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AGAINST METHOD*

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AGAINST METHOD

When we see that we have arrived at the utmost extent of human [understanding], we sit down contented. HUME[1]

The more solid, welldefined, and splendid the edifice erected by the understanding, the more restless the urge of life ... to remove itself from it into freedom. [Appearing as] reason it is negative and dialectical, for it dissolves into nothing the detailed determinations of the understanding. HEGEL[2]

Although science taken as whole is a nuisance, one can still learn from it. BENN[3]

(1) Introduction; the Limits of Argument. The idea of a methodology that provides firm, absolute ~~[illegible]~~ and eternal principles for conducting the business of science gets into considerable difficulty when confronted with the results of historical research. We find, then, that there is not a single rule, however firmly ~~well~~ grounded in epistemology ~~supported by reason~~" that is not violated at some time or other. we learn that such violations are not accidental occurrences, results of insufficient knowledge or of inattention which might have been avoided, but that they are necessary for progress. Indeed, one of the

(1) A Treatise of Human Nature ed. Selby-Bigge, xxii. The word "reason" has been replaced by "understanding" in order to establish coherence with the terminology of the German idealists.
(2) The first part of the quotation, up to "appearing as" is taken from Difference des Fichteschen und Schellingschen Systems der Philosophie reprint, Hamburg 1962, 13. The second part is from the Wissenschaft der Logik i, 6 (Felix Meiner, Hamburg).
(3) Letter to Gert Michael Simon, 11.ix. 49. Quoted from Gottfried Benn, Lyrik und Prosa, Briefe und Dokumente Wiesbaden 1962, ~~234~~ 235.

most striking features of recent methodological thought is the realization that events such as the Copernican Revolution, or the development of atomism in antiquity and during the past 100 years (kinetic theory; quantum theory) took place only because some scientists either decided not to be bound by certain "obvious" methodological demands [illegible], or because they unwittingly broke them.[4]

These scientists were not completely without guidance, however. They had ideas concerning the manner in which the incomplete ideology they possessed could be improved, and perhaps superseded with the imperfect means (auxiliary theories, instruments, senses, traditions) at their disposal. They had strong views about the structure, or the "nature" of knowledge (simplicity, empirical adequacy, truth, etc.) as well as about the main features of the world they lived in. Some of these views were held by them quite dogmatically; yet, they were never enforced, come what may.[5] For example, new hypotheses were not abandoned when they clashed with experience (or with experimental results) of the most solid and convincing kind, or when they turned out, on elaboration, to become rather clumsy, and perhaps even inconsistent. In practice the guiding ideas functioned therefore not as exclusive and inexorable norms of reason; they were rather treated like rules of thumb: they arose in a somewhat erratic fashion, [illegible] they were given due consideration, but

(4) For details and further literature cf. "Problems of Empiricism, Part ii" in The Nature and Function of Scientific Theory ed. Colodny, Pittsburgh 1969.

(5) An excellent example is Newton who made his discoveries and by violating almost every single rule of the methodology he introduced (which still paralyses the minds of contemporary empiricists). Cf. footnote 27.

they were certainly not slavishly obeyed.

This liberal practice, we have said, is not just a fact of the history of science; it is not merely a manifestation of human inconstancy and ignorance; it is reasonable, and absolutely necessary for the growth of knowledge. More specifically, one can show the following: considering any rule, however "fundamental", there are always circumstances when it is advisable not only not to listen to the rule, but to adopt its opposite. For example, there are circumstances when it is advisable to introduce, elaborate, defend ad hoc hypotheses, or hypotheses which contradict well established and generally accepted experimental results, or hypotheses whose content is smaller than the content of the existing (and empirically adequate) alternatives, or inconsistent hypotheses, and so on.[6]

(6) One one the few physicists to see this feature of the development of scientific knowledge was Niels Bohr: "... he would never try to outline a 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 startingpoints for further exploration. In speculating about the prospects of some line of investigation he would dismiss the usual considerations of simplicity, elegance, even consistency with the remark that such qualities can only be properly judged after the event ..." A. Pais in S. Rozentnal (ed.) Niels Bohr. His Life and work as seen by his Friends and Colleagues New York 1967, 117. For further information concerning Bohr's philosophy cf. also my essay "On A Recent Critique of Complementarity" Philosophy of Science Dec. 1968/March 1969.- As regards the quotation one must of course realise that science does not achieve final results and is therefore always "before" the event, never "after" it.

There are even circumstances - and they occur rather frequently - when argument loses its progressive and critical role and becomes an instrument of backwardness and of oppression. Nobody wants to assert[7] that the teaching of small children is exclusively a matter of argument (though argument may enter into it and should enter into it to a larger extent than is customary[8]), and almost everyone agrees that what looks like a result of reason - the mastery of a language; the existence of a richly articulated perceptual world;[9] logical ability - may be due

(7) Children "learn to imitate others ... and so learn to look upon standards of behaviour 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 5th edition, vol. ii, 390. One should also compare the remainder of appendix i/15 which gives a clear account of the irrational elements in the progress of thought.

(8) In one of his numerous lucubrations in praise of Ordinary English ["Moore and Ordinary Language" The Philosophy of G.E. Moore ed. Schillpp, Evanston 1952, 354f] Malcolm makes the following comment: "If a child who was learning the language were to say, in a situation where we are sitting in a room with chairs about that it was (highly probable' that there were chairs, then we would 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 and their imagination in the face of this and of other "methods" of education".

(9) Cf. below, text to footnote

partly to indoctrination, partly to a process of growth that proceeds with the force of natural law, [illegible]. And where arguments do seem to have an effect this is often due to their physical repetition rather than to their semantic content.[10] This much having been admitted we must also concede the possibility of non argumentative growth in the adult as well as in (the theoretical parts of) institutions such as science, religion, prostitution, and so on. We certainly cannot take it for granted that what is possible in the case of children - to slide, on the slightest provocation, into entirely new reaction patterns - is beyond the reach of their elders and inaccessible to one of the (so everyone says) most outstanding adult activities: science. Quite the contrary. It is to be expected that catastrophic changes, [illegible] wars, the breakdown of encompassing systems of morality, political revolutions will transform and perhaps multiply reaction patterns, patterns of argumentation included[11], just as an ecological crisis multiplies mutations. This may again be an entirely natural process, like growing in size and the only function of rational discourse may consist in increasing the mental tension that precedes and causes the behavioural outburst. And such a natural process may be triggered by theoretical

(10) Commenting on his early education by his father, and especially on the explanations he received on matters of logic, J.St. Mill offers the following observations: "The explanations did not make the matter at al clear to me at the time; but they were not therefore useless; they remained a nucleus for my observations and reflections to crystallise upo the import of his general remarks being interpreted to me, by the parti cular instances which came under my notice afterwards".- In "Problems o Empricism, Part ii" I have argued that the development of science exhib phase differences of precisely this kind, a new principle serving as a "nucleus for observations and reflections to crystallise upon" until we obtain a theory that is understood even by the most uneducated empirist For a general discussion of the problem touched upon in this remark cf. Hegel, Wissenschaft der Logik Vol. i, 51-64.

breakdowns as well, thus giving rise to a period of scientific revolution. Now - does not the occurrence of such developments restrict the effectiveness of argument (except as a causative agent ~~whi~~ leading to developments very different from what is demanded by their content)? Does it not show that science which, after all, is part of the evolution of man[12] is not entirely rational and cannot be entirely rational? For if there are events, not necessarily arguments, which cause us to adopt new standards, will it then not be up to the defenders of the status quo to provide, not just arguments, but also contrary causes? And if the old forms of argumentation turn out to be too weak a contrary cause, must they then not either give up, or resort to stronger and more "irrational" means? (It is very difficult, and perhaps entirely impossible, to combat the effects of brainwashing by argument). Even the most puritanical rationalist will then be forced to leave argument and to use, say, propaganda not, because some of his arguments have

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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" available a.o. in Hans Meyer (ed) Meisterwerke Deutscher Literaturkritik Stuttgart 1962, 741-747.

(11) "Recourse to direct action changed the whole tenor of the struggle for the workers' self-confidence is enormously increased 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 ~~xxx~~ rationality], but simply as a natural response to a concrete situation." Cohn-Bendit Obsolete Communism, The Left Wing Alternative London 1968, 67.- Cohn-Bendit's emphasis on "spontaneity, ... the chief enemy of all burocrats" [op. cit., 154] agrees with the tenor of the present paper which wants to eliminate burocracy not only from government, but ~~xxxx~~ also from the administration of knowledge (where it appears as an ~~xxx~~ appeal to rationality).

(12) For the interpretation of science as a continuation of the struggle for survival cf. Boltzmann, Populaere Schriften Leipzig 1906, Mach Erkenntnis und Irrtum Leipzig 1916 as well as footnote 37.

ceased to be valid, but because the psychological conditions which enable him to effectively argue in this manner, and thereby to influence others, have disappeared. And what is the use of an argument that leaves people unmoved?[13]

(13) [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" [Op. cit., 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 aim to come closer to the truth be reached in an entirely rational fashion, 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 insight into the limitations of all methodological rules as well as into their dependence on a certain developmental stage of mankind is found in Lenin's and Mao's political writings. 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 40f of Lenin's "'Left Wing' Communism, an Infantile Disorder [first published in 1920; quoted from the edition of the Foreign Language Press Peking 1965; very useful as a theoretical basis for the criticism of contemporary left radicalism, campus radicals and other leftovers from the political stoneage]: "We can (and must) begin to build Socialism not with imaginary human material [as does the doctrine of liberalism, especially in the form defended in Mill's On Liberty - see below, section 3] nor with human material specially prepared by us [as do all Stalinists, both in politics, and 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" and "capitalism" by, e.g., "Popperian methodology" - and our case is stated with perfect clarity. - I would like at this point to acknowledge that my interpretation of science owes/quite a lot to the political writings of Lenin, Marx, Mao, Hegel. It is surprising how substitutions such as the one just carried out will transform a political lesson into a lesson for "rationality" which, after all, is part of the process by means of which we move from one historical stage to another. It would also seem to me that attention to the wider political context is necessary if the philosophy of science wants to free itself from the Nagel-Carnap-Popper-Kuhn carousell and if it wants to procede to a transformation not just of its own pet doctrines, but of science itself. 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 needed is that he confess his vices openly so that others may learn to delight and enlighten us in a similar way.

These general considerations are supported by what we have learned and are continuously learning about the history of human perception, thought, and self consciousness. Was it argument that led to the idea of self determination and freedom or did whatever arguments existed receive content only after man had started to see himself as an autonomous originator of action rather than as an intersection point of cosmic forces and political demands? And was this latter development not the result of the breaking up of old orders and of quite irrational catastrophies such as wars and revolutions?[14] Was human self consciousness not raised to a higher level by turbulent events such as the French Revolution so that it needed argument and this particular and rather violent experience to comprehend and to make sense of an otherwise purely verbal, or "abstract" notion of freedom? Starting from a stage that views man as a bundle of limbs[15] occasionally invaded by mischievous demons, thus causing him to become angry, or sad, or ferocious,

(14) "As social practice cohtinues, things that give rise to man's sense perceptions and impressions in the course of his practice are repeated many times; then a sudden change (leap) takes place in the brain in the process of cognition, and concepts are formed ... Between concepts and sense perceptions there is not only a quantitative but also a qualitative difference." Mao Tse-Tung, "On Practice" in Four Essays on Philosophy Forgeign Language Press Peking 1966, 5.- "Practice, knowledge again practice, and again knowledge. This form repeats itself in endless cycles, and with each cycle the content of practice and knowledge rises to a [qualitatively different] higher level." Op. cit., 20.- A development such as this is a "historical process which can only be realised in action ... It is not guaranteed by any law, and though probable, it is by no means inevitable ... The real meaning of revolution is not a change in management, but a change in man." Cohn-Bendit, op. cit., 111f.

(15) B. Snell, The Discovery of Mind Harper Torchbooks 1960, Ch. i, esp p 7.

(16) E.R. Dodds, The Greeks and the Irrational Boston 1957, Ch. i, Ch, esp. p. 16: "This habit of 'objectivising emotional drives', treating them as not-self, must have opened the door wide to the religious idea of psychic intervention ..."

we witness the gradual arrival both of the notion and of the phemomenon of individuality[17] until the individual turns from a somewhat insignificant though perhaps unique element of an oppressive social world into a judge of the most basic principles of this world.[18] At the same time there arrive new, more complex, and more realistic forms of argumentation: a new consciousness, seeing the world in new ways, approaches it with new instruments. Now it is clear that the appeal to argument has either no content at all and can be made to conform with any procedure[19] or else it is bound, at such turning points, to have a conservative function: it tries to set limits to what is about to become a natural way of behaviour.[20] It is also clear that in the latter case the appeal cannot remain entirely rational (where the word "rational" is now interpreted in the more definite sense of the second alternative). Basing his argument on natural habits of reasoning which have either become extinct or which have no point of attack in the new situation ~~that surrounds him~~ the champion of "rationality" must first restore the earlier conditions. This, however, involves him in "a struggle of interests and forces, not of argument".[21]

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(17) Snell, op. cit., Chs. iii, iv.
(18) R. Kroner Speculation and Revelation in the Age of Christianity Philadelphia 1959, 43ff.
(19) According to Popper we do not "need any ... definite frame of reference for our criticism", we may revise even the most fundamental rul and drop the most fundamental demands if the need for different measures of excellence should arise [Op. cit., 390].
(20) "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 Tschechoslowakischen Schriftstellerverbandes Verlag Suhrkamp 1968, 17. "Our case" is of course also the case of revolutionar developments in science and methodology.- In his introduction to the tra lation 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 1965, 95]: "...the eulogist of new systems always finds opinion on his side [optimist!] while the defender of the old must appeal to reason." The "opinion" of today is, of course, the "reason" of tomorrow which is already present in a naive, immediate, undeveloped form.

That interests, forces, propaganda, brainwashing techniques play a much greater role in the growth of our knowledge and, afortiori, of science than is commonly believed can also be seen from an analysis of the relation between idea and action. One often takes it for granted that a clear and distinct understanding of new ideas precedes and should precede any formulation and any institutional expression of them. First we have an idea, then we act, i.e. either speak, or build, or destroy. This assumption certainly does not apply to small children. They use words, they combine them, they play with them until they grasp a meaning that so far has been beyond their reach, and the initial playful activity is an essential presupposition of the final act of understanding.[10,14] There is no reason why this mechanism should cease to function in the grownup (unless he is the unfortunate victim of teachers and institutions who believe that everyone grows into and then forever remains in a certain stage of behavioural adaptation to his surroundings, called "rationality"). Quite the contrary, we must expect for example, that the idea of liberty could be made clear only by means of the very same actions which were supposed to bring it about. So that these actions were guided, not by a well defined program but by a vague urge giving rise to specific behaviour which in turn created the ideas necessary for looking at the whole process in a rational manner.[22]

(21) Leon Trotsky The Revolution Betrayed New York 1965, 86f.
(22) 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 expressed himself [quoted from Gooch, op. cit., 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 enthroned. 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 pre supposion of whatever clarity one would like to possess, but can achie only after the event, as the result of the actions performed. For

Similarly the determined use of the telescope as an instrument for the exploration of a Copernican reality was an essential element in the discovery of the theories which later on provided a scientific justification for it. Strictly speaking Galileo had to treat unknown phenomena as if they were perfectly familiar and he had to regard parts of a refuted theory as strong positive evidence for another refuted theory.[4] And this is the normal case: theories often become clear only after incoherent parts of them have been used for a considerable time and such unreasonable, nonsensical, unmethodical[1] foreplay is a necessary precondition of clarity and empirical success.[23] An attempt to describe developments of this kind in a general manner must of course use the existing forms of thinking - but it must apply them in a Pickwickian fashion. "Moreover, since the traditional categories are the gospel of everyday thinking (including ordinary scientific thinking) and of everyday practice [such an attempt at understanding] in effect presents rules and forms of false thinking and action - false, that is, from the standpoint of

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material from the history of science cf. "Problems of Empiricism, Part II" op. cit., esp. sections 7,8, 11. In politics the point just made implies the necessity of (mass) action over and above 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-a-vis the ever changing multitude of social conditions. But it is just to such conditions that their content must be referred and in the process "anarchistic" action i.e. action that is neither directly related to theory nor to the existing institutions has to play an essential part: "We cannot tell ... what immediate cause will most serve to rouse, kindle, and impel into the struggle the very wide masses [of scientists, for example] who are at present dormant... History generally, and the history of revolutions in particular, is always richer in content, more varied, more manysided, more lively and 'subtle' that 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 aspects, of social act

commonsense."[24] This is how dialectical thinking arises as a form of thought that "dissolves into nothing the detailed determinations of the understanding".[25]

We see, then, that the idea of a fixed method, or of a fixed theory of rationality arises from too naive a view of man and of his social surroundings. To those who look at the rich material provided by history and who are not intent on impoverishing this material in order to make it fit certain preconceived notions, to such people it will seem that there is only one principle that can be defended under all circumstances and in all stages of human development. It is the principle: anything goes.[26]

This abstract principle must now be elucidated, and explained in concrete detail.

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vity, 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, op. cit., 102f, 100f - the application to scien is quite straightforward if we keep the proper rules of translation (fn. 13[B]) in mind. Cohn-Bendit op. cit., gives a vivid account of an anarchism of this kind. "Problems of Empiricism, Part ii" applies the lesson to science.

(23) Our understanding of ideas and concepts, says Hegel [Gymnasialrede quoted from K. Loewith, M. Riedel eds., Hegel Studienausgabe Vol. i Frankfutt 1968, 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 Vol. i, 39f.

(24) H. Marcuse Reason and Revolution Boston 1960, 130. The quotation is about Hegel's logic.

