sonable to assume that a point of view such as the point of view of classical mechanics that has been found wanting in various respects, that gets in difficulty *with its own facts* (see above, on crucial experiments), and must therefore be regarded as self-inconsistent (another application of Hegelian principles!), cannot have entirely adequate concepts? Is it not equally reasonable to try replacing its concepts with those of a more promising cosmology? Besides, why should the notion of explanation be burdened by the demand for conceptual continuity? This notion has been found to be too narrow before (demand of derivability), and it had to be widened so as to include partial and statistical connections. Nothing prevents us from widening it still further and admitting, say, "explanations by equivocation."

Incommensurable theories, then, can be *refuted* by reference to their own respective kinds of experience, i.e., by discovering the *internal contradictions* from which they are suffering (in the absence of commensurable alternatives these refutations are quite weak, however[216]). Their *content* cannot be compared, nor is it possible to make a judgment of *verisimilitude* except within the confines of a particular theory. None of the methods which Popper (or Carnap, or Hempel, or Nagel) want to use for rationalizing science can be applied, and the one that can be applied, refutation, is greatly reduced in strength. What remains are esthetic judgments, judgments of taste, and our own subjective wishes.[217] Does this mean that we are ending up in subjectivism? Does this mean that science has become arbitrary, that it has become an element of the general relativism which so much exercises the conscience of some philosophers? Well, let us see.

14. The Choice between Comprehensive Ideologies

To start with, it seems to me that an enterprise whose human character can be seen by all is preferable to one that looks "objective" and impervious to human actions and wishes.[218] The sciences, after all, are our own creation, including all the severe standards they seem to impose on us. It is good to be constantly reminded of this fact. It is good to be constantly reminded of the fact that science as we know it today is not inescapable, and that we can construct a world in which it plays no role whatever. (Such a world, I venture to suggest, would be more pleasant to behold than the world we live in today, both materially and intellectually.) What better reminder is there than the realization that the choice between theo-

ries which are sufficiently general to yield a comprehensive world view and which are empirically disconnected may become a matter of taste? *That the choice of a basic cosmology may become a matter of taste?*

Secondly, matters of taste are not completely beyond the reach of argument. Poems, for example, can be compared in grammar, sound structure, imagery, rhythm, and can be evaluated on such a basis (cf. Ezra Pound on progress in poetry[219]). Even the most elusive mood can be analyzed *and should be analyzed* if the purpose is to present it in a manner that either can be enjoyed or increases the emotional, cognitive, perceptual, etc., inventory of the reader. Every poet who is worth his salt compares, improves, argues until he finds the correct formulation of what he wants to say.[220] Would it not be marvelous if this free and entertaining[221] process played a role in the sciences also?

Finally, there are more pedestrian ways of explaining the same matter which may be somewhat less repulsive to the tender ears of a professional philosopher of science. One may consider the *length* of derivations leading from the principles of a theory to its observation language, and one may also draw attention to the number of *approximations* made in the course of the derivation. All derivations must be standardized for this purpose so that unambiguous judgments of length can be made. (This standardization concerns the form of the derivation, it does not concern the *content*.) Smaller length and smaller number of approximations would seem to be preferable. It is not easy to see how this requirement can be made compatible with the demand for simplicity and generality which, so it seems, would tend to increase both parameters. However that may be, there are many ways open to us once the fact of incommensurability is understood, and taken seriously.

15. Conclusion

The idea that science can and should be run according to some fixed rules, and that its rationality consists in agreement with such rules, is both unrealistic and vicious. It is *unrealistic*, since it takes too simple a view of the talents of men and of the circumstances which encourage, or cause, their development. And it is *vicious*, since the attempt to enforce the rules will undoubtedly erect barriers to what men might have been, and will reduce our humanity by increasing our professional qualifications. We can free ourselves from the idea and from the power it may possess over us (i) by a detailed study of the work of revolutionaries such as Gali-

leo, Luther, Marx, or Lenin; (ii) by some acquaintance with the Hegelian philosophy and with the alternative provided by Kierkegaard; (iii) by remembering that the existing separation between the sciences and the arts is artificial, that it is a side effect of an idea of professionalism one should eliminate, that a poem or a play can be intelligent as well as informative (Aristophanes, Hochhuth, Brecht), and a scientific theory pleasant to behold (Galileo, Dirac), and that we can change science and make it agree with our wishes. We can turn science from a stern and demanding mistress into an attractive and yielding courtesan who tries to anticipate every wish of her lover. Of course, it is up to us to choose either a dragon or a pussycat as our companion. So far mankind seems to have preferred the latter alternative: "The more solid, well defined, and splendid the edifice erected by the understanding, the more restless the urge of life . . . to escape from it into freedom." We must take care that we do not lose our ability to make such a choice.

Appendix. Science without Experience

1. One of the most important properties of modern science, at least according to some of its admirers, is its *universality*: *any* question can be attacked in a scientific way leading either to an unambiguous answer or else to an explanation of why an answer cannot be had. Let us therefore ask whether the *empirical hypothesis* is correct, i.e., whether experience can be regarded as a true source and foundation (testing ground) of knowledge.

2. Asking this question and expecting a scientific answer assumes that a science *without* experience is a *possibility*, that is, it assumes that the idea is neither absurd nor self-contradictory. It must be possible to imagine a natural science without sensory elements, and it should perhaps also be possible to indicate how such a science is going to work.

3. Now experience is said to enter science at three points: testing; assimilation of the results of test; understanding of theories.

A test may involve complex machinery and highly abstract auxiliary assumptions. But its final outcome has to be recognized by a human observer who *looks* at some piece of apparatus and *notices* some observable change. Communicating the results of a test also involves the senses: we *hear* what somebody says to us; we *read* what somebody has written down. Finally, the abstract principles of a theory are just strings of signs, without relation to the external world unless we know how to connect them

with experiment and that means, according to the first item on the list, with experience, involving simple and readily identifiable sensations.

4. It is easily seen that experience is needed at none of the three points just mentioned.

To start with, experience does not need to enter the process of *test*: we can put a theory into a computer, provide the computer with suitable instruments directed by him (her, it) so that relevant measurements are made which return to the computer leading there to an evaluation of the theory. The computer can give a simple yes-no response from which a scientist may *learn* whether or not a theory has been confirmed without having in any way *participated* in the test (i.e., without having been subjected to some relevant *experience*).

5. Learning what a computer says means being informed about some simple occurrence in the macroscopic world. *Usually* such information travels through the senses giving rise to distinct sensations. But this is not always the case. Subliminal perception leads to reactions directly, and without sensory data. Latent learning leads to memory traces directly, and without sensory data. Posthypnotic suggestion leads to (belated) reactions directly, and without sensory data. In addition there is the whole unexplored field of telepathic phenomena. I am not asserting that the natural sciences as we know them today could be built on these phenomena alone and could be freed from sensations entirely. Considering the peripheral nature of the phenomena and considering also how little attention is given to them in our education (we are not trained to effectively use our ability for latent learning) this would be both unwise and impractical. But the point is made that sensations are not *necessary* for the business of science and that they occur for practical reasons only.

6. Considering now the objection that we understand our theories, that we can *apply them* only because we have been told how they are connected with experience, one must point out that experience arises *together with* theoretical assumptions, *not* before them, and that an experience without theories is just as uncomprehended as is (allegedly) a theory without experience: eliminate part of the theoretical knowledge of a sensing subject and you have a person who is completely disoriented and incapable of carrying out the simplest action. Eliminate further knowledge and his sensory world (his "observation language") will start disintegrating, even colors and other simple sensations will disappear until he is in a stage even more primitive than a small child. A small child, on the other

hand, does not possess a stable perceptual world which he uses for making sense of the theories put before him. Quite the contrary. He passes through various perceptual stages which are only loosely connected with each other (earlier stages *disappear* when new stages take over) and which embody all the theoretical knowledge achieved at the time. Moreover, the whole process (including the very complex process of learning up to three or four languages) gets started only because the child reacts correctly toward signals, *interprets them correctly*, because he possesses means of interpretation even before he has experienced his first clear sensation. Again we can imagine that this interpretative apparatus acts without being acompanied by sensations (as do all reflexes and all well-learned movements such as typing). The theoretical knowledge it contains certainly can be *applied* correctly, though it is perhaps not *understood*. But what do sensations contribute to our understanding? Taken by themselves, i.e., taken as they would appear to a completely disoriented person, they are of no use, either for understanding or for action. Nor is it sufficient to just *link them* to the existing theories. This would mean extending the theories by further elements so that we obtain longer *expressions*, i.e., longer series of events, not the *understanding* of the shorter expressions which we wanted. No—the sensations must be incorporated into our behavior in a manner that allows us to pass smoothly from them into action. But this returns us to the earlier situation where the theory was applied but allegedly not yet understood. Understanding in the sense demanded here thus turns out to be ineffective and superfluous. Result: sensations can be eliminated from the process of understanding also (though they may of course continue to *accompany* it, just as a headache accompanies deep thought).

NOTES

1. V. I. Lenin, *'Left Wing' Communism, an Infantile Disorder* (Peking: Foreign Language Press, 1965), p. 100 (the book was first published in 1919 in order to criticize certain puritanical elements in German communism). Lenin speaks of parties and the revolutionary vanguard rather than of scientists and methodologists. The lesson is, however, the same.

2. H. Butterfield, *The Whig Interpretation of History* (New York: Norton, 1965), p. 66.

3. *Ibid.*, p. 21.

4. *Ibid.*, p. 25.

5. Lenin, *'Left Wing' Communism*, p. 100. It is interesting to see how a few substitutions can turn a political lesson into a lesson for methodology which, after all, is part of the process by means of which we move from one historical stage to another. We also see how an individual who is not intimidated by traditional boundaries can give useful advice to everyone, philosophers of science included. Cf. notes 27 and 33, 35, 38.

6. P. A. Schilpp, ed., *Albert Einstein, Philosopher-Scientist* (Evanston, Ill.: Tudor, 1948), p. 683.

7. D. Hume, *A Treatise of Human Nature* (Oxford: Oxford University Press, 1888), p. 180.

8. Popper and his followers distinguish between the socio-psychological process of science where errors abound and rules are constantly broken and a "third world" where knowledge is changed in a rational manner, and without interference from "mob psychology," as Lakatos expresses himself. For details and a criticism of this poor man's Platonism see the text to note 194 below.

9. E. H. Carr, *Michael Bakunin* (London: Macmillan, 1937), pp. 8–9.

10. Thus external pressure is replaced by bad conscience, and freedom remains restricted as before. Marx describes a similar development in the case of Luther in the following words: ". . . Luther eliminates *external* religiousness and turns religiousness into the *inner* essence of man . . . he negates the raving parish-priest outside the layman, for he puts him right into his heart." *Nationaloekonomie und Philosophie;* quoted from *Marx, die Frühschriften*, ed. S. Landshut (Stuttgart: Kroner, 1953), p. 228.

Whatever remains of irrationality in history is suppressed by the quasi-historical and indeed quite mythological manner in which scientists describe the genesis of their discoveries, or of the discoveries of others. ". . . history is wholly subordinated to the needs of the present, and indeed only survives to such an extent, and in such form, as serves present needs." Among the present needs, however, the propagation of what is thought to be good science is the most important one. Hence, history is replaced by myths "which are to be consonant with what [one thinks] to be good physics, and they are to be internally consistent." Paul Forman, "The Discovery of the Diffraction of X-Rays by Crystals: A Critique of the Myths," *Archive for the History of the Exact Sciences*, 6 (1969), 68–69. Forman's paper presents an interesting example to illustrate this statement. Another example is the myths which have been invented to explain the origin of the special theory of relativity. For an excellent account with plentiful sources see G. Holton, "Einstein, Michelson, and the 'Crucial' Experiment," *Isis*, 60 (1969), 133–197.

11. "This unique prevalence of the *inner* logic of a subject over and above the *outer* influences is not . . . to be found at the beginning of modern science." H. Blumenberg, *Die Kopernikanische Wende* (Frankfurt: Suhrkamp, 1965), p. 8.

12. "Nothing is more dangerous to reason than the flights of the imagination . . ." Hume, *A Treatise of Human Nature*, p. 267.

13. An *expert* is a man or a woman who has decided to achieve excellence in a narrow field at the expense of a balanced development. He has decided to subject himself to standards which restrict him in many ways, his style of writing and the patterns of his speech included, and he is prepared to conduct most of his waking life in accordance with these standards (this being the case, it is likely that his dreams will be governed by these standards, too). He is not averse to occasionally venturing into different fields, to listen to fashionable music, to adopt fashionable ways of dressing (though the business suit still seems to be his favorite uniform, in this country and abroad), or to seduce his students. However, these activities are aberrations of his *private* life; they have no relation whatever to what he is doing as an expert. A love for Mozart, or for *Hair*, will not make his physics more melodious, or give it a better rhythm. Nor will an affair make his chemistry more colorful.

This separation of domains has very unfortunate consequences. Not only are special subjects voided of ingredients which make a human life beautiful and worth living, but these ingredients are impoverished, too, emotions become crude and thoughtless, just as thought becomes cold and inhumane. Indeed, the private parts of one's existence suffer much more than does one's official capacity. Every aspect of professionalism has its watchdogs; the slightest change, or threat of a change, is examined, broadcast, warn-

ings are issued, and the whole depressing machinery moves at once in order to restore the status quo. Who takes care of the quality of our emotions? Who watches those parts of our language which are supposed to bring people together more closely, which have the function of giving comfort, understanding, and perhaps a little personal criticism and encouragement? There are no such agencies. As a result professionalism takes over even here.

To mention some examples:

In 1610 Galileo reported for the first time his invention of the telescope and the observations he made with it. This was a scientific event of the first magnitude, far more important than anything we have achieved in our megalomaniac twentieth century. Not only was here a new and very mysterious instrument introduced to the learned world (it was introduced to the *learned* world, for the essay was written in Latin), but this instrument was at once put to a very unusual use: it was directed toward the sky; and the results, the astonishing results, quite definitely seemed to support the new theory which Copernicus had suggested over sixty years earlier, and which was still very far from being generally accepted. How does Galileo introduce his subject? Let us hear.

"About 10 months ago a report reached my ears that a certain Dutchman had constructed a spyglass by means of which visible objects, though very distant from the eye of the observer, were distinctly seen, as if nearby. Of this truly remarkable effect several experiences were related, to which some persons gave credence while others denied them. A few days later the report was confirmed to me in a letter from a noble Frenchman in Paris, Jacques Badovere, which caused me to apply myself wholeheartedly to enquire into the means by which I might arrive at the invention of a similar instrument . . ." Quoted from Stillman Drake, ed., *Discoveries and Opinions of Galileo* (New York: Doubleday Anchor Books, 1957), pp. 28–29.

We start with a personal story, a very charming story, which slowly leads us to the discoveries, and these are reported in the same clear, concrete, and colorful way: "There is another thing," writes Galileo, describing the face of the moon, "which I must not omit, for I beheld it not without a certain wonder; this is that almost in the center of the moon there is a cavity larger than all the rest, and perfectly round in shape. I have observed it near both the first and last quarters, and have tried to represent it as correctly as possible in the second of the above figures . . ." Quoted from Drake, ed., *Discoveries and Opinions of Galileo*, p. 36. Galileo's drawing attracts the attention of Kepler who was one of the first to read Galileo's essay. He comments: "I cannot help wondering about the meaning of that large circular cavity in what I usually call the left corner of the mouth. Is it a work of nature, or of a trained hand? Suppose that there are living beings on the moon (following the footsteps of Pythagoras and Plutarch I enjoyed toying with this idea, long ago . . .). It surely stands to reason that the inhabitants express the character of their dwelling place, which has much bigger mountains and valleys than our earth has. Consequently, being endowed with very massive bodies, they also construct gigantic projects . . ." Quoted from *Kepler's Conversations with Galileo's Sidereal Messenger*, trans. Edward Rosen (New York: Johnson Reprint Corporation, 1965), pp. 27–28.

"I have observed"; "I have seen"; "I have been surprised"; "I cannot help wondering"; "I was delighted"—this is how one speaks to a friend or, at any rate, to a live human being.

The awful Newton who more than anyone else is responsible for the plague of professionalism from which we suffer today starts his first paper on colors in a very similar style: ". . . in the beginning of the year 1666 . . . I procured me a triangular glass prisme, to try therewith the celebrated phenomena of colours. And in order thereto having darkened my chamber, and made a small hole in my window shuts, to let in a convenient quantity of the sun's light, I placed my prisme at its entrance, that it might be thereby refracted to the opposite wall. It was at first a very pleasing divertisement, to view the vivid and intense colours produced thereby; but after a while applying myself to consider them more circumspectly, I became surprised to see them in an oblonge

form . . ." Quoted from *The Correspondence of Isaac Newton*, vol. I (Cambridge: Cambridge University Press, 1959), p. 92.

