317; cf. also the extensive presentation by Alexander Gosztonyi, *Der Raum*, vol. I, 465ff.

[38] *Mechanics sive Motus Scientia Analytice Exposita*, Chapt. 1, (§56.

[39] Cf. Carl Neumann, *Die Prinzipien der Galilei-Newton Theorie*, Leipzig, 1870, 27f.; quoted by E. Cassirer in HS I, 220, fn. 158. Cf. the similar arguments of Clarke: 5th Reply §§26–32; and also Ernst Mach's critique of Neumann: Mach, 340.

PART TWO

[1] "The reason why, among men, an artificer is justly esteemed so much the more skilful, as the machine of his composing will continue longer to move regularly without any farther interposition of the workman; is because the skill of all human artificers consists only in composing, adjusting, or putting together certain movements, the principles of whose motion are altogether independent upon the artificer: such as are weights and springs, and the like; whose forces are not made, but only adjusted, by the workman. But with regard to God, the case is quite different; because he not only composes or puts things together, but is himself the author and continual preserver of their original forces or moving powers" (Clarke's First Reply, §4).

CHAPTER IV

[1] On the scholastic conception of the relation of element and system, cf. below, 115–122. On Hariot cf. Robert H. Kargon, *Atomism in England from Hariot to Newton*, Oxford University Press, 1966, 6–29.

[2] The following presentation is based on the early writings of Bacon:
(1) 'The Masculine Birth of Time' (before 1603), abbreviated: *Masc.*
(2) 'Thoughts and Conclusions' (shortly after 1603): *Thoughts.*
(3) *'Cognitationes de Natura Rerum'* (between 1603 and 1605): *Cogit.*
(4) 'The Refutation of Philosophies' (1608): *Refut.*
(5) *'De Principiis atque Originibus'* (around 1612): *De Princ.*
The works 1, 2, and 4 will be quoted from the English translation by Benjamin Farrington in: *The Philosophy of Francis Bacon. An Essay on its Development from 1603 to 1609*, Liverpool Univ. Press, 1964. The works 3 and 5 will be quoted from the English translation in J. Spedding: *The Works of Francis Bacon* (ed. J. Spedding, R. Ellis, and D. D. Heathe), London, 1861, Vol. V, 419–439, 461–500. On the interpretation cf. Farrington *op. cit.* and Paolo Rossi, *Francis Bacon. From Magic to Science*, London, 1968.

[3] "Inficitur autem intellectus humanus ex intuitu eorum quae in artibus mechanicis fiunt, in quibus corpora per compositiones aut separationes ut plurimum alterantur; ut cogitet simile quiddam etiam in natura rerum universali fieri. Unde fluxit commentum illud elementorum, atque illorum concursu, ad constituenda corpora naturalia . . .". The expression '. . . atque illorum concursu' is grammatically false: as Fowler remarks in a footnote to this passage, it can be taken either as *'atque concursus'* or as *'deque concursu'*. Both versions have the same sense.

[4] The *Regulae* will be cited according to the edition of Adam and Tannery vol. X; R denotes the rule, AR the appendix to the rule. Kemp Smith's translation in Descartes, *Philosophical Writings* has been consulted where possible.

The *Discours de la Méthode* will be quoted in the translation of F. E. Sutcliffe; citations are to part and paragraph, and to the page in the edition of Adam and Tannery Vol. VI.

The *Meditationes de Prima Philosophia* is quoted in the translation of F. E. Sutcliffe; citations are to part and paragraph, and to the page in the edition of Adam and Tannery Vol. VII.

The *Principia Philosophiae* will be quoted according to the translation of V. R. and R. P. Miller, René Descartes, *Principles of Philosophy*, Dordrecht, 1983; citations are to part and paragraph.

[5] The distinction between extension and the extended, or more precisely: the assumption that space (extension) could exist if there were nothing extended arises from a "misjudgement of the understanding" (R 14, 8: 442f.; cf. R 14, 18). Extension is one of those "entities which have their being only in something else and which can never be conceived without a subject" (R 14, 11: 444).

[6] Cf. *Princ. Phil.* II, 4. Descartes attempt to arrive at extension as the only determination of material body by abstraction (*Med.* II, 16) is not convincing. There is no reason why, from the differing resistance of bodies, it should be concluded that resistance is not a property of body. One of Descartes' achievements consisted precisely in introducing such general concepts for supposedly contradictory opposites. From the fact that a body

can rest or be in motion, Descartes formed the concept of 'state of motion'. Descartes is obviously endeavoring to admit only such properties as can be represented geometrically. He is thus later on compelled to introduce the concept 'soliditas' without justification (*Princ. Phil.* II, 121). On this problem, cf. Lasswitz, vol. II, 97f.

[7] In November of 1635, Descartes learned of the condemnation of Galileo and of the Church's prohibition on teaching the motion of the earth. He thereupon suppressed *Le Monde*, the work which was supposed to prove this theory. He then wrote the essay, which later appeared under the title, *'Discours de la Méthode'*, in which he briefly reported the contents of *Le Monde* (5th Discourse) in order to move those who were interested in his physics to bring about a change in the situation which prevented him from publishing the earlier work (cf. Letter to Mersenne, April 27, 1637, AT I, 368). If his method were to be accepted, he remarked, he would have no fear that the principles of his physics might be badly received (AT I, 370).

Four years later Descartes published his *Meditations*, which "contain all the foundations of my physics". He hoped, "that those who read them will accustom themselves insensibly to my principles and recognize their truth before perceiving that they destroy those of Aristotle" (Letter to Mersenne, Jan. 28, 1641, AT III, 297f.). Descartes expressed his intentions most clearly when he conceived the plan to have his *Principia* published together with a traditional syllabus of physics by a scholastic author, so that everyone could compare the two and learn contempt for the school philosophy (cf. Letter to Mersenne, Dec., 1640, AT III, 259f.).

This achievement of Descartes was recognized early: "We need not be surprised then that the Cartesian Philosophy (for Des-Cartes was in reality the first who attempted this [i.e., the Newtonian] method) tho it does not perhaps contain a word of truth", was universally received by the scholars of Europe, wrote Adam Smith. "The Great superiority of the method over that of Aristotle" as well as the low state of knowledge induced scholars to accept Cartesianism eagerly (*Lectures on Rhetoric and Belles Lettres*, 146).

The "unified world view" of Descartes, wrote Lasswitz, "gave proof that mechanism was in a position to provide a unified explanation of the world, such as only substantial forms had hitherto achieved" (Col. II, 125). Cf. Dijksterhuis, 456f. and Burtt, 105.

[8] The introduction of the Aristotelian concept of place – "the boundary between the surrounding and the surrounded bodies" (*Princ. Phil.* II, 15; cf. Aristotle, *Physics* IV, 2, 209b, 1; IV, 4, 210b, 34) – so that he could assert the 'rest' of the earth (*Princ. Phil.* II, 62; III, 26, 29), is apologetic in character. In the *Regulae* Descartes rejects this concept as an example of the misuse of words (R 12, 23: 426; R 13, 5, 433), and he employs it here only to avoid the charge of heresy. In his objections to the *Meditations* Arnauld wrote that Descartes' theory of matter contradicts "what the Church teaches about the sacrosanct mysteries of the altar. For according to the faith, we believe that, the substance of the bread having been removed from the Eucharistic bread, only the accidents of the same remain" (*Med.*, 217) "Yet the author denies that these faculties can be conceived without any substance in which they inhere" (217–218).

In his reply Descartes maintains that sense perception arises through contact, but only the surface of a body is in touched. This surface is, however, not a part of the substance but only "that boundary which is conceived to be located between the individual particles and the bodies surrounding them and which does not at all have real being but only modal" (AT VII, 251). If one says that "the substance of bread and wine are thus changed into the substance of some other thing in such a way that this new substance

is truly contained within the same boundaries within which the others formerly were, or exists in precisely the same place . . . ," then it necessarily follows, "that this new substance must affect our senses in just the same manner as bread and wine would affect them if no transsubstantiation had occured" (251). Cf. furthermore: Letter to Pater Vatier, Feb. 22, 1638, (AT I, 564f.); Letters to Pater Mesland, May 2, 1644 (?) (AT IV, 119f.), Feb. 9, 1645 (?) (AT IV, 162ff.), and 1645 or 1646 (AT IV, 346ff.).

Let it be remembered that Descartes' *Principia Philosophiae* was put on the Index because his theory of matter oculd not be reconciled with the dogma of transsubstantiation.

Cassirer, who maintains that with the concept of *'locus externus'* Descartes "essentially did not advance beyond Aristotle" (*Leibniz*, 50), overlooks the context in which the concept is used.

[9] Cartesian space, "which contains only celestial matter, offers no resistance to the motion of a body made of tertiary matter and behaves just like a vacuum in relation to this motion" (Dijksterhuis, 466). On the agreement between Descartes and the atomists as far as their results are concerned, cf. Lasswitz, II, 55–80.

CHAPTER V

[1] The particular divisions, which philosophers in the 17th century introduced vary from one to the next, but this general division is common to them all. Bacon determines as the subject matter of philosophy (in addition to *philosophia prima*, the "universal science, mother to the rest"): God, nature, man (*De Dignitate et Augmentis Scientiarum*, III, 1). The systematic position of 'natural theology' varies from author to author; however, the division into nature and man is used by others too (cf. Descartes, *Princ. Phil.*, Preface; Hobbes, *De Corpore* I, i, 8).