(25) "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 op. cit., 64. Cf. also footnote 13[B].- It is interesting (but not at all surprising) to see how well revolutionaries such as Marx, Engels, Lenin, Mao, Cohn-Bendit comprehend the concrete situation of the knowing subject and how far ahead they are in this respect of all the contemporary children of the Vienna Circle. Moreover, they are able to express their findings in the language of the common people so that everyone, and not only a small sect of professionals, can profit from them. Where is the philosopher of science who can write equally well and who is guided by similarly humanitarian considerations? Cf. also footnote 72.

(2) Counterinduction i: Theories. It was said that considering any rule, however fundamental or "necessary for science" one can imagine circumstances when it is advisable not only not to listen to the rule, but to adopt its opposite. Let us apply this to the rule that "experience", or "the facts", or "experimental results", or whatever words are being used to describe the "hard" elements of our testing procedures measure the success of a theory so that agreement is to be regarded as favouring the theory (or as leaving the situation unchanged) while disagreement endangers, or perhaps even eliminates it (this rule is an essential part of all theories of induction, including even some theories of corroboration). Taking the opposite view we suggest introducing, elaborating, and propagating hypotheses which are inconsistent either with well established theories, or with well established facts or, as we shall express ourselves, we suggest to proceed counterinductively.

There is no need to discuss the first part of the suggestion which favours hypotheses inconsistent with well established theories. The main argument has already been published elsewhere.[26] We may summarise it by saying that evidence that is relevant for the test of a theory T can often be unearthed only with the help of an incompatible alternative theory T' so that the advice to postpone alternatives until the first refutation has occurred means putting the cart before the horse. In this connexion I also advised increasing the (actually available) empirical contents with the help of a principle of proliferation: invent and elaborate theories which are inconsistent with the accepted point of view even if the latter should happen to be highly confirmed and generally accepted. Considering the arguments just summarised such a principle would seem to be an essential part of any critical empiricism.[24] [27]

(26) "Problems of Empiricism" Beyond the Edge of Certainty ed. Colodny Prentice Hall 1965, sections ivff, especially section vi. (The relevant material has been reprinted in P.H. Nidditch (ed) The Philosophy of Science Oxford 1969, 12 ff, especially 25-33.) "Realism and Instrumentalism" The Critical Approach ed. Bunge, Glencoe 1964. "Reply to Criticism" Boston Studies in the Philosophy of Science Vol. ii, Cohen and Wartofsky eds., New York 1965.

17 (24) 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; 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 - here the reader is invited to compare footnote 16 - nightmares; and so on) and objectively observed (phantom pregnancy; disintegration of speech patterns). Denying the power of the devil in these times was almost as foolish (or, considering the threat of hellfire, much more foolish) as denying the exi-

It is also an essential part of a humanitarian outlook. Progressive educators have always tried to develop the individuality of their pupils and to bring to fruition the particular and sometimes quite unique talents and beliefs they may possess. But such an education very often seemed to be a futile exercise in daydreaming: is it not necessary to prepare the young "for life"; and does this not mean that they must learn one particular set of views to the exclusion of everything else? And if there should still remain a trace of their youthful gift of imagination - will it not find its proper application in the arts, that is, in a thin domain of dreams that has but little to do with the world we live in? Will this procedure not finally lead to a split between a hated reality and welcome fantasies, science and the arts, careful description and unrestrained self-expression? The need for proliferation shows that such is not the case. It is possible

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STENCE 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 cf. the reference in footnote 4]. 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 shall neglect these small and inconsiderable errors" - Principia, ed. Motte-Cajori, California 1953, 405. For a more detailed analysis of Newton's dogmatic philosophy and of his dialectical method cf. my paper "Classical Empiricism" The Methodological Heritage of Newton ed. R.E. Butts, Toronto 1969.) Yet - all these lessons are in vain. Now as ever counter-induction is ruled out by methodology. "The Counterinductive rule" says W. Salmon in his essay "The Foundation of Scientific Inference", Mind and Cosmos ed. Colodny, Pittsburgh 1966, 185, is "demonstrably unsatisfactory". He fails to explain how the application of a "demonstrably unsatisfactory" rule can lead to so many satisfactory results which, as we now see, could not have been obtained in any other way.

to retain what one might call the freedom of artistic creation and to use it to the full not just as a road of escape, but as a necessary means for discovering and perhaps even changing the properti of the world we live in. For me this coincidence of the part (individual man) with the whole (the world we live in), of the purely subjective and arbitrary with the objective and lawful is one of the most important arguments in favour of a pluralistic methodology.

(3) Philosophical Background: Mill, Hegel. The idea that a pluralistic methodology is necessary both for the advancement of knowledge and for the development of our individuality has been discussed by J. St. Mill in his admirable essay On Liberty.[28] This essay, according to Mill[26] is "a kind of philosophical textbook of a single truth which the chang progressively taking place in modern society tend to bring out into eve stronger relief: the importance, to man and society, of a large variet of character and of giving full freedom to human nature to expand itse in innumerable and conflicting directions". Such variety is necessary for the production of "well developed human beings"[258] and fo the improvement of civilization. "What has made the Europea family of nations an improving, instead of a stationary portion of mankind: Not any superior expellence in them which, when it exists, exists as the effect, not as the cause; but their remarkable diversity

(28) I shall quote from The Philosophy of John Stuart Mill, Marshall Cohen Ed. Modern Library, New York 1961. Numbers in square brackets fr now on mean pages in this book.
(26) Autobiography, quoted from Essential Works of John Stuart Mill ed. Lerner New York 1961, 149.

of character and culture. Individuals, classes, nations, have been extremely unlike one another, they have struck out a great variety of paths, each leading to some valuable; and although in every period those who travelled in different paths would have thought it an excellent thing if all the rest would have been compelled to travel this road, their attempt to thwart each others' development have rarely had a permanent success, and each has in time endured to receive the good which others have offered. Europe is, in my judgement, wholly indebted to this plurality of paths for its progressive and many sided development"[268f].[27] The benefit to the individual derives from the fact that "[t]he human faculties of perception, judgement, discrimination, feeling, mental activity, and even moral preference, are exercised only in making a choice ... the mental and moral, like the muscular powers, are improved only by being used. The faculties are called into no exercise by doing a thing merely because others do it, no more than by believing a thing only because others believe it" [252]. Choice presupposes alternatives between which to choose, it presupposes a society which contains, and encourages "different opinions" [249], "antagonistic modes of thought"[28] as well as "different experiments of living" [249] so that the "worth of different modes of life is proved not just in the imagination, but practically"[250].[29] "[U]nity of opinion", however,

(27) For one particular element of this plurality cf. K.R. Popper, "Back to the Presocratics", Conjectures and Refutations New York 1962, 136.

(28) Mill's essay on Coleridge, The Philosophy of John Stuart Mill etc., 62.

(29) Cf. also "Outline of a Pluralistic Theory of Knowledge and Action" Planning for Diversity and Choice ed. S. Anderson MIT Press 1968 which establishes the connexion with scientific method alluded to towards the end of the last section.

"unless resulting from the fullest and freest comparison of opposite opinions, is not desirable, and diversity not an evil, but a good."[249].

This how is proliferation is introduced by Mill. It is not the result of a detailed epistemological analysis or, what would be worse, of a linguistic examination of the usage of such words as "to know", "to have evidence for", and the like. Nor is proliferation proposed as a solution to epistemological problems such as Hume's problem, or the problem of the testability of general statements. (The idea that experience might be a basis is at once removed by the

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For the relation between idea and action cf. text to footnote 21.- Emphasis on action with a libertarian framework plays an important role in Cohn-Bendit, op. cit., esp. Ch. v, 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, including scientific theories and ideologies]... It must accordingly grant minority groups the right of independent action - only if the plurality of ideas is allowed to express itself in social practice does the 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 schools educational institutions, universities, institutes 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 a combination of Mill's general ideas and of a practical anarchism such as that of Cohn-Bendit which refuses to be intimidated, or restricted by specialist knowledge (including the specialist knowledge disseminated by our contemporary critical rationalists), which tries to reform the corresponding institutions, especially those safe-deposit boxes of wisdom, our universities, and which encourages the free flow of individuals from position to position ["No 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 New York 1966, 109] assuring at the same time that every position in society is treated with equal respect, it seems to me that such an ideology is the best starting point in our attempts to remove the still existing fetters to thought and action. And let no one say that science, being purely theoretical, has nothing to do with

remark that "[t]here must be discussion, to show how experience is to be interpreted"[208].) Proliferation is introduced as the solution to a problem of life : how can we achieve full consciousness, how can we learn what we are capable of doing, how can we increase our freedom so that we are able to decide (rather than adopt by habit) the manner in which we want to use our talents. Considerations like these were common at times when ~~science was not yet seen as an autonomous discipline capable of finding the truth by its own particular method, when~~ the connexion between truth and self expression was still regarded as a problem and when even the arts were supposed not just to please, but to elevate and to instruct.[33] Today the only question is how science can improve its own resources no matter what the human effect of its methods and of its results. For Mill the connexion still exists. Scientific method is part of a general theory of man. It receives its rules from this theory and is built up in accordance with our ideas of a worthwhile human existence.

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action and even less with politics. The scientist whose results are received with respect by the rest of the community and whose methods are eagerly imitated lives in a peculiar and often quite constipated environment that has its own style, 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 a position of power; careful supervision of the educational process so that personal or group-ideosyncracies do not become a national malaise; absolute distrust of expert testimony; and so on) are taken. The connexion between theory and politics must always be considered.

(33) For the propagandistic function of mediaeval art cf. Rosario Assunto Die Theorie des Schoenen im Mittelalter Cologne 1963, esp. 21f.

In addition it can be shown to lead to the truth:" ... the peculiar evil of silencing the expression of an opinion is, that it is robbing the human race; posterity as well as the existing generation; those who dissent from the opinion, still more than those who hold it. If the opinion is right, they are deprived of the opportunity of exchanging error for truth; if wrong, they lose, what is almost as great a benefit, the clearer perception and livelier impression of the truth, produced by its collision with error" [205]. "The beliefs we have most warrant for, have no safeguard to rest on, but a standing invitation to the whole world to prove them unfounded"[209]. If "with every opportunity for contesting it [a certain opinion, or a hypothesis] has not been refuted" [207] then we can regard it as better than another opinion that has "not gone through a similar process"[209].[34] "If even the

(33a) "Ideological struggle" says Mao Tse-Tung ["On the Correct Handling of Contradictions Among the People" quoted from Four Essays on Philosophy Peking 1966, 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 to avoid hasty conclusions. We believe that such an attitude can help to ensure a relatively smooth development of the arts and sciences"[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"[117f].- 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 contraditions still exist in socialist society, and in response to the country' urgent need to speed up its economic and cultural development"[113; cf. 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"]. 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" [117; cf. H. Marcuse, "Repressive Tolerance" in Wolff-Moore-Marcuse A Critique of Pure Tolerance Boston 1967, 100]. The restriction occurs already in Mill, though with different reasons, which are expressed in a different terminology: "It is, perhaps, hardly necessary to say that [our] 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 the 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", op. cit., 197f; cf. Lenin, op. cit., 40: "We can (and must) begin to build socialism not with imaginary human material ... but with the human material bequeathed to us ..."]. This insight into the limitations of free discussion is missing in Popper.

cf. also footnote 72

(36) 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 "deny the existence ... not only of a public truth, but of any truth whatever" as we can read in Willmore Kendall's bombastic but singularly uninformed essay "The 'Open Society' and its Fallacies" Am.Pol.Sc. Rev. liv (1960), 972ff, quoted from Radcliff (ed) Limits of Liberty Belmont California 1966, 38 and 32. To refute the charge of suspension of judgement we should also consider this passage: "No wise man ever acquired his wisdom in any mode but this; nor is it 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 light which can be thrown upon the subject from any quarter - he has a right to think his judgement better than that of any person, or any multitude, who have not gone through a similar process" [209; my italics]. Nor is the insinuation correct than Mill's society is "so to speak, a debating club" [Op. cit., 36; italics in the original] - just think of Mill's insistence on different "experiments of living" [249]. Of course, such attention to detail is not to be expected from a selfrighteous conservative for whom any discussion of freedom, and any attempt to achieve it is but "evil teaching" [op. cit., 35].

For an important difference between Mill and Popper cf. the end of the last footnote.

Newtonian philosophy were not permitted to be questioned, mankind would not feel as complete an assurance of its truth as they now do"[209]. "So essental is this discipline to the real understanding of moral and human subjects [as well as of natural philosophy - 208] that if opponents of all important truths do not exist, it is indispensable to imagine them, and to supply them with the strongest arguments which the most skilful devil's advocate can conjure up"[228]. There is no harm if such opponents produce positions which sound absurd and eccentric: "Precisely because the tyranny of opinion is such as to make excentricity a reproach, it is desirable, in order to break through that tyranny that people should be eccentric"[267].[35] Nor should those who "admit the validity of the argument for free discussion ... object to their being 'pushed to the extreme': ... unless the reasons are good for an extreme case, they are not good for any case"[210].[36] Thus methodological and humanitarian arguments are intermixed in every part of Mill's treatise and it is on <u>both</u> grounds that a pluralistic epistemology is defended, for the natural as well as for the social sciences.[37]

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(35) For a different argument which is entirely in Mill's spirit cf. my "Problems of Empiricism" <u>op. cit.</u>, 185. Today increase of testability can be added to the epistemological reasons 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 which are already present in Mill.

(36) This quotation has been added mainly for the benefit of Professor Herbert Feigl who keeps criticising 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 contemporary infatuation with "syntheses" and "dialogues" which one hears so often 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 any 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

Institute for Marxist Studies Vol. vi/1, Jan;Feb 1969, first page bottom] will hardly be prepared to accept the doctrines of a toughminded Marxist who is interested in progress, not in peace of mind.
(37) Later in the century proliferation was defended by evolutionary arguments: Just as animal species improve by producing variations and weeding out the less competetive variants, in the very same manner science is thought to improve by proliferation and criticism. Conversly, "well established" results of science and even the "laws of thought" are now regarded as temporary results of adaptation; they are not given absolute validity. According to Boltzmann [Populaere Schriften Leipzig 1906, 398; 318,258f] 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"[401] which means of course, that there are circumstances, not factually circumscribed nor determined in any other way when we must introduce ideas which contradict them. In short - 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 but pure experience"[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 ancient custom and rule of behaviour; but this activity is beneficial and it must be carried out in order to prevent us from falling into barbarism. Yet petrification does not set in, for there are those who are emancipated, relaxed, the hommes sans gêne. Both classes of people fight each other and together they achieve a well balanced society."[32] But Boltzmann does not always carry his ideas through to the end. Occasionally he relies on a more primitive empiricism such as when he says that "a well determined fact remains unchanged forever"[343] or when he regards "my waking sensations [as] the only elements of my thought"[173] so that "we infer the existence of objects from the impressions made on our senses"[19] or when he declares, more than once, that the task of science is "to adapt our thought, ideas, and concepts to the given rather than subjecting the given to the judgement of the laws of thought" [354 - cf. with this the assertion, on p 286, that "the simplest words such as yellow, sweet, sour, etc. which seem to represent mere sensation do 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 (for

Simplistic

One of the consequences of pluralism and proliferation is that stability of knowledge can no longer be guaranteed. However convincing the support a theory received from experience, however wellfounded its categories and basic principles, however forceful the impact of experience itself - there is always the possibility that new forms of thought will arrange matters in a different way and will lead to a transformation even of the most immediate impressions we receive from the world. Considering this possibility we may even say that the longlasting success of our categories, the omnipresense of a certain point of view is not a sign of excellence, an indication that the truth or part of the truth has at last been found but that it is rather the indication of a failure of reason to find suitable alternatives which might be used to transcend an accidental intermediate stage of our knowledge. This remark leads to an entirely new attitude to success and stability.

The customary aim of all methodologies is to find principles and facts which, if possible, are not subjected to change. Principles which give the impression of stability are of course tested. One tries to refute them. If all attempts at refutation fail we have a positive result, nevertheless: we have succeeded in discovering a new stable feature of the world that surrounds us. Moreover, the process of refu-

reasons consult Lenin's Materialism and Empiriocriticism). Here 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., e.g., footnote 13[B]).

tation re ts itself on assumptions which are not further investigated. An "instrumentalist" will assume that there are stable facts, sensations everday situations, classical states of affair which do not change, not even as the result of the most revolutionary discovery. A "realist" may admit such changes, but he will insist on the separation between subject and object and will try to restore it wherever research seems to have found fault with it.[38] Believing in an "approach to the truth" he will even have to set limits to the development of concepts; for example, he will have to exclude incommensurable concepts from a series of succeeding theories.[39] So far the traditional attitude, up to, and including, Popper's critical rationalism.

As opposed to it the attitude about to be discussed regards any prolonged stability either of ideas and impressions which are capable of test, or of background knowledge which one is not willing to give up (realism; commensurability of concepts) as an indication of <u>failure</u>, pure and simple. <u>We have failed to transcend an accidental stage of knowledge and we have failed to rise to a higher stage of consciousnes and of understanding</u>. It is even questionable whether we can still claim to possess knowledge. As we become familiar with the existing categories and with the alternatives which are being used in the examination of the

(38) Popper, for example, <u>takes it for granted</u> that the subject cannot enter the domain of science and he also defends a rather simple form of mechanical materialism in his attack on Bohr. For details cf. part ii of "On a Recent Critique of Complementarity", <u>op. cit</u>.
(39) Cf. below, sections 12 and 13.

received view our thinking loses its spontaneity until we are reduced to the "bestial and goggle-eyed contemplation of the world around us".[40] "The more solid, well defined, and splendid the edifice erected by the understanding, the more restless the urge of life to remove itself from it into freedom".[41] Each successful refutation, by opening the way to a new and as yet untried system of categories, temporarily returns to the mind the freedom and spontaneity that is its essential property. But complete freedom is not achieved. For however large the change it will lead to a new system of fixed categories; things, processes, states will be separated from each other, the existence of different elements, of a manifold, will be "exaggerated into an opposition by the understanding"[42] and this "evil manner of reflection[43], to always work with fixed categories"[44] will be extended to the most widely presupposed and unanalysed opposition between a subject and an entirely different world of objects.[45] The following assumptions which are important for methodology are made in this connexion: "the object ... is something finished and perfect that does not need the slightest amount of thought in order to achieve reality while thought itself is ... something deficient that needs ... material for its completion[46] and must be soft enough to adapt itself to the material in question".[47] "If thought and appearance

(40) "Verhaeltnis des Skeptizismus zur Philosophie" quoted from Hegel, Studienausgabe Vol. i, 113; cf. also 112.
(41) Differenz des Fichteschen und Schellingschen Systems, 13.
(42) Logik, ii, 61.
(43) "Reflective reason ... is nothing but the understanding which uses abstraction, separates, and insists that the separation be maintained and taken seriously." Logik i, 26.
(44) Logik i, 82.
(45) Cf. Differenz, 14.
(46) Cf. the Carnap quotation, text to footnote 146.
(47) Logik i, 25.

do not completely correspond to each other one has, to start with, a choice: the one or the other may be at fault. [Scientific empiricism] blames thought for not adequately mirroring experience ..."[48] "These are the ideas which form the core of our customary views concerning the relation between subject and object"[49] and they are responsible for whatever immobility remains in science, even at times of crisis.