Remember that all these reports are about cold, objective, "inhuman" *inanimate* nature, they are about stars, prisms, lenses, the moon, and yet these are described in a most lively and fascinating manner, communicating to the reader an interest and an excitement which the discoverer felt when first venturing into strange new worlds.

Now compare with this the introduction to a recent book, a best seller even, *Human Sexual Response* by W. H. Masters and V. E. Johnson (Boston: Little, Brown, 1966). I have chosen the book for two reasons. First, because it is of general interest. It removes prejudices which influence not only the members of some profession, but the everyday behavior of a good many apparently "normal" people. Second, because it deals with a subject that is new and without special terminology. Also, it is about man rather than about stones and prisms. So one would expect a beginning even more lively and interesting than that of Galileo, or Kepler, or Newton. What do we read instead? Behold, oh patient reader: "In view of the pervicacious gonadal urge in human beings, it is not a little curious that science develops its sole timidity about the pivotal point of the physiology of sex. Perhaps this avoidance . . ." and so on. This is human speech no more. This is the language of the expert.

Note that the subject has completely left the picture. Not "*I* was very surprised to find" or, since there are two authors, "*We* were very surprised to find," but "*It is* surprising to find"—only not expressed in these simple terms. Note also to what extent irrelevant technical terms intrude and fill the sentences with antediluvian barks, grunts, squeaks, belches. A wall is erected between the writers and their readers not because of some lack of knowledge, not because the writers do not know their readers, but in order to make utterances conform to some curious professional ideal of objectivity. And this ugly, inarticulate, and inhuman idiom turns up everywhere, and takes over the function of the most simple and the most straightforward description.

Thus on page 65 of the book we hear that the female, being capable of multiple orgasm, must often masturbate after her partner has withdrawn in order to complete the physiological process that is characteristic for her. And, so the authors want to say, she will stop only when she gets tired. This is what they *want* to say. What they actually say is: "usually physical exhaustion alone terminates such an active masturbatory session." You don't just masturbate; you have an "active masturbatory session." On the next page the male is advised to *ask* the female what she wants or does not want rather than try to guess it on his own. "He should ask her"—this is what our authors want to convey. What is the sentence that actually lies there in the book? Listen: "The male will be infinitely more effective if he encourages vocalization on her part." "Encourages vocalization" instead of "asks her"—well, one might want to say, the authors want to be *precise*, and they want to address their *fellow professionals* rather than the general public and, naturally, they have to use a special lingo in order to make themselves understood. Now as regards the first point, precision, remember that they also say that the male will be "*infinitely* more effective" which, considering the circumstances, is not a very precise statement of the facts. And as regards the second point we must say that we are not dealing with the structure of organs, or with special physiological processes which might have a special name in medicine, but with an ordinary affair such as *asking*. Besides, Galileo and Newton could do *without* a special lingo although the physics of their time was highly specialized and contained many technical terms. They could do without a special lingo because they wanted to start afresh and because they were sufficiently free and inventive not to be dominated by words, but to be able to dominate them. Masters and Johnson find themselves in the same position, but they cannot speak straight any more, their linguistic talents and sensibilities have been distorted to such an extent that one asks oneself whether they will ever be able to speak normal English again.

The answer to *this* question is contained in a little pamphlet which came into my hands and which contains the report of an ad hoc committee formed for the purpose

of examining rumors of police brutality during some rather restless weeks in Berkeley (winter 1968–69). The members of the committee were all people of good will. They were interested not only in the *academic* quality of life on campus; they were even more interested in bringing about an atmosphere of understanding and of compassion. Most of them came from sociology and from related fields, that is, they came from fields which deal not with lenses, stones, stars, as did Galileo in his beautiful little book, but with humans. There was a mathematician among them who had devoted considerable time to setting up and defending student-run courses and who finally gave up in disgust —he could not change the "established academic procedures." How do these nice and decent people write? How do they address those to whose cause they have devoted their spare time and whose lives they want to improve? Are they able to overcome the boundaries of professionalism at least on this occasion? Are they able to *speak*? They are not.

The authors want to say that policemen often make arrests in circumstances when people are bound to get angry. They say: "When arousal of those present is the inevitable consequence." "Arousal"; "inevitable consequence"—this is the lingo of the laboratory, this is the language of people who habitually mistreat rats, mice, dogs, rabbits, and carefully notice the effects of their mistreatment, but the language they use is now applied to humans, too, to humans, moreover, with whom one sympathizes, or says one sympathizes, and whose aims one supports. They want to say that policemen and strikers hardly talk to each other. They say: "*Communication* between strikers and policemen is nonexistent." Not the strikers, not the police, not people are at the center of attention, but an abstract process, "communication," about which one has learned a thing or two and with which one feels more at ease than with living human beings. They want to say that more than 80 people took part in the venture, and that the report contains the common elements of what about 30 of them have written. They say: "This report tries to reflect a consensus from the 30 reports submitted by the 80 plus faculty observers who participated." Need I continue? Or is it not already clear that the effects, the miserable effects, of professionalism are much deeper and much more vicious than one would expect at first sight? That some professionals have even lost the ability to *speak* in a civilized manner, that they have returned to a state of mind more primitive than that of an eighteen-year-old who is still able to adapt his language to the situation in which he finds himself, talking the lingo of physics in his physics class and quite a different language with his friends in the street (or in bed)?

Many colleagues who agree with my general criticism of science find this emphasis on language farfetched and exaggerated. Language, they say, is an *instrument* of thought that does not influence it to the extent I surmise. This is true as long as a person has different languages at his disposal, and as long as he is still able to switch from one to another as the situation demands. But this is not the case here. Here a single and rather impoverished idiom takes over all functions and is used under all circumstances. Does one want to insist that the thought that hides behind *this* ugly exterior has remained nimble and humane? Or must be not rather agree with V. Klemperer and others who have analyzed the deterioration of language in fascistic societies that "words are like small doses of arsenic: they are swallowed unawares, they do not seem to have any noticeable effect, and yet the poisonous influence will be there after some time. If someone frequently enough replaces words such as 'heroic' and 'virtuous' by 'fanatical' he will believe in the end that without fanaticism there is no heroism and no virtue." *Die Unbewaeltigte Sprache* (Munich: Deutscher Taschenbuch Verlag, 1969), p. 23. Similarly the frequent use of abstract terms from abstract disciplines ("communication"; "arousal") in subjects dealing with humans is bound to make people believe that a human being can be dissolved into a few bland processes and that things such as emotion and understanding are just disturbing elements, or, rather, misconceptions belonging to a more primitive stage of knowledge.

In their search for a bland and standardized language with uniform spelling, punctuation, standardized references, and so on experts receive increasing support from *publishers*. Idiosyncrasies of style and expression that have been overlooked by a referee will certainly be noticed by printers or editors, and much energy is wasted in quarrels over a phrase, or the position of a comma. It seems that language has ceased to be the property of writers and readers and has been purchased by publishing houses, so that authors are no longer allowed to express themselves as they see fit and to make their contribution to the growth of English.

14. John Stuart Mill, *On Liberty*, quoted from *The Philosophy of John Stuart Mill*, ed. Marshall Cohen (New York: Modern Library, 1961), p. 258.

15. *Ibid.*, p. 265.

16. Even in undetermined and ambiguous situations uniformity of action is soon achieved, and adhered to tenaciously. Cf. M. Sherif, *The Psychology of Social Norms* (New York: Harper Torchbooks, 1964).

17. *A Treatise of Human Nature*, p. xxii. The word "reason" has been replaced by "understanding" in order to establish coherence with the terminology of the German idealists.

18. The first part of the quotation, up to "appearing as," is taken from *Differenz des Fichte'schen und Schelling'schen Systems der Philosophie*, ed. G. Lasson (Hamburg: Felix Meiner, 1962), p. 13. The second part is from the *Wissenschaft der Logik*, vol. I (Hamburg: Felix Meiner, 1965), p. 6.

19. Letter to Gert Micha Simon of October 11, 1949. Quoted from *Gottfried Benn, Lyrik und Prosa, Briefe und Dokuments* (Wiesbaden: Limes Verlag, 1962), p. 235.

20. For details and further literature see "Problems of Empiricism, Part II," in *The Nature and Function of Scientific Theory*, ed. R. G. Colodny (Pittsburgh: University of Pittsburgh Press, 1970).

21. One of the few physicists to see and to understand this feature of the development of scientific knowledge was Niels Bohr: ". . . he would never try to outline any finished picture, but would patiently go through all the phases of the development of a problem, starting from some apparent paradox, and gradually leading to its elucidation. In fact, he never regarded achieved results in any other light than as starting points for further exploration. In speculating about the prospects of some line of investigation, he would dismiss the usual considerations of simplicity, elegance or even consistency with the remark that such qualities can only be properly judged *after* [my italics] the event . . ." L. Rosenfeld in S. Rozental, ed., *Niels Bohr, His Life and Work as Seen by His Friends and Colleagues* (New York: Interscience, 1967), p. 117.

One must of course realize that science does not achieve final results and that it is therefore always "before" the event, never "after" it. Simplicity, elegance, consistency are therefore *never* a *conditio sine qua non* of scientific knowledge.

Considerations like these are usually criticized by the childish remark that a contradiction entails every statement and that self-inconsistent views are therefore useless for science. I call the remark childish because it assumes that a self-consistent science is a realistic possibility, that the rule which leads to the result just mentioned is the only possible rule, and that the scientist is obliged to play the thinking games of the logician. There is of course no such obligation. Quite the contrary, the scientist can criticize the logician for providing him with inadequate instruments that make nonsense of the complex, delicate, and often self-inconsistent theories he uses.

For further information concerning Bohr's philosophy see my essay "On a Recent Critique of Complementarity," *Philosophy of Science*, 35 (1968), 309–331, and 36 (1969), 82–105. The essay also cites relevant literature.

22. Children "learn to imitate others . . . and so learn to look upon standards of behavior as if they consisted of fixed, 'given' rules . . . and such things as sympathy and imagination may play an important role in this development . . ." K. R. Popper, *The Open Society and Its Enemies* (New York: Harper Torchbooks, 1967), II, 390.

One should also compare the remainder of appendix i/15 which gives a clear account of the irrational elements in our knowledge.

23. In one of his numerous lucubrations in praise of Ordinary English ("Moore and Ordinary Language," in *The Philosophy of G. E. Moore*, ed. P. A. Schilpp, New York: Tudor, 1952, pp. 354ff) Malcolm makes the following comment: ". . . if a child who was learning the language were to say, in a situation where we were sitting in a room with chairs about, that it was 'highly probable' that there were chairs there, we should smile, *and correct his language*" (italics in the original). One can only hope that the children whom Malcolm addresses in this manner are not as gullible as are most of his students and that they will retain their intelligence, their imagination, and especially their sense of humor in the face of this and other "methods" of education.

24. Cf. below, text to note 208.

25. Commenting on his early education by his father, and especially on the explanations he received on matters of logic, J. S. Mill made the following observations: "The explanations did not make the matter at all clear to me at the time; but they were not therefore useless; they remained as a nucleus for my observations and reflections to crystallize upon; the import of his general remarks being interpreted to me, by the particular instances which came under my notice afterwards." *Autobiography* (London: Oxford University Press, 1963), p. 16. In "Problems of Empiricism, Part II" I have argued that the development of science exhibits phase differences of precisely this kind. A strange and incomprehensible new principle often serves as a "nucleus for observations and reflections to crystallize upon" until we obtain a theory that is understood even by the most uneducated empiricist. For a general discussion of the problem touched upon in this remark, see Hegel, *Wissenschaft der Logik*, I, 51–64. See also St. Augustine, *De doctrina Christiana*, II/9: "The first . . . case is to know these books [i.e., the books of the old and of the new testament]. Altogether, we may not yet understand them, but by reading we can either memorise them, or become somehow acquainted with them." The way in which apparently aimless talk may lead to new ideas and to a new state of consciousness has been described, briefly, but exquisitely, by Heinrich von Kleist, "Ueber die allmaehliche Verfertigung der Gedanken beim Reden," in Hans Meyer, ed., *Meisterwerke Deutscher Literaturkritik* (Stuttgart: Goverts, Neue Bibliotek der Weltliteratur, 1962), 741–747.

26. "Recourse to direct action changed the whole tenor of the struggle, for the workers' self-confidence is enormously increased (and their knowledge transformed) once they act without delegating any of their power to political parties or trade unions. 'The factory is ours so do we need to start working for the bosses again?' This idea arose quite spontaneously, not by command, or under the aegis of the so-called vanguard of the proletariat [with its special methods, rules, prescriptions, and its special idea of rationality], but simply as a *natural response to a concrete situation*." D. Cohn-Bendit, *Obsolete Communism: The Left Wing Alternative*, trans. A. Pomerans (London: André Deutsch, 1968), p. 67. Cohn-Bendit's emphasis on "spontaneity . . . The chief enemy of all bureaucrats" (p. 154) agrees with the tenor of the present paper which wants to eliminate excessive bureaucracy not only from *government, but also from the administration of knowledge* (where it appears as an appeal to rationality). For the formation of natural responses to ambiguous situations, see also Sherif, *The Psychology of Social Norms*.

27. (A) K. R. Popper, whose views I have in mind when criticizing the omnipresence of argument, has admitted that "rationalism is necessarily far from comprehensive or self-contained." *The Open Society and Its Enemies*, II, 231. But the question I am asking is not whether *there* are limits to our reason. The question is *where* these limits are situated. Are they outside the sciences, so that science itself remains entirely rational (though the decision to become scientific may be an irrational decision); or are irrational changes an essential part of even the most rational enterprise that has been invented by man? Does the historical phenomenon 'science' contain ingredients which defy a rational analysis? Can the abstract goal of coming closer to the

truth be reached in an entirely rational fashion, or is it perhaps inaccessible to those who decide to rely on argument only? These are the questions to which I want to address myself in the present essay.

(B) Surprising insights into the limitations of methodological rules as well as into their dependence on a certain developmental stage of mankind are found in Lenin's and Mao's political writings and, of course, in Hegel's philosophy. It needs only a little imagination to turn the positive advice contained in these writings into advice for the scientist, or the philosopher of science.

Thus, we read on pp. 40ff of Lenin's *'Left Wing' Communism* (a book that is very useful as a theoretical basis for the criticism of contemporary left radicalism, campus radicals, leftist puritans, and other leftovers from the undialectical political stone age): "we can (and must) begin to build socialism, not with imaginary human material [as does the doctrine of critical rationalism], nor with human material specially prepared by us [as do all Stalinists, in politics as well as in the philosophy of science], but with the [quite specific] human material bequeathed to us by capitalism. True, that is very 'difficult,' but no other approach to this task is serious enough to warrant discussion." Replace "socialism" by "rationality of the future," "capitalism" by "critical rationalism," and our case is stated with perfect clarity.

It seems to me that such attention to the wider political context will free the philosopher of science from the Nagel-Carnap-Popper-Kuhn carrousel. The only philosopher who secretly imbibes the forbidden brew of Leninism is Lakatos—and the results are evident in his magnificent work. All that is required now is that he confess his vices openly so that others may learn to delight and enlighten us in a similar way.