[2] I want to emphasize explicitly that the use of a hint from Leibniz in choosing the object for investigation by no means implies an unsupported acceptance of his interpretation. The purpose is merely to find a convenient starting point; in the following we shall see whether the results also apply to other philosophers. Furthermore it is to be supposed that Leibniz rather means Locke than Hobbes; his critique of the 'idol' of some modern Englishmen, as far as the interpretation of the analytic-synthetic method and the resulting theory of space are concerned, applies to the same extent to both Hobbes and Locke.

[3] *De Corp.* I, i, 9; cf. the division of philosophy in the table at the end of the 9th chapter of *Leviathan.*

[4] Hobbes discusses the first way in *De Corpore* I, 1, 9; the sequence is thus: physics, ethics, politics. He takes up the second way in *Leviathan*. The saying, "*Nosce teipsum, Read thy self*," teaches us according to Hobbes, that "whosoever looketh into himself, and considereth what he doth, when he does *think, opine, reason, hope, feare*, etc., and upon what grounds; he shall thereby read and know, what are the thoughts, and Passions of all other men, upon the like occasions. I say the similitude of *Passions*, which are the same in all men . . ." (*Leviathan*, Preface, 82f.).

[5] The question, whether the struggle for power presupposes that all or only a few have a striving for limitless power, is discussed at length by Macpherson, 42–46.

[6] It is unimportant here, whether Hobbes considered the 'state of nature' (on his use of

the concept, cf. Macpherson, 25–26) as a hypothetical constuct or as an historical condition (The latter possibility was by no means excluded. Cf. *Lev.*, Ch. 13, 187; and the addition to the Latin edition). In the same manner, it changes nothing in his formulation of the law of inertia, whether he believed that the world was once really empty and only contained a single body which perservered in its state of motion.

CHAPTER VI

[1] *Discours sur l'origine et les fondements de l'inégalité parmi les hommes, Oeuvres Complètes* III, 132.

[2] It is in this context that Rousseau's assertion is to be seen, that the origin of society is due to a series of accidental external circumstances and thus was not necessary; cf. 162.

In the 'Letter to Philopolis' Rousseau relativizes the accidental character of socialization. He maintains that society arose "with the help of certain external circumstances," which could have occurred or not occurred, or at least could have occurred earlier of later (*Oeuvres* III, 232f.). Rousseau's entire argument is directed to proving that the socialization does not arise from any necessity in human nature.

[3] On the occasion of the question of whether man is by nature a two-legged of a four-legged creature, Rousseau writes that it does not suffice merely to show the possibility (that man developed from a four-legged to a two-legged creature): "one must . . . at least show the probability (*vraisemblance*)" (*Discours*, 197 n. 3). The reasons why he does not abide by this rule in the present argument will be discussed later.

[4] "The great Montesquieu," wrote John Millar, "pointed out the road. He was the Lord Bacon of this branch of philosophy ['philosophical history' – G.F.]. Dr Smith is the Newton" (quoted by Skinner, Introduction, 30).

"We say, in the same manner, of a hero," wrote Adam Smith, "that he is an Alexander; of an orator, that he is a Cicero; of a philosopher, that he is a Newton" (*Considerations*, 204).

[5] LRBL, Jan. 24, 1763: 145–146; my italics.

Cf. also Smith's judgment on Newton's scientific achievements in HA: Newton not only achieved "the greatest and most admirable improvement that was ever made in philosophy, when he discovered, that he could join the movements of the Planets by so familiar a principle of connection" (98), he also calculated with greater precision the force with which the earth and the moon gravitate towards each other (99–100), and that the earth must be flattened at the poles (101). Only Newton's theory describes the "real chains which Nature makes use of to bind together her several operations" (105).

The number of studies on Smith's method is probably due to his recognition as a scientist. Some of the more recent of these are those by Bittermann, Becker, Thompson, Lindgren, and Campbell (part I). None of these authors take up Smith's use of the analytic-synthetic method. This method is discussed by Wilhelm Hasbach, *Die allgemeinen philosophischen Grundlagen der von F. Quesnay und A. Smith begründeten politischen Ökonomie*, Leipzig, 1890, 126–160; and *Untersuchungen über Adam Smith und die Entwicklung der politischen Ökonomie*, Leipzig, 1891, 339–412. He does not, however, touch on the problems discussed in the following.

[6] Cf. TMS VII.iii.i.2; cf. the analogy with a watch: TMS II.ii.3.5.

[7] Cf. WN I.ii.1; ED, 570f.; LJ(A), 347f.
[8] Cf. WN I.ii.4–5; ED, 573.
[9] WN I.ii.1. This propensity, Smith adds at the same place, is "common to all men, and to be found in no other race of animals, which seem to know neither this nor any other species of contracts." The same is said in ED, 570f.

In WN Smith does not want to commit himself to a decision whether the "propensity in human nature . . . to truck, barter, and exchange one thing for another" is "one of those original principles in human nature, of which no further account can be given; or whether, as seems more probable, it be the necessary consequence of the faculties of reason and speech" (WN I.ii.2).

In his *Lectures on Jurisprudence* (1766) Smith tries to suggest as the "foundation" of the propensity to barter "that principle to perswade which so much prevails in human nature." "We ought then mainly to cultivate the power of perswasion, and indeed we do so without intending it. Since a whole life is spent in the exercise of it, a ready method of bargaining with each other must undoubtedly be attained" (LJ(B), 493f.).

The attempt to subsume the 'propensity to barter' under a more comprehensive property while at the same time not determining man as a 'rational creature' has the result, that the faculty of reason and speech, which was intended as a more general determination, is determined merely as the ability to bargain and thus, although it is not a propensity but a power, it has the same determinate content.

Smith alludes directly to the traditional definition of man as a member of the genus 'creature' within which he is determined by the specific difference 'rational', when he distinguishes man from other animals only by his ability or propensity to barter and when he concludes that in spite of the great difference between the 'tribes' of the same species of animal each individual animal – due to the lack of the propensity to trade – "is still obliged to support and defend itself, separately and independently, and derives no sort of advantage from that variety of talents with which nature has distinguished its fellows" (WN I.ii.5).

[10] *Zur Kritik der politischen Ökonomie* (1859), Ch. 1; MEW 13, 45.
[11] TMS II.i.1.2; cf. II.i.5.10; II.ii.3.5–10.
[12] The original and the derivative principles of human nature are developed in direct analogy to the theory of the primary and secondary qualities of bodies in contemporary natural science. Original properties of man are those which belong to him independently of every society; secondary properties depend on social life; for this distinction, the hypothetical sssumption or an unsocial condition is indispensible. Cf. Campbell, 80 and 67f.
[13] Smith refers in many places to the original autarchic existence of individual men. His remarks on the necessity of social life always refer to 'civilized society' (cf. e.g., ED, 562). In the 'rude state of society', however, man is autarchic and needs no society:

> Every man endeavours to supply by his own industry his own occasional wants as they occur. When he is hungry, he goes to th forest to hunt; when his coat is worn out, he cloaths himself with the skin of the first large animal he kills: and when his hut begins to go to ruin, he repairs it, as well as he can, with the trees and the turf that are nearest it (WN II, Introd. 1–2; cf. ED, 563).

Based on the assumed autarchy in the rude state of society, Smith can hypothetically presuppose an isolated existence of men, in order, for instance, to explain the origin

of language and of moral consciousness. Cf. on this: *Considerations*, 203; TMS II.i.3; IV.1.8.

In light of this fundamental agreement between Smith and Rousseau, it is scarcely surprising that Smith, in a long review of the *Discours sur l'inégalité,* begins his translation of central passages with that section in which Rousseau grounds the independence of men from one another in the earliest social state by asserting that everyone supported himself and no one was dependent on the division of labor in society. Cf. 'A Letter to the Authors of the Edinburgh Review', *Works*, Vol. 3, 251f. The passage from Rousseau's *Discours* is to be found in *Oeuvres* III, 171.

CHAPTER VII

[1] To my knowledge Newton made no attempt to carry out this program. In his opinion a direct analogy between the 'natural' and the 'political' world underlies the 'mystical language'; this analogy serves him as a guide to interpreting the Bible but not to pursuing physical research.

> I received also much light in this search [of the Scriptures – G.F.] by the analogy between the world natural and the world politic. For the mystical language was founded in this analogy, and will be best understood by considering its original.
>
> The whole world natural consisting of heaven and earth signifies the whole world politic consisting of thrones and people, or so much of it as is considered in the prophecy; and the things in that world signify the analogous things in this. For the Heavens with the things therein signify thrones and dignities and those that enjoy them, and the earth with all the things therein the inferior people, and the lowest parts of the earth, called Hades or Hell, the lowest and most miserable part of people (*Sir Isaac Newton Theological Manuscripts*, (H. McLachlan, ed.) Liverpool, 1950, 120).

[2] Here, Rousseau uses the analogy with the machine: "Ainsi la volonté du peuple, et la volonté du Prince, et la force publique de l'Etat, et la force particulière du Gouvernement, tout répond au même mobile, tous les ressorts de la machine sont dans la même main, tout marche au même but, il n'y a point de mouvements opposés qui s'entredétruisent, et l'on ne peut imaginer aucune sorte de constitution dans laquelle un moindre effort produise une action plus considérable. Archimède assis tranquillement sur le rivage et tirant sans peine à flot un grand Vaisseau, me représente un monarque habile gouvernant de son cabinet ses vastes Etats, et faisant tout mouvoir en paraissant immobile" (C.S. III. 6, 408).