How can this immobility be overcome? How can we obtain insight into the most fundamental assumption not only of science and commonsense, but of our existence as thinking beings as well? Insight cannot be obtained as long as the assumptions form an unreflected and unchanging part of the world; but if they are allowed to change - does this not mean that we cannot finish the task of criticising as identically the same persons that started it? Problems like these are raised not only by the abstract question of criticism but also by more recent discoveries in anthropology, history of science, methodology. We shall return to them when discussing incommensurable theories. For the moment I would like to indicate, very briefly, how certain ideas of Hegel can be used to get a tentative first answer and thus to make a first step in our attempt to reform the sciences.

Science and commonsense use fixed categories in addition to the many changing views they contain. As a result they are not fully rational. Full rationality can be obtained by applying criticism to the stable

(48) Encyclopaedie der Philosophischen Wissenschaften ed. Lasson, Leipzig 1920, 72f. In the original the reference is to Kant, not to scientific empiricism.
(49) Logik i, 25.

parts also. This presupposes (see the preceding section) the invention of alternative categories and their application to the whole rich material at our disposal. The categories and all other stable elements must be set in motion. "Our task is to make fluid the petrified material which we find, and to relight (wieder entzuenden) the concepts contained in this dead stuff".[50] We must "dissolve the opposition of a frozen subjectivity and objectivity and comprehend the origin of the intellectual and real world as a becoming, we must understand their being as a product, as a form of producing".[51] Such dissolving is carried out by reason which is "the force of the negative absolute, that is, an absolute negation"[52] and which "annihilates"[53] science, commonsense, as well as the state of consciousness associated with both. This annihilation is not a conscious act of a scientist who has decided to eliminate some basic distinctions in his field. For although he may consciously try to overcome the limitations of a particular stage of knowledge he may not succeed for want of objective conditions (in his brain, in his social surroundings, in the physical world[54]) favouring his wish.[55] Hegel's general theory of development gives an account of such conditions.

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(50) Logik ii, 211.
(51) Differenz, 14. Cf. Lenin's comments on a simpler passage in his notes on Hegel's Logic, quoted from W.I. Lenin Aus dem Philosophischen Nachlass Berlin 1949, 136ff, esp. 142.
(52) Cf. also "Skepticismus", op. cit., 117: "that scepticism is intrinsically connected with every true philosophy". Also 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."
(53) Differenz, 25.
(54) "It is my aim to read Hegel in a materialistic fashion ..." Lenin, Nachlass, 20. The same is true of Professor D. Bohm.
(55) Cf. the note on the limit and the ought, Logik i, 121f: "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, neutralised, and so on. In the process of oxidation, neutralization etc. its limit, i.e., only to be a basis, is lifted ... and it contains the ought to such an extent that only force can prevent it from ceasing to be a basis..."

According to this theory every object, every determinate being is related to everything else: "a well determined being, a finite entity is one that is related to others; it is a content that stands in the relation of necessity to another content and, in the last resort, to the whole world. Considering this mutual connectedness of the whole metaphysics could assert ... the tautology that the removal of a single grain of dust must cause the collapse of the whole universe".[56] The relation is not external but such that the very nature of each process, object, state etc. is affected by and contains (part of) the nature of every other process, object, state, etc.[57] Conceptually this means that the complete description of an object is self-contradictory. It contains elements which say what it is - these are the elements used in the customary description provided by science and by commonsense - and it contains also other elements which say what it is not - these are the elements used by science and commonsense to describe other things supposed to be completely separated: "all things are beset by an internal contradiction

(56) Logik i, 71.

(57) "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 London 1963, 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 especially the Logic 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 recognised 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

This contradiction cannot be eliminated by using different terminology for example, by using the terminology of a process and its modifications. For the process will again have to be separated, at least in thought, from something other than itself (otherwise it is pure being which is in no way different from pure nothingness[59]), it will contain part of what it is separated from, this part will have to be described by ideas inconsistent with the ideas used for describing the original process which therefore is bound to contain contradictions also.[60] Hegel himself has a marvellous talent to make visible the contradictions which arise when we examine a concept in detail, wishing to give a complete account of the state of affairs it describes. "Concepts which usually appear stable unmoved, dead are analysed by him and it becomes evident that they move".

Now this motion - and with this we come to a second principle of Hegel's cosmology - is not merely a motion of the intellect which, starting the analysis with a certain determinations moves away from them and is led to their negation. It is an objective development caused by the fact that every finite (well determined, limited) object, process, state, etc. has the tendency to emphazise the elements of other objects present in it, and to become what it is not. The object "being restless within its own limit"[62] "strives not to be what it is".[63] "Calling things

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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 is projection is ... an integral part of the total process that is being projected." Op. cit., 482.

(58) Logik, ii, 53.

(59) Logik i, 67. Cf. also the physical model for this identity in i, 78f according to which neither "pure light" nor "pure darkness" give rise to (the perception of) objects which are recognised and "distinguished only in the determined light, ... which is turbid light."

(60) Bohm will therefore not be able to keep contradiction out of his ideas as he occasionally seems to believe (e.g. in op. cit., 482, second paragraph). He agrees, but tries to circumvent any particular contradictio by moving to a different level of reality. Cf. his Causality and Chance i Modern Physics Harper Torchbooks 1962.

(in other places)

finite we mean that they are not merely determined, have qualities not merely as a real determination, that they are not merely limited ... but rather that the negative is essential to their nature and to their being ... Finite things are but the truth of their being is their end.[64] What is finite does not merely change ... it passes away; nor is this passing away merely possible, so that the finite thing could be, without passing away; quite the contrary, the being of a finite thing consists in its having in itself the seed of passing away ... : the hour if its birth is the hour of its death."[65] "What is finite, therefore, can be set in motion."[66]

Moving beyond the limit the object ceases to be what it is and becomes what it is not - it is negated. The result of the negation - and this may be regarded as a third principle of Hegel's cosmology - is "not a mere nothing; it has a special content, for ... it is the negation of a determined and well defined thing".[67] Conceptually speaking we arrive at a "new concept which is higher, richer than the concept that preceded it, for it has been enriched by its negation or opposition, contains it as well as its negation, being the unity of the original concept and of its opposition"[68] - an excellent description, for example, of the transition from the Newtonian conception of space to that of Einstein provided

(61) Lenin, Nachlass, 27.
(62) Logik i, 115.
(63) Jenenser Logik, Metaphysik und Naturphilosophie ed. Lasson, Hamburg 1923, 31.
(64) In German the statement is more impressive: "Die Wahrheit [des] Seins der endlichen Dinge ist ihr Ende."
(65) Logik i, 117.
(66) loc. cit.
(67) Op. cit., 36.
(68) Loc. cit.

we make the Einsteinian notion contain the unchanged Newtonian concept.[69] "It is clear that no presentation can be regarded as scientific that does not follow the path and simple rythm of this method, for this is the path pursued by the things themselves."[70]

Considering that the motion beyond the limit is not arbitrary, but is directed "towards its [i.e. the object's] end"[71] it follows that not all the aspects of other things which are present in it are realised in the next stage. Negation, accordingly, "does not mean simply saying no, or declaring that something does not exist, or destroying it in any way one likes ... Each class of things ... has its appropriate form of being negated in such a way that it gives rise to a development and it is just the same with each class of conceptions or ideas ... This has to be learned, like everything else."[72] What has to be learned, too, is that the "negation of the negation" does not lead further away from the origin starting point but that it returns to it.[73] This is "an extremely general and for this reason extremely comprehensive and important - law of development of Nature, history, and thought; a law which ... holds good in the animal and plant kingdom, in society, in mathematics,[73a] in history, and in philosophy."[74] Thus for example "a grain of barley [falling under suitable conditions on suitable soil] ceases to exist - it is negated, and in its place appears the plant which has arisen from it, the negation of the grain ... [This plant] grows, flowers, is fertilised and finally

(69) Cf. below, section 13 as well as footnote 116 of "Problems of Empiricism", op. cit.
(70) Logik i, 36; cf. also ii 54, 58ff.
(71) Logik i, 117.
(72) F. Engels Anti-Duehring New York 1939, 155. 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 applies of course also to 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 footnote 25.

once more produces grains of barley, and as soon as these have ripened the stalk dies, is in its turn negated. As a result of this negation of the negation we have once again the original grain of barley, but not as a single unit, but ten, twenty, or thirtyfold [and perhaps even] qualitatively better."[75] "It is obvious that in describing [the process] as the negation of the negation I do not say anything concerning the particular processes of development, for example, of the grain of barley from germination to the death of the fruitbearing plant ... I [rather] bring [all these processes] together under this one law of motion and for this reason I leave out of account the peculiarities of each separate individual process. Dialectics is nothing more than the science of the general laws of motion and development of nature, human society, thought."[76]

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(73) Logik i, 107.

(73a) 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 to 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' 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. One the other hand one must perhaps also criticise 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 to be mistaken for a wittgensteinian rather than being classified with the dialectical tradition to which he belongs? Cf. also footnote 13[B].

(74) Anti-Duehring, 154.

(75) 149.

(76) 154f; my italics. Epistemologically these laws belong to the Aristotelian rather than to the Newtonian tradition.

So far concepts and real things were regarded as separate and certain similarities and coffespondences were noted: each thing contains in itself elements of everything else, it develops, changes, tries to return to itself. The notion of ~~xhx~~ each thing, accor ingly, contains contradictory elements, it is negated, and moves in a way corresponding to the movement of the thing. This presentation has one serious disadvantage: "Thought is here described as a mere subjective and formal activity while the world of objects, being situated vis-a-vis thought, is regarded as something fixed and as having independent existence. This dualism ... is not a true account of things and it is pretty thoughtless to simply take over the said properties of subjectivity and objectivity without asking for their origin ... Taking a more realistic view we must say that the subject is only a stage in the development of being and essence."[77] The concept, too, is then part of the general development of using again a materialistic interpretation of Hegel[54] - Nature. "Life", for example, "or organic nature is that phase of nature when the concept appears on the stage; it enters the stage as a blind concept that does not comprehend itself, i.e., does not think."[78] Being part of the natural behaviour first, of an organism, then of a thinking being it not only mirrors a nature that "lies entirely outside of it"[79], it ceases to be "something subjective and accidental"[80], "merely a concept"[81], it participates in the general nature of all things i.e., it contains an element

(77) Encyclopaedie der Philosophischen Wissenschaften, ergaenzt durch Vortraege und Kollegienhefte, ed. by L. Henning, K. Michelet, and Bouman Berlin 1840, 395f; cf. also Lenin, Nachlass, 102. Or, to use Bohm's terminology: "as long as, by our customary habit of thinking, we try to say that in an experiment some part of the world is observed, [and described] with the help 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

of everything else and also has the tendency to be the end result of the development of a specific thing so that, finally, the concept and this thing become one.[82] "That real things do not agree with the idea [read - with the total knowledge of man"[83]] constitutes their finitude, their untruth because of which they are objects, each determined in its special sphere by the laws of mechanics, chemistry, or by some external purpose".[84] In this stage "there can be nothing more detrimental and more unworthy of a philosopher than to point, in an entirely vulgar fashion, to some experience that contradicts the idea ... When something does not correspond to its concept, it must be led up to it."[85] until "concept and thing have become one".[86]

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exist". Op. cit., 482f - the reader should go on and consider the beautiful example of the observation of a mirror image.
(78) Logik ii, 224.
(79) ii, 227.
(80) ii, 408.
(81) ii, 225.
(82) ii, 408.
(83) Lenin, Nachlass, 114.
(84) ii, 410.
(85) ii, 408f.
(86) ii, 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, op. cit., 115.

To sum up: knowledge is part of nature and is subjected to its general laws. According to these general laws - the laws of dialectics - which apply to the motion of objects, concepts, as well as to the motion of higher units comprising objects and concepts every object participates in every other object and tries to change into its negation. This process is understood only if we attend, not to those elements in our subjectivity which are still in relative isolation and whose internal contradictions are not yet revealed - most of the customary concepts of science, mathematics and especially the rigid categories used by our modern axiomaniacs are of this kind - but to those other elements which are fluid, about to turn into their opposite, and which have therefore a change to bring about knowledge, truth, which is "the identity of thing and concept".[87] The identity must be achieved, not mechanically, i.e. by keeping stable some aspects of reality (which, being in motion, will soon be lost and be replaced by dogmatic opinions of them, rigid perceptions included) and fiddling around with some other aspect, or theory until agreement is achieved, but dialiectically i.e. via an interaction of concept and fact (observation, experiment, basic statement etc.) that changes both elements. The lesson for methodology is - not to work with stable concepts, not to eliminate counter induction, not to be seduced into thinking that one has at last found the correct description of "the facts" when all that has happened is that some new categories have been adapted to some older categories which are so familiar that we take their outlines to be the outlines of the world itself.

(87) Logik ii, 228. The whole introduction to the Subjective Logic 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 of in his lectures in Berkeley in 1959: even an Oxford philosopher occasionally stumbles upon the truth.

(4) Counterinduction ii: Experiments, Observations, "Facts". Considering now the invention, the use, and the elaboration of theories which are inconsistent, not only with other theories, but even with experiments, facts, observations we can start by pointing out that not a single theory ever agrees with all the known facts in its domain. And the disagreement is not with rumours, or with the results of sloppy procedure, but with experiments and observations of the highest precisio and reliability. Thus the Copernican view when it was first introduced was inconsistent with facts so plain and obvious that even Galileo had to call it "surely false".[88] "There is no limit to my astonishment" he writes in a later work[89] "when I reflect that Aristarchus and Copernicus were able to make reason so conquer sense that, in defiance of the latter, the former became mistress of their belief". Newton's theory of gravitation was beset, from the very beginning, by a considerable number of difficulties which were serious enough to provide material for refutations. Even today, and in the non relativistic domain, there exist "numerous discrepancies between observation and theory".[90] Bohr's atomic model was introduced, and retained in the face of very precise and unshakeable contrary evidence.[91] The theory of relativity was retained despite D.C. Miller's decisive refutation (I call the refutation "decisive" as the experiment was, from the point of view of contemporary knowledge, at least as well performed as the

88 (9) The Assayer, quoted from Drake-O'Malley (eds) The Controversy on the Comets of 1618 Philadelphia 1960, 184f.

89 (10) Dialogue Concerning the Two Chief World Systems tr. St. Drake, Berkeley 1953, 328.

90 (11) Brower-Clemence, Methods of Celestial Mechanics New York 1961, v. Cf. also R.H. Dicke, "The Observational Basis of General Relativity" in Chiu-Hoffmann, Eds. Gravitation and Relativity New York 1964, 1-16.

91 Cf. section 2.2 of Max Jammer The Conceptual Development of Quantum Mechanics New York 1966.

earlier experiment of Michelson and Morley[23]). There is no need to continue this list whose principal content is well known to all philosophers of science. But don't they realise that it plays havoc with the rule, mentioned in section 5, that theories are judged and, possibly, refuted by experience and with the associated rule that experience and theory must always be kept separate? For it now turns out that theories are not judged by all relevant experiments, but only by some. And that the principle of selection is not the reliability of the experiment, or the clarity vs. opaqueness of its relation to the theory but the hope that the theory will prevail. Nor is this hope always based on wellknown, testable, and highly confirmed hypotheses whose application to the problematic case is clear and might bring with it the desired reconciliation. More often it is not connected with any existing assumption at all but with the expectation that a suitable saving hypothesis will some day be found. Now if it is possible to discard contrary facts on the basis of a metaphysical conjecture of this kind, then why should we accept, and regard as measures of excellence, those facts which are in agreement with the theory? If, on the other hand, we take all available facts at their face value and exclude any idea that is not immediately connected with what we know, then how shall we be able ever to arrive at any theory at all? These are some of the contradictions created by the clash between customary practice and methodology.

92 (23) 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 finished his series, that a satisfactory account of his results was found. Cf. R.S. Shankland, "Conversations with Einstein", Am. Journ. Phys. Vol. 31 (1963), 51ff as well as footnote 19 and 34. Cf. also the inconclusive discussions at the Conference on the Michelson and Morley Experiment Pasadena 1928.