(C) An excellent example of the need for moving forces in addition to argument is provided by the history of witchcraft in the thirteenth to seventeenth centuries. "No mere skepticism, no mere 'rationalism,' could have driven out the old cosmology," writes H. Trevor-Roper in his analysis (*The European Witch Craze*, New York: Harper Torchbooks, 1969, p. 181). "A rival faith had been needed . . ." Despite all the arguments against it "the intellectual basis of the witch craze remained firm all through the seventeenth century. No critic had improved on the arguments of Weyer; none had attacked the substance of the myth . . ." (pp. 160-161). Such attacks did not occur, and *they could not have been effective*. They could not have been effective, because the science of the schools was "empirically confirmed" (p. 191), because it "created its own evidence" (p. 166), because it was firmly rooted in common belief (p. 124), leading to strong experiences, to "illusions" which were "centralised . . . around" the main characters of the dominating myth such as for example "the devil" (p. 125), and because *strong emotional forces* were expressed by the myth as well. The existence of the empirical evidence made it difficult to argue against witchcraft in a "scientific" manner. The existence of the emotional force would have neutralized even an effective scientific counterargument. What was needed was not simply a formal criticism, or an empirical criticism; what was needed was a *change of consciousness*, a "rival faith" as Trevor-Roper expresses himself, and this rival faith had to be introduced against tremendous odds, and even in the face of reason. Now it is of course correct that a general and forceful education in the rules of rationalism, dogmatic, critical, or otherwise, will make it more easy for arguments to win the day—well-trained dogs heel more promptly than do their anarchistic counterparts—but the discussion of the *value* of argument will now be considerably more difficult, and perhaps entirely impossible. Besides, man was not meant to be just a rational animal. At any rate he was not meant to be castrated and cut apart. But whatever our position on that head, we shall have to admit that rational argument works with rational people only and that an appeal to rational argument is therefore discriminatory. Rational people are specially prepared, they have been conditioned in special ways, their freedom of action and of thought has been considerably restricted. If we oppose discrimination and mental restriction, then the omnipresence of reason can no longer be guaranteed and our assertion in the text holds. Cf. also Burr's letter to A. D. White, quoted from *George Lincoln Burr, His Life and*

Selected Writings (Ithaca, N.Y.: Cornell University Press, 1943), p. 56, my italics: "To my thought—and here I differ widely from both Buckle and Lecky . . . —it was not science, not reason that put an end to inhumanity in so many fields: *the pedants were as cruel as the bigots.* Reason came in only to sanction here reforms which had been wrought in spite of her. *The real antagonist of theology and of rationalism alike* [and it does not make any difference whether we speak here of dogmatic rationalists, or of skeptics, or of critical rationalists as is shown by the example of Glanville] *was the unreasoning impulse of human kindliness.*"

(D) The example of witchcraft shows that the wider context we need in order to see science, or the "search for truth," in perspective need not be politics. It can be religion, metaphysics, theology, or what have you. In "Classical Empiricism" (in R. E. Butts, ed., *The Methodological Heritage of Newton*, Toronto: University of Toronto Press, 1970), I have linked developments of science with developments in theology and I have commented on the wider perspective of the theologians when compared with that of the scientists. Today, of course, politics are much more popular. Besides, Professor Imre Lakatos, the secretary general of the slowly disintegrating Popperian party, is a politician first, and a theologian only much much later, and he knows Lenin better than he knows St. Thomas. This is why I have taken my extrascientific quotations from revolutionary politics, and not from revolutionary theology (besides, everyone has by now forgotten that St. Thomas was a revolutionary, too).

28. According to Popper we do not "need any . . . definite frame of reference for our criticism"; we may revise even the most fundamental rules and drop the most fundamental demands if the need for different measures of excellence should arise. *The Open Society and Its Enemies*, II, 390.

29. "No new progressive epoch has ever defined itself by its own limitations . . . In our case, however, watching the boundaries is regarded as more virtuous than transcending them." Speech of Milan Kundera at the IVth Congress of Czech Authors, Prague, June 1967. Quoted from *Reden Zum IV. Kongress des Tschchoslowakischen Schriftstellerverbandes* (Frankfurt: Suhrkamp, 1968), p. 17. "Our case" is of course also the case of revolutionary developments in science and methodology. In his introduction to the German translation of Burke's writings on the French Revolution, Gentz comments in a similar vein (quoted from P. G. Gooch, *Germany and the French Revolution*, London: Longmans, 1920, p. 95): ". . . the eulogist of new systems always finds opinion on his side [optimist!], while the defender of the old must [read: will] appeal to reason." The "opinion" of today is, of course, the "reason" of tomorrow which is already present in a naive, immediate, undeveloped form.

30. Leon Trotsky, *The Revolution Betrayed*, trans. M. Eastman (Garden City, N.Y.: Doubleday, 1937), pp. 86–87.

31. The priority of idea over behavior, problem over physical adaptation, brain over body—these are other versions of the ideology I am criticizing, and all of them have been refuted by more recent research. Thus the discovery of the australopithecines confronted us with a being that combines the brain of an ape with nearly human dentition, posture, and (possibly), behavior. Such a combination "was not anticipated in earlier speculation" (George G. Simpson *et al.*, *Life: An Introduction to College Biology*, New York: Harcourt, Brace, 1957, p. 793) where it was assumed that it is the brain that is responsible for the remaining human features and not the other way around: man became erect, he started using his hands, because his brain told him so. Today, we must admit that a new posture leading to new tasks may "create" the brain needed for these tasks (this, essentially, was also Engels's conjecture in his little essay about the function of the hand in the humanization of our apelike ancestors).

It also seems that certain comprehensive features of early civilization such as domestication or agriculture did not arise as attempts to solve problems. Rather "man at play inadvertently discovered their practical use." F. Alexander, *Fundamentals of Psychoanalysis* (New York: International Universities Press, 1948), p. 113; cf. also G. Róheim, *The Origin and Function of Culture* (New York: Nervous and Mental Disease Monographs, 1943), pp. 40–47, on the origin of the economic activity of mankind, and *Psychoanalysis and Anthropology* (New York: International Universities Press, 1950), p. 437, on the reasons why parents take care of their children. This is most easily proved by the fact that wool in sheep, a surplus of milk in cows, an abundant amount of eggs laid by fowls are all a consequence of domestication and cannot have acted as a reason for it. Hahn (*Die Haustiere in ihrer Beziehung zur Gesellschaft des Menschen*, Leipzig: Johann Ambrosius Barth, 1896, pp. 79, 154, 300, paraphrased after R. H. Lowie, *The History of Ethnological Theory*, New York: Farrar and Reinhart, 1937, pp. 112ff) suggests that people kept poultry originally as alarm clocks, or for cockfights—both non-economic motives. He also suggests that early man was an idler, doing useful labor as a pastime, rather than with serious and problem-conscious intent. O. H. Schultz ("Some Factors Influencing the Social Life of Primates in General and of Early Man in Particular," in S. L. Washburn, ed., *Social Life of Early Man*, Chicago: Aldine, 1961, p. 63) says: "It was no radical innovation for Dawn man to use their hands for picking up rocks or clubs as ready defence to overcome the lack of large teeth. Nearly every captive macaque delights in carrying new objects around its cage, and apes are *entertained for hours* by a blanket, or a bucket which they will not let out of their hands without a fight" (my italics).

Wherever we look we see a happy and playful activity leading to accidental solutions of unrealized problems. We do *not* see serious problem-conscious thinkers engaged in the attempt to intellectually discuss and then properly solve the problems they have set up. Later on the sequence is of course inverted by postulating either a divine inventor or a problem situation to which the minds of the contemporaries are supposed to have found the appropriate solution. Such an intellectualistic account is neither correct nor helpful for it prevents us from improving unknown faults of our situation in a spontaneous way and it also prevents us from recognizing such faults in retrospect, after their removal has made their substance clear. By all means, let us be rational: But let us not make the mistake of believing that man can and should improve his lot by reasoned planning only.

32. Cf. notes 22 and 25.

33. I cannot believe that a revolution such as the French Revolution occurred "*in the full consciousness* of [the] rights [which people possess] as men and citizens" as Wilhelm von Humboldt expresses himself (quoted from Gooch, *Germany and the French Revolution*, p. 109), or that a revolution such as the Copernican Revolution proceeded in the full consciousness of the ideas and methods, and with a full understanding of the instruments about (i.e., within the next 300 years) to be invented. In all these cases the element of *action*—unreasonable, nonsensical, mad, immoral action when seen from the point of view of a contemporary—is a necessary presupposition of whatever clarity one would like to possess, but can achieve only *after the event*, as the *result* of the actions performed. For material from the history of science see my "Problems of Empiricism, Part II," especially sections 7, 8, 11.

In *politics* and *religion* the point just made implies the need for (mass) action in addition to (party) doctrine, even if the doctrine should happen to contain definite and absolutely clear rules of procedure. *For such rules, while clear and complete when compared with other rules, are always woefully inadequate vis-à-vis the ever changing multitude of social conditions.* (In physics the situation is exactly the same: the *formalism* of the elementary quantum theory is a monster of beauty and precision. But it is very difficult to exactly specify experimental arrangements capable of *measuring* even the simplest observable. Here we must still rely on the correspondence principle.) But it is just to such conditions that their content must be referred and in the process 'anarchistic' action, i.e., action that is directly related neither to theory nor to the existing institutions, plays an essential part: "We cannot tell . . . *what* immediate cause will most serve to rouse [a revolution], kindle it, and impel very wide masses [of scientists, for example] who are at present dormant into the struggle . . . History gen-

erally, and the history of revolutions in particular, is always richer in content, more varied, more many-sided, more lively and 'subtle' than even the best parties and the most class conscious vanguards of the most advanced classes imagine . . . From this follow two very important practical conclusions: first, that in order to fulfil its task the revolutionary class must be able to master *all* forms, or sides of social activity without exception . . . second, that the revolutionary class must be ready to pass from one form to another in the quickest and most unexpected manner." Lenin, *'Left Wing' Communism*, p. 100. Cf. also the text to note 5. The application to science is quite straightforward if we keep the proper rules of translation (note 27(B)) in mind. Cohn-Bendit, *Obsolete Communism*, gives a vivid account of an anarchism of the kind. "Problems of Empiricism, Part II" applies the lesson to science. Cf. also notes 35 and 38.

[Addition in fall 1969: I now prefer the label of *Dadaism* to that of *anarchism*. There is not much difference between the two procedures *theoretically* (for partial argument see my essay "The Theatre as an Instrument of the Criticism of Ideologies," *Inquiry*, 10 (1967), 298–310, especially footnote 12 and text). *But an anarchist is prepared to kill while a Dadaist would not hurt a fly.* The only thing he does hurt is the "professional conscience" of the defenders of the status quo which at any rate must be exposed to discomfort if one wants to find its limits and if one wants to move beyond them. The necessity for mass action (interruption of "professional meetings," for example) is not denied—*but it must be restricted by a dogmatic respect for human lives and by a somewhat less dogmatic respect for the views of the opposition.*]

In *philosophy* this point implies the dependence of theoretical structure on individual action and individual decision: Kierkegaard's analysis of the Ethical applies to the sciences as well. See note 35.

34. The phrase "magical" is quite appropriate, for the inclusion of well-formed observational reports was demanded in books on magic, down to Agrippa's *De occulta philosophia*.

35. Our understanding of ideas and concepts, says Hegel (*Gymnasialreden*; quoted from K. Loewith and J. Riedel, eds., *Hegel, Studienausgabe*, vol. I, Frankfurt: Fischer Bücherei, 1968, p. 54), starts with "an uncomprehended knowledge of them" ("Es ist damit derselbe Fall wie mit anderen Vorstellungen und Begriffen, deren Verstehen gleichfalls mit einer unverstandenen Kenntnis anfaengt . . ."). Cf. also *Logik*, I, 39–40. "It sometimes happens that at a new turning point of a movement, theoretical absurdities cover up some practical truth." Lenin, diary note at the Stuttgart Conference of the Second International, quoted from Bertram D. Wolfe, *Three Who Made Revolution* (Boston: Beacon, 1948), p. 599.

The ideas which are needed in order to explain and to justify a certain procedure in the sciences are often created only by the procedure itself and remain unavailable if the procedure is not carried out. This shows that the element of action and faith which some believe has been eliminated from the sciences is absolutely essential for it: "Even intellectual history, we now admit, is relative, and cannot be dissociated from the wider social context with which it is in constant interaction." Trevor-Roper, *The European Witch Craze*, p. 100. "We are here up against an extremely interesting historical and philosophical phenomenon," writes Ronchi in his discussion of Galileo and the telescope ("Complexities, Advances, and Misconceptions in the Development of the Science of Vision: What Is Being Discovered?" in A. C. Crombie, ed., *Scientific Change*, London: Heinemann, 1963, p. 552), "which illustrates the possible harm that can be caused by logic and reason [i.e., by the exclusive use of well-established ideas and rational methods] while pure faith—for all its unreasonableness—may bring about the most fruitful results."

It is also interesting to note to what extent Kierkegaard's ideas about the role of faith, passion, subjectivity apply to our scientific life (provided, of course, we are interested in fundamental discoveries, and not just in the preservation of the status quo, in methodology, and elsewhere). Cf. *Concluding Unscientific Postscript*, trans. David

F. Swensen and Walter Lowrie (Princeton, N.J.: Princeton University Press, 1941), especially chapter II: "Truth as Subjectivity." Kierkegaard emphasizes the process over the result. "While objective thought translates everything into results and helps all mankind to cheat, by copying these off and reciting them by rote, subjective thought puts everything in process and omits the result; partly, because this belongs to him who has the way, partly because as an existing individual he is constantly in process of coming to be which holds true of every human being who has not permitted himself to be deceived into becoming objective, inhumanly identifying himself with speculative philosophy in the abstract [for example, with the rules of critical rationalism]" (p. 68). One might add that the results of objective thought which are supposed to give reason to everything emerge only at the end of a long process which therefore will have to occur without reason and will have to be passed through on faith only: The "rationality" of the early Royal Society, to take but one example, was entirely a matter of faith.

Kierkegaard's thought has had a decisive influence on Bohr (for material see M. Jammer, *The Conceptual Development of Quantum Mechanics*, New York: McGraw-Hill, 1966, pp. 172ff). It could be used, in conjunction with material from the history of science, to help us construct a new methodology which takes into consideration the role of the individual thinker, not just because he is there, and because his fate should be of interest to us, but because even the most dehumanized and "objective" form of science could not exist without his unreasonable and humorless passionate efforts. Cf. also note 27.

36. H. Marcuse, *Reason and Revolution* (London: Oxford University Press, 1941), p. 130. The quotation is about Hegel's logic.

37. Cf. note 18.

38. "It would be absurd to formulate a recipe or general rule . . . to serve all cases. One must use one's own brains and be able to find one's bearings in each separate case." Lenin, *'Left Wing' Communism*, p. 64. Cf. also note 27(B).

The reader should remember that despite all my praise for Marxism and its various proponents I am defending its *anarchistic* elements only and that I am defending those elements only insofar as they can be used for a criticism of epistemological and moral rules. I quote Lenin because of his insight into the complexity of historical conditions (which is incomparably superior to the insight of scientists and of philosophers of science) and because he recommends an appropriately complex method. I recommend Luxemburg because in elaborating her method she has always the individual before her eyes (one cannot say the same about Sir Karl Popper). I quote Mao because he is prepared to abandon doctrine, to experiment, even in quite fundamental matters. However, I do *not* quote these authors because of their defense of a uniform society of the future, or because of their belief in inexorable laws of history (in the case of Lenin the latter belief is present in a more critical form, for it is connected with *potentialities* rather than with actual developments). Such a society, such laws, it seems to me, would be even less attractive than the "system" of today whose dogmatism has the advantage of being tempered by dishonesty, doubt, cowardice, and indolence.

Some of my friends have chided me for elevating a statement such as "anything goes" into a fundamental principle of epistemology. They did not notice that I was joking. Theories of knowledge as I conceive them *develop*, like everything else. We find new principles, we abandon old ones. Now there are some people who will accept an epistemology only if it has some stability, or "rationality" as they are pleased to express themselves. Well, they can have such an epistemology, and "anything goes" will be its only principle.

39. "Problems of Empiricism," in *Beyond the Edge of Certainty*, ed. R. G. Colodny (Englewood Cliffs, N.J.: Prentice-Hall, 1965), sections IVff, especially section VI. (The relevant material has been reprinted in P. H. Nidditch, ed., *The Philosophy of Science*, London: Oxford University Press, 1969, pp. 12ff, especially pp. 25–33.) "Realism and Instrumentalism," in *The Critical Approach to Science and Philosophy*, ed. M. Bunge (Glencoe, Ill.: Free Press, 1964). "Reply to Criticism," in *Boston Studies*

in the Philosophy of Science, vol. II, ed. R. S. Cohen and M. W. Wartofsky (New York: Humanities, 1965).

40. Looking back into history we see that progress, or what is regarded as progress today, has almost always been achieved by counterinduction. Thales' principle according to which there is unity behind the variety of appearances lies at the bottom of all science, ancient and modern. Yet it is contradicted by observations of the most primitive kind (change; the difference between air and iron, for example). The same applies, and to an even larger extent, to Parmenides' principle of the impossibility of all motion. (Even a rationalist like Popper now feels inclined to attack Parmenides on empirical grounds.) The modern interpretation of mental illness as being due not to the action of some external spiritual principle but to autonomous disturbances of the sick organism ran counter to numerous instances where the action of such a principle was both *felt* (split personality, hearing voices, forced movement, objective appearance of emotions and dreams, nightmares, etc.) and *objectively observed* (phantom pregnancy, disintegration of speech patterns). Denying the power of the devil in these times was almost as foolish as (or, considering the threat of hellfire, much more foolish than) denying the existence of material objects is regarded today. Then, Copernicus put forth his magnificent hypothesis and upheld it in the face of plain and indubitable experience (for literature see the reference in note 20). Even Newton, who explicitly advises against the use of alternatives for hypotheses which are not yet contradicted by experience and who invites the scientist not merely to *guess*, but to *deduce* his laws from "phenomena" (cf. his famous rule IV), can do so only by using as "phenomena" *laws which are inconsistent with the observations at his disposal.* (As he says himself: "In laying down . . . Phenomena, I neglect those small and inconsiderable errors." *Sir Isaac Newton's Mathematical Principles of Natural Philosophy and His System of the World*, trans. A. Motte, rev. F. Cajori, Berkeley: University of California Press, 1953, p. 405.) For a more detailed analysis of Newton's dogmatic philosophy and of his dialectical method see my paper "Classical Empiricism."