[3] Drawing both determinations together, Spinoza determines the limits within which the state can demand the obedience of the individual:

> If, for instance, I say that I can rightfully do what I will with this table, I do not certainly mean, that I have the right to make it eat grass. So, too, though we say, that men depend not on themselves, but on the commonwealth, we do not mean, that men lose their human nature and put on another; nor yet that the commonwealth has the right to make men wish for this or that, or (what is just as impossible) regard with honour things which excite ridicule or disgust (*Tractatus Politicus*, IV, 4).

[4] "Equality and freedom are thus not only respected in exchange based on exchange values, but, also, the exchange of exchange values is the productive, real basis of all *equality* and *freedom*. As pure ideas they are merely the idealized expressions of this basis; as developed in juridical, political social relations, they are merely this basis to a higher power" (Marx, *Grundrisse*, 156; Engl., 245; cf. the argument, 152–156).

[5] This notion found its classical representation in the figure of the autarchic Robinson Crusoe living on his island in Defoe's novel; it is hardly surprising that Rousseau prescribes this as the first book that Émile is to read and that it for a long time is to constitute his only reading (cf. *Émile ou sur l'éducation*, III, 5).

[6] Christopher Hill, 'Hobbes and the Revolution in Political Thought', in: *Puritanism and Revolution*, London (Panther Books), 1969, 267–288; here: 268.

[7] On Hobbes's study of Aristotle's philosophy cf. *Opera Latina*, I, xiii and lxxxvi. On his attack on Bellarmine, cf. *Leviathan*, Ch. 42. That a principle of the relation of element and system much different from that of Hobbes underlies these theories will be shown below.

[8] Newton, too, was instructed in Aristotelian philosophy, and he developed his own theory above all in contention with the Cartesian theory (cf. *De Gravitatione*).

CHAPTER VIII

[1] Christopher Hill, 'Thomas Hobbes and the Revolution in Political Thought', in: Hill, *Puritanism and Revolution*, London, 1969, 267–288; here: 267.

[2] The common interest of the bourgeoisie and feudal nobility (though based on contrary motives) in the absolutist monarchy, the fostering of bourgeois interests by progressive absolutism, and the growing community of interest between the absolutist monarchy and feudal nobility as the power of the bourgeoisie increased are cogently presented by F. Tomberg, *Polis und Nationalistaat* (Darmstadt and Neuwied, 1973), pp. 169–175.

A characterization of absolutism in several European countries is given by L. Kofler, *Zur Geschichte der bürgerlichen Gesellschaft*. On English absolutism, cf. 153–163, 400ff.

The peculiarity of English absolutism – the absence of its own burocracy and standing army (cf. A. Meusel, 'Aus der Vorgeschichte der bürgerlichen Revolution in England'; and Christopher Hill, *The Century of Revolution 1603–1714*, Part I, passim) – led to a much greater dependence on the classes supporting it than was, for instance, the case in France. This difference is well illustrated by the fact, that the King of France was able to rule from 1614 to the Revolution without summoning the parliament, while Charles I managed to rule only eleven years (1629–1640) alone.

On the progressive character of the Tudor monarchy (with the exception of the later years of the reign of Elizabeth), historians are, as far as I can see, in agreement. From the point of view of the bourgeoisie, its achievement consisted above all in developing England into a nation state: in overcoming the feudal division of the land by preventing private wars of the feudal lords (after the greatest feudal families had wiped each other out in the War of the Roses) and in standardizing laws, weights, and measures; furthermore, it dissolved the ties to Rome and confiscated part of Church property to the advantage of the King and of those who could afford to buy the estates. In the present connection, only those developments are of importance which compelled the bourgeoisie to turn against the absolutism of the Stuart kings.

The following presentation lays of course no claim to being a social history of pre-revolutionary England; its purpose is rather to highlight the development of those characteristics, which are decisive for my interpretation of the social theories. The reason for the detailed account of some points is not that social theories are in general determined by the events of the day but rather that in a revolutionary period processes occur in short spaces of time, which otherwise can only be observed in the course of decades. In presentation and interpretation I follow Christopher Hill; references are given only where Hill is directly quoted.

[3] In the "expropriation of the agricultural producers, of the peasants from the soil" (*Capital 1*, 716; MEW 23, 744), Marx saw the basis for the development of capitalist relations of production. Two things are necessary if the capital relation is to be developed on the basis of commodity production:

> two very different kinds of commodity-possessors must come face to face and into contact; on the one hand, the owners of money, means of production, means of subsistence, who are eager to increase the sum of values they possess, by buying other people's labour-power; on the other hand, free labourers, the sellers of their own labour-power, and therefore the sellers of labour. Free labourers, in the double sense that neither they themselves form part and parcel of the means of production, as in the case of slaves, bondsmen, etc., nor do the means of production belong to them, as in the case of peasant-proprietors; they are, therefore, free from, unencumbered by, any means of production of their own .... The process, therefore, that clears the way for the capitalist system, can be none other than the process which takes away from the labourer the possession of his means of production; a process that transforms, on the one hand, the social means of subsistence and of production into capital, on the other, the immediate producers into wage-labourers (*Capital 1*, 714; MEW 23, 742; on the course of this process in England, cf. *ibid.*, Chapt. 26–32 *passim*).

[4] "Fear of possible seduction of the lower orders into social and political heresy underlay the paranoiac opposition to religious toleration in the sixteen-forties. Both Charles I and the Parliamentary leaders expected this social anxiety to bring the other side to accept their terms in the Civil War. We shall often misinterpret men's thoughts and actions if we do not continually remind ourselves of this background of potential unrest" (Hill, *Century*, 34).

[5] "Monopolies were the most uneconomical form of taxation. It has been estimated that whereas every 6*s*. charged to the consumer by the Customs brought 5*s*. into the Exchequer, 6*s*. increased cost to the consumer in monopolies brought about 10*d*. into the Exchequer. The rest went to the privileged group of Court parasites, who fulfilled no productive function themselves and were an enormous drag on full development of the productive capacities of the country" (Hill, *The English Revolution 1640*, 37).

[6] Hill, 'The Preaching of the Word,' in: *Society and Puritanism*, 37f. On the controversy over sermons, cf. also 'The Ratsbane of Lecturing', in *op. cit.* 78–120.

[7] Quoted by Hill, *Century*, 156. Hill explains the lack of a bourgeois theory of sovereignty by a "remarkable stop in the mind" of the parliamentary leaders (cf. *op. cit.* 62f.). Such an assumption seems to me neither necessary nor convincing.

[8] On Macpherson's use of models, cf. Macpherson, 46–70. A general critique of this methodological failing cannot be given here. I refer the reader to the discussion of the

same failing in Zilsel's work on the social history of the natural sciences: G. Freudenthal and H. O. Riethus review of E. Zilsel, *Die soziale Ursprünge der neuzeitlichen Wissenschaft*, in *Argument, 103*, 395–397.

CHAPTER IX

[1] "Non esse definiendas propositiones extra S. Thomam, nisi paucissimas easque solum ratione securitatis" (1592); quoted by F. X. Arnold, *Die Staatslehre des Kardinal Bellarmin*, Munich, 1934, p. 10, cf. 25.

[2] Doubtless, this procedure is problematical; scholastic natural philosophy is by no means so uniform as it appeared to the authors of the 17th century, and between Aquinas and Suarez, for instance, there exist considerable differences. But it is impossible within the framework of this study to undertake an analysis of the numerous late scholastic writings on metaphysics and natural philosophy, especially since the area to my knowledge has been so little studied. A still unsurpassed basic presentation is given by Karl Werner, *Thomas von Aquino*, and *Franz Suarez und die Scholastik der letzten Jahrhunderte*.

The blanket judgement of 'Aristotelians' and 'scholastics' by Descartes, Bacon, and Hobbes is however not groundless; at least the basic principle on the relation of system and element is to my knowledge essentially the same for Thomas and subsequent Thomists.

This principle permeates the entire work of Thomas and can only be discussed here on particular points; references to teleology and theology had not been attempted. The reader is referred to Werner, *Thomas von Aquino*, Vol. II, whom the sketch given here follows in all essential points.

[3] "In loco non est tantum continentia locati, sed est ibi virtus conservans et formans locatum" (*De Natura Loci*; cf. *De Generatione et Corruptione* II.1.3).

Thomas accepted Aristotle's definition of place as the inner boundary between the surrounding body and the body surrounded (cf. *Physics*, 209b 1ff.). The requirement that place be immovable (for otherwise no determination of motion would be possible) leads to the concept of general place (*topos koinos, Physics*, 209a 32). The general place is determined by two points of reference: by the center of the earth and by an arbitrary point on the celestial sphere. The motion of a body to its 'natural place' is determined by the geometrical frame of reference and not by the fact that the earth is in the middle and the celestial bodies form the surroundings (cf. *De Caelo*, 296b 9ff.).

A connection of the 'contained' with the 'container' is furthermore made by Thomas between God's omnipresence and his preservation of the world (cf. *Summa Theologica*, I, Qu. 8). From this arises the difficulty of distinguishing presence from the falling up of space, which today still occupies scholastic philosophers. Cf. e.g., G. Ludwig, *Raum und Zeit*, pp. 7–16.