It is not immediately obvious how this clash is to be resolved, Scientific practice is always influenced by accidental developments such as the degeneration of schools, the availability of government funds, the general philosophical and political temper of the times. Theories which to start with are regarded with suspicion and are rejected by scientists gradually become accepted and even turn into presuppositions of research (relativistic invariance!). As a result the excellent arguments which originally paved the way for their acceptance are forgotten and are replaced by a summary, naive, and almost ritual reference to "the facts".[14] 93 Methodological rules, on the other hand, speak of "theories" and "observations" as if as if these were clear and well defined objects whose properties are easy to evaluate and are understood in the same way by every scientist while the material which a scientist has actually at his disposal - his laws, his experimental results, his mathematical techniques, his epistemological prejudices - is indeterminate in many ways, ambiguous, and never fully separated from the historical background. It is always contaminated by principles which we do not know and which, if known, would be extremely hard to test. Questionable views on cognition such as the view that our senses, used in normal circumstances, give reliable information about the world may invade the observation language itself, constituting the observational terms and the distinction between veridical and illusory appearances (we shall soon present an example of this situation). As a result observation languages

93 (14) Concerning quantum theory J.A. Wheeler writes as follows: "Many a young scientist lacks conviction about important points in workaday quantum theory and is deprived of the deepest insights into the quantum principle itself, because he does not know the debates that settled the issues firmly for the fathers of quantum theory. He troubles over the same old issues indecisively and ingloriously." Sources for History of Quantum Physics, Kuhn-Heilbron-Forman-Allen eds., Philadelphia 1967, vi.

are bound to older layers of speculation which affect, in this roundabout fashion, even the most progressive cosmology (example: the absolute space-time frame of classical physics which was codified, and consecrated, by Kant). The sensory impression itself, however simple, may contain, and as a matter of fact ot always does contain a component that expresses the reaction of the perceiving subject and has no objective correlate whatever. This component often merges with the rest and forms and unstructured whole which must be subdivided from the outside, with the help of counterinductive procedures (example: the appearance of a fixed star to the naked eye which contains the subjective effects of irratiation and diffraction). Finally, there are the auxiliary premises which are needed for the derivation of testable premises and which often form entire auxiliary sciences. In the case of the Copernican hypothesis whose invention, defence, and partial vindication runs counter to almost every methodological rule one might care to think of these auxiliary sciences consisted of laws describing the properties andthe influence of the terrestrial athmosphere (meteorology), optical laws dealing with the structure of the eye, of telescopes, with the behaviour of light, dynamical laws describing motion in moving systems and, most importantly, they contained a theory of cognition that postulated a certain simple relation between perceptions and physical objects. Not all these auxiliary subjects were available in explicit form, many of them merged with the observation language leading to the situation described at the beginning of the present section. Considering all these circumstances

observation terms, sensory core, auxiliary sciences - we realise that a theory may be inconsistent with the evidence not because it is not correct, but because the evidence is contaminated, that is, because it either contains unanalysed sensations which only partly correspond to external processes, or because it is presented in terms of antiquated views, or because it is evaluated with the help of backward auxiliary subjects (the Copernican theory was in trouble for all these reasons[13][14]). It is this historico-physiological character of the evidence, the fact that it expresses not merely some objective state of affairs but also some subjective, mythical, and long forgotten views concerning this state of affairs that forces us to take a fresh look at methodology: in the last analysis our judgement of theories

(13) For details cf. again "Problems of Empiricism, Part II", op. cit.

rests (if we take the path of empiricism and demand tests by an independent experience) upon our particular, ideosyncratic reactions to the outer world (this is the "sensory core" of the test statements[95]) which are in turn expressed in terms of some deepseated (epistemological, physiological, cosmological) beliefs (this constitutes the content of the observational concepts). The beliefs and the auxiliary sciences which relate observation to a newly invented theory (which is the negation of the previous unreflected state of affairs) are usually earlier in origin, and they are often already half forgotten. A straightforward and unqualified judgement of theories by "the facts" is therefore bound to eliminate ideas simply because they do not fit into the framework of some older cosmology. This makes us suspect that theory and "the facts", theory and experiment, theory and observation will have to enter tests in a symmetrical fashion so that theories can be criticised and removed by facts and vice versa (considering the antiquarian character of observation concepts I would be prepared to say that a well thought out new idea should always be given greater weight than even the most impressive experimental result. The strength with which such a result, or a more primitive observation impresses itself upon our senses and upon our minds is, after all, but the strength of a habitual and petrified connexion between concepts and sensations). This finishes the general argument for the second part of the demand for counterinduction. Counterinduction, therefore, is both a fact, and a legitimate, and much needed move in the game of science.

(95) In what follows the reader is advised always to consult his Hegel and to compare our statements with Hegel's own dialectical formulations.

(5) The Tower Argument Stated. First Steps of the Analysis. As a concrete illustration, and as a basis for further discussion I shall now briefly describe the manner in which Galileo defused an important counterargument against the idea of the motion of the earth. I say "defused", and not "refuted" because we are dealing with a changing conceptual system we well as with certain attempts at concealment.

According to the argument (which convinced Tycho and which is used against the motion of the earth in Galileo's own Trattato della sfera) we see that "heavy bodies ... falling down from high, go by a straight and vertical line to the surface of the earth. This is considered an irrefutable argument for the earth being motionless. For if it made the diurnal rotation, a tower from those top a rock was let to fall, being carried by the whirling of the earth, would travel many hundreds of yards to the east in the time the rock would consume in its fall, and the rock ought to strike the earth that distance away from the base of the tower".[96]

(96) Dialogue etc., 126

Considering the argument Galileo at once admits the correctness of the sensory content of the observation made, viz. that "heavy bodies, falling from a hight, go perpendicular to the surface of the earth".[97] Considering an author (Chiaramonti) who sets out to convert Copernicans by repeatedly mentioning this fact he says:[98] "I wish that this author would not put himself to such trouble trying to have us understand from o senses that this motion of falling bodies is simple straight mption and no other kind, nor get angry and complain because such a clear, obvious, and manifest thing should be called into question. For in this way he hints at believing that to those who say such motion is not straight at all, but rather circular, it seems that they see the stone move visibly in an arc since he calls upon their senses rather than

(97) Op. cit., 125.
(98) 256.

their reason to clarify the effect. This is not the case, Simplicio, for just as I ... have never seen nor ever expect to see the rock fall any way but perpendicularly, just so do I believe that it appears to the eyes of everyone else. It is therefore better to put aside the appearance, on which we all agree, and to use the power of reason either to confirm its reality, or to reveal its fallacy." The correctness of the observation is not in question. What is in question is its "reality" or "fallacy". What is meant by this expression?

The question is answered by an example that occur in the very next paragraph and "from which one may learn how easily one may be deceived by simple appearances, or, let us say, by the impressions of one's senses. This event is the appearance to those who travel along a street by night of being followed by the moon, with steps equal to theirs, when they see it gliding along the eaves of the roofs. Then it looks to them just as would a cat really running along the tiles and putting them behind it; an appearance which, if reason did not intervene, would only too obviously deceive the senses".

In this example we start with a sensory impression and consider a statement that is forcefully suggested by it (the suggestion is so strong that it has led to entire systems of belief and rituals as becomes clear from a closer study of the lunar aspects of witchcraft and of other religions). Now "reason intervenes": the statement suggested by the impression is examined and one considers other statements in its place. The nature of the impression is not changed a bit by this activity (this is only approximately true but we can omit, for our present purpose, the complications arising from the interaction of impressions and propositions) but it enters new observation-statements and plays new - better, or worse - parts in our knowledge. What are the reasons and

the methods which regulate such exchange?

(48) To start with we must become clear of the nature of the total phenomenon: appearance plus statement. There are not two acts, the one: noticing a phenomenon; the other: expressing it with the help of the appropriate statement, but only one viz.: saying, in a certain observational situation, "the moon is following me" or, "the stone is falling straight down". We may of course abstractly subdivide this process into parts, and we may also try to create a situation where statement and phenomenon seem to be psychologically apart and waiting to be related (this is rather difficult to achieve and is perhaps entirely impossible[49]). But under normal circumstances such a division does not occur and describing a familiar situation is for the speaker an event in which statement and phenomenon are firmly glued together.

This unity is the result of a process of learning that starts in one's very childhood. From very early days we learn to react to situations with the appropriate (linguistic, or other) reactions. The teaching procedures both shape the "appearance" or the "phenomenon" and establish a firm connexion with words so that finally the phenomena seem to speak for themselves, and without outside help or extraneous knowledge. They just are what the associated statement asserts them to be. The language they "speak" is of course influenced by beliefs which have been held for such a long time that they no longer appear as separate principles but enter the very terms of everyday discourse and, as described, appear to emerge from the things themselves: this we obtain the situation that was described in the last section.

[49] "Problems of Empiricism", op. cit., 204ff.

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Now at this point we may want to compare, in our imagination, and quite abstractly, the results of the teaching of different languages, incorporating different ideologies. We may even want to consciously change some of these ideologies and adapt them to more "modern" points of view. It is very difficult to say how this will change our situation unless we make the further assumption that the quality and structure of sensations (perceptions), or at least the quality and structure of those sensations which enter the body of science is independent of their linguistic expression. I am very doubtful even about the approximate validity of this assumption (which can be refuted by simple examples) and I am sure that we are depriving ourselves of new and surprising discoveries as long as we remain within the limits defined by it. Yet the present essay will remain quite consciously within these limits. (My first task, if I ever should resume writing, would be to explore these limits, and to try venturing beyond them).

Making our additional simplifying assumption [illegible] we can distinguish between (A) sensations and (B) these "operation[s] of the mind which follow[] [so] closely upon the senses" (17) and are so firmly connected with their reactions that a separation is difficult to achieve. Considering the origin and the effect of such operations I shall call them natural interpretations.

[illegible]

(17) Bacon, Novum Organum, Introduction.

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(6) Natural Interpretations. In the history of thought natural interpretations have been regarded either as apriori presuppositions of science, or else as prejudices which must ~~which must~~ be removed before serious examination. The first assumption is made by Kant and, in a very different manner, on the basis of very different talents, by some contemporary linguistic philosophers. The second assumption is due to Bacon (there are however predecessors, such as the Greek skeptics). Galileo is one of those rare thinkers who neither wants to retain natural interpretations, nor wants to altogether eliminate them. Wholesale judgements of this kind are quite alien to his way of thinking. He insists on a critical discussion which is to decide which natural interpretations can be retained and which must be replaced. This does not always become clear from his writings. Quite the contrary, the methods of reminiscence to which he appeals to freely are designed to create the impression that nothing has changed and that we continue expressing our observations in the old and familiar way. Yet his attitude is relatively easy to ascertain: natural interpretations are necessary. The senses alone, and without the help of reason, cannot give us a true account of nature. What is needed for arriving at such a true account are "the ... senses accompanied by reasoning."[20] Moreover, in the arguments dealing with the motion of the earth it is this reasoning, and not the message of the senses, the appearance, that causes trouble. "It is therefore better to put aside the appearances on which we all agree, and to use the power of reason either to confirm [their] reality, or to reveal [their] fallacy".[21] "To confirm the reality or reveal the fallacy of appearances" means however to examine the truth of those natural interpretations which in our natural thinking are so inte-

(101) Dialogue, 255.
(102) 256.

mately connected with the appearances that we no longer regard them as separate assumptions. We now take a look at the first natural interpretation implicit in the argument from falling stones.

According to Copernicus the motion of a falling stone should be "mixed straight-and-circular".[103] And by the "motion of the stone" is meant not just its motion relative to some visible mark in the visual field of the observer, or its observed motion but rather its motion in the solar system, or in (absolute) space, or its real motion. The familiar facts appealed to in the argument assert a different kind of motion, a simple vertical motion. This result refutes the Copernican hypothesis only if the concept of motion that occurs in the observation statement is the same as the concept of motion that occurs in the Copernican prediction. The observation statement "the stone is falling straight down" must therefore likewise refer to a movement in (absolute) space. It must refer to a real motion.

Now the force of an "argument from observation" derives from the fact that the observation statements it involves are firmly connected with the appearances. There is no use appealing to observation if one does not know how to describe what one sees, or if one can offer one's description with hesitation only, as if one had just learned the language in which it is formulated. An observation statement merges into one two very different psychological events, viz. (1) a clear and unambiguous sensation and (2) a clear and unambiguous connexi

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(103) 248.

between this sensation and parts of a language. This is the way in which the sensation is "made to speak". Do the sensations in the above argument "speak the language" of real motion?

They speak the language of real motion in the context of 17th century everyday thought - or at least this is what Galileo tells us. He tells us that the everyday thinking of the time entailed the "operative" character of all motion[104] or, to use well known philosophical terms, it entailed a naive realism with respect to motion: except for occasional and avoidable illusions seen motion is identical with real (absolute) motion. According to what has been said in the last section this distinction was not explicitly drawn. One did not first distinguish the seen motion from the real motion and then connect the two by a correspondence rule. Quite the contrary - one described, perceived, acted towards the seen motion as if it were already the real thing. For

[104] (24) 171.

we proceed in this manner under all circumstances - it is admitted that objects may move which are not seen to move; and it is also admitted that certain motions are illusory (cf. the example in section 7 above). Seen motion and real motion are not always identified. However there are paradigmatic cases in which it is psychologically very difficult, if not plainly impossible, to admit deception. It is from these paradigmatic cases and not from the exceptions that naive realism (with respect to motion) derived its strength. These are also the situations in which we first learn our kinematic vocabulary. From our very childhood we learn to react to them with concepts which have naive realism built right into them and which inextricably connect movement and the appearance of movement. The motion of the stone in the argument, or the alleged motion of the earth is exactly such a paradigmatic case (how could one possibly be unaware of the swift motion of a large bulk of matter such as the earth is supposed to be! How could one possibly be unaware of the fact that the falling stone traces a vastly extended trajectory through space!) From the points of view of 17th century argument and language the argument is therefore impeccable, and quite forceful. However we notice again how theories ("operative character" of all motion, essential correctness of sense reports) which are not formulated explicitly enter a debate in the guise of observational terms. And we realise again that observational terms are Trojan horses which must be watched very carefully. How is one supposed to proceed in such a sticky situation?

The argument from falling stones seems to refute the Copernican view. This may be due to an inherent disadvantage of Copernicanism; it may also be due but to the existence of natural interpretations which are in need of improvement. The first task, then, is to discover and eliminate unexamined obstacles to progress.

It was Bacon's belief that natural interpretations could be discovered by a method of analysis that peels them off, one after another, until the sensory core of every observation is laid bare. This method has serious drawbacks. One: natural interpretations of the kind considered by Bacon are not just added to a previously existing field of sensations, they are instrumental in constituting the field. Eliminating all natural interpretations and you also eliminate the ability to think and to perceive. Two: disregarding this fundamental function of natural interpretations it should still be clear that a person who faces a perceptual field without a single natural interpretation at his disposal would be completely disoriented - he could not even start the business of science. Three: the fact that we do start, even after some Baconian analysis, shows that the analysis has stopped prematurely. And it has stopped at precisely those natural interpretations of which we are not aware and without which we cannot proceed. It follows that the intention to start from scratch, after a complete removal of all natural interpretations has taken place, is self-defeating.

Nor is it possible to even partly unravel the cluster of natural interpretations. At first sight the task would seem to be simple enough: one takes observation statements, one after the other, and analyses their content. However concepts which are hidden in observation statements are not likely to reveal themselves in the more abstract parts

of language. And if they do, it will still be difficult to nail them down (concepts just as percepts are ambiguous, and dependent on background). Moreover, the content of a concept is determined also by the way in which it is related to perception. Yet, how can this way be discovered without circularity? Perception must be identified and the identifying mechanism will contain some of the very same elements which govern the use of the concept to be investigated. We never penetrate this concept completely, for we always use part of it in the attempt to find its constituents.[25] There is only one way to get out of this circle and it consists in using an external measure of comparison including new ways of relating concepts and percepts. Removed from the domain of natural discourse and from all those principles, habits, attitudes which constitute its "form of life" such an external measure will look strange indeed. This, however, is not an argument against its use. Quite the contrary, such an impression of strangeness reveals that natural interpretations are at work, and it is a first step towards their discovery. Let us explain this situation

(25) Cf. "Problems of Empiricism", op. cit., 204ff.

with the help of our example!

The argument intends to show that the Copernican view is not in accordance with "the facts". Even from the point of view of these "facts" the idea of the motion of the earth appears to be outlandish, absurd, obviously false, to mention only some of the expressions which were frequently used at the time (and which are still heard whereever professional squares confront a new and counterfactual theory). This makes us suspect that the Copernican view is an external measure stick of precisely the kind described above. We can now turn the argument around and use it as a <u>detecting device</u> that helps us to discover what precisely it is that excludes the motion of the earth. Turning the argument around we <u>first assert</u> the motion of the earth and <u>then inquire</u> what changes will remove the contradiction. Such an inquiry may take considerable time and there is a good sense in which we can say that it is not yet finished, not even today. The contradiction, therefore, may stay with us for decades, and even centuries. Still, <u>it must be upheld</u> (Hegel!) until we have finished our examination or else the examination - the attempt to discover the antediluvian components of our knowledge - cannot even start. (This, incidentally, is one of the reasons one can give for <u>retaining</u> and, perhaps, even for <u>inventing</u> theories which are inconsistent with the facts). We conclude, then, that ideological ingredients of our knowledge and, more especially, of our observations, are discovered with the help of theories which are refuted by them. <u>They are discovered counterinductively</u>.

Let us repeat what has been asserted so far. Theories are tested and, possibly, refuted, by facts. Facts contain ideological components, older views which have vanished from sight or were perhaps never formulated in an explicit manner. These components are highly suspicious first, because of their age, because of their antediluvian origin, secondly, because their very nature protects them from a critical examination and always has projected them from such an examination. Considering a contradiction between a new and intelligent theory and a collection of "firmly established facts" the best procedure is, therefore, not to abandon the theory but to use it for the discovery of hidden principles which are responsible for the contradiction. Counter induction is an essential part of this process of discovery. (Excellent historical example: the arguments against motion and atomicity of Parmenides and Zenon. Diogenes of Sinope, the Cynic, took the simple course that would be taken by many contemporary scientists and all contemporary philosophers - he refuted the argument by rising and walking up and down. The opposite course, recommended here, led to much more interesting results as is witnessed by the history of the argument. One should not be too hard on Diogenes, however, for it is also reported that he beat up a pupil who was content with his refutation exclaiming that he had given reasons which the pupil should not accept without additional reasons of his own.)