Yet all these lessons are in vain. Now as ever counterinduction is ruled out by methodology. "The Counterinductive rule," says W. Salmon in his essay "The Foundation of Scientific Inference" (*Mind and Cosmos*, ed. R. G. Colodny, Pittsburgh: University of Pittsburgh Press, 1966, p. 185), is "demonstrably unsatisfactory." He fails to explain how the application of a "demonstrably unsatisfactory" rule can lead to so many satisfactory results which could not have been obtained in any other way.

41. "Fantasy as encountered in many people today is split off from what the person regards as his mature, sane, rational, adult experience. We do not then see fantasy in its true function, but experienced merely as an intrusive, sabotaging, infantile nuisance." R. D. Laing, *The Politics of Experience* (New York: Ballantine, 1967), p. 31.

Laing restricts his discussion of experience and of fantasy to their effect upon interpersonal relations (p. 23: "here, however, I am concentrating upon what we do to ourselves and to each other"). Fantasy, for him, is "a particular way of relating to the [social] world" (p. 31), telling us of problems, abilities, wishes which have become suppressed. The domain of natural science, the physical universe, remains unaffected.

But why should we restrict ourselves to rebuilding man's perception of *society* and of his *fellow men*? Why should we be interested in social reform alone and consider only new pictures of *society*? Is the structure of our *physical world* to be taken for granted? Are we expected to meekly accept the fact that we are living in a lousy material universe, that we are alone in a great ocean of lifeless matter? Or should we not try to change our vision of this universe, too, by leaving the domain of orthodox physics and considering more charming cosmologies? (The only alternative is to become mechanical oneself—this is the path chosen by some scientists, astronauts, and other strange beings.) Proliferation (revival of astrology, witchcraft, magic, alchemy, elaboration of Leibnitz's *Monadology*, and so on) will be a powerful guide in these matters. Psychiatrists and sociologists, however, must not rest content with changing perception

and society. They must interfere with the *physical* world and contemplate *its* reform in terms of our fantasies.

42. Those who want to consider the psychological consequences of proliferation will have to distinguish between intraindividual proliferation (plurality of world views within one and the same individual) and interindividual proliferation (plurality of world views in society, each individual holding only a single view and developing it according to his talents and his drive).

Intraindividual proliferation may in extreme cases lead to multiple personality. If we believe the teaching of psychoanalysis then there are always at least two elements present, the ego and the ego ideal, and the latter is ambivalent, being the result of the Oedipus complex. Freud, *Das Ich und das Es* (Leipzig-Vienna-Zurich: Internationaler Psychoanalytischer Verlag, 1923), p. 40. It is this ambivalence which turns the elements *against each other*, contributes to the *development* of both, and creates the dynamics of the individual. (In an animal which is also guided by different principles, for example by different instincts, the principles are not in competition *but work peacefully side by side*, each becoming active in specific circumstances only: G. Róheim, *Psychoanalysis and Anthropology*, p. 430.) This participation of various elements *in any particular human action* explains the "increase of flexibility, as compared to the animal world"; it explains why man "is the only organism normally and inevitably subjected to psychological conflict" (J. Huxley, *The Uniqueness of Man*, London: The Mall, 1941, p. 22); but it also explains why human behavior always presents "a mild case of insanity" (Róheim, *Psychoanalysis and Anthropology*, p. 442). The situation is further complicated by teachers, deans, bosses, and other authorities "who perpetuate the role of the father, whose demands and restrictions have remained active in the ego-ideal, and now act as moral censors in the form of our conscience" (Freud, *Das Ich und das Es*, p. 44). Imposing such a multiplicity of demands with merciless insistence, with a great amount of moralistic grumbling, threatening, headshaking, is bound to lead to crises in the life of the individual so treated and to extreme actions. "There are . . . disastrous choices [such] as those which confronted young people who felt that the service of God demanded forswearing the world forever, as in the Middle Ages, or cutting off one's finger as a religious offering, as among the Plains Indians." M. Mead, *Coming of Age in Samoa* (New York: Morrow, 1961), p. 200. Are we forced to renounce pluralism in favor of happiness and a balanced development?

I do not think we are driven to those extremes. Proliferation produces crises only if the chosen alternatives are played against each other with a vengeance. "The organization of science," writes R. K. Merton ("Behavior Patterns of Scientists," *American Scholar*, 38 (Spring 1969), 220), "operates as a system of institutionalized vigilance, involving competitive cooperation. It affords both commitment and reward for finding where others have erred or have stopped before tracking down the implications of their results, or have passed over in their work what is there to be seen by the fresh eye of another. In such a system, scientists are at the ready to pick apart and appraise each new claim to knowledge. This unending exchange of critical judgment, of praise and punishment, is developed in science to a degree that makes the monitoring of children's behavior by their parents seem little more than child's play." In a warlike community of this kind proliferation will certainly lead to tension and nastiness (and there exists a good deal of nastiness in science, as well as in other critically rationalistic enterprises) but there is no need to combine proliferation with a war of all against all. All that is needed is less moralism, *less seriousness*, less concern for the truth, a vastly deflated "professional conscience," a more playful attitude, conventionalization of "a lack of deep feeling" (Mead, *Coming of Age in Samoa*, p. 7; cf. also p. 35: "and with this goes the continual demand that [one] should not be too efficient, too outstanding, too precocious. [One] *must never excel his fellows by more than a little*," my italics)—and a good deal of laziness—and we shall be able to have our cake: to have freedom of choice in practical as well as in intellectual matters—and to eat it: to have this freedom without too much mental or emotional strain. This is one of the reasons why I regard

the moralism of today, whether it is now found on the right, with the defenders of "The System," or on the left, with the "New Revolutionaries," whether it carries with itself the invitation to "search for the truth," or the admonition to pursue some practical aim, as one of the most vicious ideologies invented by man.

43. *Autobiography* (London: Oxford University Press, 1963), p. 215. Many people are inclined to call Mill a liberal and to dismiss him because of the weaknesses of the liberal creed they have perceived. This is somewhat unjust, for Mill is very different indeed from much that is called "liberalism" today. He is a *radical* in many ways. Even as a radical, however, he excels by his rationality and his humanity. Cf. R. Lichtman, "The Façade of Equality in Liberal Democratic Theory," *Inquiry*, 12 (1969), 170–208.

44. For one particular element of this plurality, see K. R. Popper, "Back to the Presocratics," *Conjectures and Refutations* (New York: Basic Books, 1962), p. 136.

45. "Coleridge," in Cohen, ed., *The Philosophy of John Stuart Mill*, p. 62. (Numbers in parentheses in the text are pages in this edition.) ". . . I had to learn that I would recognize the value of health even in sickness, the value of rest through exertion, the spiritual through deprivation of material things . . . through evil the value of good . . . I suppose all that I ever tried to teach is expressed in these words." Sybil Leek, *Diary of a Witch* (New York: Quadrangle, 1969), pp. 49, 122.

46. Cf. also my essay "Outline of a Pluralistic Theory of Knowledge and Action," in *Planning for Diversity and Choice*, ed. S. Anderson (Cambridge, Mass.: MIT Press, 1968), which establishes the connection with scientific method alluded to toward the end of the last section.

For the relation between idea and action see the text to note 31. Emphasis on action within a libertarian framework plays an important role in Cohn-Bendit, *Obsolete Communism*, especially chapter V, p. 254: "Every small action committee [in the customary political language of the West: every institution, however small], no less than every mass movement [every large institution, including government bodies, etc.] which seeks to improve the lives of all men must resolve: (i) to respect and guarantee the plurality and diversity of political currents [in the widest sense of including scientific theories and other ideologies] . . . It must accordingly grant minority groups [such as witches, to mention only one example] the right of independent action—only if the plurality of ideas is allowed *to express itself in social practice* does this idea have any real meaning." In addition Cohn-Bendit demands *flexibility* and a *democratic base* for all institutions: "all delegates are accountable to, and subject to immediate recall by those who have elected them . . ." For example, one must "oppose the introduction of specialists and specialization" and one must "struggle against the formation of any kind of hierarchy" including the hierarchies of our educational institutions, universities, schools of technology, and so on. As regards knowledge the task is "to ensure a continuous exchange of ideas, and to oppose any control of information and knowledge." It seems to me that the best starting point in our attempt to remove the still existing fetters to thought and action is a combination of Mill's general ideas and of a practical anarchism such as that of Cohn-Bendit. Such a combination produces an ideology and a people that refuses to be intimidated, or restricted, by specialist knowledge (including the specialist knowledge disseminated by our contemporary critical rationalists), that tries to reform the corresponding institutions, especially those graceless safe-deposit boxes of wisdom, our universities, and that encourages the free flow of individuals from position to position ("[N]o function must be allowed to petrify or become fixed . . . the commander of yesterday can become a subordinate tomorrow"—Bakunin, quoted after James Joll, *The Anarchists*, London: Eyre and Spottiswoode, 1964, p. 109), assuring at the same time *that every position in society is equally attractive, and is treated with equal respect.* Let no one say that science, being purely theoretical, has nothing to do with action and politics. The scientist whose results are received with respect and even with fear by the rest of the community and whose "methods" are eagerly imitated lives in a peculiar and often quite constipated environment. It has its own style (cf. note 13), its own rules, its own silly jokes, its own standards of 'integrity' which are likely to poison the

whole republic unless special preventive measures (elimination of specialists from positions of power: careful supervision of the educational process so that personal or group idiosyncrasies do not become a national malaise; and *absolute distrust of expert testimony* and of expert morality) are taken. The connection between theory and politics must *always* be considered.

47. For the propagandistic function of medieval art, see Rosario Assunto, *Die Theorie des Schoenen im Mittelalter* (Cologne: DuMont Schauberg, 1963), especially pp. 21–22.

48. "Ideological struggle," says Mao Tse-Tung ("On the Correct Handling of Contradictions among the People," quoted from *Four Essays on Philosophy*, Peking: Foreign Language Press, 1966, p. 116), "is not like other forms of struggle. The only method to be used in this struggle is that of painstaking reasoning and not crude coercion." ". . . the growth of new things may be hindered in the absence of deliberate suppression simply through lack of discernment. It is therefore necessary to be careful about questions of right and wrong in the arts and sciences, to encourage free discussion and avoid hasty conclusions. We believe that such an attitude can help to ensure a relatively smooth development of the arts and sciences" (p. 114). "People may ask, since Marxism is accepted as the guiding ideology by the majority of the people in our country, can it be criticised? Certainly it can . . . Marxists should not be afraid of criticism from any quarter. Quite the contrary, they need to temper and develop themselves and win new positions in the teeth of criticism and in the storm and stress of struggle . . . What should our policy be towards non-Marxist ideas? . . . Will it do to ban such ideas and deny them any opportunity for expression? Certainly not. It is not only futile but very harmful to use summary methods in dealing with ideological questions among the people . . . You may ban the expression of wrong ideas, but the ideas will still be there. On the other hand, if correct ideas are pampered in hothouses without being exposed to the elements or immunized from disease, they will not win out against erroneous ones. Therefore, it is only by employing the method of discussion, criticism and reasoning that we can really foster correct ideas and overcome wrong ones, and that we can really settle issues" (pp. 111–118). The similarity to Mill, whom Mao read in his youth, is remarkable.

It is to be noted that this advice is not put forth generally, but "in the light of China's specific conditions, on the basis of the recognition that various kinds of contradictions still exist in socialist society, and in response to the country's urgent need to speed up its economic and cultural development" (p. 113; see also p. 69, i.e., "On contradiction": ". . . we must make a concrete study of the circumstances of each specific struggle of opposites, and should not arbitrarily apply the formula to everything. Contradiction and struggle are universal and absolute, but the methods of resolving contradictions, that is, the forms of struggle, differ according to the differences in the nature of the contradictions"). Cf. also note 89.

Nor is freedom of discussion granted to everyone: "As far as unmistakable counter-revolutionaries and saboteurs of the socialist cause are concerned, the matter is easy: we simply deprive them of their freedom of speech." *Four Essays on Philosophy*, p. 117. (Cf. H. Marcuse, "Repressive Tolerance," in R. P. Wolff, B. Moore, Jr., H. Marcuse, *A Critique of Pure Tolerance*, Boston: Beacon Press, 1965, p. 100. Marcuse's case is quite interesting. He demands that certain powerful elements be excluded from the democratic debate. This assumes that he has the power to suppress them and to prevent them from speaking out and making themselves heard. Now, if he has *this* power, then he certainly has the power to make his own views better known, and he has also the power to educate people in the art of critical thinking. One wonders why he prefers to use an imaginary power which he does not yet possess but which he (or his wife) would certainly like to have, for *suppressing opponents* rather than for *education* and a more balanced discussion of views. Does he perhaps realize that well-educated people would never follow him, no matter how omnipresent his slogans and how seductive his presentation?)

The restriction occurs already in Mill, though with different reasons, and expressed in different terminology: "It is, perhaps, hardly necessary to say that this doctrine is meant to apply only to human beings in the maturity of their faculties . . . The early difficulties in the way of spontaneous progress are so great that there is seldom any choice of means for overcoming them; and a ruler full of the spirit of improvement is warranted in the use of any expedients that will attain an end perhaps otherwise unattainable. Despotism is a legitimate mode of government in dealing with barbarians, provided the end be their improvement and the means justified by actually effecting that end. Liberty, as a principle, has no application to any state of things anterior to the time when mankind have become capable of being improved by free and equal discussion. . . ." *On Liberty*, pp. 197–198; cf. Lenin, *'Left Wing' Communism*, p. 40: "We can (and must) begin to build socialism not with imaginary human material . . . but with the human material bequeathed to us . . ." The *difference between Mill and Popper*, however, seems to lie in this. For Mill the (material and spiritual) welfare of the individual, the full development of his capabilities, is the primary aim. The fact that the methods used for achieving this aim also yield a scientific philosophy, a book of rules concerning the 'search for the truth,' is a side effect, though a pleasant one. For Popper the search for the truth seems to be much more important and it seems occasionally to even outrank the interests of the individual. In this issue my sympathies are firmly with Mill.

49. This and similar remarks make it clear that Mill (and Popper, who follows Mill in all the respects so far enumerated) is not "dedicated to a national religion of skepticism, to the suspension of judgement" and that he does not "den[y] the existence . . . not only of a public truth, but of any truth whatever," as we can read in Willmore Kendall's bombastic but uninformed essay "The 'Open Society' and Its Fallacies," *American Political Science Review*, 54 (1960), 972ff, quoted from P. Radcliff, ed., *Limits of Liberty* (Belmont, Calif.: Wadsworth, 1966), pp. 38 and 32. To refute the charge of suspension of judgment we should also consider this passage: "No wise man ever acquired his wisdom in any mode but this; nor is it in the nature of human intellect to become wise in any other manner. The steady habit of correcting and completing his own opinion by collating it with those of others, *so far from causing doubt and hesitation* in carrying it into practice, is the only stable foundation for a just reliance on it; for, being cognizant of all that can, at least obviously, be said against him, and having taken up his position against all gainsayers—knowing that he has sought for objections and difficulties instead of avoiding them, and has shut out no limit which can be thrown upon the subject from any quarter—he has a right to think his judgment better than that of any person, or any multitude, who have not gone through a similar process" (p. 209; my italics). Nor is the insinuation correct that Mill's society is, "so to speak, a *debating club*" (p. 36, italics in the original). Just think of Mill's insistence on different "*experiments of living*" (p. 249). Of course, such attention to detail is not to be expected from a self-righteous conservative for whom any discussion of freedom, and any attempt to achieve it, is but "evil teaching" (p. 35).

The possibilities of Mill's liberalism can be seen from the fact that it provides room for any human desire, and for any human vice. There are no general principles apart from the principle of minimal interference with the life of individuals, or groups of individuals who have decided to pursue a common aim. For example, *there is no attempt to make the sanctity of human life a principle that would be binding for all.* Those among us who can realize themselves only by killing humans and who feel fully alive only when in mortal danger are permitted to form a subsociety of their own where human targets are selected for the hunt, and are hunted down mercilessly, either by a single individual or by specially trained groups (for a vivid account of such forms of life see the film *The Tenth Victim*). So whoever wants to live a dangerous life, whoever wants to taste human blood, will be permitted to do so within the domain of his own subsociety. *But he will not be permitted to implicate others;* for example, he will

not be permitted to force others to participate in a "war of national honor," or what have you. He will not be permitted to cover up whatever guilt he may feel by making a potential murderer out of everyone. It is very strange to see how the *general* idea of the sanctity of human life that frowns upon simple, innocent, and rational murders such as the murder of a nagging wife by a henpecked husband does not object to the *general* murder of people one has not seen and with whom one has no quarrel. Let us admit that we have different tastes, let those who want to wallow in blood receive the opportunity to do so without giving them the power to make "heroes" of the rest of society. As far as I am concerned a world in which a louse can live happily is a better world, a more instructive world, a more mature world than a world in which a louse must be wiped out. (For this point of view see the work of Carl Sternheim; for a brief account of Sternheim's philosophy, see Wilhelm Emrich's Preface to C. Sternheim, *Aus dem Buergerlichen Heldenleben*, Neuwied: Hermann Luchterhand, 1969, pp. 5–19.) Mill's essay is a first step in the direction of constructing such a world.