On the space theory of Aquinas, cf. P. Duhem, *Le Système du Monde*, Paris, 1956, Vol. VII, 167–178.

[4] "Diversae rerum species gradatim naturam entis possident. Ratio determinatae speciei consistit in hoc, quod natura communis in determinato entis gradu collocatur" (*Summa contra Gentiles*, II, c. 95; cf. Werner, *Thomas*, Vol. II, 193ff.).

[5] Werner, Thomas, Vol. II, 461f.; cf. the citations on pp. 288ff., 252, 245; cf. further *De Regimine Principum*, Bk. I, Ch. 2, 3, and 12.

[6] The circumstance that God contains the entire world brings with it the following difficulty: if God encompasses the entire world, then the hierarchy, in which God's place is 'on top' cannot be imagined or represented pictorially. In medieval art various attempts were made to solve the problem. Cf. Hans Leisegang, *Dante und das christliche Weltbild, Schriften der Deutschen Dantegesellschaft*, No. 6, Weimar, 1941.

[7] Cf. *Summa Theologica*, I.ii., Qu. 91a. 3. The following presentation is based on Aquinas' work, *De Regimine Principum*.

A classical presentation embracing authors of the 11th to 15th centuries is given by Otto Gierke, *Das deutsche Genossenschaftsrecht*, Vol. III, Berlin, 1881, §11: "Die publicistischen Lehren des MA", 501–644; cf. also Ernst Troeltsch, *Die Soziallehren der christlichen Kirchen und Gruppen*, Tübingen, 1922 (*Gesammelte Schriften*, Vol. I) (Reprint: Aalen 1977), 252–358.

[8] Cf. Gierke, 514–516, who also points out the relationship to natural philosophy. Troeltsch sees the 'basic pattern' of medieval social doctrine as a synthesis of 'organism' and 'patriarchalism': "The powerful hierarchical expansion of the Church in the middle ages with its ranks of clerics, monks, and laity, whereby the clergy in turn is extraordinarily finely divided in levels, unites with the simultaneous hierarchichal structure of social life in the thought of an organism structured in ranks and groups" (Troeltsch, 297).

[9] Cf. Gierke, 518.

[10] "Tota ecclesia dicitur unum corpus mysticum per similitudinem ad naturale corpus humanum" (*Summa Theol.*, III, Qu. 8; cf. Gierke, 550f.).

The necessity of a hierarchy is derived from this comparison for the Church as for every social organism; in this case the relationship dealt with is that of Pope, bishop, priest, each of which is to be seen as the head of an organism. Cf. the citations in Gierke, 560ff.

The notion of the Church as the body of Christ goes back to Paul; cf. Romans 12, 4–6; Corinthians 1, 12–31. On the reception of this conception in the theory of the state in the Middle Ages, cf. Gierke, 517f., 546ff.

[11] "Potestas saecularis subditur spirituali, sicut corpus animae" (*Summa Theol.*, II.i, Qu. 60a.6 ad 3; Gierke, 527–529). Kings are even taken as vassals of the Church: *Quaestiones de Quodlibet*, 12q, 13a, 19 ad 2; cf. Gierke, 529.

[12] Franz Xaver Arnold, *Die Staatslehre des Kardinal Bellarmin*, Munich, 1934, p. 7.

On the historical course of the controversies in the 17th century and on the writings published, cf. Werner, *Suarez*, vol. I, 40ff., 61, and 12f.

[13] *Epistola Apologetica*, quoted by Arnold 91; cf. also 86. Sixtus V even put Bellarmine on the Index; Urban VII repealed the prohibition in 1590 (Arnold, 12). Arnold gives a survey of the controversies in politics and theory (296–324).

[14] Arnold, 349f. *De Summo Pontifice*, I.5, Ch. 6; *De Potestate Summi Pontificis* . . . , Ch. 5; cf. Arnold, 98–100, where Bellarmine's conception, that the relation of state and Church is analogous to the subordination of the body to the soul, is cited.

[15] March 21, 1610; quoted by Kenyon, 12f.

[16] This development includes the nobility. Under Henry VII there were only 29 peers; at the beginning of the reign of James I there were about 60, and in 1640 – as a result of extensive sales of titles – already 140.

[17] Cf. Ch. 22, where Hobbes demands, among other things, the prohibition of 'corporations' which serve a foreign authority and spread forbidden doctrines, of 'leagues' for defense, of religious leagues (papists, Protestants), and of political 'factions' (like the patricians and plebians of ancient Rome).

[18] This was precisely formulated by Feuerbach:

> In the supreme state power the entire effusive plenty of unlimited natural right is still thrown together and piled up uncurtailed, but just because of this piling up at one point, the right of the people, of those subjected to state power, is only the meager remnant, the puny, pitiful remains of what is left over of the originally unlimited sphere of right now restricted by the state; so that the state appears, on the one hand, as opposed to the state of nature but, on the other, hand, is not qualitatively different from it; it does not transpose men to a standpoint which is in concept and content qualitatively and specifically different from the state of nature, to an ethical and intellectual level, but rather appears only as a *limited state of nature*" (Feuerbach, Vol. II, 126).

> Pîibram concretizes one aspect: "While the territorial state in its own interest destroys the compulsory associations within it and guarantees the individual an ever more extensive economic and commercial freedom, at the same time as it broke the firm pillars which the medieval economic system possessed, it also broke the spirit of collectivism. It isolated the individual, who now faced the state without any mediating links between them. With this, the state itself aided the formation of a free, conscious, and responsible personality and thus undercut the foundations of its omnipotence" (Karl Pîibram, *Die Entstehung der individualistischen Sozialphilosophie*, Leipzig, 1912, 41f.).

> Julius Lips goes so far as to say: "the development of real English politics, grounded in the person of Cromwell, had such eminant points of contact with the doctrine of Hobbes, that the still remaining differences are no longer fundamental but rather only gradual" (*Die Stellung des Thomas Hobbes zu den politischen Parteien der großen englischen Revolution*, Leipzig, 1927 (Reprint: Darmstadt, 1970), 75; cf. the discussion, 75–96).

[19] The autarchy of man in the economic sense is directly asserted by Hobbes: "for infants have need of others to help them live, and those of riper years to help them live *well*" (*De Cive*, I, 2, 75; *Works* II, p. 2, n.; cf. *Leviathan*, Ch. 13, 188).

[20] After Hobbes had represented the equality of men as natural, that is, as the equality of individuals of the same species, it became necessary for him to keep the sociality of men from appearing to be a species property. Thus Hobbes polemicizes against the Aristotelian determination of man as a social being and endeavors to point out the differences between man and socially living animals – ants and bees serve as examples (Ch. 17). One of the differences mentioned is that "the agreement of these creatures is Naturall; that of men is by Covenant only, which is Artificiall" (Ch. 17, 226); with this Hobbes comes close to Smith's definition of man as a contract-making animal.

[21] Hobbes employs the analogy between the parts of the human body and the functions of state officials (Ch. 23) not the parts and members of the social body in general. It is not the social body that needs a head but the ministers –and only they fulfill for the sovereign the function of organs in the human body, and they do this only in their quality as ministers: their interests as private persons remain unaffected (Ch. 23, 289). Hobbes holds fast to the difference 'of great importance' from a natural body, that the ministers, the parts, can turn against the interests of the sovereign (Ch. 25, 306f.).

[22] Laws are not made by tradition (Ch. 26, 313f.), nor by customs (315), and precedents

do not create right (323f.); the contract laws are determined by the sovereign (Ch. 24, 293). The definition of injustice is non-fulfillment of a contract (Ch. 15, 202).

[23] "Further, seeing it is not enough to the Sustentation of a Common-wealth, that every man have a propriety in a portion of Land, or in some few commodities, or a naturall property in some usefull art, and there is no art in the world, but is necessary either for the being, or well being almost of every particular man; it is necessary, that men distribute that which they can spare, and transferre their propriety therein, mutually one to another, by exchange, and mutuall contract" (Ch. 24, 299).

Macpherson bases his view, that Hobbes took "for granted" "the normality of the wage relationship", on a passage in which Hobbes discusses the importing of foreign goods "by Exchange, or by just Warre, or by Labour" and grounds this last possibility, saying: "for a mans Labour also, is a commodity exchangeable for benefit, as well as any other thing" (Ch. 24, 295). Macpherson however does not quote the next sentence: "And there have been Common-wealths that having no more Territory, than hath served them for habitation, have neverthelesse, not onely maintained, but also encreased their Power, partly by the *labour of trading* from one place to another, and partly by selling the Manifactures, whereof the Materials were brought in from other places" (*ibid.*). The labor which can be exchanged with benefit like any other commodity is, on the one hand, trading and, on the other, the labor embodied in the product independently of whether it was done by an independent producer or a wage laborer. Hobbes nowhere speaks of wages, that is, from the sale of labor power for a period of time.

[24] Hobbes's intention of representing contractual relations as universally valid even led him to interpret the labor of extracting raw materials as a contract between God and man: God sells man commodities for labor (cf. Ch. 23, 294).

CHAPTER X

[1] The following remarks do not of course provide an account of the course of the English Revolution, rather they are intended to adumbrate the background of the later social theories. Thus, stress will be placed on the different political consequences that could be drawn from the same conception of civil society as a society of free commodity possessors.