(1654) Cf. Hegel [illegible] Sophist

(444) Having discovered a particular natural interpretation the next question is how it is to be examined and tested. Obviously we can not proceed in the usual way: derive predictions and compare them with the "results of observation". These results are no longer available. The idea that the senses, employed under normal circumstances, produce correct reports of real events such as the real motion of physical bodies this idea which has been found to be an essential part of the anti-Copernican argument has now been removed from it and from all observational statements. But without it our sensory reactions cease to be relevant for tests. This conclusion has been generalised by some rationalists who decided to build their science on reason only and ascribed to observation as auxiliary function. Galileo does not adopt this procedure. If one natural interpretation causes trouble for an attractive view, if its elimination removes the view from the domain of observation, then the only way out of trouble is to use other interpretations and to see what happens. The interpretation which Galileo uses restores the senses to their position as instruments of exploration but only as regards the reality of relative motion. Motion "among things which share it in common" is "non operative" that is, "it remains insensible, imperceptible and without any effect whatever".[25] Galileo's first step in the joint examination of the Copernican doctrine and of a familiar, but hidden assumption of the older point of view consists therefore in the replacement of the latter by a different assumption or, to use modern terminology, he introduces a new observation language (this is again an idealization, as we shall see below, but entirely satisfactory in the present context).

(25) 171.

This is if course an entirely legitimate move. The observation language which enters an argument has been in use for a long time and is quite familiar. Considering the structure of common idioms on the one hand and of the Aristotelian philosophy on the other neither this use nor the familiarity can be regarded as a test of the underlying principles. These principles, these natural interpretations occur in every description and extraordinary cases which might create difficulties are defused with the help of "adjuster words"[27] 107 such as "like", or "analogous" which divert them so that the basic ontology remains unchallenged. A test is however urgently needed. It is needed especially in those cases where the principles seem to threaten a new theory. It is then quite reasonable to introduce alternative observation languages and to compare them both with the original idiom and with the theory under examination. Proceeding in this way we must make sure that the comparison is <u>fair</u>, that is, we must not criticize an idiom that is supposed to function as an observation language because it is not yet well known and is therefore less strongly connected with our sensory reactions and less plausible than is another, and more "common" idiom. Superficial criticisms of this kind which have been elevated into an entire new "philosophy" abound in discussions of the mind-body problem. Philosophers who want to introduce and to test new views thus find themselves faced not with <u>arguments</u> which they could most likely answer, but with an impenetrable stone wall of well entrenched <u>reactions</u>. (This is not at all different from the attitude of people ignorant in foreign languages who feel that a certain colour

167 (27) L.J. Austin, <u>Sense and Sensibilia</u>, 74.

is much better described by "red" th n by "rosso".) As opposed to such attempts to win by appeal to familiarity ("I know what pains are, and I also know, from introspection, that they have nothing whatever to do with material processes!") we must emphazise that a comparative judgement of observation languages (materialistic observation language; phenomenalistic observation language; objective-idealistic observation language; theological observation language etc.) can start only when all of them are spoken equally fluently. Assuming this condition to be satisfied - how will the judgement be carried out?

Let me assert at this point that while it is possible to consider, and to actively apply various rules of thumb and while we may in this way arrive at a satisfactory judgement it is not at all wise to go further and to turn these rules of thumb into necessary conditions of science. For example, one might be inclined to say, following Neurath, that an observation language A is preferable to an observation language B if it is at least as useful as B in our everyday life (one always seems to assume that observation languages should be employed not only in laboratories, but also at home, and in the "natural surroundings" of the scientist) and if more, and more comprehensive theories are compatible with it than are with B. Such a criterion takes into account that both our perceptions (natural interpretations included) and our theories are fallible and it also pays attention to our desire for a harmonious and comprehensive point of view. However we must not forget that we find and improve the assumptions hidden in our observational reports by a

method that makes use of inconsistencies. Hence, we might prefer B to A as a starting point of analysis and arrive at a language C which satisfies the criterion even better but which cannot be reached from A (conceptual progress like any other kind of progress depends on psychological circumstances and these may prohibit in one case what they encourage in another. Moreover the psychological factors which come into play are never clear in advance.) Nor can the demand for practicability and sensory content be regarded as a conditio sine qua non. We possess detecting mechanisms whose performance outdistances our senses. Combining such detectors with a computor we may test a theory directly, and without intervention of a human observer. This would eliminate sensations and perceptions from the process of testing. Using hypnosis one could eliminate them from the transfer of the results into the human brain also and thus arrive at a science that is completely without experience. Considerations like these which indicate possible paths of development should cure us once and for all of the belief that judgements of progress, improvement, etc. are based on rules which can be revealed now and will remain in action for all the years to come. My discussion of Galileo has therefore not the aim to arrive at the "correct method". It has rather the aim to show that such a "correct method" does not and cannot exist, More especially, it has the limited aim to show that counterinduction is very often a reasonable move. Let us now proceed a step further with our analysis of Galileo's reasoning.

(7) The Tower Argument, Analysis Continued. Galileo replac one natural interpretation by a very different and as yet (1630!) at least partly unnatural interpretation. How does he proceed? How does he manage to introduce absurd and counterinductive (assertions such as the assertion that the earth moves, and how does he manage to get them a just and attentive hearing? We anticipate that arguments will not suffice - an interesting, and highly important limitation of rationalism - and Galileo's utterances are indeed arguments in appearance only. For Galileo uses propaganda, he uses psychological tricks in addition to whatever intellectual reasons he has to offer. These tricks (are very successful, they) lead him to victory - but they obscure the new attitude towards experience that is in the making and postpone for centuries the possibility of a reasonable philosophy. They obscure the fact that the experience on which Galileo wants to base the Copernican view is nothing but the result of his own fertile imagination, that it has been invented. They obscure this fact by insinuating that the new results which emerge are known and conceded by all and need only be called to our attention to appear as the most obvious expression of the truth.

Galileo "reminds" us that there are situations in which the noncoperative character of shared motion is just as evident and as firmly believed as is the idea of the operative character of all motion in other circumstances (this latter idea is therefore not the only natural interpretation of motion). The situations are: events in a boat; in a smoothly moving carriage and in any other system which contain an observer and permit him to carry out some simple operations: the

Segredo

[redacted]: There just occurred to me a certain fantasy which passed through my imagination one day while I was sailing to Aleppo, where I was going as consul for our country ... If the point of a pen had been on the ship during my whole voyage from Venice to Alexandretta and had had the property of leaving visible marks of its whole trip, what trace - what mark - what line would it have left?

Simplicio: It would have left a line extending from Venice to there; not perfectly straight - or rather not lying in the perfect arc of a circle - but more or less fluctuating according as the vessel would now and again have rocked. But this bending in some places a yard or two to the right or left, up or down, in a length of many hundred miles, would have made little alteration in the whole extent of the line. These would scarcely be sensible, and without an error of any moment it could be called part of a perfect arc.

Sagredo: So that if the fluctuation of the waves were taken away and the motion of the vessel were calm and tranquil, the true and precise motion of that pen point would have been an arc of a perfect circle. Now if I had had that same pen continually in my hand, and had moved it only a little sometimes this way or that, what alteration should I have brought into the main extent of this line?

Simplicio: Less than that would be given to a straight line a thousand yards long which deviated from absolute straightness here and there by a flea's eye.

Sagredo: Then if an artist had begun drawing with that pen on a sheet of paper when he left the port and had continued doing so all the way to Alexandretta, he would have been able to derive from the pen's motion a whole narrative of many figures, completely traced and sketched in thoudands of directions, with landscapes, buildings, animals, and other things.

but the actual, real, essential movement marked by the pen point would have been only a line; long, indeed, but very simple. But as to the artist's own actions, these would have been conducted exactly the same as if the ship had been standing still. The reason that of the pen's long motion no trace would remain except the marks drawn upon the paper is that the gross motion from Venice to Alexandretta was common to the paper, the pen, and evrything else in the ship. But the small motions back and forth, to right and left, communicated by the artist's fingers to the pen but not to the paper, and belonging to the former alone, could thereby leave a trace on the paper which remained stationary to these motions."[28]

Or:

"Salviati: ... imagine yourself in a boat with your eyes fixed on a point of the sail yard. Do you think that because

[28] Dialogue, 172f

the boat is moving along briskly, you will have to move your eyes in order to keep your vision always on that point of the sail yard and to follow its motion?

Simplicio: I am sure that I should not need to make any change at all; not just as to my vision, but if I had aimed a musket I should never have to move it a hairsbreadth to keep it aimed, no matter how the boat moved.

Salviati: And this comes about because the motion which the ship confers upon the sail yard, it confers also upon you and upon your eyes, so that you need not move them a bit in order to gaze at the top of the sail yard, which consequently appears motionless to you. (And the rays of vision go from the eye to the sailyard just as if a cord were tied between the two ends of the boat. Now a hundred cords are tied at different fixed points each of which keeps its place whether the ship moves or remains still[29]). It is clear that these situations lead to a non-operative concept of motion even within commonsense.

On the other hand commonsense (and we now always mean 17th century commonsense) also contains the idea of the operative character of all motion. This latter idea arises when a limited object that does not contain too many parts moves in vast and stable surroundings, for example, when a camel trots through the desert, or when a stone descends from a tower.

[29] Dialogue, 294f.

Now Galileo urges us to "remember" the conditions in which we assert the non operative character of shared motion in this case also and [illegible] to subsume the second case under the first.

Thus the first of the two paradigms of non-operative motion mentioned above is followed by the assertion that "it is likewise true that the earth being moved, the motion of the stone descending is actually a long stretch of many hundred yards, or even many thousands; and had it been able to mark its course in motionless air or upon some other surface, it would have left a very long slanting line. But that part of all this motion which is common to the rock, the tower, and ourselves remains insensible and as if it did not exist. There remains observable only that part in which neither the tower nor we are participants; in a word, that with which the stone in falling measures the tower."

And the second paradigm preceeds the exhortation to "transfer this argument to the whirling of the earth and to the rock placed on top of the tower, whose motion you cannot discern because in common with the rock you possess from the earth that motion which is required to follow the tower; you do not need to move your eyes. Next, if you add to the rock a downward motion which is peculiar to it and not shared by you, and which is mixed with the circular motion, the circular portion of the motion which is common to the stone and the eye continues to be imperceptible. The straight motion alone is sensible, for to follow that you must move your eyes downwards."

This is strong persuasion indeed.

Yi-lding to this persuasion we now quite automatically start confounding the conditions of the two cases and become relativists (this is the essence of Galileo's trickery). As a result the clash between Copernicus and "the conditions affecting ourselves and those in the air above us" dissolves into thin air, and we finally realise "that all terrestrial events from which it is ordinarily held that the earth stands still and the sun and the fixed stars are moving would necessarily appear just the same to us if the earth moved and the others stood still".

Let us now look at the situation from a more abstract point of view. We start with two conceptual systems of ordinary Mayle. One of them regards motion as an absolute process which always has effects, effects on our senses included. The description of this conceptual system which we have given in the present paper may be somewhat idealised but the arguments of the

opponents of Copernicus which are quoted by Galileo himself and which according to him were "very plausible"[112] show that there was a widespread tendency to think in its terms and that this tendency was a serious obstacle for the discussion of alternative ideas. Occasionally one finds even more primitive ways of thinking where concepts such as "up" and "down" are used absolutely such as in the assertion "that the earth is too heavy to climb up over the sun and then fall headlong back down again"[113]; or in the assertions that "after a short time the mountains, sinking downward with the rotation of the terrestrial globe, would get into such a position that whereas a little earlier one would have had to climb steeply to their peaks, a few hours later one would have to

112 Dialogue, 81.
113 SW 327.

stoop and descend in order to get there".[34] Galileo, in his

114 (34) Dialogue, 330.-

The idea that there is an absolute direction in the universe has a very interesting history. It evidently 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 commonsense and gives the terms "up" and "down" an absolute meaning (this is an natural interpretation in precisely the sense that was explained in the text above Lactantius, a church father of the 4th 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 exist nce 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]. The attempts of the Presocratics (Thales, Anaximenes, Xenophanes) to find support for the earth which prevents it from falling "down" [Arist., de coelo, 294a12ff] shows that almost all early philosophers (with the only exception of Anaximander) have shared in this way of thinking. (For the atomists who assume that the atoms originally fall "down" cf. Jammer, Concepts of Space, Harvard University Press 1953, 11). Even Galileo who thoroughly ridicules the idea of the falling antipodes [Dialogue, 331] occasionally speaks of the "upper half of the moon" [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 recognise their own limitation" [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 commonsense at the time of Galileo, astronomical commonsense included, the reader is invited to consult E. M. W. Tillyard The Elizabethan World Picture Penguin Books 1963.

marginal notes, calls these "utterly childish reasons [...] sufficient to keep imbeciles believing in the fixity of the earth" [115] and he thinks it unnecessary "to bother about such men as these, whose name is legion, or to take notice of their fooleries" [116]. But we see that the absolute idea of motion was "well entrenched" and that the attempts to replace it was bound to encounter strong resistance.

The second conceptual system is built around the relativity of motion and is also well entrenched in its own domain of application. Galileo aims at replacing the first system by the second in all cases, terrestrial as well as celestial. Naive realism with respect to motion is to be completely eliminated.

115 (M) Dialogue, 327

116 (M) Loc. cit.

Paradigm i : Motion of compact objects in stable surroundings of great spatial extension. Deer observed by the hunter.		Paradigm ii : Motion of objects in boats, coaches and other moving systems	
Natural Interpretation: Abs motion is operative		Natural Interpretation: Only relative motion is operative	
Falling stone proves	Motion of earth predicts	Falling stone proves	Motion of earth predicts
↓	↓	↓	↓
Earth at rest	oblique motion of stone	No relative motion between starting point and earth	No relative motion between starting point and stone

Now we have seen that this naive realism is on occasions an essential part of our observational vocabulary. In these occasions (paradigma i) the observation language contains the idea of the efficacy of all motion. Or, to express it in the material mode of speech, our experience in these situations is the experience of objects which move absolutely. Taking this into consideration we see that Galileo's proposal amounts to a partial revision of our observation language, or of our experience. An experience which partly contradicts

the idea of the motion of the earth is turned into an experience that confirms it, at least as far as "terrestrial things" are concerned [117]. That is what actually happens. But Galileo wants to persuade us that no change has taken place, that the second conceptual system was already universally known, even though it was not universally used. Both Salviati, his representative in the dialogue and his opponents, Simplicio, and also Sagredo, the intelligent layman connect Galileo's method of argumentation with Platon's theory of anamnesis [118] - a clever tactical move, typical Galileo, one is inclined to say, which however must not deceive us about the revolutionary development that is actually taking place.

The resistance against the assumption that shared motion is noncoperative is equated with the resistance which forgotten ideas exhibit towards the attempt to make them known. Let us accept this interpretation of the resistance! But let us not forget its existence. We must then admit that it restricts the use of the relativistic ideas, confining them to part of our everyday experience. Outside this part, and that means, in interstellar space, they are "forgotten" and therefore not active. But outside this part there is not complete chaos. Other concepts are used, among them those very same absolutistic concepts which derive from the first paradigm. We not only use them, but we must admit that they are empirically entirely adequate. No difficulties arise as long as one remains within the limits of the first paradigm. "Experience", that is the totality of all

(117) (118) 112, 416. — Cf. footnote 137 of "Problems of Empiricism, Part II", which.

facts from all domains described with the concepts which are appropriate in these domains, this experience cannot force us to carry out the change which Galileo wants to introduce. The motive for a change must come from a different source.

It comes, first, from the desire to see "the whole correspond to its parts with wonderful simplicity" as already Copernicus expressed himself. It comes from "typically metaphysical urge" for unity of understanding and of conceptual presentation. And the motive for a change is connected, secondly, with the intention to make room for the motion of the earth which Galileo had accepted and was not prepared to give up. The idea of the motion of the earth is closer to the first paradigm than to the second - or at least it was at the time of Galileo. This great strength to the Aristotelian arguments and made them very plausible. To eliminate this plausibility it was necessary to subsume the first paradigm under the second and to extend the relative notions to all phenomena. The idea of anamnesis functions here as a psychological crutch, or a psychological lever which smoother the procss of subsumption by concealing its existence.

. We are now ready to apply the relative notions not only to boats, coaches, birds, but also to the "solid and well established earth" as a whole and we have the impression that this readiness was in us all the time

(119) 241.—

although it took some effort to make it conscious. This impression is most certainly erroneous - it is the result of Galileo's propagandistic machinations. We would do better to describe the situation in a different way, as a change of our conceptual system or, as we are dealing with concepts which belong to natural interpretations and are therefore connected with sensations in a very direct way, as a change of experience that allows us to accomodate the Copernican doctrine. The change corresponds perfectly to the pattern outlined in [illegible]: an inadequate view, the Copernican theory, is supported by another inadequate view, the idea of the nonoperative character of shared motion and both gains, and gives, strength in the process (the inadequacy of the second view is of course covered up by Galileo's tricks - but it can be easily revealed [illegible]). It is this change which constitutes the transition from the Aristotelian point of view to the epistemology of modern science.

For experience now ceases to be that unchangeable fundament which it is both in commonsense and in the Aristotelian philosophy. The attempt to suppport Copernicus makes experience "fluid" in the very same manner in which it makes the heavens fluid, "so that each star moves around by itself" [illegible]. An empiricist who starts from experience and builds on it without ever looking back now loses the very ground on which he stands. Neither the earth, "the solid, well established earth", nor the facts on which he usually relies can be

(120) 120.

trusted any longer. It is clear that a philosophy that uses such a fluid and changing experience needs new methodological principles which do not insist on an asymetric judgment of theories by experience. Classical physics intuitively adopts such principles; at least the great and independent thinkers, thinkers such as Newton, ~~Boltzmann~~ Faraday, and Boltzmann proceed in this way. But its official doctrine still clings to the idea of a stable and unchanging experience.[121] The clash between this doctrine and the actual procedure is concealed by a tendentious presentation of the results of research that hides their revolutionary origin and suggests that they have flown from the stable and unchanging experience praised by the doctrine. These methods of concealment start with Galileo's attempt to introduce new ideas under the cover of anamnesis and they culminate in Newton.[122] They must be exposed if we want to arrive at a better account of the progressive elements in science.