It also seems to me the United States is very close to a cultural laboratory in the sense of Mill where different forms of life are developed and different modes of human existence tested. There are still many cruel and irrelevant restrictions, and excesses of so-called lawfulness threaten the possibilities which this country contains. However, these restrictions, these excesses, these brutalities occur in the brains of human beings; they are not all found in the Constitution. Accordingly, they can be removed by propaganda, enlightenment, special bills, personal effort (Ralph Nader!), and numerous other legal means. Of course, if such enlightenment is regarded as superfluous, if one thinks it irrelevant, if one assumes from the very beginning that the existing possibilities for change are either insufficient or condemned to failure, if one is determined to use "revolutionary" methods (methods, incidentally, which real revolutionaries, such as Lenin, would have regarded as utterly infantile, and which must increase the resistance of the opposition rather than removing it), then, of course, the "system" will appear much harder than it really is. It will appear harder *because one has hardened it oneself,* and the blame falls back on the bigmouth who calls himself a critic of society. It is depressing to see how a system that has much inherent elasticity is increasingly made less responsive by fascists on the Right and extremists on the Left until democracy disappears without ever having had a chance. My criticism, and my plea for anarchism, is therefore directed *both* against the traditional puritanism in science and society *and* against the "new," but actually age-old, antediluvian, primitive puritanism of the "new" Left which is always based on anger, on frustration, on the urge for revenge, but never on imagination. Restrictions, demands, moral arias, generalized violence everywhere. A plague on both your houses!

50. For a different argument which is entirely in Mill's spirit, see my "Problems of Empiricism," p. 185. Today increase of testability can be added to the list of epistemological benefits presented by Mill ("Problems of Empiricism," section vi). This is not a real addition, however, but only a more detailed and more technical presentation of ideas already developed by him.

51. This quotation has been added mainly for the benefit of Professor Herbert Feigl who keeps making fun of me for adopting extreme positions. Extreme positions are of extreme value. They induce the reader to think along different lines. They break his conformist habits. They are strong instruments for the criticism of what is established and well received. On the other hand, the current infatuation with "syntheses" and "dialogues" which are defended in the spirit of tolerance and of understanding can only lead to an end of all tolerance and of all understanding. To defend a "synthesis" by reference to tolerance means that one is not prepared to tolerate a view that does not show an admixture of one's own pet prejudices. To invite to a "dialogue" by reference to tolerance means inviting one to state one's views in a less radical and therefore mostly less clear way. An author who can write, in the spirit of "dialogue," that "Christianity and Marxism are not contrary to each other" (Guenther Nenning, quoted from the *Newsletter of the American Institute for Marxist Studies*, vol. 6, no. 1 (January–Febru-

ary 1969), first page bottom) will hardly be prepared to accept the doctrines of a tough-minded Marxist who is interested in progress, not in peace of mind.

52. In a singularly pretentious, ignorant, and narrow-minded book, *The Poverty of Liberalism* (Boston: Beacon, 1968), R. P. Wolff objects to proliferation on the grounds that it does not follow from the happiness principle. This criticism is certainly irrelevant to the thesis of *On Liberty*. The purpose of *On Liberty* is not to *establish a proposition*, be it now by reference to happiness, or in any other way; the purpose is *to set an example*, to present, explain, defend a certain form of life and to show its consequences in special cases (this becomes crystal clear from the relevant pages of the *Autobiography*). True—Mill also wrote on the happiness principle; but he was free and inventive enough not to restrict himself to a single philosophy, but to pursue different lines of thought. As a result maximum happiness plays no role in *On Liberty*. What does play a role is the free and unrestricted development of an individual. One can understand, however, why the author concentrates on happiness. This gives him the opportunity to display his knowledge (if one can call it that) of some of the tools which analytic "philosophers" have constructed for the endless discussion of hedonism.

In addition to the complaint just mentioned—for one can hardly call it an argument—Wolff offers what amounts to a series of rhetorical questions. "It is hard to believe," he says (p. 17), "that even the most dedicated liberal will call for the establishing of chairs of astrology in our astronomy departments or insist that medical schools allow a portion of their curriculum to the exposition of chiropractice in order to strengthen our faith in the germ theory of disease." This is hard to believe indeed, for our "most dedicated liberals" are often moral and intellectual cowards who would not dream of attacking that prize exhibit of the twentieth century—science. Besides, who would think that increasing the number of *university chairs* is going to lead to a more critical point of view? Are university chairs the only things a contemporary "radical philosopher" (text on front flap of the book) can think on when considering the possibilities of intellectual improvement? Are the limits of a university also the limits of the imagination of our academic radicals? If so, then the attack against Mill collapses at once, for how can a person with such a restricted point of view hope to even *comprehend* the simple nonacademic message of Mill's philosophy?

"Does anyone suppose," Wolff continues his inquiry (p. 16), "that a bright young physicist must keep his belief in quantum mechanics alive by periodically rehearsing the crucial experiments which gave rise to it?" Yes sir, there are lots of people who suppose just that, among them the founders of the quantum theory. There are lots of people who point out that science was often advanced with the help of some *historical* piece of knowledge and who explain the boorishness of much of contemporary physics by the very same lack of perspective which our radical author takes as the basis of his criticism. Of course, "no material harm" (p. 16) will come from the suppression of history and of alternatives just as brothels do not suffer from the philosophical ignorance of the whores—they flourish, and continue flourishing. But a philosophical courtesan certainly is preferable to a common broad because of the added techniques she can develop; and a science with alternatives is preferable to the orthodoxy of today for exactly the same reasons.

It is interesting to see how conservative so-called "radicals" become when confronted with the apparently more solid and more difficult parts of the establishment, such as for example science. Which again shows that they are moral cowards who dare to sing their arias only when there is absolutely no danger of a serious intellectual fight and when they can be absolutely sure of the support of what they think are the "progressive" elements of society.

53. Later in the nineteenth century proliferation was defended by *evolutionary arguments*: Just as animal species improve by producing variations and weeding out the less competitive variants, science was thought to improve by proliferation and criticism. Conversely, "well-established" results of science and even the "laws of thought" were regarded as temporary results of adaptation; they were not given absolute validity. Ac-

cording to Boltzmann (*Populaere Schriften*, Leipzig: Johann Ambrosius Barth, 1905, pp. 398, 318, 258–259), the latter "error finds its complete explanation in Darwin's theory. Only what was adequate was also inherited. . . . In this way the laws of thought obtained an impression of infallibility that was strong enough to regard them as supreme judges, even of experience . . . One believed them to be irrefutable and perfect. In the same way our eyes and ears were once assumed to be perfect, too, for they are indeed most remarkable. Today we know that we were mistaken—our senses are not perfect." Considering the hypothetical status of the laws of thought, we must "oppose the tendency to apply them indiscriminately, and in all domains" (p. 40). This means, of course, that there are circumstances, not factually circumscribed or *determined in any other way*, in which we must introduce ideas that contradict them. We must be prepared to introduce ideas inconsistent with the most fundamental assumptions of our science *even before* these assumptions have exhibited any weakness. Even "the facts" are incapable of restricting proliferation, for "there is not a single statement that is pure experience" (pp. 286, 222). Proliferation is important not only in science but in other domains too: "We often regard as ridiculous the activity of the conservatives, of those pedantic, constipated, and stiff judges of morality and good taste who anxiously insist on the observance of every and any ancient custom and rule of behavior; but this activity is beneficent and it must be carried out in order to prevent us from falling back into barbarism. Yet petrification does not set in, for there are also those who are emancipated, relaxed, the hommes sans gêne. Both classes of people fight each other and together they achieve a well-balanced society" (p. 322).

But Boltzmann does not always carry his ideas through to the end. Occasionally he relies on a more simplistic empiricism such as when he says that "a well-determined fact remains unchanged forever" (p. 343), or when he regards "my waking sensations [as] the only elements of my thought" (p. 173) so that "we infer the existence of objects from the impressions made on our senses" (p. 19), or when he declares, more than once, that the task of science is "to adapt our thoughts, ideas, and concepts to the given rather than subjecting the given to the judgment of the laws of thought" (p. 354; cf. with this the assertion, on p. 286, that "the simplest words such as yellow, sweet, sour, etc. which seem to represent mere sensations already stand for concepts which have been obtained by abstracting from numerous facts of experience"). He also warns us not to "go too far beyond experience." This vacillation between a sound scientific philosophy and a bad positivistic conscience is characteristic of almost all so-called "realists" from Boltzmann up to, and including, Herbert Feigl. Reasons for this phenomenon are found in Lenin's *Materialism and Empirio-Criticism* (New York: International Publishers, 1927). Popper's theory of falsification which tells us why we can *and should* go as far beyond experience as possible has considerably improved the situation. All that is needed now is a little dialectics and attention to specific historical conditions (cf., for example, note 27(B)).

54. Popper, for example, *takes it for granted* that the subject cannot enter the domain of science, and he also uses a rather simple form of mechanical materialism in his attack on Bohr. For details see part II of "On a Recent Critique of Complementarity," especially section 9. All these principles are used by him dogmatically, and without the shred of an argument. No Hegelian would ever proceed in such a simpleminded manner.

55. Cf. below, sections 12 and 13.

56. "Verhaeltnis des Skeptizismus zur Philosophie," quoted from *Hegel, Studienausgabe*, I, 113; cf. also p. 112.

57. *Differenz des Fichte'schen und Schelling'schen Systems*, p. 13.

58. "Process becomes converted back to praxis, the patient becomes an agent." Laing, *The Politics of Experience*, p. 35. There is a good deal of similarity between Hegel's attempt to set concepts in motion and the attempts of some contemporary psychiatrists to return to the individual the control of some of the defense and projection mechanisms he has himself invented.

59. *Logik*, II, 61.
60. "Reflective reason . . . is nothing but the understanding which uses abstraction, separates, and insists that the separation be maintained and taken seriously." *Logik*, I, 26.
61. *Logik*, I, 82.
62. Cf. *Differenz*, p. 14.
63. Cf. the Carnap quotation, text to note 206.
64. *Logik*, I, 25.
65. *Encyclopaedie der Philosophischen Wissenschaften*, ed. G. Lasson (Leipzig: Teubner, 1920), pp. 72–73. In the original the reference is to Kant, not to scientific empiricism.
66. *Logik*, I, 25.
67. *Logik*, II, 211.
68. *Differenz*, p. 14. Cf. Lenin's comments on a similar passage in his notes on Hegel's *Logic*, quoted in V. I. Lenin, *Aus Dem Philosophischen Nachlass* (Berlin, 1949), pp. 136ff, especially p. 142.
69. Cf. also "Skepticismus," *Hegel, Studienausgabe*, p. 117: "that scepticism is intrinsically connected with every true philosophy." Also p. 118: "Where can we find a more perfect and independent document and system of true scepticism than in Plato's . . . Parmenides? Which embraces and destroys the whole domain of a knowledge achieved by the concepts of our understanding."
70. *Differenz*, p. 25.
71. "It is my aim to read Hegel in a materialistic fashion . . ." Lenin, *Nachlass*, p. 20. The same is true of Professor D. Bohm.
72. Cf. the note on the limit and the ought, *Logik*, I, 121–122: "Even a stone, being something, is differentiated into its being for itself and its Being and so it, too, transcends its limit . . . If it is a basis for acidification, then it can be oxidized, neutralized, and so on. In the process of oxidation, neutralization, etc. its limit, i.e., only to be a basis, is removed . . . and it contains the ought to such an extent that only force can prevent it from ceasing to be a basis . . ."
73. *Logik*, I, 71.
74. "Everything that exists is linked in this way to everything else: to the *total* process of the universe. This linkage is either direct, by means of a single quantum, or else indirect, through a series of such linkages." This is how Bohm describes (*Scientific Change*, ed. Crombie, p. 478) the situation created by the quantum theory. The similarity to Hegel is no accident. Bohm has studied Hegel in detail, and he has taken the *Logic* especially as the point of departure for some of his scientific views: ". . . may we not try to understand the world as a total process, in which all parts (for example, the system under observation, observing apparatus, man, etc.) are aspects or sides whose relationships are determined by the way in which they are generated in the process? Of course, in physics, man can, in an adequate approximation, probably be left out of the totality, because he obtains his information from a piece of apparatus on the large-scale level, which is influenced in a negligible way by his looking at it. But at a quantum mechanical level of accuracy, the apparatus and the system under observation must be recognized to be linked indivisibly. Should not the theory be formulated so as to say that this is so . . . ? In a total process of the kind that I am talking about, an observation is regarded as a particular kind of movement, in which some aspects of the process are, as it were, 'projected' into certain large-scale results . . . This process of projection is . . . an integral part of the total process that is being projected" (p. 482).
75. *Logik*, II, 53.
76. *Logik*, I, 67. Cf. also the physical model for this identity in I, 78–79, according to which neither "pure light" nor "pure darkness" gives rise to (the perception of) objects which are recognized and "distinguished only in the determined light . . . which is turbid light."

77. Bohm will therefore not be able to keep contradiction out of his ideas as he occasionally seems to believe (e.g., in *Scientific Change*, p. 482, second paragraph). He agrees in other places but tries to circumvent particular contradictions by moving to a different level of reality. Cf. his *Causality and Chance in Modern Physics* (New York: Harper Torchbooks, 1961).
78. Lenin, *Nachlass*, p. 27.
79. *Logik*, I, 115.
80. *Jenenser Logik, Metaphysik und Naturphilosophie*, ed. G. Lasson (Hamburg: Felix Meiner, 1967), p. 31.
81. In German the statement is more impressive: "Die Wahrheit [des] Seins der *endlichen* Dinge ist ihr *Ende*."
82. *Logik*, I, 117.
83. *Ibid.*
84. *Ibid.*, p. 36.
85. *Ibid.*
86. Cf. below, section 13, as well as footnote 116 of "Problems of Empiricism, Part II."
87. *Logik*, I, 36; cf. also II, 54, 58ff.
88. *Logik*, I, 117.
89. F. Engels, *Anti-Duehring* (Chicago: Charles H. Kerr, 1935), pp. 144–145; my italics. I am quoting Engels, Lenin, Mao, and similar thinkers rather than the usual bunch of Hegelian or anti-Hegelian scholars as they have still kept the freshness of mind that is necessary to interpret *and to concretely apply* the Hegelian philosophy. The same is true of such physicists as Bohm, Vigier, and even Bohr who may occasionally be regarded as an unconscious Hegelian. Cf. the remarks on subject and object below. Cf. also note 38.
90. *Logik*, I, 107.
91. Mathematics was for a long time regarded as lying outside the domain of dialectics. The examples used by Hegel and Engels and especially the example of the differential calculus, so it was thought, only showed the immaturity of the mathematics of the time and the limitations of even the greatest philosophers. One should not have been quite so generous, however. What Hegel says of mathematics applies to *informal* mathematics and, insofar as informal mathematics is the source of the rest, to all of mathematics. That a dialectical study of mathematics can lead to splendid discoveries, even today, is shown by Lakatos's *Proofs and Refutations* (first published in the *British Journal for the Philosophy of Science*, 1963–64). One must praise Lakatos for having made such excellent use of his Hegelian upbringing. On the other hand one must perhaps also criticize him for not revealing his source of inspiration in a more straightforward manner but giving the impression that he is indebted to a much less comprehensive and much more mechanical school of thought. Or has his temporary membership in this school made him lose his sense of perspective? So that he prefers being mistaken for a Wittgensteinian to being classified with the dialectical tradition to which he belongs? Cf. also note 27(B).
92. *Anti-Duehring*, pp. 143–144.
93. *Ibid.*, pp. 138–139.
94. *Ibid.*, p. 144; my italics. Epistemologically these laws belong to the Aristotelian rather than to the Newtonian tradition.
95. *Encyclopaedie der Philosophischen Wissenschaften, ergaenzt durch Vortraege und Kollegienhefte*, ed. L. Henning *et al.* (Berlin, 1840), pp. 395–396; cf. also Lenin, *Nachlass*, p. 102. Or, to use Bohm's terminology: "as long as, by our customary habits of thinking, we try to say that in an experiment, some part of the world is observed [and described], with the aid of some other part, we introduce an element of confusion into our thought process. Indeed, even the very word 'observation' is misleading, as it generally implies a separation between the observing apparatus and the object under observation, of a kind that does not actually exist." *Scientific Change*, pp. 482–483.

The reader should go on and consider the beautiful example of the observation of a mirror image.