[2] The exclusion of Royalist from the right to vote – at least for a few years – was not in dispute at Putney. Cf. Macpherson, 122, fn. 3. On the exclusion of criminals, cf. 124.

The necessity of demanding equal civil rights for all is based on the simple fact that otherwise no one can be sure of his own rights. Cf. Lilburne's argument, *ibid.* 143. The following remarks are based on Macpherson's analysis, *ibid.* 107–159, although somewhat different conclusions are drawn.

[3] Quoted by Macpherson, 123; my italics. Onthe exclusion of minors cf. *ibid.* 124; on the exclusion of women cf. *ibid.* Note 'I', 296. The exclusion of servants does not stand in contradiction to the natural freedom of all men, because servants have voluntarily given up their freedom. At the time of the debate, however, it could not seem compelling to assume that servants had alienated their free wills, in as much as many of the soldiers had formerly been 'dependents' in civilian life. Thus, for the Levellers all free and independent civilians as well as all who had fought in the parliamentary army were to have right to vote. Cf. *ibid.*, Note 'K', 297. The problem of the soldiers' right to vote had only temporary significance.

[4] Quoted by H. N. Brailsford: *The Levellers and the English Revolution* (ed. Christopher Hill), Manchester 1976, 573.

[5] "The votes which they [the Levellers – G.F.] proposed to confer on the copyholders would be useless, unless the tenants were first of all emancipated from the pressure to which their landlords could subject them . . . .

"The obvious solution was to turn the copyhold into a peasant owner, a yeoman in the proper sense of that word. The clearest statement of it is to be found in *A New Engagement or Manifesto*, claiming to speak for 'many thousands' in London and the counties round about which seems (. . .) to have been drafted just as the second Civil War was breaking out. It proposed (§16):

> that the ancient and almost antiquated badge of slavery, *viz.* all base tenures by copies, oaths of fealty, homage, fines at the will of the lord, etc. (. . .) may be taken away; and to that end that a certain valuable rate be set, at which all possessors of lands so holden may purchase themselves freeholders, and in case any shall not be willing or able, that there be a prefixed period of time after which all services, fines, customs, etc. shall be changed into and become a certain rent, that so persons disaffected to the freedom and welfare of the nation may not have the advantage upon the people to draw them into a war against themselves upon any occasion by virtue of an awe upon them in such dependent tenures" (Brailsford, 440).

[6] Macpherson stresses that independence presupposed the possession of means of production (in his terminology: 'capital'). Cf. *op. cit.*, 149f. But since he considers only the Leveller texts on the franchise and abstracts from their practical struggle against enclosures, he characterizes them as 'radical liberals' rather than 'radical democrats' (cf. *ibid.*, 110, 158). His interpretation implies that the Levellers would have been willing to exclude most of their supporters – the copy holders and small masters and journeymen – from the franchise.

The connection between political program and determination of the natural rights of man is clearly stated by Overton:

> For by naturall birth, all men are equally and alike borne to like propriety, liberty, and freedome, and as we are delivered of God by the hand of nature into this world, every one with a naturall, innate freedome and propriety (. . .) even so are we to live, every one equally and alike to enjoy his Birth-right and priviledge; even all whereof God by nature hath made him free. . . . and no further: and no more [of the natural powers of each man – G.F.] may be communicated then stand for the better being weale, or safety thereof . . . he that gives more sins against his owne flesh; and he that takes more, is a Thiefe and Robber to his kind . . . (*ibid.*, 140).

[7] For this and the following, cf. Hill, 'The Agrarian Legislation of the Revolution', in: *Puritanism and Revolution*, 154–193. In this paper Hill summarizes the results of a Soviet scholar, S. I. Arkhangelsky, *Agrarnoye Zakonodatelstvo Velikoy Angliyskoy Revolyutsii*, (2 vols) Moskow/Leningrad, 1935 and 1940.

[8] "The conditions of sale themselves made against the creation of a population of small proprietors, and worked all in the interests of a relatively small group of people – the monied men of the City, the squires and self-made men who officered the New Model Army" (Hill, *Puritanism and Revolution*, 177).

No point in the conditions of sale stood in contradiction to the laws of civil society, whose realization was also favored by the Levellers. Later on, when in the course of the plundering of Ireland small parcels of land were given to the soldiers, the same result occurred: small property was bought out by large property.

[9] John Locke, *Civil Magistrate* (1660), quoted by Laslett, Introduction to *Two Treatises*, 32–33. The work deals in particular with the question, whether in inessential things with regard to religious services, i.e., in things not laid down by natural law or revelation, the civil magistrate has the right to decide. On the background of the English Revolution, in which parties presented themselves as religious groupings, the explosive character of the theme is obvious.

[10] Locke summarized the essence of the theory of Robert Filmer (1588–1653) as follows: "Men are not born free, and therefore could never have the liberty to choose either Governors, or Forms of Government. Princes have their Power Absolute, and by Divine Right, for Slaves could never have a Right to Compact or Consent. Adam was an absolute Monarch, and so are all Princes ever since." John Locke, *Two Treatises* (1689) I, 5. All the following quotations are from this work. The text is cited according to the critical edition by Peter Laslett, Cambridge UP, 1963.

[11] Christopher Hill writes that Locke and Newton were "the backroom boys of the whig Junto" (*Century*, 253).

CHAPTER XI

[1] I have dealt with Smith's method and its socio-historical background in more detail in 'Adam Smith's Analytic-Synthetic Method and the "System of Natural Liberty" ', *History of European Ideas* **2** (1981), 135–154.

[2] The 'Statute of Artificers' (1563: 5 Eliz. I, c.4; excerpts quoted by G. R. Elton, *The Tudor Constitution*, 466–470), called by Sombart the "Magna Charta of unfreedom" (I, 2; 816), allowed every 'employer' to forcibly employ unemployed skilled laborers and forcibly to take boys as apprentices.

The 'Act of Settlement' (1662) made it possible to confine any laborer to the place of his birth even if he had already found work elsewhere. Cf. excerpts from the Act in Browning, *English Historical Documents, 1660–1714*, London, 1953, 464.

Smith mentions the legislative fixing of the highest permissible wages in 1768 (8 George III, c.17) and remarks: "Whenever the legislature attempts to regulate the differences between masters and their workmen, its counsellors are always the masters" (WN I.x.c.61).

Smith was quite in favor of higher wages: "Servants, labourers and workmen of different kinds, make up the far greater part of every great political society. But what improves the circumstances of the greater part can never be regarded as an inconveniency to the whole. No society can surely be flourishing and happy, of which the far greater part of the members are poor and miserable. It is but equity, besides, that they who feed, cloath and lodge the whole body of the people, should have such a share of the produce of their own labour as to be themselves tolerably well fed, cloathed and lodged" (WN I.viii.36).

The rise in wages in the first half of te 18th century was also noted by Smith (cf. WN I.viii; I.xi.p.9).

Jacob Viner discusses the economic and social tasks, which Smith took to be the duties of the State and concludes that "Adam Smith was not a doctrinaire advocate of laissez faire" ('Adam Smith and laissez-faire', in: *Adam Smith 1776–1926*, New York 1928, 116–155, here: 153). As important as it is to point out that Smith does not conceive of the state as a mere 'night watchman', it should not be overlooked that the central thesis of the *'laissez-faire* doctrine' – the state may not regulate the economy – is not affected.

[3] Joachim Moebus points out that Smith wants to see the self-control of the savage retained by the citizens; this would then benefit the society in case the harmonious course of capitalistic development should be disturbed. This interpretation does not stand in contradiction to mine, since in Smith's perspective all citizens in a state would be bourgeois. The approximation to the picture of the future citizen must be made from both sides – by the contemporary workers just as much as by the bourgeoises. Cf. Joachim Moebus, 'Die Einzelstücke auf dem Schachbrett und die Wilden. Fußnote zu Adam Smith,' unpubl. Ms., Berlin, 1979.

[4] Political economy, writes Marx, has never even asked itself why "labour is represented by the value of its product and labour-time by the magnitude of that value." In a footnote to this remark he explains that the reason for this is that "the value-form of the product of labour is not only the most abstract, but is also the most universal form, taken by the product in bourgeois production, and stamps that production as a particular species of social production, and thereby gives it its special historical character. If then we treat this mode of production as one eternally fixed by Nature for every state of society, we necessarily overlook that which is the differentia specifica of the value-form, and consequently of the commodity-form, and of its further developments, money-form, capital-form, etc." (*Capital* 1, 80–81; MEW 23, 95f.).

Marx touches on the methodological problem: "The value of commodities is the very opposite of the coarse materiality of their substance, not an atom of matter enters into its composition. Turn and examine *a single commodity, by itself*, as we will, yet in so far as in remains an object of value, it seems impossible to grasp it" (*Capital* 1, 47; MEW 23, 62; my italics). He illustrates the problem with an example' one wants to determine the weight of a sugar-loaf and uses some pieces of iron, whose weight has already been determined, as a measure. "In this relation, the iron officiates as a body representing nothing but weight .... Just as the substance iron, as a measure of weight, represents in relation to the sugar-loaf weight alone, so, in our expression of value [20 yards of linen = 1 coat – G.F.], the material object, coat, in relation to the linen, represents value alone" (*Capital* 1, 56–57; MEW 23, 71).