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(21) Cf. "Classical Empiricism", op. cit.

(8) The Law of Inertia. Our discussion of the anti-Copernican argument is not yet complete. So far we have tried to discover what assumption will m a stone that moves alongside a moving tower appear to fall "straight down" instead of being seen to move in an arc. The assumption that our senses notice only relative motion and are completely insensitive to a motion which objects have in common - an assumption which we shall call the relativity principle - was seen to do the trick. What remains to be explained is why the stone stays with the tower and why it is not left behind. If we want to save the Copernican view then we must explain not only why a motion that preserves th relation among visible objects remains unnoticed but also why a common motion of various objects does not affect their relation, tha is, why such a motion is not a causal agent. Turning the question around in the manner explained in section 6 we now see that the anti-Copernican argument of section 7 rests on two natural interpretations, viz. the epistemological assumption that absolute motion is always noticed as well as upon the dynamical principle that objects (such as the falling stone) which are not interfered with remain in a state of absolute rest. Our present problem is to supplement the relativity principle with a new law of inertia in such a fashion that the motion of the earth can still be asserted. One sees at once that the following law - the principle of circular inertia as we shall call it - does the trick: an object that moves with a given angular velocity on a frictionless sphere around the center of the earth will forever continue moving with the same angular velocity. Combining the appearance of the falling stone with the relativity principle, the principle of circular inertia as well as with some simple assumptions concerning the composition of velocities we

obtain an argument which no longer endangers Copernicus but can be used to give it partial support.

(117) The relativity principle was defended in two ways; first by showing how it helps Copernicus - this defence is truly ad hoc - secondly by pointing to its function in commonsense and by surreptitiously generalising that function (see section 13). No independent argument is given for its validity. Galileo's support for the principle of circular inertia is of exactly the same kind. He introduces it again, not by reference to experiment, or to independent observation, but by reference to what everyone is already supposed to know:

"Simplicio: So you have not made a hundred tests or even one? And yet you do freely declare it to be certain?...

Salviati: Without experiment, I am sure that the effect will happen as I tell you, because it must happen that way; and I might add that you yourself also know that it cannot happen otherwise, no matter how you may pretend not to know it ... But I am so handy at picking peoples' brains that I shall make you confess this in spite of yourself".[42] (122) Step by step Simplicio is forced to admit that a body that moves without friction on a sphere concentric with the center of the earth will carry out a "boundless", a "perpetual" motion.[43] (123) We know, of course, especially after the analysis we have just completed (regarding the non-operative character of shared motion) that what Simplicio accepts is based neither on experiment, nor on corroborated theory, but is a daring new suggestion involving a tremendous leap of the imagination. A little more

(122) (42) Dialogue, 145.
(123) (43) 147.

analysis then shows us that this suggestion is connected with experiments (such as the "experiments" of the Discorsi) by ad hoc hypotheses, for the amount of friction to be eliminated follows not from independent investigation - such investigation commences only much later, in the 18th century - but from the very result to be achieved, viz. the circular law of inertia. Viewing natural phenomena in this way leads, as we have already said, to a complete reevaluation of all experience or, as we can now say, it leads to the invention of a new kind of experience that is more sophisticated, but also far more speculative than is the experience of Aristotle, or of commonsense. Speaking paradoxically (but not incorrectly) we may say that Galileo invents an experience that has metaphysical ingredients. This is how part of the transition from a geostatic cosmology to the point of view of Copernicus and Kepler was achieved.

(9) Progressive Role of Ad Hoc Hypotheses. This is the place to briefly mention certain ideas which have been developed by Lakatos and which throw new light on the problem of the growth of knowledge.

It is customary to assume that good scientists refuse to employ ad hoc hypotheses, and to assert that they are right in their refusal. New ideas, so it is thought, go far beyond the available evidence and they must go beyond it in order to be of value. Ad hoc hypotheses are bound to creep in eventually, but they should be resisted, and kept at bay. This is the customary attitude as it is expressed, for example, in the writings of K.R. Popper.

As opposed to this Lakatos, in lectures, and now also in publications

has pointed out that adhocness is neither despicable, nor absent from the body of science. New ideas, he emphazises, are usually almost entirely ad hoc, they cannot be otherwise, and they are reformed only in a piecemeal fashion, by gradually extending them beyond their starting point. Schematically:

Popper: new theories have, and must have, excess content which is (but should not be) gradually infected by ad hoc adaptations.

Lakatos: new theories are, and cannot be anything but, ad hoc. Excess content is, and should be created in a piecemeal fashion, by gradually extending them to new facts and domains.

The historical material we have just analysed (and the more extensive material presented in "Problems of Empiricism, Part ii") lends unambiguous support to the position of Lakatos. Let us show this in some detail.

First, <u>kinematic relativity</u> (cf. section 7, above):

Just like Newtonian physics Aristotelian physics, too, distinguishes between relative space and absolute space.[124] In addition it allows us to "operationally" determine absolute places, directions, velocities. One may proceed in the following way: the <u>centre</u> of the universe is found, for example, by backwardly elongating the direction of two flames and it is tested by using a third flame. Flames function here as testbodies and not as referencebodies for relative motion. <u>Distance</u> from the centre is determined by the strength of the upward motion of flames (or of suitable mixtures which may be enclosed in test capsules):

(124) Cf. <u>Physics</u> 208b10ff.

we see, how space is traced out, in an entirely physical way, by using known physical laws. Direction, finally, is determined by determining the axis of rotation of the stellar sphere. This whole physical background is removed by Galileo. With it, we lose all means of testing, and the new relativistic principles (only relative motion is "operative" are therefore metaphysical and, because adapted to the tower experiment, also ad hoc.

Considering now dynamical relativity (section 8) we should remember, first of all, that the natural character of circular motion was not first asserted by Galileo. It was an old assumption, concerning all supralunar entities. The new assumption that was introduced by Galileo (and by Copernicus before him, in ~~xxxx~~ chapter viii of de revolutionibus) is that circular motion is a natural motion for terrestrial objects also. On the one hand this is an immediate consequence of having made the earth a star: stars move in circles hence, if the earth is a star, its natural motion will be circular both as whole (around the sun) as as regards "its motion with respect to itself" as its rotation was described at the time. Now - does this particular assumption of the rotation of the earth assert anything over and above what was known to happen at its surface at Galileo's own time? My attitude (which is in accordance with Lakatos' general theory) is that the answer must be no. The only consequence of the assertion is that it connects moving objects rigidly with the framework of the moving (i.e. rotating) earth thus leaving everything as it is, and especially leaving the

result of the tower experiment and the cannon experiment as it is.[125] No further consequence is implied at the time (it was different with the motion of the earth around the sun which led one to expect a sizeable stellar parallax). Not even the later Newtonian argument (distant objects, moving with the same angular velocity, will hit the earth ahead of the tower) can be used at this stage for it is not at all clear whether Galileo would want distant objects to move with the same angular velocity (in the case of the planets he notices their decreasing angular velocity - the effect of Kepler's third law - and he might be inclined to treat bodies circulating around the earth in the same way; on the other hand he calculates the time a stone will take dropping from the moon to the earth by assuming a constant acceleration all the way[126]). Nor do I think that bringing in the tradition of the impetus theory will improve matters. First, because the impetus theory does not introduce a circular law of inertia, but a linear law. Secondly, because it is again ad hoc, this time not with respect to the tower and to cannon balls, but with respect to the behaviour of things thrown (which continue to move, contrary to Aristotle's law of inertia). And when a circular law is asserted, as seems to be the case with Buridan, the problem is the same as with Galileo. Finally, one must not argue against ad hocness by pointing to the fact that experiments were made in boats, with cannon balls, on towers, and so on.[127] These experi-

(125) Galileo seems to have been aware of this situation. He silently abandons the idea of the non-operative 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 Vol. 53 (1962), 161-185 and the literature there.

(126) Such a stone, says Galileo [Dialogue, 233] would arrive ahead of the tower.

(127) For an enumeration of such experiments cf. A. Armitage "The Deviation of Falling Bodies" Annals of Science Vol. 5 (1941/47), 342-351. For further material and discussion cf. A. Koyré Metaphysics and Measurement London 1968. For a comprehensive survey cf. G. Hagen La Rotation de la

ments did not lead to a decisive result. Besides, they did not test any excess content of the law of circular inertia, but tried to establish the fact which the law then explains in an ad hoc fashion. Reference to the experiments with the inclined plane is also beside the point. These experiments test (if that is the right word) the law of the free fall - but of course there still remains the task to subdivide that motion into an inertial motion and something else. However one looks at the matter - the best conjecture is that at the time in question the circular law of inertia (and even more so the idea of the relativity of motion) was an ad hoc hypothesis designed to get out of the trouble of the tower.

Now, if one is right is assuming that Galileo framed an ad hoc hypothesis at this point, then one can also praise him for his methodological acumen. It is obvious that the moving earth demands a new dynamics. One test of the old dynamics consists in the attempt to establish the motion of the earth: trying to establish the motion of the earth is the same as trying to refute the old dynamics. Now the motion of the earth is inconsistent with the tower experiment interpreted in accordance with the old dynamics. Interpreting the tower experiment in accordance with the old dynamics therefore means trying to save the old dynamics in an ad hoc fashion. If we do not want to do this we must find a different interpretation for the phenomena of free fall. What interpretation shall we choose? We want an interpretation that turns the motion of the earth into a refuting instance of the old dynamics without lending ad hoc

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, loc.cit., p. 346.

support to the motion of the earth itself. The first step towards such an interpretation is to establish contact, however vague, with the "phenomena", i.e. with the falling stone, and to establish it in such a manner that the motion of the earth is not obviously contradicted. The most primitive element of this first step is to frame an ad hoc hypothesis with respect to the rotation of the earth (which hypothesis, obviously, will not be ad hoc with respect to the old dynamics). The next step would be to elaborate, so that additional predictions become possible. Copernicus, Galileo, and Buridan before them take this first and most primitive step. This step looks despicable only if one forgets that the aim was to test older views rather than to prove new ones, and if one also forgets that developing a good theory takes time. But why, an impatient methodologist might ask, why did it take so long before additional phenomena were added? It took so long because the domain of possible phenomena had first to be clarified by the further development of the Copernican hypothesis. It is much better to remain ad hoc for a while and in the meantime to develop heliocentrism in all its astronomical ramifications which can then be used as guidelines for a further elaboration of dynamics.

Therefore: Galileo was adhoc. It was good that he was ad hoc; had he not been ad hoc he would have been ad hoc anyway, but this time with respect to an older theory. Hence, if one cannot escape being ad hoc it is better being ad hoc with respect to a new theory which, like all new things, may give a feeling of freedom and progress. Galileo is to be applauded because he preferred protecting an interesting hypothesis to protecting a dull one.

(10) Summary of Analysis of the Tower Argument. I repeat and summarise:

An argument is proposed which refutes Copernicus by observation. The argument is inverted in order to discover those natural interpretations which are responsible for the contradiction. The offensive interpretations are replaced by others, propaganda and appeal to distant and highly theoretical parts of commonsense being used to defuse old habits and to enthrone new ones. The new natural interpretations which are also formulated explicitly, as auxiliary hypotheses, are established partly by the support they give to Copernicus, partly by plausibility considerations and ad hoc hypotheses. An entirely new "experience" arises in this way. Independent evidence is as yet entirely missing -

presenting our position

with his

and we continue - this is no drawback as it is to be expected that independent support will take a long time appearing After all, what is needed is a theory of friction, a theory of solid objects, aerodynamics, hydrodynamics, and all these sciences are still hidden in the future. But their task is now well defined for Galileo's assumptions, his ad hoc hypotheses included, are sufficiently clear and simple to prescribe the direction of future research Let it be noted, incidentally, that Galileo's procedure drastically reduces the content of dynamics: Aristotelian dynamics was a general theory of change comprising locomotion, qualitative change, generation and corruption. Galileo's dynamics and its successors deal with locomotion only the other kinds of motion being pushed aside with the promissory note (due to Democritos) that locomotion will eventually be capable of explaining all motion. Thus a comprehensive empirical theory of motion is replaced by a much narrower theory plus a metaphysics of motion just as an "empirical" experience is replaced by an experience that contains strange and speculative elements. Counterinduction, however, has now been justified both for theories and for facts. It is seen to play an important role in the advancement of science. This concludes the considerations which started in section 2. For details and further examples the reader is again referred to "Problems of Empiricism, Part ii", op. cit.

(11) Discovery and Justification; Observation and Theory. Let us now use the material of the preceding sections for throwing light on the following features of contemporary empiricism: 1st, the distinction between a context of discovery and a context of justification; 2nd, the distinction between observational terms and theoretical terms; 3rd, the problem of incommensurability.

One of the objections which may be raised against the preceding discussion is that it has confounded two contexts which are essentially apart, viz. a context of discovery, and a context of justification. Discovery may be irrational and need not follow any recognised method. Justification, on the other hand (or, to use the Holy Words of a different school, criticism) starts only after the discoveries have been made and proceeds in an orderly way. Now if our example (and the examples we have used in earlier papers) shows anything then it shows that the distinction refers to a situation which either does not arise in practice at all or which, if it does arise, reflects a temporary slowing down of the process of research and should therefore be eliminated as quickly as possible. Research at its best is an interaction between new theories which are stated in an explicit manner and older views which have crept into the observation language, it is not a one sided action of the one upon the other. Reasoning within the context of justification however presupposes that one side of this pair - observation - has frozen and that the principles which constitute the observation concepts are preferred to the principles of a newly invented point of view. The former feature indicates that the discussion of principles is not carried out as vigorously as is desirable, the latter feature reveals that this lack of vigour may be due to some unreasonable and perhaps not even explicit preference.

But is it wise to be dominated by a preference of this kind? Is it wise to make it the raison d'être of a distinction that separates two entirely different modes of research? Or should we not rather demand that our methodology treat explicit and implicit assertions, doubtful and intuitively evident theories, known and unconsciously held principles in exactly the same way and that it provide means for the discovery and the criticism of the latter? Abandoning the distinction between a context of discovery and a context of justification is the first step towards satisfying this demand.

Another distinction which is clearly related to the distinction between discovery and justification is the distinction between observational terms and theoretical terms. It is now generally admitted that the distinction is not as sharp as it was thought to be only a few decades ago and it is also admitted, in complete agreement with Neurath's original views, that both theories and observation statements are open to criticism. Yet the distinction is still held to be a useful one and is defended by almost all philosophers of science. But what is its point? Nobody will deny that the sentences of science can be classified into long sentences and short sentences, or that its statements can be classified into those which are intuitively obvious and others which are not. But nobody will put particular weight on the distinctions, or will even mention them for they do not play any role in the business of science (this was not always so - intuitive plausibility, for example, was once thought

to be a most important guide to the truth; but the distinction disappeared from methodology the very moment intuition was replaced by experience). Does experience play such a role? Is it as essential to refer to experience as it was once thought essential to refer to intuition? Certainly not. True, much of our thinking arises from experience, but there are large portions which do not arise from experience at all but are firmly grounded on intuition, or on even deeper lying reactions. True, we often test our theories by experience, but we equally often invert the process, we analyse experience with the help of more recent views and we change it in accordance with these views (see our above discussion of Galileo's procedure). It is again true that we often rely on our experience in a way that suggests that we have here a solid foundation of knowledge, but such reliance turns out again to be just a psychological quirk as is shown whenever the testimony of an eye-witness crumbles under cross examination; moreover we equally firmly rely on general principles so that our most solid perceptions become indistinct and ambiguous when they clash with these principles. The symmetry between observation and theory which emerges from such remarks is perfectly reasonable for experience just as our theories contains abstract and even metaphysical ideas (for example, it contains the idea of observer-independent existence). True, these abstractions, these speculative ideas are connected with sensations and perceptions, but first of all this does not at all give them a privileged position unless we want to assert that perception is an infallible authority; and secondly it is quite possible to altogether eliminate perception from all the essential activities of science (see above,

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section 6 44). All that remains is that some of our ideas are accompanied by strong and vivid psychological processes, "sensations", while others are not - which is a peculiarity of human existence as much in need of criticism and investigation as anything else. Now, if we want to be "truly scientific" (dreaded words!) should we then not regard the thesis "experience is the foundation of our knowledge" or "experience helps us to discover the properties of the external world" as (very general) hypotheses which must be examined just like any other hypothesis and perhaps even more vigorously as so much depends on their truth? And will not such an examination be rendered impossible by a method that either justifies, or criticises on the basis of experience? These are some of the questions which arise in connexion with the customary distinction between observation and theory, discovery and justification. None of them is really new. They are known to philosophers of science, and are discussed by them at length. But the inference that the distinction between theory and observation has now ceased to be relevant is/not either drawn, or explicitly rejected.[129] Let us make a step forward and let us abandon this last remainder of anthropomorphism in science!

(128) Critical debate concerning the properties of objects can be carried out in a fashion which leaves the question "empirical science, or pure mathematics" entirely open. Thus Lakatos' exciting and beautiful discussion in his Proofs and Refutations can be interpreted as dealing with real physical objects (crystals, for example) and their properties; but it can also be interpreted as dealing with "ideal" objects of some special and "pure" science (though one will see at once that the latter interpretation has no merit at all, if separated from the former). In both cases the method of discussion is the same. Does this not show that the distinction between empirical sciences and formal sciences is a distinction without a difference?

(129) "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 1959, 97.