96. *Logik*, II, 224.
97. *Ibid.*, p. 227.
98. *Ibid.*, p. 408.
99. *Ibid.*, p. 225.
100. *Ibid.*, p. 408.
101. Lenin, *Nachlass*, p. 114.
102. *Logik*, II, 410.
103. *Ibid.*, pp. 408–409.
104. *Ibid.*, p. 228. "Knowledge is the eternal infinite approach of thought and object. The mirroring of nature in human thought is not 'dead,' it is not 'abstract,' *it is not without motion*, not without its contradictions but is to be conceived as an eternally moving process that gives rise to contradictions and removes them." Lenin, *Nachlass*, p. 115.
105. *Logik*, II, 228. The whole introduction to the *Subjective Logik*, i.e., II, 213–234, can be used for a criticism of what has become known as Tarski's theory of truth. If I remember correctly, this criticism is similar to a criticism voiced by the late Professor Austin in his lectures in Berkeley in 1959. Which shows that even an Oxford philosopher occasionally stumbles upon The Truth.
106. *The Assayer*, quoted from S. Drake and C. D. O'Malley, eds., *The Controversy on the Comets of 1618* (London: Oxford University Press, 1960), pp. 184–185.
107. *Dialogue concerning the Two Chief World Systems*, trans. S. Drake (Berkeley: University of California Press, 1953), p. 328.
108. D. Brouwer and G. M. Clemence, *Methods of Celestial Mechanics* (New York: Academic, 1961), p. v. Cf. also R. H. Dicke, "Remarks on the Observational Basis of General Relativity," in Hong-Yee Chiu and W. F. Hoffmann, eds., *Gravitation and Relativity* (New York: Benjamin, 1964), pp. 1–16. For a more detailed discussion of some of the difficulties of classical celestial mechanics see chapters IV and V of J. Chazy, *La Théorie de la Relativité et la Méchanique Céleste*, vol. I (Paris: Gauthier-Villars, 1928).
109. Cf. section 22 of Jammer, *The Conceptual Development of Quantum Mechanics*. For an analysis see the paper by Lakatos referred to in note 188 of the present essay.
110. H. A. Lorentz studied Miller's work for many years and could not find the trouble. It was only in 1955, 25 years after Miller had finished his experiments, that a satisfactory account of his results was found. See R. S. Shankland, "Conversations with Einstein," *American Journal of Physics*, 31 (1963), 47–57, especially p. 51, as well as footnotes 19 and 34. See also the inconclusive discussion at the "Conference on the Michelson-Morley Experiment," *Astrophysical Journal*, 68 (1928), 341ff. For general relativity see Chazy, *La Théorie de la Relativité*, I, 228ff.
111. For arguments see my essay "In Defence of Classical Physics" in the first issue of the *Studies in the History and Philosophy of Science*, Spring 1970, pp. 59–85.
112. This has been pointed out by K. R. Popper, for example in his paper "Rationality and the Search for Invariants" (Opening Address to the International Colloquium for the Philosophy of Science, London, 1965).
113. W. Heisenberg, "Der gegenwaertige Stand der Theorie der Elementarteilchen," *Naturwissenschaften*, 42 (1955), 640ff. For a comprehensive account of Heisenberg's philosophy, see Herbert Hörz, *Werner Heisenberg und die Philosophie* (Berlin: Deutscher Verlag der Wissenschaften, 1966).
114. *Physics*, book VI; *De coelo*, 303a3ff; *De generatione et corruptione*, 316a. Aristotle's theory of the continuum seems to be closely connected with his empiricism. In Aristotle the empirical doctrine is not just a philosophical dogma, it is a cosmological hypothesis that is clearly formulated (one hears, for a change, what kind of process experience is supposed to be) and *leads to a solution of problems which arose in other,*

and more 'metaphysical,' traditions. The problem of the continuum seems to be one of these problems.
115. Cf. A. Grünbaum, "A Consistent Conception of the Extended Linear Continuum as an Aggregate of Unextended Elements," *Philosophy of Science*, 19 (1952), 288ff.
116. Sir Isaac Newton, *Opticks* (New York: Dover, 1952), p. 266.
117. The rule is enunciated in Kepler's *Ad Vitellionem Paralipomena, Johannes Kepler, Gesammelte Werke herausgegeben im Auftrage der Deutschen Forschungsgemeinschaft und der Bayrischen Akademie der Wissenschaften*, vol. II (Munich: C. H. Beck'sche Verlagsbuchhandlung, 1939), p. 72. For a detailed discussion of Kepler's rule and its influence see Vasco Ronchi, *Optics: The Science of Vision* (New York: New York University Press, 1957), sections 43ff.
118. *Lectiones XVIII Cantabrigiae in Scholis publicis habitae in quibus Opticorum Phenomenon genuinae Rationes investigantur ac exponentur* (London, 1669), pp. 125–126. The passage is used by Berkeley in his attack on the traditional, 'objectivistic' optics. *An Essay towards a New Theory of Vision*, vol. I, *Works*, ed. A. C. Fraser (London, 1901), pp. 137ff.
119. Assuming M to be the observed mass of the charged particle, we obtain for its acceleration at time t the value

$$b(t) = b(O) \cdot \exp[3/2 \cdot Mc^3/e^2] \cdot t.$$

Cf. D. K. Sen, *Fields and/or Particles* (New York: McGraw-Hill, 1968), p. 10.
120. G. Källèn, *Helvetica Physica Acta*, 25 (1952), 417, as well as Sen, *Fields and/or Particles*, pp. ix and 73. ". . . this treatment illustrates how we can extract sensible numbers that can be compared with observation despite the divergence difficulties inherent in the present form of field theory." J. J. Sakurai, *Advanced Quantum Mechanics* (Reading, N.Y.: Addison-Wesley, 1967), p. 72.
121. The difficulty was realized by Bohr in his thesis. Bohr also pointed out that the velocity changes due to the change of the external field would equalize after the field is established so that no magnetic effect could arise. Cf. J. L. Heilbron and T. S. Kuhn, "The Genesis of the Bohr Atom," *Historical Studies in the Physical Sciences*, 1 (1969), 221.

The argument in the text is taken from vol. II of *The Feynman Lectures* (Reading, N.Y.: Addison-Wesley, 1965), chapter 34.6. For a somewhat clearer account see R. Becker, *Theorie der Elektrizitaet*, vol. II (Leipzig: Teubner, 1949), p. 132.
122. Cf. my translation of Ehrenhaft's lectures on singular magnetic poles which can be obtained from me at the drop of a postcard.
123. Example: the theory of Eudoxus was misunderstood for a considerable time until Schiaparelli made it comprehensible through calculations of his own. For details see N. Herz, *Geschichte der Bahnbestimmung von Planeten und Kometen*, vol. I, *Die Theorien des Altertums* (Leipzig: Teubner, 1887), pp. 18ff. This is one of the reasons why even obscure or refuted theories should not be abandoned but be made available to all, so that some sympathetic and intelligent guy may pick them up and demonstrate their hidden virtue.
124. "The ephemerides are calculated in accordance with the Newtonian law of gravitation, modified by the theory of general relativity." *Explanatory Supplement to the Astronomical Ephemeris and the American Ephemeris and Nautical Almanack* (London: Her Majesty's Stationery Office, 1961), p. 11. "In the theory of relativity the law of attraction can be formulated rigorously only for the movement of an infinitely small mass under the influence of a fixed spherical mass; this movement is determined by the geodesics of the ds^2 of Schwarzschild . . . if we now want to pass in the study of planetary movements from the Newtonian theory to the theory of relativity, then it suffices . . . to add to the Newtonian perturbations the advancements of the perihelia . . . obtained from the ds^2 of Schwarzschild." J. Chazy, *La Théorie de la Relativité et la Méchanique Céleste*, I, 228. "This mixture of the theories of

Newton and Einstein is intellectually repellent, since the two theories are based upon such different fundamental concepts. The situation will be made clear only when the many-body problem has been handled relativistically in a rational and mathematically satisfactory way." J. L. Synge, *Relativity, the General Theory* (Amsterdam: North-Holland, 1964), pp. 296–297.

125. One might be inclined to deny this statement by referring to the numerous "derivations" of classical mechanics from the general theory of relativity, some of them dealing quite explicitly with the n-body problem. Now, such derivations are but formal exercises *unless* it is shown that not only *momentary* effects but also *long-term* effects are excluded, and this for the whole period for which useful astronomical observations are available (more than 3000 years!): one would have to show that the minute deviations neglected in the usual approximations *have no cumulative effect* which might endanger the stability of the planetary system. This is precisely what is missing in the derivation of the ds^2 of Schwarzschild that is given in J. Chazy, *La Théorie de la Relativité et la Méchanique Céleste*, vol. II (Paris: Gauthier-Villard, 1930), chapters IX to XI. Planets are here quite properly embedded in the solar system, and the basic equations of relativity are used to show that the combination, referred to in note 124, of Newtonian perturbation theory and the ds^2 of Schwarzschild is valid to the degree of approximation used. However, Chazy's statement (p. 182) that "this method has thereby been shown to be legitimate" cannot be accepted, for cumulative effects have been omitted from the calculation. Considering the difficulties of the relativistic many-body problem it is not likely that they will soon be taken into account. And even if they are some day, we must still concede the existence of periods in the history of science which, from a sternly methodological point of view, are close to madness, but whose elimination is bound to wipe out science.

126. "The complete, or almost complete mistakes and failures are usually forgotten, by the prophets as well as by the faithful," says a "modern man" and decided opponent about astrology (Franz Boll and Carl Bezold, *Sternglaube und Sterndeutung*, Leipzig: Teubner, 1931, pp. 74, 72). It is clear that the judgment applies to the so-called "sciences" as well.

127. For details see again "Problems of Empiricism, Part II." The fact that science, or any historically grown subject, contains components of different age and different sophistication which hinder each other has been seen and described in a political context by Lenin, Trotsky, and others: "The gist of the matter lies in this," writes Trotsky ("The School of Revolutionary Strategy," Speech at a General Party Membership Meeting of the Moscow Organization, July 1921, quoted from *The First Four Years of the Communist International*, vol. II, New York: Pioneer Publishers, 1923, p. 5): "that the different aspects of the historical process—economics, politics, the growth of the working class—do not develop simultaneously along parallel lines." Cf. also Lenin, *'Left Wing' Communism*, p. 59, as well as the quotation in note 38 of the present essay.

The same is true of the relation between observation, auxiliary sciences, theories, and so on.

An excellent example of the phase difference between different parts of the historical process is provided by the history of witchcraft. Witchcraft persecutions were at their peak at the beginning of the seventeenth century and later on, when Galileo reported his telescopic discoveries, Kepler found the laws of planetary motion (and had to defend his own mother against the accusation of witchcraft), when Descartes developed his rationalism and his materialistic physics, 80 years after Copernicus, 40 to 50 years after Montaigne, and they continued into the age of Newton. And the belief was very often held by people who were otherwise perfect examples of the new "scientific spirit." In these times "in which science and art were reborn . . . when people were painting and sculpting anew and once more turned towards investigation and writing, the making of new discoveries and new inventions, when the old classical world and bookprinting seemed to recast the face of Western civilization—in those very days humanity

stood in one respect on a lower level of mental development than do some of the primitive races of today." C. Binz, *Doctor Johann Weyer* (Bonn: Landesverlag, 1895), p. 3.

128. In what follows the reader is advised to always consult his Hegel and to compare my statements with Hegel's own dialectical formulations. The reader will also realize that my analysis at once invalidates the direct and naively empirical "refutations" of Marxism by Bernstein, Popper, and others. Things are not quite that simple! Cf. also the next section.

129. *Dialogue concerning the Two Chief World Systems*, p. 126.

130. *Ibid.*, p. 125.

131. *Ibid.*, p. 256.

132. "Problems of Empiricism," pp. 204ff.

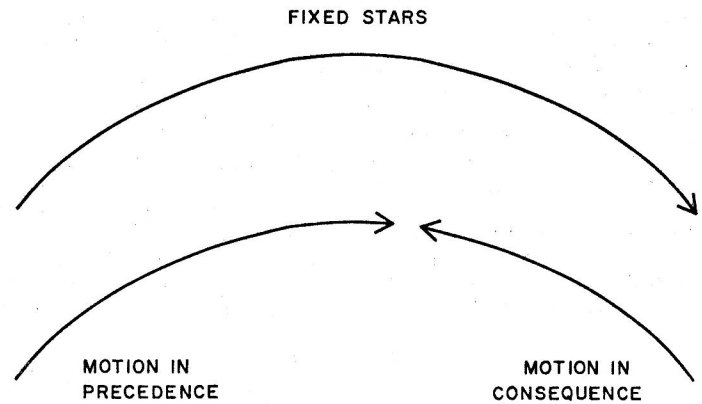
133. Bacon, *The New Organon*, Introduction.

134. *Dialogue concerning the Two Chief World Systems*, p. 255. My italics.

135. *Ibid.*, p. 256.

136. *Ibid.*, p. 248.

137. *Ibid.*, p. 171. Only one example to support this thesis: In the Middle Ages there existed two theories of planetary motion, one asserting a motion in consequence, with Saturn the slowest planet and the moon the fastest, the other asserting a motion



in precedence, i.e., from east to west, with Saturn the fastest (but not as fast as the celestial sphere) and the moon the slowest. The first theory is held by Plato (*Laws*, 822a), by all the followers of Ptolemy; it occurs in the Sphere of Sacrobosco (Lynn Thorndike, *The "Sphere" of Sacrobosco and Its Commentators*, Chicago: University of Chicago Press, 1949, p. 120, Latin text p. 79), in the German Sphere of Conrad von Megenberg, and in many encyclopedias and textbooks (Vitruvius, Isidore, Bede, Hrabanus Maurus, and others). The second theory occurs in Democritus, in Wolfram von Eschenbach's *Parzival* (cf. G. K. Bauer, *Sternenkunde und Sterndeutung der Deutschen im 9.–14. Jahrhundert*, Berlin, 1937, pp. 27–28). Both theories are compared in the book *De solis affectibus* (Jacques Paul Migne, *Patrologia Latina*, vol. 172, p. 108): "Utrique sententiae, sive contra firmamentum vadunt planetae, seu cum firmamentum potest opponi." Yet we have here a perfect example of relative motion. An even better

example of the operative interpretation of motion is provided by the habit of interpreting Bible passages concerning motion as dealing with absolute motion. Altogether the interpreters of the Bible disregard *appearances* and regard terms such as "move," "to be at rest," as absolute terms referring to *objective situations* having unique consequences. This in turn is the result of a naive realism of fantastic proportions. Thus St. Augustine (*De Genesi ad litteram*, II, chapter XVI; Migne, *Patrologia Latina*, vol. 134, p. 277) rejects the idea of fixed stars bigger than the sun on the basis of the duo luminaria magna of Genesis 1:16. The persistence of the belief in witchcraft is at least partly due to this instinctive naive realism that was reluctant to declare as illusory what one had experienced so plainly. Cf. Gregory Zilboorg, *The Medical Man and the Witch during the Renaissance* (Baltimore: Johns Hopkins Press, 1935). Cf. also note 40.

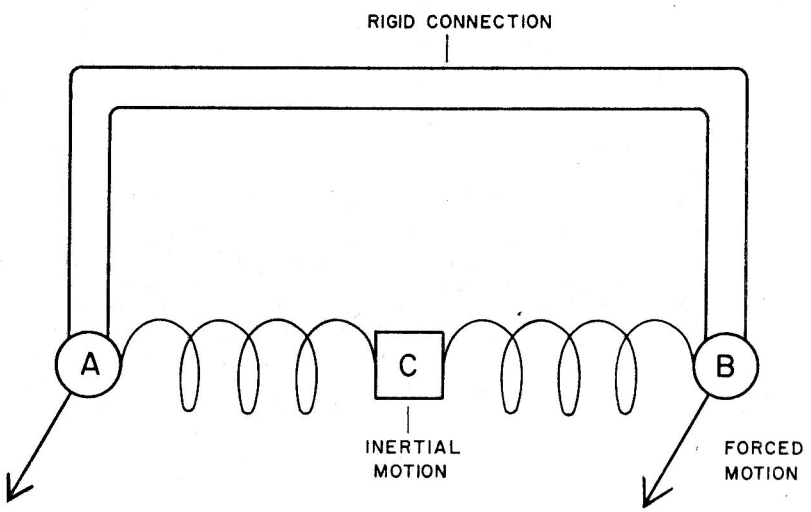
Finally, it must not be overlooked that the *impetus theory* which Galileo accepts in his early writings on mechanics (*De motu*; *De motu dialogus*) and which had been the *opinio communis* since the fifteenth century demands an absolute view of motion. For if the motive force *resides* in a moving object in the same way in which heat resides in a piece of iron, or sound in a bell that has just been struck (for these examples see *De motu* as translated by I. E. Drabkin in Galileo Galilei, *On Motion and On Mechanics*, ed. S. Drake and I. E. Drabkin, Madison: University of Wisconsin Press, 1960, p. 77, and memorabilia on motion as translated by I. E. Drabkin in Drake and Drabkin, eds., *Mechanics in 16th Century Italy*, Madison: University of Wisconsin Press, 1969, p. 379), then the necessary effect of such a force, i.e., motion, cannot depend on the *relation* of the object to an arbitrarily chosen coordinate system: the impetus theory entails the absolute, or operative, view of *all* motion.