Methodologically, the analogy has more to say than Marx explicates. For the 'weight' of iron is the expression of the mutual gravitation of the iron and the earth; the attempt to ascertain the value-form in an isolated commodity is analogous to the attempt to ascertain gravitation in a single material body, and both are impossible.

[5] Marx's theory, to which I refer here, need not be discussed; but since it is as far as I know the only explanation of the profit of capital developed on the basis of the labor theory of value, the question may be asked, why Smith tolerated contradictions but did not think of a solution like that of Marx's.

[6] Marx, *Capital* 1, 509, 766; MEW 23, 532, 794.

[7] The fortune of a man is in proportion "to the quantity either of other men's labour,

or, *what is the same thing*, of the produce of other men's labour, which it enables him to purchase or command" (WN I.v.3; my italics).

Marx saw in this "the first occasion for confusing the determination of the value of commodities by the *quantity, labor*, contained in them with the determination of their value by the quantity of living labor that they can buy, that is, their determination by the *value of labor*" ('Theories on Surplus Value', MEW 26.1, 47; my italics). Cf. further, 26.1, 54; 26.2, 162; *Capital* 1, 541–542 (MEW 23, 564) and *Capital* 3, 830–831 (MEW 25, 838f.).

[8] The following interpretation is consciously abridged and neglects tendencies running in other directions in other writings by Rousseau which point beyond civil society. This seems to me to be justified since Rousseau never overcame the limitations of the "social contract".

[9] *Discours sur l'inégalité, Oeuvres Complètes*,Vol. III, 176–178.

[10] "The ideal social 'base' of Rousseau's republic is a *society of small proprietors*, who either cultivate their own land with their own labor or produce with their own tools necessary products and exchange them for the excess production of agriculture" (Fetscher, 222). Cf. the remarks and references, pp. 214–228.

[11] On the external necessity of the contract, cf. C.S. I.6, 360. On the external necessity of founding families, cf. *Discours*, 165–168.

[12] In this passage Rousseau polemicizes explicitly against Grotius, Hobbes, Aristotle, and against Filmer – the feudal-absolutist theoretician of the English Restoration. Cf. C.S. I.2, 353f. The analogy between the king and the father of a family is rejected by Rousseau with clear allusions to Bossuet. Cf. C.S. III.6, 412f.

The equation of Grotius and Hobbes with Aristotle and Filmer was probably made for polemical effect.

CHAPTER XII

[1] Marx's determination of society as the expression of the relations of the individuals has to my knowledge never given occasion to an interpretation that the relations exist independently of the individuals; the interpretation of the determination of human essence in its reality as an ensemble of social relations seems more problematical. For a discussion, cf. Friedrich Tomberg, 'Menschliche Nature in historish-materialistischer Definition', in G. Rückriem *et al.* (ed.), *Historischer Materialismus und menschliche Natur*, Cologne, 1978. In *Polis und Nationalstaat*, Tomberg presents his view in a "superstructure analysis" of successive social formations which my interpretation follows in some central points.

[2] Cf. the *Projet de constitution pour la Corse*, in: *Oeuvres Complètes* III, 901–950 and *Considérations sur le gouvernement de Pologne*, 953–1041.

[3] I should point out that this bourgeois conception does not come to expression merely in social philosophy nor is its dominance confined to that field. In Defoe's *Robinson Crusoe*, for instance, all the points of view discussed here and demonstrated for social philosophy can also be found. However, we cannot take up the relation between scientific and non-scientific knowledge here.

CHAPTER XIII

[1] "Phaenomena voco quaecumque sentiri possunt, sive res externae quae per sensus quinque innotescunt, sive internae quas in mentibus nostris intuemur cogitando. Ut quod ignis calidus est, aqua humida est, aurum grave est, sol lucidus est, ego sum et cogito. Hae omnia sensibilia sunt et sensu laxo phaenomena vocari possunt. Phaenomena proprie dicuntur quae videri possunt sed accipio sensu laxiora" (ULC, Add. 3965.13, Fol. 422v; my italics). I would like to thank the University Library of Cambridge for sending me a photocopy of the manuscript.

According to J. E. McGuire ('Body and Void', 238f.), who published the English translation, this is a draft of the definition of phenomena for the second edition of the *Principia*.

Cf. also the lengthy text in which Newton undertakes a refutation of Descartes' theory of 'innate ideas' in Koyré, *'Regulae Philosophandi'*, 14.

[2] This conception can be traced – albeit with considerable modifications – back to Aristotle and Galen. Numerous references can be found in Thomas S. Hall, *Ideas of Life and Matter: Studies in the History of General Physiology, 600 B.C.–A.D. 1900* (Chicago, 1969); for the 16th and 17th centuries, cf. Karl E. Rothschuh, *Physiologie* (Freiburg and Munich, 1968), 1–132.

[3] With regard to the *arguments* for Newton's concept of free spontaneity, the discussion is based on Clarke's reasonings; the concept itself can be found in Newton's own deliberations. My argument is thus independent of whether Clarke is reporting Newton's thoughts or expounding his own.

Furthermore, we know that Newton was kept *au courant* of the progress of the discussion (K/C, 81) and that Clarke's arguments sometimes repeat word for word Newton's drafts. In the letter which the Princess of Wales sent with Clarke's Second Reply, she told Leibniz: "*Vous ne vous étiez point trompé à l'odeur [l'auteur ?] des réponses; elles ne sont pas écrites sans l'avis du chevalier Newton*" (Robinet, 46).

Finally, it is improbable that Clarke uses arguments that would not have been approved by Newton; the discussion was generally considered as one between Leibniz and Newton and was intended for publication from the beginning. Since Clarke and Newton were neighbors and met regularly, no written communication between them was necessary; it is thus no argument against Newton's participation that no such documents have been found.

A. R. Hall doubts Newton's participation in the discussion but gives no grounds for his doubts (cf. Hall, 219f. and the corresponding footnotes). However, he too believes that Newton's and Clarke's philosophical views were essentially the same.

[4] "And since Space is divisible *in infinitum*, and Matter is not necessarily in all places, it may be also allow'd that God is able to create Particles of Matter of several Sizes and Figures, and in several Proportions to Space, and perhaps of different Densities and Forces, and thereby to vary the Laws of Nature, and make Worlds of several sorts in several Parts of the Universe. At least, I see nothing of Contradiction in all this" (*Opticks*, Qu. 31, 403f.).

[5] ULC, Add. 3965.13, Fol. 541v; McGuire, 'Active Principles,' 201.

[6] ULC, Add. 3970, Fol. 620r; quoted by McGuire, "Active Principles", 170f. This is a draft of Qu. 23 of the *Opticks* 1706 (in the fourth edition: Qu. 31) and was probably written in 1705.

[7] The argument by analogy from the ability of the human will to move the body to the ability of God to move the bodies of the world was often used by Newton. For instance:

> Since each man is conscious that he can move his body at will . . . the free power of moving bodies at will can by no means be denied to God, whose faculty of thought is infinitely greater and more swift (*De Gravitatione*, Hall and Hall, 105; Engl., 139).

It is characteristic of the way Newton presupposed as a matter of course the independence of the willful actions from God and from the world, that he never considered that this argument by analogy, just as the determination that all bodies are in God's sensorium, is problematical. For if God moves the bodies of the world, then this could also apply to the human body, which would then not be moved by the human will. The conclusion would then contradict the premise. The inference can only be made if man (will and body) on the one hand, and world (God and bodies) on the other are conceived as two mutually independent systems with regard to willful actions.

[8] *Encyclopédie*, Article: 'Mouvement'; Vol. 10, 833; cf. also *Traité de dynamique*, Paris 1758 (2nd edition), xxiv.

Cf. Holbach's critique, in which this power of the soul is taken as the starting point of a critique of the asserted immateriality of the soul: *Système de la nature* (1770), Chapt. 7.

[9] L. Euler, *Lettres à une Princesse d'Allemagne* . . . , (1768–1772), in *Opera Omnia*, Ser. tertia, XI; the quotations are from the Letters 80, 85, and 97 (cf. *Letters of Euler on Different Subjects in Natural Philosophy*, New York: Arno Press, 1975). Cf. also Immanuel Kant, *Metaphysische Anfangsgründe der Naturwissenschaft* (1786), 'Mechanik' Lehrsatz 3, fn., A129f.

[10] I take up this question for the following reasons. If the concept of the autarchic individual did in fact affect the concept of 'element' with its properties, which belong to it independently of the system, then the same systematic problem would arise with respect to the 'system': How can the stability of a system be asserted (or secured) if the properties and thus the behavior of the elements are independent of it?

On the basis of Newton's deliberations a more direct relationship also results, in that the free individual is both an element of the commonwealth (and thus an object of social philosophy) and a component of the world system (and thus an object of natural philosophy).

Finally, Clarke employs the analogy between a king and God to which I refer in his second letter, which, according to the Princess of Wales, Newton had examined.

I do not of course assert a direct influence of political views on Newton's conception of the analytic-synthetic method. On the political content of the discussion between newton and Leibniz, cf. Steven Shapin, 'Of Gods and Kings: Natural Philosophy and Politics in the Leibniz-Clarke Disputes', *ISIS* 72 (1981), 187–215.

[11] Ludwig Feuerbach observed the relation of philosophy (science) and religion in England very closely:

> In France, England, and Italy an *independent* philosophy begins *outside* the existing religion . . . with a separation from it, but a separation *which left it uncontested, with the severance into a world of faith, where reason had no place, and a world of reason, from which faith is excluded* (*Leibniz*, 11; last italics mine).