(12) Rationality Again. Incommensurability which we shall discuss next is closely connected with the question of the rationality of science. Indeed, one of the most general objections, either against the use of incommensurable theories, or even against the idea that there are such theories is the fear that they would severely restrict the efficacy of (traditional, non-dialectical) argument. Let us therefore look a little more closely at the critical standards which, at least according to some people, constitute the content of a rational argument.

Within the Popperian school with whose ratiomania we are here mainly concerned, the standards are standards of testability, content, simplicity, closeness to truth, and so on. It seems that such standards are now applied more liberally, mainly as the result of Lakatos' investigations.[130] This would be good new indeed were it not for the fact that the "new liberalism" means either giving up standards altogether - a step which Lakatos is hardly prepared to take - or is identical with Popper's own and more conservative philosophy. According to this philosophy ~~This attitude judges (i.e. accepts, or condemns)~~ a theory, as soon as it is introduced into the discussion. Lakatos gives a theory time, he permits it to develop, he permits it to show its hidden strength and he judges it only "in the long run". The "critical standards" he

(130) "Criticism and the Methodology of Scientific Research Programs" to appear in Criticism and the Growth of Knowledge ed. Lakatos-Musgrave North Holland Publishing Company 1969. Quotations are from the typescript of this paper which Lakatos was kind enough to let me have prior to its publication. In this typescript the reference is mostly to Popper. Had Lakatos been as careful with acknowledgements as he is when the Spiritual Property of the Popperian Church is concerned he would have pointed out that this liberalization which sees knowledge as a process is indebted to Hegel.

employs provide for an interval of hesitation. They are applied "with hindsight". They are applied after the occurrence of either "progressive", or of "degenerating" problem shifts.

Now it is easy to see that standards of this kind have practical force only if they are combined with a time limit (what looks like a degenerating problem shift may be the beginning of a much longer period of advance). But introduce the time limit and the argument against the more conservative point of view or "naive falsificationism" as Lakatos calls it reappears with only a minor modification (if you are permitted to wait, then why not wait a little longer?) Thus the new standards which Lakatos wants to defend are either vacuous - one does not know how to apply them -, or they can be criticised on grounds very similar to those which led to them in the first place. [Or else they hide the fact that in concrete situations one just continues using good old "naive falsificationism"].

In these circumstances one can do one of the following two things. One can stop appealing to permanent standards which remain in force throughout history and govern every single period of scientific development and every transition from one period to another. Or can retain such standards as a verbal ornament, as a memorial to happier times when it was still thought possible to run a complex and often catastrophic business like science by following a few simple, and "rational" rules. It seems that Lakatos wants to choose the second alternative.

Choosing the second alternative means abandoning permanent standards *in fact* though retaining them *in words*. *In fact* Lakatos' position now seems to be identical with the position of Popper as summarised in the marvellous Appendix i/15 of the Fifth Edition of the **Open Society**.[131] 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 a different measure of excellence should arise.[132] Is such a position irrational? Yes and no. Yes - because there no longer exists a single set of rules that will guide us through all the twists and turns of the history of thought (science), either as participants, or as historians who want to reconstruct its course. One can of course *force* history into such a pattern, but the results will always be poorer and much less interesting than were the actual events. No - because each particular episode is rational in the sense that some of its features can be explained in terms of reasons which were either accepted at the time of its occurrence, or invented in the course of its development. Yes- because even these local reasons which change from age to age are never sufficient to explain *all* the important features of a particular episode. We must add accidents, prejudices, material conditions (such as the existence of a particular type of glass in one country and not in another for the explanation of the history of optics), the vicissi-

(131) pp 388ff.
(132) 390. Cf. also footnote 19.

tudes of married life (Ohm!), superficiality, pride, oversight, and many other things in order to get a complete picture. No - because transported into the climate of the period under consideration and endowed with a lively and curious intelligence we might have had still more to say, we might have tried to overcome accidents, and to "rationalise" even the most whimsical sequence of events. But - and now we come to a decisive point for the discussion of incommensurability - how is the transition from certain standards to other standards to be achieved? More especially, what happens to our standards (as opposed to our theories) during a period of revolution? Are they changed in the manner suggested by Mill, by a critical discussion of alternatives, or are there processes which defy a rational analysis? Well, let us see!

That standards are not always adopted on the basis of argument has been emphazised by Popper himself. Children, he says, "learn to imitate others ... and so learn to look upon standards of behaviour as if they consisted of fixed, 'given' rules ... and such things as sympathy and imagination may play an important role in this development".[133] Similar considerations apply to those grownups who want to continue learning and who are intent on expanding both their knowledge and their sensibility - this we have already discussed in section 1. Popper again admits that new standards may be discovered, invented, accepted, imparted upon others in a very irrational manner but/that he also asserts one can criticise them after

(133) loc. cit. Cf. footnote 7 and the corresponding text ff.

they have been adopted and that it is this possibility which keeps our knowledge rational. "What, then, are we to trust?" he asks after a survey of possible sources for standards.[134] "What are we to accept? The answer is: whatever we accept we should trust only tentatively, always remembering that we are in possession, at best, of partial truth (or rightness), and that we are bound to make at least some mistake or misjudgement somewhere - not only with respect to facts but also with respect to the adopted standards; secondly, we should trust (even tentatively) our intuition only if it has been arrived at as the result of many attempts to use our imagination; of many mistakes, of many tests, of many doubts, and of searching criticism."

Now this reference to tests and to criticism which is supposed to guarantee the rationality of science and, perhaps, of our entire life may be either to well defined procedures without which a criticism or test cannot be said to have taken place, or it may be purely abstract so that it is left to us to fill it now with this, and now with that concrete content. The first case has just been discussed. In the second case we have again but a verbal ornament. The questions asked in the last but one paragraph remain unanswered in either case.

In a way even this situation has been described by Popper who says that "rationalism is necessarily far from comprehensive or self-contained".[135] But when we start discussing incommensurability our question

(134) Op. cit., 391.
(135) 231.

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, or are irrational changes an essential part even of the most rational enterprise that has been invented by man? Does the historical phenomenon "science" contain ingredients which defy a rational analysis although they may be described with complete clarity in psychological or sociological terms? Can the abstract aim to come closer to the truth be reached in an entirely rational manner, or is it perhaps inaccessible to those who decide to rely on argument only? This are the problems which were raised, in different terms, by Hegel. They are the problems to which we wish to address ourselves.

Considering these further problems Popper and Lakatos reject sociology and psychology or, as Lakatos expresses himself, "mob psychology" and assert the rational character of all science. According to Popper it is possible to arrive at a judgement as to which of two theories is closer to the truth, even if the theories should be separated by a catastrophic upheaval such as a scientific (or other) revolution (A theory is closer to the truth than another theory if the class of its true consequences, its truth content, exceeds the truth content of the latter without an increase of the falsity content). According to Lakatos the apparently unreasonable features of science occur only in the material world and in the world of (psychological) thought; they are absent from the "world of ideas, [from] Plato's and Popper's 'third world'". It is in this third world that the growth of knowledge takes place and that a rational judgement of all aspects of science becomes possible. ~~However~~ it must be pointed

(Now as regards this flight into higher

out that the scientist is unfortunately dealing with the world of matter and of (psychological) thought also - or, rather, it is mainly with this material world that he is dealing - and that the rules which create order in the third world may be entirely inappropriate for creating order in the brains of living human beings (unless these brains and their structural features are put in the third world also, a point that does not become clear from Popper's account[136]). The numerous deviations from the straight and rather boring path of rationality which we observe in actual science may well be necessary if we want to achieve progress with the brittle and unreliable material (instruments; brains; assistants; etc.) at our disposal.

However, there is no need to pursue this objection further. There is no need to argue that real science may differ from its third-world shadow in precisely those respects which make progress possible.[137] For the Popperian model of an approach to the truth breaks down even if we confine ourselves to ideas entirely. It breaks down because there are incommensurable theories.

(136) I am referring here to the following two papers: "Epistemology without a knowing Subject" Rootsclaar-Staal (eds.) Logic, Methodology, and Philosophy of Science Amsterdam 1968 as well as "On the Theory of the Objective Mind". In the first paper birdnests are assigned to the "Third World" (op. cit., 341) and an interaction is assumed between the 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, and 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".
(137) Cf. again "Problems of Empiricism, Part ii", op. cit.

(13) Incommensurability. The accepted scheme of theory-succession is as follows (Fig. 1): T is superseded by T'. T' explains why T fails when it does (F); it also explains why T has been at least partly successful (S); and it makes additional predictions (A). Now if this scheme is to work, then there must be statements which follow (with, or without the help of definitions and/or correlation hypotheses) both from T and T'. But there are cases which invite a comparative judgement

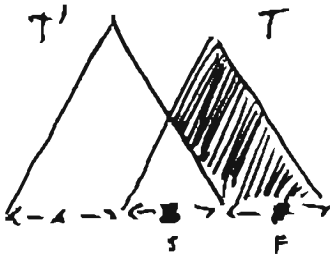

Fig. 1

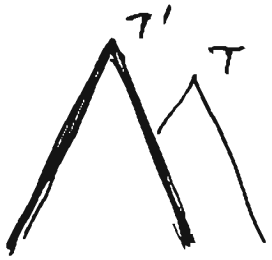

Fig. 2

without satisfying the conditions just stated. The relation between such theories is as shown in Fig. 2 (here the area below T' should be imagined as lying either in front of the area below T, or behind it, so that there is no overlap). A judgement involving a comparison of content classes is now clearly impossible. For example, T' cannot be said to be either closer to, or father from the truth, than T. T and T' are then said to be incommensurable.

As regards incommensurability we can ask three questions:[138]

(138) Cf. the treatment of the corresponding questions in "Reply to Criticism", loc. cit., 234ff.

(i) Are there incommensurable theories? This is a historical question

(ii) Should we permit incommensurable theories into the domain of our knowledge? More especially, should we permit a theory to be superseded by a theory that is incommensurable with it? This is a methodological questions

(iii) Is it possible to introduce theories which are incommensurable with the theories already in existence? This question may be understood in two ways (a): is it conceptually possible to introduce such theories? - which reduces to question (ii). Or (b): is it physiologically, or psychologically possible to introduce such theories? This last question is an empirical question.

In the present section I shall mainly deal with question (ii) and I shall try to show that science will not suffer from the use of incommensurable theories and that it may be considerably enhanced by it.

As we have seen it is possible, and often necessary to change one's observation language by replacing certain natural interpretations either with other natural interpretations, or with entirely new concepts which must then be learned until one uses them as fluently as one used their natural predecessors. Such replacement may introduce concepts which are incommensurable with the concepts hitherto in use. And we shall say that concepts are incommensurable if they cannot occur in the same atomic statement (the same argument), or if their occurrence

in the same atomic statement (the same argument) is excluded by the grammatical rules of the language systems (subsystems) to which they belong.[139 47] Number concepts and psychological concepts are incommensurable in this sense. Incommensurability can be recognised either intuitively, as is the case with concepts of some common idiom, or by paying attention to rules of application. If the rules of one set of concepts, B', allow application only under conditions C', and the rules of B" only under conditions C", then B' and B" are incommensurable either if C' and C" are inconsistent (as is the case with precise quantum mechanical position and momentum, at least if these concepts are explained in the manner of Bohr), or if they are themselves incommensurable. This explanation is of course not complete, it is just a first step in dealing with the tricky problem of incommensurability. Two theories are incommensurable if all their concepts are incommensurable and especially if their observation concepts are incommensurable. In the latter case one cannot decide between them on the basis of crucial experiments, nor is it possible to use them for mutual criticism in the manner outlined in section 2. [40] Does this put a limitation upon our interpretation of observation statements? Is this sufficient reason to restrict our reinterpretation of observation terms such that a minimum of conceptual stability is guaranteed? Are we now after all that has been said forced to accept a stable

139 (47) Talking in this way I do not mean to subscribe to the analytic-synthetic dichotomy, except in a [illegible] Pickwickian manner. For I am convinced that every feature of a conceptual system is open to change and that experience is always a possible reason for change. This does not obliterate the distinction between conceptual changes and changes in the outer world; however, just as [illegible] the use of automatic telescopes or of particle counters does not obliterate the distinction between changes in the construction of telescopes, or of counters on the one hand, and changes in the stars and particles they are supposed to detect on the other.

observation language and to adopt a partial instrumentalism (it is easily seen that incommensurable theories can be made commensurable by interpreting them instrumentalistically, on the basis of the same observation language)? I do not think so. Incommensurability only shows that the idea of fixed methodological rules cannot be maintained and in this way supports the main thesis of the paper. It does not show that science is an impossible enterprise. Let us now take a look at some objections.

(a) Natural interpretations are replaced by others which may be incommensurable with them. One proceeds in this way in order to adapt observation to the point of view of a new theory. Thus Galileo replaces the idea of the operative character of all motion by his relativity principle in order to accomodate the new views of Copernicus. The procedure is entirely natural. A cosmological theory such as the Copernican theory, or the theory of relativity, or the quantum theory (though the last with certain restrictions) makes assertions about the world as a whole and it applies to observed as well as to unobserved (unobservable, "theoretical") processes. The theory of relativity, for example, does not just invite us to rethink unobserved length, mass, duration; it entails the relational character of all lengths, masses, durations, whether observed or unobserved. However such an adaptation of observation to theory - and this is the gist of the first objection - removes conflicting observation reports and saves the theory in an ad hoc manner. Moreover there arises the suspicion that observations which are interpreted in terms of a new theory can no longer be used to refute that theory. It is not difficult to reply to these points.

140 (48) This point has been argued in detail by R.E. Butts, Philosophy of Science Vol 33 (1966), 383-393.

As regards the objection we point out, in agreement with what has been said before, that an inconsistency between theory and observation may reveal a fault of our observational terminology (and even of our sensations) so that it is quite natural to change this terminology, to adapt it to the new theory, and to see what happens. Such a change gives rise, and should give rise to new auxiliary subjects (hydrodynamics, theory of solid objects, optics in the case of Galileo) which more than compensate for the empirical content lost by the adaptation. And as regards the suspicion we must remember that the predictions of a theory depend on its postulates, the associated grammatical rules as well as on initial conditions while the meaning of the "primitive" notions depends on the postulates (and the associated grammatical rules) only. In those rare cases, however, where we encounter initial conditions inconsistent with the theory (an example seems to be the Einstein-Infeld-Hofmann theory of matter) we are still able to refute the theory with the help of self-inconsistent observation reports such as "object A does not move on a geodesic" which, if analysed in accordance with the Einstein-Infeld-Hoffmann account reads "singularity which moves on a geodesic does not move on a geodesic". The oddity of such a procedure is removed by simple examples, such as the ones enclosed, which make evident the occasional need for inconsistent observational reports (another example is the wellknown impression of spatial movement without change of location).[141] Finally let us not forget that experience need not al-

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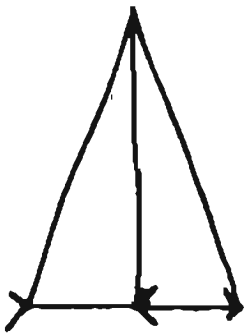
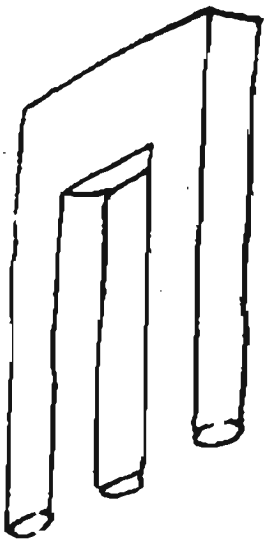
141 (1949) In a discussion with the author Professor Ayer tried to chase away these examples by pointing out that the impression of movement (in the lastmentioned example) should be described by saying "it appears to move" rather than "it moves" - and then the contradition disappears. It does not. For the "it appears that ..." belongs to the beginning of the whole description, viz. "it appears that the object moves and does not move" ; and this is just what I have asserted: the existence of appearance which can only be described by an inconsistent statement. The two figures in the text make the situation even clearer.





ways be a judge of theories. How for example would we judge a theory that denies experience this function ("by experience")? But even this case does not lead into trouble for refutation by experience, or indirect refutation with the help of alternative theories (in the manner briefly indicated in section 2) is not the only way of eliminating a theory (see below). The first objection, therefore, seems to receive a satisfactory answer.

In order to explain the next objection, let us briefly discuss the relation of classical celestial mechanics (CM) and the special theory of relativity (SR). To start with one should emphazise, in this case as in all other cases, that the question: "are CM and SR incommensurable?" is not a complete question. Theories can be interpreted in different ways. They will be commensurable in some interpretations, incommensurable in others. Instrumentalism, for example, makes commensurable all those theories which are related to the same observation language and are interpreted on its basis. A realist, on the other hand, wants to give a unified account, both of observable and of unobservable matters, and he will

use the most abstract terms of whatever theory he is contemplating for that purpose. This is an entirely natural procedure. SR, so one would be inclined to say, does not just invite us to rethink unobserved length, mass, duration; it would seem to entail the relational character of all lengths, masses, durations, whether observed or unobserved, observable or unobservable. Now extending the concepts of a new theory T to all its consequences, observational reports included, may change the interpretation of these consequences to such an extent that they disappear from the consequence classes either of earlier theories, or of available alternatives. These earlier theories, these alternatives will then all become incommensurable with T. The relation between SR and CM is a case in point. The concept of length as used in SR and the concept of length as presupposed in CM are different concepts. Both are relational concepts, and very complex relational concepts at that (just consider determination of length in terms of the wave length of a specified spectral line). But relativistic length (or relativistic shape) involves an element that is absent from the classical concept and is in principle excluded from it.[142] It involves the relative velocity of the object concerned in some reference system. It is of course true that the relativistic scheme very often gives us numbers which are practically identical with the numbers we get from CM - but this does not make the

(142) 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 de Witt and de Witt eds. New York 1964. For the k-calculus cf. H. Bondi, Assumption and Myth in Physical Theory Cambridge 1967, 28ff as well as D. Bohm, The Special Theory of Relativity New York 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.

concepts more similar. Even the case $c \to \infty$ (or $v \to 0$) which yields identical predictions cannot be used as an argument for showing that the concepts must coincide at least in this case: different magnitudes based on different concepts may give identical values on their respective scale without ceasing to be different magnitudes (the same remark applies to the attempt to identify classical mass with relativistic rest mass[143]). This conceptual disparity, if taken seriously, infects even the most "ordinary" situations: the relativistic concept of a certain shape, such as a table, or of a certain temporal sequence, such as my saying "yes" will differ from the corresponding classical concept also. It is therefor vain to expect that sufficiently long derivations may eventually return us to the older ideas.[144] The consequence classes of SR and CM are related as in Fig. 2. A comparison of content, and a judgement of verisimilitude cannot be made.[145]

(143) For this point and further arguments cf. A. St. Eddington The Mathematical Theory of Relativity Cambridge 1963, 33. The more general problem of concepts and numbers has been treated by Hegel, Logik i, Das Mass

(144) This takes care of an objection which professor J.W.N. Watkins has raised on various occasions.