138. Cf. "Problems of Empiricism," pp. 204ff.

139. Cf. Hegel, *Vorlesungen uber die Geschichte der Philosophie*, part I, ed. C. L. Michelet (Berlin: Duncker und Humblot, 1840), p. 289.

140. *Dialogue concerning the Two Chief World Systems*, p. 171.

Galileo's relativism with respect to motion is far from being satisfactory, or even consistent. He proposes the view, (i), expressed in the quotation in the text, that shared motion has *no effect whatever*. "Motion," he says (*Dialogue*, p. 116), "insofar as it is and acts as motion, to that extent exists relatively to things that lack it; and among things which all share equally in any motion, it does not act and is as if it did not exist." "Whatever motion comes to be attributed to the earth must necessarily remain im-



perceptible . . . so long as we look only at terrestrial objects" (p. 114). ". . . motion that is common to many moving things is idle and inconsequential to the relation of these movables among themselves . . ." (p. 116).

On the other hand, (ii), there is the assertion (cf. *Dialogue*, p. 19) that "nothing . . . moves in a straight line *by nature*. The motion of all celestial objects is in a circle; ships, coaches, horses, birds, all move in a circle around the earth; the motions of the parts of animals are all circular; in sum—we are forced to assume that only *gravia deorsum* and *levia sursum* move apparently in a straight line; but even that is not certain as long as it has not been proven that the earth is at rest."

Now, if (ii) is adopted, then (i) cannot be correct. For assume that two objects, A and B, being rigidly connected, move in a straight line and that a third object, C, is fastened to them by a spring. Clearly C, being moved forcibly, will tend to assume its natural circular motion and will therefore change its relation to A and B, thus contradicting the assertion, inherent in (i), that common motion does not affect the relation between things. It is this inconsistency which has forced me to split the argument in the text into two steps, one dealing with the relativity of motion (only relative motion it *noticed*), the other dealing with inertial laws (and only inertial motion *leaves* the relation between *the parts of a system unaffected*—assuming, of course, that neighboring inertial motions are approximately parallel). For the two steps of the argument see the beginning of section 8.

It is also important to realize that accepting the relativity of motion even for inertial paths means giving up the impetus theory (cf. the last part of note 137). This Galileo seems to have done by now, for his argument for the existence of "boundless" or "perpetual" motions which he outlines on pp. 147ff of the *Dialogue* appeals to motions which are neutral, i.e., neither natural nor forced and which may therefore(?) be assumed to go on forever.

141. J. L. Austin, *Sense and Sensibilia* (New York: Oxford University Press, 1964), p. 74.

142. For details see the Appendix at the end of this paper.

143. *Dialogue concerning the Two Chief World Systems*, pp. 171–172.

144. *Ibid.*, pp. 249–250.

145. *Ibid.*, pp. 172–173.

146. *Ibid.*, p. 250.

147. Ptolemy, *Syntaxis*, i.7.

148. *Dialogue concerning the Two Chief World Systems*, p. 416. Cf. the *Dialogues concerning Two New Sciences*, trans. Henry Crew and Alfonso de Salvio (London, 1914; New York: Dover, 1958), p. 164: "The same experiment which at first glance seemed to show one thing, when more carefully examined, assures us of the contrary."

149. *Dialogue concerning the Two Chief World Systems*, p. 131.

150. *Ibid.*, p. 327.

151. *Ibid.*, p. 330.

The idea that there is an absolute direction in the universe has a very interesting history. It rests on the structure of the gravitational field on the surface of the earth or of that part of the earth which the observer knows, and generalizes the experiences made there. The generalization is only rarely regarded as a separate hypothesis; it rather enters the "grammar" of common sense and gives the terms "up" and "down" an absolute meaning. (This is a natural interpretation, in precisely the sense that was explained in the text above.) Lactantius, a church father of the fourth century, appeals to this meaning when he asks (*Divinae Institutiones*, III, de falsa sapientia): "Is one really going to be so confused as to assume the existence of humans whose feet are above their heads? Or of regions where the objects which fall with us rise instead? Where trees and fruit grow not upward, but downwards?" The same use of language is presupposed by that "mass of untutored men" who raise the question why the antipodes are not falling off the earth (Pliny, *Natural History*, II, 161–166; cf. also Ptolemy,

Syntaxis, i.7). The attempts of the Presocratics, Thales, Anaximenes, Xenophanes, to find support for the earth which prevents it from falling "down" (Aristotle, *De coelo*, 294a12ff) show that almost all early philosophers with only the exception of Anaximander have shared in this way of thinking. (For the Atomists who assume that the atoms originally fall "down," see M. Jammer, *Concepts of Space*, Cambridge, Mass.: Harvard University Press, 1953, p. 11). Even Galileo, who thoroughly ridicules the idea of the falling antipodes (*Dialogue concerning the Two Chief World Systems*, p. 331) occasionally speaks of the "upper half of the moon" (p. 65), meaning that part of the moon "which is invisible to us." And let us not forget that some linguistic philosophers of today "who are too stupid to recognize their own limitations" (p. 327) want to revive the absolute meaning of "up-down" at least *locally*. Thus the power over the minds of his contemporaries of a primitive conceptual frame assuming an anisotropic world, which Galileo had also to fight, must not be underestimated. For an examination of some aspects of common sense at the time of Galileo, including astronomical common sense, the reader is invited to consult E. M. W. Tillyard, *The Elizabethan World Picture* (London: Penguin, 1963). The agreement between popular opinion and the central-symmetrical universe is frequently asserted by Aristotle. See, for example, *De coelo*, 308a23f.

152. *Dialogue concerning the Two Chief World Systems*, p. 327.

153. *Ibid.*, p. 327; italics added.

154. *Ibid.*, pp. 132, 416.

155. Cf. footnote 137 of "Problems of Empiricism, Part II."

156. *Dialogue concerning the Two Chief World Systems*, p. 341. Galileo here quotes part of Copernicus's address to Pope Paul III in *De revolutionibus*. Cf. also the Narratio Prima (quoted from E. Rosen, *Three Copernican Treatises*, New York: Dover, 1959, p. 165): "For all these phenomena appear to be linked most nobly together, as by a golden chain; and each of the planets, by its position, and order, and every inequality of its motion, bears witness that the earth moves and that we who dwell upon the globe of the earth, instead of accepting its changes of position, believe that the planets wander in all sorts of motions of their own." Note that empirical reasons are absent from the argument, and they have to be, for Copernicus himself admits (Commentariolus, Rosen, *Three Copernican Treatises*, p. 57) that the Ptolemaic theory is "consistent with the numerical data."

157. *Dialogue concerning the Two Chief World Systems*, p. 120.

In their book *Geschichte der Hexenprozesse*, vol. I (Stuttgart: Cotta, 1880), p. 64, W. G. Soldan and H. Heppe comment on the *fluidity* of concepts such as striga, empusa, Lamia, and they continue: "it must not be forgotten that no physiology has been written for the domain of superstition and that there remained, despite the existence of certain essential elements, sufficient leeway for variety in the particulars, according to age, locality, or the fantasy of the individual poet." Cf. also the material assembled by J. Frank, "Geschichte des Wortes Hexe," in J. Hansen, *Quellen und Untersuchungen zur Geschichte des Hexenwahns und der Hexenverfolgungen im Mittelalter* (Bonn: Olbers, 1901), chapter VII. My analysis of Galileo shows that such fluidity is a characteristic of science also and that it takes possession not only of the accidental elements of a concept, but of its very essence. Moreover, it is a precondition of scientific progress. The stability of concepts is not the differentia specifica that separates science from witchcraft (magic, poetry, and so on).

158. Cf. "Classical Empiricism."

159. Cf. note 140.

160. *Dialogue concerning the Two Chief World Systems*, p. 145.

161. *Ibid.*, p. 147.

162. Cf. note 140.

163. Charles B. Schmitt, in an interesting and very important article ("Experience and Experiment: A Comparison of Zabarella's View with Galileo's *De motu*," *Studies*

in the Renaissance, 16 (1969), 80–138) discusses the various notions of experience which were active in the sixteenth and seventeenth centuries and tries to determine Galileo's own position during his years in Pisa. Galileo then regarded experience as a "useful device to resolve a particular dispute. By merely observing the world around us we can sometimes decide either for or against a particular opinion which has been brought forth. Therefore, Aristotle can sometimes be criticized for holding positions which are not in conformity with experience. On the other hand, Aristotle sometimes relies too much upon experience, to the extent that he does not allow a sufficient role to *rationes*; but according to Galileo it is through *rationes* that demonstration takes place. That is to say: demonstration and proof depend upon 'objects of thought' rather than 'objects of experience' (pp. 111–112). Accordingly, "with the young Galileo . . . experience is not always so carefully selected and, more often than not, proves to be deceptive or, at least, not capable of resolving the problem at hand" (p. 124). In addition Galileo seems to distrust experience because of its occult overtones (p. 135): there was a tradition, in the sixteenth and seventeenth centuries, when experience went hand in hand with the study of magic and of the occult, being a source of knowledge in cases which could not be reached by reason: "There are hidden forces," writes Cornelius Agrippa in his *Occult Philosophy* (I, 10), "whose causes are inaccessible because reason cannot thoroughly explore them. Therefore philosophers have studied the greater number of these causes by experience rather than by thought" (cf. Schmitt, pp. 86ff, and the literature there). Now our hypothesis is (a) that later on Galileo neither rejected experience nor relied on it to the exclusion of everything else, *but that he changed it so that 'objects of thought' became perceptible*, and (b) that his belief in the Copernican theory played an essential part in the transformation. This hypothesis will of course have to be supported by a more detailed study than I have given here. Schmitt's article shows that the situation is less settled than is usually assumed and that many popular views concerning Galileo (including those put forth more recently by Geymonat—see Schmitt, footnote 133) are oversimplified, to say the least. "What are some of the broader implications of our investigation?" asks Schmitt at the end of his paper (p. 136). "Although it seems obvious that the 'experimental method' which emerged in the 17th century was in some way or another an outgrowth of the observationalist and experientialist tradition of the preceding centuries, it is not at all clear precisely *how*. To see it as merely an outgrowth of technological practice on the one hand, or of Aristotelian empiricism on the other, seems to oversimplify the situation to the point of distortion. At the same time, one must be careful not to dismiss entirely the significance of observation and experience and to make the 'scientific revolution' merely a conceptual revolution in which a Platonic view of the universe replaced an Aristotelian one. It seems clearly to have been a more complex process than either of these interpretations would seem to suggest. It is the belief of the present writer," Schmitt continues, "that more light could be shed on this subject through a detailed study of sixteenth century writings on natural philosophy, both scholastic, and non-scholastic." I would add that one must also study the manner in which the wish to make Copernicus true has influenced the procedures of some thinkers, and especially of Galileo.

164. Cf. *Physics*, 208b10ff.

165. Galileo seems to have been aware of this situation. He silently abandons the idea of the nonoperative character of circular motion in his attempt to prove the motion of the earth from the tides. Cf. H. L. Burstyn, "Galileo's Attempt to Prove That the Earth Moves," *Isis*, 53 (1962), 161–185, and the literature cited there.

166. Such a stone, says Galileo (*Dialogue concerning the Two Chief World Systems*, p. 233), would arrive ahead of the tower.

167. One might be inclined to assume that the phenomenon of projectile motion which in the fourteenth century had led to various criticisms of the Aristotelian point of view was a clear empirical basis for a law such as Galileo wanted to establish. A

little consideration shows that this cannot have been the case. All one knew about projectile motion was that it proceeded for some time and then came to a halt. Galileo's circular law is in no way determined by this phenomenon. It is determined by his wish to preserve the Copernican view. Cf. also notes 137, 140, and the text below. Buridan, incidentally, *rejected* the rotation of the earth.

168. Cf. note 140.

169. For an enumeration of such experiments see A. Armitage, "The Deviation of Falling Bodies," *Annals of Science*, 5 (1941–47), 342–351. For further material and discussion see A. Koyré, *Metaphysics and Measurement* (Cambridge, Mass.: Harvard University Press, 1968). For a comprehensive survey see G. Hagen, *La Rotation de la Terre* (Rome, 1911). It is interesting to see how the experiments ceased after their first inconclusive results, and how they were resumed when Newton made a new prediction concerning their outcome. Cf. Armitage, "The Deviation of Falling Bodies," p. 346.

170. *De motu*, trans. Drabkin, p. 73.

171. *Ibid.*, p. 78.

172. Drabkin translation, p. 338. Drake in footnote 10 of the same page comments that "Galileo was not a Copernican when he wrote this."

173. Quoted from Drake and Drabkin, eds., *Mechanics in 16th Century Italy*, p. 228.

174. *De motu*, pp. 73–74.

175. *Ibid.*, p. 74.

176. *Physics*, VII, 1; 241b34–36.

177. *De motu*, p. 79. Cf. also notes 137 and 140.

178. *De motu*, chapter XVIII in Drabkin's subdivision.

179. Cf. notes 137 and 140.

180. *De revolutionibus*, i.8.

181. *Dialogue concerning Two New Sciences*, pp. 215, 250.

182. Pp. 147ff. Cf., however, the inconsistency described in note 137 of the present essay.

183. According to Anneliese Maier, *Die Vorlaeufer Galileis im 14. Jahrhundert* (Rome: Edizioni di Storia e Litteratura, 1949), pp. 151ff, Galileo replaces impetus by inertia in order to explain the "fact" that "neutral" motions go on forever. Now, to start with, there is no such fact. Secondly, Galileo initially does not believe, and rightly so, that there is such a fact. This we have just seen. There is therefore no need for him "to explain certain newly detected *phenomena*" (p. 151). The need was purely theoretical: to accommodate, to "save," not a phenomenon, *but a new world view.*

184. The so-called scientific revolution led to astounding discoveries and it considerably extended our knowledge of physics, physiology, and astronomy. This was achieved by pushing aside and regarding as irrelevant, *and often as nonexistent*, those facts which had supported the older philosophy. Thus all the evidence for witchcraft, demonic possession, all the empirical phenomena one had been able to cite in favor of the existence of the devil, were pushed aside *together with* the "superstitions" they once confirmed. The result was that "towards the close of the Middle Ages science was forced away from human psychology, so that even the great endeavour of Erasmus and his friend Vives, as the best representatives of humanism, did not suffice to bring about a rapprochement, and psychopathology had to trail centuries behind the developmental trend of general medicine and surgery ["The hatred and jealousy of the doctors," says von Gleichen, "when they persecute, [is] as dangerous as that of the priests"]. As a matter of fact . . . the divorcement of medical science from psychopathology was so definite that the latter was always totally relegated to the domain of theology and ecclesiastic and civil law—two fields which naturally became further and further removed from medicine . . ." Zilboorg, *The Medical Man and the Witch*, pp. 3–4 as well as 70ff. ("Dr. Zilboorg," says H. Sigerist in his introduction to the book, "recognised that witchcraft is the central problem in the development of occidental psychiatry. In the changing attitude towards witchcraft modern psychiatry was born as a medical discipline.") Astronomy advanced, but our knowledge of man slipped back into an earlier, more primitive stage. Cf. note 127.

Another example is *astrology*. "In the early stages of the human mind," writes A. Comte (*Philosophie Positive*, Paris: Littré, 1836, III, 273–280), "these connecting links between astronomy and biology were studied from a very different point of view, *but at least they were studied and not left out of sight*, as is the common tendency in our own time, under the restricting influence of a nascent and incomplete positivism. Beneath the chimaerical belief of the old philosophy in the physiological influence of the stars, there lay a strong though confused recognition of the truth that the facts of life were in some way dependent on the solar system. Like all primitive inspirations of man's intelligence this feeling needed rectification by positive science, but not destruction; though unhappily in science, as in politics, it is often hard to reorganise without some brief period of overthrow."

185. "Neurath fails to give . . . rules [which distinguish empirical statements from others] and thus unwittingly throws empiricism overboard." K. R. Popper, *The Logic of Scientific Discovery* (New York: Basic Books, 1959), p. 97.

186. *Papirer*, ed. P. A. Heiberg (Copenhagen, 1909), VII, part I, see A, Nr. 182. Cf. also sections 7ff of my forthcoming paper "Abriss einer anarchistischen Erkenntnislehre."