Ths historical difference between Germany and England already appears to Feuerbach as a national one.

[12] Cf. the extensive presentation by M. C. Jacob, *The Newtonians and the English Revolution: 1689–1720*, Hassocks, 1976.

CHAPTER XIV

[1] One might have some doubt whether Leibniz, as Feuerbach continues, always stood "above the oppositions never within them" and was a "judge not a participant" (*Leibniz*, 26). Feuerbach's characterization of Leibniz's attempts at mediation is, however, accurate; cf. *op. cit.*, §1 'Charakteristik Leibniz', 14–32.

[2] 'Grundriß eines Bedenkens von Aufrichtung einer Sozietät in Deutschland zu Aufnehmen der Künste und Wissenschaft' (1671), A. IV.i, 530–543; Leibniz, *Politische Schriften* (ed. H. H. Holz), Frankfurt/Main, 1967, Vol. II, 32–42 §§11, 5 (my italics).

"The opportunity to take immediate political action in Leibniz's time was reserved for princes and their usually aristocratic ministers. All others were condemned to serve within the framework set for them by the princes and ministers. Thus Leibniz's possibilities for development were limited. On account of his bourgeois origins the path to action on his own responsibility was closed from the start. He could ever be only servant and advisor" (Carl Haase, 'Leibniz als Politiker und Diplomat', in: *Leibniz*, (ed. W. Totok and C. Haase) Hannover, 1966, 195–226, here: 197).

The admonition not to undertake '*turbierende Machinationes*' applies to Leibniz himself as well; two years earlier Leibniz had drafted the plan for a secret society ('*Societas Philadelphica*' 1669) like that of the Pythagoreans, which – in a peculiar mixture between the Jesuits and the Dutch East India Company – was to seize power in the European states.

[3] Leibniz was familiar not only with Hobbes's *De Cive* and *Leviathan*, which he often quoted, but also with Locke's *Two Treatises*: "*Le livre de feu Mr. Algernon Sidney m'est bien connu, aussi bien que se feu Mr. Locke a écrit contre Filmer, et qu'il m'a envoyé luy-même*" (Letter to de Falaiseau, July 8, 1705, Klopp IX, 142f.).

Locke's reference to man's being a 'social creature' was – with or without intent – fundamentally misunderstood by Leibniz. Locke introduced the concept in order to explain the origin of language; in his *Two Treatises* (II, §77) Locke paraphrases the Bible quotation "God said, it is not good that the man should be alone" (Genesis II, 18), and then speaks of the '*first society*' between man and woman and then between parents and children who make up a family. To this 'first society' can be added that of master and servant. It is only to the family that Locke's determination of man as a 'social creature' applies; a society consisting of many families is not derived from the 'social nature' of man according to Locke; it arises either by consent or by contract.

[4] Ms. on natural societies (1678), in Grua II, 600–603; Holz II, 138–140; PPL, 428–429; corrupted version, Guhrauer I, 414–417.

[5] "Of particular importance in this construction of the *status naturalis* are the thoughts, that the stateless original condition was not a separate, individual life but a life in a community, and that within this community a system of rights, unthinkable without it, was realized. Thus there is right before the state, but this right is conceived as social: it arises in the human community" (Erwin Ruck, *Die Leibniz'sche Staatsidee*, Aalen, 1969 (Tübingen, 1909), 58).

[6] Holz is certainly right when he remarks on these plans, that "Leibniz quite undoubtedly stands in opposition to the tendencies of his age, which were directed towards the establishment of private-economic capitalist relations of production" (*Politische Schriften II*, Introduction, 17).

Cf. further Leibniz's manuscript 'De Jure et Justitia', Grua II, 618ff.; republished and translated (into German) in Holz, *Herr und Knecht bei Leibniz und Hegel*, Neuwied and Berlin, 1968, 86–96.

[7] On these three degrees of right, cf. the excerpts from the Preface to *Codex Juris Gentium Diplomaticus*, GP III, 386–389; PPL, 421–424; Riley, 165–176; and 'Meditation sur la Notion de la Justice,' Mollat, 57ff.; PPL, 561–573; Riley, 45–64.

[8] This relation of justice to law also determines Leibniz's view of the constitution of the state:

> When one loves true freedom, one is not for that a republican, since reasonable liberty is more secure when the king and the assemblies are bound by good laws than when arbitrary power is in the hands of the king or the multitude" (Letter to Mr. Burnet de Kemney (1701), Klopp VIII, 276; cf. also 270).

In his polemic against state of affairs in England, Leibniz wrote that he would judge the English to be happy because they "obey only the laws"; but he added the retraction: "if their laws were good"; he preferred the rule of a just Christian monarch to the rule of bad laws (such as those in England on his view). (Letter to Burnet, April, 1699, Klopp VIII, 121.)

[9] Each of these possible interpretations has been developed by various authors. However fruitful these interpretations are in terms of systematics, they do only partial justice to the historical Leibniz. The 'logical' interpretation is best exemplified by Couturat and Russell. Couturat chose as the motto of his classic presentation of Leibnizian logic the sentence: "*Cum Deus calculat . . . fit mundus.*" He left out the words: "*et cogitationem exercet.*" Russell saw no connection between the 'esoteric' and the 'exoteric' philosophy of Leibniz: to the latter he attributed everything that did not fit his interpretation. In his *History of Western Philosophy* (1946), written for a general public, he explains the circumstance that Leibniz allegedly held two separate philosophies with Leibniz's lack of character (cf. 563ff.).

Ernst Cassirer likewise attempts to pass off his Neo-kantian interpretation as fully comprehensive for the historical Leibniz. He goes so far as to confront his own interpretation with Leibniz's definition of the monad as 'substantial atom' and recommends us not to let ourselves be led astray by the latter (cf. Cassirer's introduction to the *'Monadenlehre'* in HS II, 105f.).

For a 'metaphysical' interpretation, the reader is referred to Feuerbach's excellent presentation. Of particular significance for the relation of element and system is Hegel's critique of Leibniz (cf. *Wissenschaft der Logik* (ed. Lasson), Vol. I, 152f., 160), which is shared by Feuerbach but also criticized (cf. Feuerbach, *Leibniz*, §7, fn. 22, 214–216).

Finally, let it be remarked that the various possible interpretations of the *Monadology*, that is, of the concept of 'representation' are anchored in the history of this concept. In the *Lexicon Philosophicum*, to which Leibniz appealed in the discussion with Clarke, the entry for *'repraesentatio'* lists: (1) signify (*significare*), (2) bring into presence (*rem praesentem facere*). The examples given there deal with the conception of transubstantiation or with the 'exhibition' of a sum of money in the purchase of a

commodity. Then a distinction is made between representation on the basis of a similarity (*similitudo*) and on the basis of an analogy (*proportio*). Cf. Rudolph Goclenius, *Lexicon Philosophicum*, Frankfurt, 1613, 981.

[10] "What is exhibited by the reaction of a resistant body and the restitution of a compressed body mechanically or extensively ... is concentrated dynamically and monadically in the entelechia itself, in which lies the font of mechanism and the representation of mechanical things. For the phenomena result from the monads (which are the only true substances). And while mechanical things are determined from external circumstances, in the font itself the primitive entelechia is harmoniously modified through itself, since it can be said that a body has all its derivative force from itself" (Leibniz to Chr. Wolff, July 9, 1711, in *Briefwechsel zwischen Leibniz und Christian Wolff* (ed. C. I. Gerhardt), Halle, 1860, 139).

[11] From the conception mentioned above it follows for Leibniz that physics, which makes use of the principles of geometry and dynamics, is subordinated to these, which are in turn subordinated to arithmetic and metaphysics. Geometry as a "science of extension" is subordinated to arithmetic, "since in extension ... is a repetition or a multitude; and dynamics is subordinated to metaphysics, which deals with cause and effect" (GM VI, 100).

[12] Cf. *'De rerum originatione radicali,'* GP VII, 302–308 and the precise summary, *'Résumé de Metaphysique'*, Couturat, 533–535; cf. also the explications of the concepts 'possible' and 'compossible' in the correspondance with Bourguet, GP III, 544ff.

Russell has remarked critically (*A Critical Exposition of the Philosophy of Leibniz*, Cambridge University Press, 1900, 18–20, 67) that in Leibniz's logical theory no contradiction can subsist between two predicates of a subject, and thus every 'composition' of such single substances must be possible. The same critique is made by Couturat (*La Logique*, 219, fn. 2). The presupposition of this criticism is that according to Leibniz all simple concepts, out of which the composite concepts consist, are positive. Russell appeals to the sketch of a proof of the possibility of God which Leibniz presented to Spinoza, and in which he wrote: "I call a perfection every simply quality which is positive and absolute, or (*seu*) expresses without any limits whatever it expresses." From this Leibniz concluded, "that all perfections are *compatible inter se* or can be in the same subject" ('Quod Ens Perfectissimum Existit', GP VII, 261; Russell, *op. cit.*, 287; PPL, 167).