(145) For further details, especially concerning the concept of mass, the function of "bridge laws", or "correspondence rules", and the two-language model cf. section iv of "Problems of Empiricism", op. cit. 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 a corresponding relativistic law). The possibility to connect the formulae 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 cf. section 3 of "On A Recent Critique of Complementarity", Philosophy of Science Dec. 1968. Cf. also section 2 of the same article for more general considerations.

We now present the second and most popular objection against incommensurability. This objection proceeds from the version of realism described above. "A realist" we said "will want to give a unified account, both of observable and of unobservable matters, and he will use the most abstract terms of whatever theory he is contemplating for his purpose". He will use such terms in order to either give meaning to observation sentences, or else to replace their customary interpretation (for example, he will use the ideas of SR in order to replace the customary CM-interpretation of everyday statements about shapes, temporary sequences, and so on). As against this it is pointed out that theoretical terms receive their interpretation by being connected with a preexisting observation language, or with another theory that has already been connected with such an observation language and that they are devoid of content without such connexion. Thus Carnap asserts[146] that "there is no independent interpretation for L_T [the language in terms of which a certain theory, or a certain world view is formulated]. The system T [the axioms of the theory and the rules of derivation] is itself an uninterpreted postulate system [Its] terms obtain only an indirect and incomplete interpretation by the fact that some of them are connected by correspondence rules with observational terms". Now, if theoretical terms have no "independent interpretation" then they cannot be used for correcting the interpreta-

(146) "The Methodological Character of Theoretical Concepts" Minnesota Studies in the Philosophy of Science Vol. i., H. Feigl and M. Scriven eds., Minneapolis 1956, 47.

tion of the observation statements which is the one and only source of their meaning. It follows that realism as described by us is an impossible doctrine.

The guiding idea behind this very popular objection is that new and abstract languages cannot be introduced in a direct way but must be first connected with an already existing (and presumably stable) observational idiom.[147]

This guiding idea is refuted at once by pointing to the way in which children learn to speak and in which anthropologists and linguists learn the unknown language of a newly discovered tribe.

The first example is instructive for other reasons also, for incommensurability plays an important role in the early months of human development. As has been suggested by Piaget and his school[148] the child's perception develops through various stages before it reaches its relatively stable adult form. In one stage objects seem to behave very much like afterimages[149] - and they are treated as such: the child follows the object with his eyes until it disappears and he does not make the slightest attempt to recover it, even if this would require but a minimal physical (or intellectual) effort, an effort moreover, that is already within the child's reach. There is not even a tendency to search - and this is quite appropriate, "conceptually" speaking. For it would indeed be nonsensical to "look for" an afterimage. Its "concept" does not provide for such an operation.

(147) An even more conservative principle is sometimes used when discussing the possibility of languages with a logic different from our own: "An 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, 173.

(148) As an example the reader is invited to consult J. Piaget The Construction of Reality in the Child Basic Books 1954.

(149) Op. cit., 5ff.

The arrival of the concept, and of the perceptual image of material objects changes the situation quite dramatically. There occurs a drastic reorientation of behavioural patterns and, so one may conjecture, of thought. Afterimages, or things somewhat like them still exist, but they are now difficult to find and must be discovered by special methods (the earlier visual world therefore literally disappears). Such methods proceed from a new conceptual scheme (afterimages occur in humans, not in the outer physical world, and are tied to them) and cannot lead back to the exact phenomena of the previous stage (these phenomena should therefore be called by a different name, such as "pseudo-afterimages"). Neither afterimages, nor pseudo-afterimages are given a special position in the new world. For example, they are not treated as "evidence" on which the new notion of a material object is supposed to rest. Nor can they be used to explain this notion: afterimages arise together with it and are absent from the mind of those who do not yet regognise material objects; and pseudoafterimages disappear as soon as such recognition takes place. It is to be admitted that every stage possesses a kind of observational "basis" to which one pays special attention and from which one received a multitude of suggestions. However this basis (i) changes from stage to stage; and (ii) it is part of the conceptual apparatus of a given stage, not its one and only source of interpretation.

Considering developments such as these we may suspect that the family of concepts centring upon "material object" and the family of concepts centring upon "pseudoafterimage" are incommensurable in precisely the sense that is at issue here. Is it reasonable to expect that conceptual (and perceptual) changes of this kind occur in childhood only? Should we welcome the fact - if it is a fact - that an adult is stuck with a stable

perceptual world and an accompanying stable conceptual system which he can modify in many ways but whose general outlines have forever become immobilised? Or is it not more realistic to assume that fundamental changes, entailing incommensurability, are still possible and that they should be encouraged lest we remain forever excluded from what might be a higher stage of knowledge and of consciousness? (Cf. on this point again what has been said in section 1 [illegible], especially about the role of scientific and other revolutions in bringing about such a higher stage). Besides, the question of the mobility of the adult stage is at any rate an empirical question which must be attacked by research and cannot be settled by methodological fiat. An attempt to break through the boundaries of a given conceptual system and to escape the reach of "Popperian spectacles" (dikates) is an essential part of such research (and should be an essential part of any interesting life).[150]

(150) For the condition of research formulated in the last sentence cf. section 8 of "Reply to Criticism", Boston Studies in the Philosophy of Science Vol.if, R.S. Cohen and Marx Wartofsky, eds., New York 1965. For the role of observation cf. section 7 of the same article. For the application of Piaget's work to physics and, more especially, to the theory of relativity cf. 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 and so that we must find independent means for deciding which one to adopt. For further comments on this problem cf. section 9 of "On a Recent Critique of Complementarity", loc. cit.

Looking now at the second element of the refutation - anthropological field work - we see that what is anathema here (and for very good reasons) is still a fundamental principle for the contemporary representatives of the philosophy of the Vienna Circle. According to Carnap, Feigl, Nagel, and others the terms of a theory receive their interpretation, in an indirect fashion, by being related to a different conceptual system which is either an older theory, or an observation language.[151] Older theories, or observation languages are adopted not because of their theoretical excellence (they cannot possibly be: the older theories are usually refuted). They are adopted because they are "used by a certain language community as a means of communication".[152] According to this method the phrase "having much larger relativistic mas than ..." is partially interpreted by first connecting it with some prerelativistic terms (classical terms; commonsense terms) which are "commonly understood"[147] (presumably as the result of previous teaching in connexion with crude weighing methods). This is even worse than the once quite popular demand to clarify doubtful points by translating them into Latin. For while Latin was chosen because of its precision and clarity and also because it was conceptually richer than the slowly evolving vulgar idioms,[153] the choice of an observation language or of an

(151) For what follows cf. also the review of Nagel's Structure of Scien on pp 237-249 of the British Journal for the Philosophy of Science of 1966.
(152) Carnap, loc. cit., 40. Cf. also C.G. Hempel Philosophy of Natural Science Prentice Hall 1966, 74ff.
(153) It was for this reason that Leibniz regarded the German of his tim and especially the German of the artisans as a perfect observation langu while Latin, for him, was already too much contaminated by theoretical notions. See his "Unvorgreifliche Gedancken, betreffend die Ausübung und Verbesserung der Deutschen Sprache", published in Wissenschaftliche Beihefte zur Zeitschrift des Allgemeinen Deutschen Sprachvereines Berlin 19 292ff.

older theory as a basis for interpretation is justified by saying that they are "antecedently understood", it is due to their popularity. Besides, if prerelativistic terms which are pretty far removed from reality (especially in view of the fact that they come from an incorrect theory) can be taught ostensively, for example, with the help of crude weighing methods - and we must assume that they can be so taught, or the whole scheme collapses - then why should we not introduce the relativistic terms directly, and without assistance from the terms of some other idiom? Finally, it is but plain commonsense that the teaching, or the learning of new and unknown languages must not be contaminated by external materia Linguists remind us that a perfect translation is never possible, even if we are prepared to use complex contextual definitions. This is one of the reasons for the importance of field work where new languages are learned from scratch and for the rejection, as inadequate, of any account that relies on (complete, or partial) translation. Yet just what is anathema in linguistics is taken for granted by logical empiricism, a mythical "observation language" replacing the English of the translators. Let us commence field work in this domain also, and let us study the language of new theories not in the definition factories of the double language model, but in the company of those metaphysicians, theoreticians, playwrites, courtesans who have constructed new world views! This finishes our discussion of the guiding principle behind the second objection against realism and the possibility of incommensurable theories.

Another point that is often made is that there exist crucial experiments which refute one of two allegedly incommensurable theories and confirm the other (example: the Michelson-Morley experiment, the variation

of the mass of elementary particples, the transversal Doppler effect refute CM and confirm SR). The answer to this problem is not dif icult either: adopting the point of view of relativity we find that the experiments which of course will now be described in relativistic terms, using the relativistic notions of length, duration, speed, and so on[154] are relevant to the theory and we shall also find that they support the theory. Adopting CM (with, or without an aether) we again find that the experiments (which are now described in the very different terms of classical physics, roughly in the manner in which Lorentz described them) are relevant, but we also find that they undermine (the conjunction of classical electrodynamics and of) CM. Why should it be necessary to possess terminology that allows us to say that it is the same experiment which confirms one theory and refutes the other? But did we not ourselves use such terminology? Well, for one thing it should be easy, though somewhat laborious to express what was just said without asserting identity. Secondly, the identification is of course not contrary to our thesis, for we are now not using the terms of either relativity, or of classical physics, as is done in a test, but are referring to them and their relati to the physical world. The language in which this discourse is carried ou can be classical, or relativistic, or ordinary. It is no good insisting that scientists act as if the situation were much less complicated. If they act that way, then they are either instrumentalists (see above) or mistaken: many scientists are nowadays interested in formulae while we are discussing interpretations. It is also possible that being well ac-

(154) For examples of such descriptions cf. the article of Synge referred to in footnote 142.

quainted with both CM and SR they change back and forth between these theories with such speed that they seem to remain within a single domain of discourse.

It is also said that admitting incommensurability into science we can no longer decide whether a new view explains what it is supposed to explain, or whether it does not wander off into different fields.[155] For example, we would not know whether a newly invented physical theory is still dealing with problems of space and time or whether its author has not by mistake made a biological assertion. But there is no need to possess such knowledge. For once the fact of incommensurability has been admitted the question which underlies the objection does not arise (conceptual progress often makes it impossible to ask certain questions and to explain certain things; thus we can no longer ask for the absolute velocity of an object, at least as long as we take relativity seriously). Yet - is this not a serious loss for science? Not at all! Progress was made by the very same "wandering off into different fields" whose undecidability now so greatly exercises the critic: Aristotle saw the world as a super organism, as a biological entity while one essential element of the new science of Descartes, Galileo, and of their followers in medicine and in biology is its exclusively mechanistic outlook. Are such developments to be forbidden? And if they are not - what, then, is left of the complaint?

A closely connected objection starts from the notion of explanation, reduction, and emphazises that this notion presupposes continuity of

(155) This objection was raised at a conference by Prof. Roger Buck.

concepts (other notions could be used for starting exactly the same kind of argument). Now, to take our above example, relativity is supposed to explain the valid parts of classical physics, hence it cannot be incommensurable with it! The reply is again obvious. As a matter of fact it is a triviality for anyone who has only the slightest acquaintance with the Hegelian philosophy: why should the relativist be concerned with the fate of classical mechanics except as part of a historical exercise? There is only <u>one</u> task we can legitimately demand of a theory and it is that it should give us a correct account of the world i.e. of the totality of facts as seen through <u>its own</u> concepts. What have the principles of explanation got to do with this demand? Is it not reasonable 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 <u>with its own facts</u> (see above, on crucial experiments) and must therefore be regarded as self inconsistent (another application of Hegelian principles!) cannot have entirely adequate concepts, and is it not equally reasonable to try replacing its concepts by those of a more promising consmology? 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 connexions. Nothing prevents us from widening it still further and to admit, say, "explanation by aequivocation".

Incommensurable theories, then, can be <u>refuted</u> by reference to their own respective kinds of experience i.e. by discovering the <u>internal contradictions</u> from which they are suffereing (in the absence of commensurab

alternatives these refutations are quite weak, however[156]). Their content cannot be compared, xxxxxxx Nor xxxxx is it possible to make a judgement of verisimilitude except within the confines of a particular xxxxx theory. None of the methods which Popper (or Carnap, or Hempel, or Nagel) want to use for rationalising science can be applied and the one that can be applied, refutation, is greatly reduced in strength. What remains are aesthetic judgements, judgements of taste, and our own subjective wishes.[157] Does this mean that we are ending up in subjectivism? 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.[158] The sciences, after all, are our own creation,

(156) For this point cf. section i of "Reply to Criticism", loc. cit., as well as the corresponding sections in "Problems of Empiricism", loc. cit.

(157) That the choice between comprehensive theories rests on our interests entirely and reveals the innermost character of the one who chooses has been emphazised 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 Felix Meiner 1961, 19] "with an absolutely first act that depends on the freedom of thought entirely. It is therefore determined in an arbitrary manner [durch Willkür] 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.

(158) We meet here once more the familiar problem of alienation: what is the result of our own activity becomes separated from it, assumes an existence of its own, the connexion 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

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 may construct a world in which it plays no role whatever (such a world, I venture to suggest, would be more pleasant than the world we live in today, both materially, and intellectually). What better reminder is there than the realization that the choice between theories which are sufficiently general to provide us with a comprehensive world view and which are empirically disconnected may become a matter of taste? That the choice of our basic cosmology may become a matter of taste?[157]

Secondly, matters of taste are not completely beyond the reach of

what some people are pleased to call their "intellectual honesty", or the "scientific integrity" . [" ... Luther eliminates external religiousness and turned religiousness into the inner essence of man ... he negated the raving parish-priest outside the laymen because he puts him into the very heart of the layman" Marx 'Nationaloekonomie und Philosophie" quoted from Marx, die Fruehschriften ed. S. Landshut Stuttgart 1953, 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 Aegypt, 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 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 Erinnerungen an Bertolt Brecht Goettingen 1963, 47ff. Exactly the same development occurred between Galileo and

of argument. Poems, for example, can be compared in grammar, sound structure, imagery, rythm, and can be evaluated on such a basis (cf. Ezra Pound on progress in poetry[159]). Even the most elusive mood can be analysed and should be analysed if the purpose is to present it in a manner that can either be enjoyed, or that increases the emotional (cognitive, perceptual etc.) inventory of the reader. Every poet who is not completely irrational compares, improves, argues until he finds the correct formulation of what he wants to say.[160] Would it not be marvellous if this free and entertaining[161] process played a role in the sciences also?

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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 few physicists now who share the humour, the modesty, the sense of perspective, the philosophical interests of these extraordinary people (all of them have taken over their physics, but have thoroughly ruined it). And it is even worse in the philosophy of science. For some details cf. my papers "Classical Empiricism", loc. cit., as well as "On the Improvement of the Sciences and the Arts and the Possible Identity of the Two" Boston Studies in the Philosophy of Science Vol. iii.

(159) 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 judgement of verisimilitude can be made. The refutation of this belief eliminates an important difference (and perhaps the only important difference) between science and the arts and makes it possible to speak of styles and preferences in the first and of progress in the second.

(160) Cf. B. Brecht, "Ueber das Zerpfluecken von Gedichten" Über Lyrik Suhrkamp 1964, 119. In my lectures on the theory of knowledge I usually present and discuss the thesis that finding a new theory for given facts is like finding a new production for a well known play.- For painting cf. also E. Gombrich Art and Illusion Washington 1964.

(161) "The picture of society which we construct we construct for the river engineers, for the gardeners ... and for the revolutionaries. All of them we invite into our theatre, and we ask them not to forget their interest in entertainment when they are with us, for we want to turn over the world to their brains and hearts so that they may change it according to their wishes." Brecht, "Kleines Organon fuer das Theater" Schriften zum Theater Frankfurt 1957, 139f, my italics.

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. We may consider the length of derivations leading from the principles of a theory to its observation language, and we may also draw attention to the number of approximation made in the course of the derivation (all derivations must be standardised for this purpose so that unambiguous judgements 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 the fact that it agrees with such rules is both unrealistic and vicious. It is unrealistic as it takes too simple a view of the talents of man and of the circumstances which encourage, or cause, their development. It is vicious as the attempt to enforce the rules will undoubtedly put barriers to what we might have been, it will reduce our humanity by increasing our professional qualifications. We can free ourselves from the id and from the power it may possess over us (i) by a detailed study of th work of revolutionaries such as Galileo, Marx, or Lenin; (ii) by some acquaintance with the Hegelian philosophy; (iii) by remembering that

the existing separation between the sciences and the arts is utterly artificial, that it is a side effect of the idea of professionalism one should eliminate, that a poem, or a play can be intelligent of quite a kind informative (Hochhuth; Brecht) and a scientific theory pleasant to behold (Galileo). And we can change science so that it agrees with our wishes. We can turn it 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 either choose 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 remove itself from it into freedom."[2] We must take care that it does not lose its ability to make such a choice.