187. Cf. note 31 and text.

188. "Criticism and the Methodology of Scientific Research Programs," in *Criticism and the Growth of Knowledge*, ed. I. Lakatos and A. Musgrave (Amsterdam: North-Holland, 1969). Quotations are from the typescript of the paper which Lakatos distributed liberally before its publication. In this typescript the reference is mostly to Popper. Had Lakatos been as careful with acknowledgments as he is when the Spiritual Property of the Popperian Church is concerned, he would have pointed out that his liberalization which sees knowledge as a process is indebted to Hegel.

189. Popper, *The Open Society and Its Enemies*, pp. 388ff.

190. *Ibid.*, p. 390. Cf. also note 28.

191. *Ibid.* Cf. note 22 and the corresponding text.

192. *Ibid.*, p. 391.

193. *Ibid.*, p. 231.

194. I am referring here to the following two papers: "Epistemology without a Knowing Subject," in Bob Van Rootselaar and J. F. Staal, eds., *Logic, Methodology and a Knowledge of Science*, vol. III (Amsterdam: North-Holland, 1968), as well as "On the Theory of the Objective Mind." In the first paper, *birdnests* are assigned to the "third world" (p. 341) and an interaction is assumed between them and the remaining worlds. They are assigned to the third world *because of their function*. But then stones and rivers can be found in this third world too, for a bird may sit on a stone, or take a bath in a river. As a matter of fact, everything that is noticed by some organism will be found in the third world, which will therefore contain the whole material world and all the mistakes mankind has made. It will also contain "mob psychology."

195. Cf. again "Problems of Empiricism, Part II."

196. Cf. *Malleus Maleficarum*, trans. Montague Summers (London: Pushkin Press, 1928), part II, question 1, chapter IV: "Here follows the way whereby witches copulate with those Devils known as Incubi," second item, as to the acts, "whether it is always accompanied with the injection of semen received from some other man." The theory goes back to St. Thomas Aquinas.

197. It is of course possible to establish correlations between the *sentences* of the two theories, but one must realize that the elements of the correlation, when interpreted, cannot be both meaningful, or both true: if relativity is true, then classical descriptions are either always false or are always nonsensical. Continued use of classical sentences must therefore be regarded as an abbreviation for sentences of the following kind: "Given conditions C, the classical sentence S was uttered by a classical physicist whose sense organs are in order, and who understands his physics"—and sentences of this kind,

if taken together with certain psychological assumptions, can be used for a test of relativity. However, the *statements* which are expressed by these sentences are part of the *relativistic* framework, for they use relativistic terms. This situation is overlooked by Lakatos who argues as if classical terms and relativistic terms can be combined at will and who infers from this assumption the nonexistence of incommensurability.

198. This became clear to me in a discussion with Mr. L. Briskman, in Professor Watkins's seminar at the London School of Economics.

199. This seems to occur in certain versions of the general theory of relativity. Cf. A. Einstein, L. Infeld, and B. Hoffmann, "The Gravitational Equations and the Problem of Motion," *Annals of Mathematics*, 39 (1938), 65, and Sen, *Fields and/or Particles*, pp. 19ff.

200. This consideration has been raised into a principle by Bohr and Rosenfeld, *Kgl. Danske Videnskab. Selskab*, Mat.-Fys. Medd., 12, no. 8 (1933), and, more recently, by Robert F. Marzke and John A. Wheeler, "Gravitation as Geometry I," in Chiu and Hoffmann, eds., *Gravitation and Relativity*, p. 48: "every proper theory should provide in and by itself its own means for defining the quantities with which it deals. According to this principle, classical general relativity should admit to calibrations of space and time that are altogether free of any reference to [objects which are external] to it such as rigid rods, inertial clocks, or atomic clocks [which involve] the quantum of action."

201. It is possible to base space-time frames on this new element entirely, and to avoid contamination by earlier modes of thought. All one has to do is to replace distances by light times and to treat time intervals in the relativistic fashion, for example, by using the k-calculus (Cf. chapter II of J. L. Synge, "Introduction to General Relativity," in *Relativity, Groups, and Topology*, ed. C. M. DeWitt and B. B. DeWitt, New York: Gordon, 1964. For the k-calculus see H. Bondi, *Assumption and Myth in Physical Theory*, London: Cambridge University Press, 1967, pp. 28ff, as well as D. Bohm, *The Special Theory of Relativity*, New York: Benjamin, 1965, chapter XXVI.) The resulting concepts (of distance, velocity, time, etc.) are a necessary part of relativity, in the sense that all *further* ideas, such as the idea of length as defined by the transport of rigid rods, must be changed and adapted to them. They therefore suffice for explaining relativity. Following their own principle as described in note 200 Marzke and Wheeler have given an account of relativistic terms that does not involve any objects external to the theory (this account goes back to Robert F. Marzke, "The Theory of Measurement in General Relativity," A.B. senior thesis, Princeton University, 1959; the article by Marzke and Wheeler is the only published report available so far). All intervals, whether spatial or temporal, are expressed in terms of some (spatial or temporal) standard interval. There is no difference between the units used for intervals of distance and intervals of time. The construction which leads to measurement in terms of the standard interval is carried out with the help of light and mass points only and involves neither rigid rods nor clocks whose construction would have to be explained in nonrelativistic terms. "The importance of light rays and the light cone in the intrinsic geometry of physics comes more directly to the surface. The true function of the speed of light is no longer confused with the trivial task of relating two separate units of interval, the meter and the second, of purely historic and accidental origin" (Marzke and Wheeler, "Gravitation as Geometry I," p. 56). The difference between such terms and classical terms is now very obvious and the assertion of incommensurability is made much more precise. Cf. also note 205.

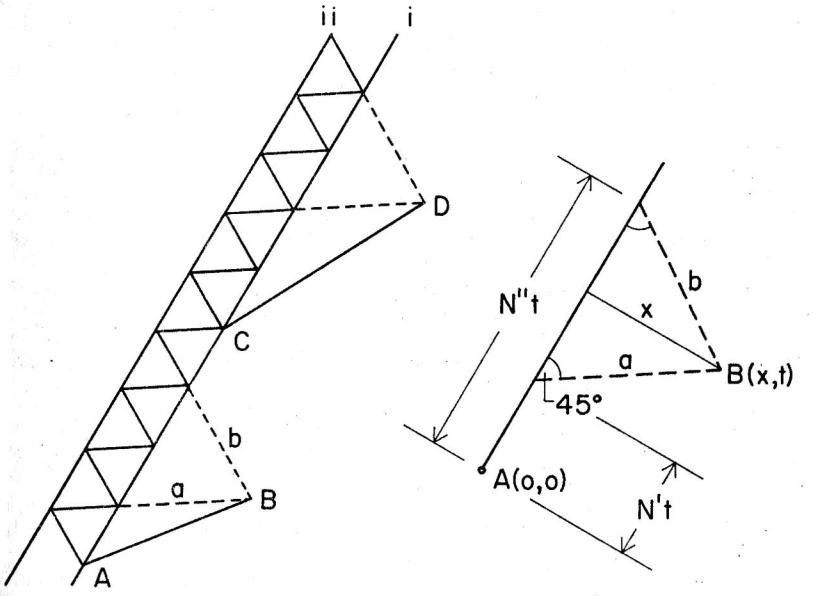
202. For this point and further arguments see A. S. Eddington, *The Mathematical Theory of Relativity* (Cambridge: Cambridge University Press, 1963), p. 33. The more general problem of concepts and numbers has been treated by Hegel, *Logik*, I, Das Mass.

203. This takes care of an objection which Professor J. W. N. Watkins has raised on various occasions.

204. For further details, especially concerning the concept of mass, the function of "bridge laws" or "correspondence rules," and the two-language model, see section iv of "Problems of Empiricism." It is clear that, given the situation described in

the text, we cannot derive classical mechanics from relativity, not even approximately. For example, we cannot derive the classical law of mass conservation from relativistic laws. The possibility of connecting the *formulas* of the two disciplines in a manner that might satisfy a pure mathematician, or an instrumentalist, is, however, not excluded. For an analogous situation in the case of quantum mechanics see section 3 of my paper "On a Recent Critique of Complementarity." See also section 2 of the same article for more general considerations.

205. Marzke and Wheeler measure length in the following way (for details see "Gravitation as Geometry I"): First, flatness of space is ascertained to the degree of precision desired. Next, a method is devised for constructing a parallel to any straight line in space-time (the method uses inertial trajectories and light rays only, thus eliminating all nonclassical space-time notions). Third, a "geodesic clock" is constructed by



letting a pulse of light be reflected back and forth between two parallels: the intersections of the pulse with one of the lines are the "ticks" of the clock. Finally, two arbitrary intervals, AB and CD, are compared, thus: A trajectory, i, is found that connects A and C. A parallel, ii, is drawn to i. A geodesic clock is constructed between i and ii. A light ray, a, is sent from i toward B and reflected from it back to i (b). $N'\tau$ and $N''\tau$ are the times of departure and arrival of this light ray, counted from A. Assuming c equal to 1 we see that

$N'\tau = t - x$

$N''\tau = t + x$, so that

$N'N''\tau^2 = t^2 - x^2 = (t - O)^2 - (x - O)^2 = (t_B - t_A)^2 - (x_B - x_A)^2 = (\Delta s_{AB})^2$,

hence

$(\Delta s_{AB}) = AB = \tau\sqrt{N'N''}$

$(\Delta s_{CD}) = CD = \tau\sqrt{N'N''}$, so that

$$\frac{CD}{AB} = \sqrt{\frac{N'''N''''}{N'N''}}$$

which gives the numerical values resulting from the comparison.

Now this method clearly works only if we can assume that it gives the same results in all inertial systems, for example, if we can assume that c has the same value in all inertial systems. If there exists a preferred system, or if the classical principle of velocity addition is still assumed to be valid, then the method no longer leads to useful numbers, and transitivity of length cannot be guaranteed for all inertial systems (just assume three systems, A, B, and C, B moving with c/ 2 relatively to A and C with c/ 2 relatively to B, then length measured in C will always be O, assuming A is the rest system).

206. R. Carnap, "The Methodological Character of Theoretical Concepts," *Minnesota Studies in the Philosophy of Science*, vol. I, ed. H. Feigl and M. Scriven (Minneapolis: University of Minnesota Press, 1956), p. 47.

207. An even more conservative principle is sometimes used when discussing the possibility of languages with a logic different from our own: "Any allegedly new possibility must be capable of being fitted into, or understood in terms of, our present conceptual or linguistic apparatus." B. Stroud, "Conventionalism and the Indeterminacy of Translations," *Synthese*, 1968, p. 173.

208. As an example the reader is invited to consult J. Piaget, *The Construction of Reality in the Child* (New York: Basic Books, 1954).

209. *Ibid.*, pp. 5ff.

210. For the condition of research formulated in the last sentence see section 8 of "Reply to Criticism," *Boston Studies in the Philosophy of Science*, vol. II, ed. Cohen and Wartofsky. For the role of observation see section 7 of the same article. For the application of Piaget's work to physics and, more especially, to the theory of relativity see the appendix of Bohm, *The Special Theory of Relativity*. Bohm and Schumacher have also carried out an analysis of the various informal structures which underlie our theories. One of the main results of their work is that Bohr and Einstein argued from incommensurable points of view. Seen in this way the case of Einstein, Podolsky, and Rosen *cannot* refute the Copenhagen Interpretation and it cannot be refuted by it either. The situation is, rather, that we have two theories, one permitting us to formulate EPR, the other not providing the machinery necessary for such a formulation. We must find independent means for deciding which one to adopt. For further comments on this problem see section 9 of my "On a Recent Critique of Complementarity."

211. For what follows cf. also my review of Nagel's *Structure of Science* on pp. 237–249 of the *British Journal for the Philosophy of Science*, 6 (1966), 237–249.

212. Carnap, "The Methodological Character of Theoretical Concepts," p. 40. Cf. also C. G. Hempel, *Philosophy of Natural Science* (Englewood Cliffs, N.J.: Prentice-Hall, 1966), pp. 74ff.

213. It was for this reason that Leibniz regarded the German of his time and especially the German of the artisans as a perfect observation language, while Latin, for him, was already too much contaminated by theoretical notions. See his "Unvorgreifliche Gedancken, betreffend die Ausübung und Verbesserung der Teutschen Sprache," published in *Wissenschaftliche Beihefte zur Zeitschrift des allgemeinen deutschen Sprachvereins*, IV, 29 (Berlin: F. Berggold, 1907), pp. 292ff.

214. For examples of such descriptions see the article of Synge referred to in note 201.

215. This objection was raised at a conference by Prof. Roger Buck.

216. For this point see section I of "Reply to Criticism," as well as the corresponding sections in "Problems of Empiricism."

217. That the choice between comprehensive theories rests on one's interests entirely and reveals the innermost character of the one who chooses has been emphasized by Fichte in his "Erste Einleitung in die Wissenschaftslehre." Fichte discusses the opposition between idealism and materialism which he calls dogmatism. He points out that there are no facts and no considerations of logic which can force us to adopt either the one or the other position. ". . . we are here faced," he says (*Erste und Zweite Einleitung in die Wissenschaftslehre*, Hamburg: Felix Meiner, 1961, p. 19), "with an

absolutely first act that depends on the freedom of thought entirely. It is therefore determined in an arbitrary manner [*durch Willkur*] and, as an arbitrary decision must have a reason nevertheless, by our *inclination* and our *interest*. The final reason for the difference between the idealist and the dogmatist is therefore the difference in their interests."

218. Here once more the familiar problem of *alienation* arises: what is the result of our own activity becomes separated from it, and assumes an existence of its own. The connection with our intentions and our wishes becomes more and more opaque so that in the end we, instead of leading, follow slavishly the dim outlines of our shadow whether this shadow manifests itself *objectively*, in certain institutions, or *subjectively*, in what some people are pleased to call their "intellectual honesty," or their "scientific integrity." (". . . Luther eliminates *external* religiousness and turns religiousness into the *inner* essence of man . . . he negates the raving parish-priest outside the layman because he puts him into the very heart of the layman." Marx, *Nationaloekonomie und Philosophie*; quoted from *Marx, die Frühschriften*, ed. Landshut, p. 228.

In the *economic field* the development is very clear: "In antiquity and in the Middle Ages exploitation was regarded as an obvious, indisputable, and unchangeable fact by both sides, by the free as well as by the slaves, by the feudal lords as well as by their bondsmen. It was precisely because of this knowledge on the part of both parties that the class structure was so transparent; and it was precisely because of the dominance of agriculture that the exploitation of the lower classes *could be seen in the strict sense of the word*. In the Middle Ages the serf worked, say, four days and a half per week on his own plot of land and one day and a half on the land of his master. The place of work for himself was distinctly separated from the place of serfdom . . . Even the language was clear, it spoke of 'bondsmen' ["Leibeigene," i.e., those whose bodies are owned by someone else] . . . of 'compulsory service' ["Fronarbeit"] and so on. Thus the class distinctions could not only be *seen*, they could also be *heard*. Language did not conceal the class structure, it expressed it in all desirable clarity. That was true in Egypt, Greece, the European Middle Ages, in Asiatic as well as in European languages. It is no longer true in our present epoch . . . Workers in early capitalism spent their whole time in the factory. There was neither a spatial nor a temporal separation between the period they worked for their own livelihood and the period they slaved for the capitalist. This led to the phenomenon I have called . . . the 'sociology of repression.' The fact of exploitation was no longer admitted and the repression was facilitated because exploitation could no longer be *seen*." Fritz Sternberg, *Der Dichter und die Ratio; Erinnerungen an Bertolt Brecht* (Gottingen: Sachse und Pohl, 1963), pp. 47ff. *Exactly the same development occurred between Galileo and, say, Laplace.* Science ceased to be a variable human instrument for exploring and changing the world and became a solid block of "knowledge," impervious to human dreams, wishes, expectations. At the same time the scientists themselves became more and more remote, "serious," greedy for recognition, and incapable and unwilling to express themselves in a way that could be understood and enjoyed by all. Einstein and Bohr, and Boltzmann before them, were notable exceptions. But they did not change the general trend. There are only a few physicists now who share the humor, the modesty, the sense of perspective, and the philosophical interests of these extraordinary people. All of them have taken over their physics, but they have thoroughly ruined it.

It is even worse in the philosophy of science. For some details, see my papers "Classical Empiricism" and "On the Improvement of the Sciences and the Arts, and the Possible Identity of the Two," in *Boston Studies in the Philosophy of Science*, vol. III, ed. R. S. Cohen and M. W. Wartofsky (Dordrecht: Reidel, 1968).

219. Popper has repeatedly asserted, both in his lectures and in his writings, that while there is progress in the sciences there is no progress in the arts. He bases his assertion on the belief that the content of succeeding theories can be compared and that a judgment of verisimilitude can be made. The refutation of this belief eliminates an important difference, and perhaps the *only* important difference, between science and