From the fact that all perfections are simple and positive, it does not follow that all simple concepts are positive and are perfections. At the same place Leibniz says expressly that a simple quality, which can neither be analyzed nor defined, can be such a one as "will be circumscribed by limits and will therefore be conceived by a negation of further progress". Cf. further the remarks by Leibniz that not all simple concepts are mutually compatible (GP VII, 293, 295). For a detailed discussion of Russell and recent literature, cf. David Copp, 'Leibniz's Thesis that not all possibles are compossibles," *Studia Leibnitiana* **5** (1973), 26–42. Copp doubts that Leibniz wanted to transform all relational propositions into subject-predicate propositions about the same subject (*ibid.*, 36f.), although this is readily possible if one, as does Leibniz, counts relational concepts to the simple concepts (*ibid.*, 37f.). On this cf. J. Mittelstraß, 'Monade und Begriff', *Studia Leibnitiana* **2** (1970), 171–200, esp. 194ff.

[13] Leibniz thought that God, out of the possible worlds chose the most perfect world and realized it ("Cum *Deus* calculat *et cogitatem exercet*, fit mundus." GP VII, 191, fn.; second italics mine). On the other hand, Leibniz wrote that the possibilities themselves

possess a 'striving to exist': otherwise it would follow that the existence itself must have an essence. But then it would have to be asked whether this essence exists (cf. e.g., 'De Veritatibus Primis,' GP VII, 194f.). The attempt to limit God's arbitrary will as much as possible is unmistakable in both conceptions.

[14] It seems to me that in this double perspective the possibility both for the logical calculus and for dialectics is implicated. The problem of the relation between the two has been put sharply into focus by Joseph König. (Cf. J. König, 'Das System von Leibniz', in: *Leibniz-Vorträge*, Hamburg, 1946, 17–45.) An adequate solution to the problem has, to my knowledge, not been worked out.

[15] Criticisms of Leibniz's clock simile often do not succeed in attaining Leibniz's niveau much less in 'superceding' his position. W. Kranz, for instance, writes that the clock simile "does not say anything to a person today" and suggests instead the comparison "with two essentially different strata", "of which the metaphysical lies above the phenomenal, but is closely connected with the latter." (cf. 'Kosmos,' *Archiv für Begriffsgeschichte* **2** (1957), 205.) What a 'person today' is supposed to understand by two 'essentially different' strata remains unclear.

Quite to the point, on the other hand, is Feuerbach:

> At that time only mechanism was, so to speak, the *principium cognoscendi* of nature privileged by the world spirit. As a *determined* mode of knowledge of nature no other than the mechanical mode of explanation was given. The *principium hylarchicum* of More, the *vis plastica* of Cudworth were undetermined principles determining nothing, which did not adequately satisfy the essential interest of the modern time, the material knowledge of the material. Only the monad was a privileged existence. Only with this, did an original philosophical principle, which connects up as an organic developing part to the series of historical systems, . . . constitute itself *within* mechanism and *out of it*" (*Leibniz*, 44f.).

Overcoming mechanism today, too, will not be achieved by falling back on a prescientific metaphysics.

[16] J. Mittelstrass remarks that in both the *'système Nouveau'* and the *'Discours de Métaphysique'* Leibniz is concerned with the concept of substance: "In the *Système Nouveau* it is required for physical reasons and at the same time brought into connection with traditional distinctions; in the *Discours de Métaphysique* it is determined" (*'Monade und Begriff,'* 177).

Since Leibniz conceives matter as plump and passive, force as active and as something mental, it would be quite worthwhile to consider whether the 'pre-establized harmony' in relation to physics is not to be seen in connection with the question of the relation between inertial and gravitational mass.

[17] *'Initia et Specimina Scientiae Novae Generalis, H'*, GP VII, 108–110. The translation of the Latin text has taken the French version into account.

[18] The importance of the problem of somehow reconciling mechanics with human freedom for the further development of philosophy can hardly be overestimated. I want here merely to point out that Spinoza had used Leibniz's example of inertial motion in just the opposite sense, namely to demonstrate constrained action.

In a letter to Schaller Spinoza wrote:

> "I say that a thing is *free* which exists and acts by the sole necessity of its nature (*ex*

sola suae naturae necessitate existit et agit); and I call that constrained which is determined to exist and to act in a certain and determinate manner by something external to itself." God is therefore free; but all created things are constrained, "all of which are determined by external causes to exist and act in a certain and determinate manner . . . ; for instance, a stone impelled by an external cause receives a certain quantity of motion, by which, the impulse of the external cause ceasing, it afterwards necessarily continues to move. This continuance of motion on the part of the stone is therefore constrained not necessary, because it must be defined by the impulse of an external moving cause." "Now conceive further that the stone as it continues to move thinks and knows that it is striving as much as it can (*quantum potest*) to continue to move: this stone, in as much as it is only conscious of its endeavor and is in no way indifferent, will believe itself to be completely free and to perservere in its motion from no other cause than that it wills to do so. And this is precisely that human freedom which all boast of having . . ." (October, 1674, *Opera* Vol. IV, 265f.).

Kant held that Leibniz's freedom was basically no better "than the freedom of a turnspit, which when once wound up also carries out its motions of itself" (*Critique of Practical Reason*, 101 (A174)). However, Kant no more tried to base freedom on overstepping the laws of nature than did Leibniz.

Lefèvre has forcefully pointed to the connection between the corpuscular philosophy and determinism on the one hand and to Leibniz's critique of atomism as an attempt to refute determinism on the other (cf. Lefèvre, 125ff.). I differ, however, with Lefèvre's interpretation on a point of decisive importance for the relationship between philosophy and natural science, in that I do not consider the determinism attributable to the corpuscular philosophy to be opposed to classical mechanics (Lefèvre, 138–141) and that I believe that Leibniz can justify his position not just 'metaphysically' but also physically (cf. Lefèvre, 137, 148).

AFTERWORD

[1] The insufficiency of an intellectual historiography of ideas is most clearly expressed in the deliberations of one of the most important representatives of this school; Ernst Cassirer writes about the Leibniz-Clarke correspondence, that it is "by no means merely a controversy between the personalities of two strong thinkers", but rather "a controversy over the fundamental conceptual modes of two philosophical methods". This opposition is 'understood' by Cassirer as follows: "Newton and Leibniz differ not only in their principles but also in their philosophical temperaments and their intellectual structures" (E. Cassirer, 'Newton und Leibniz', in: Cassirer, *Philosophie und exakte Wissenschaft*, Frankfurt, 1969, 132–164; here: 132f. and 149).

[2] Gernot Böhme has attempted to justify this notion which most others have only mentioned in passing. Cf. his 'Die kognitive Ausdifferenzierung der Naturwissenschaft – Newtons mathematische Naturphilosophie', in G. Böhme *et al.*, *Experimentelle Philosophie* (Frankfurt/Main, 1977), 239–263, esp. 251–254.

[3] A difference between Leibniz and Newton relevant in this regard is that Newton (at least in his work on optics) actually conducted experiments, Leibniz did not. This difference draws attention to an historical process: there can be no doubt that since the

seventeenth century an increasing division of labor has taken place in science and that scientists have become increasingly specialized in one discipline or the other; those who tried to be active in all fields fell behind the standards of the time in some of these fields. For instance, when Locke wanted to familiarize himself with Newton's physics, he first had to be reassured by Huygens that he could trust the mathematics of the *Principia*. His own knowledge of mathematics was not sufficient to really study the *Principia*. Although the necessity of a division of labor among natural and social scientists as well as philosophers (and even within these disciplines) cannot be denied, it does not follow that a 'separation' has occurred, rather only that in all these disciplines changes in subject matter and method have taken place.

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LIST OF ABBREVIATIONS

Bacon:	
N.O. I, 1	*Novum Organum*, Bk. I, §1
Koyré/Cohen:	
K/C	'Newton and the Leibniz-Clarke Correspondence'
Leibniz:	
GP	*Die Philosophische Schriften* (ed. by Gerhardt)
GM	*Die Mathematische Schriften* (ed. by Gerhardt)
A I.i	Akademie-Edition, Series I, Vol. i
HS I	*Hauptschriften* (ed. by Cassirer) Vol. I
N.E. I.i.1	*Nouveau Essais sur l'Entendement*, Bk. I, Ch. i, §1
PPL	*Philosophical Papers and Letters* (ed. by Loemker)
Marx:	
MEW	*Marx-Engels-Werke*
Rousseau:	
C.S. I.1	*Contrat Social*, Bk. I, Ch. 1
Smith:	
WN I.i.1	*An Inquiry into the Nature and Causes of the Wealth of Nations*, in: *Works*, Vol. 2, Bk. I, Ch. i, §1
TMS I.i.1.1	*The Theory of Moral Sentiments*, in: *Works*, Vol. 1, Part I, Sect. i, Ch. 1, §1
ED	"Early Draft" of the Wealth of Nations, in: *Works*, Vol. 5, pp. 562–581
LRBL	Lectures on Rhetoric and Belles Lettres, *Works*, Vol. 4
LJ(A)	Lectures on Jurisprudence: Report of 1762–63, in: *Works*, Vol. 5, pp. 1–394
LJ(B)	Lectures on Jurisprudence: Report dated 1766, in: *Works*, Vol. 5, pp. 395–558
Considerations	"Considerations Concerning the First Formation of Languages, and the Different Genius of Original or Compounded Languages", in: *Works*, Vol. 4, pp. 201–226

HA	'The Princples which Lead and Direct Philosophical Enquiries; Illustrated by the History of Astronomy', in: Works, Vol. 3, pp. 31–105
Letter	'A Letter to the Authors of the Edinburgh Review', in *Works*, Vol. 3, pp. 242–254

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