

CHAPTER FIVE
THE RECENT REVOLUTION IN NATURAL
SCIENCE AND PHILOSOPHICAL IDEALISM

A year ago, in *Die Neue Zeit* (1906-07, No. 52), there appeared an article by Joseph Diner-Denes entitled "Marxism and the Recent Revolution in the Natural Sciences." The defect of this article is that it ignores the epistemological conclusions which are being drawn from the "new" physics and in which we are especially interested at present. But it is precisely this defect which renders the point of view and the conclusions of the author particularly interesting for us. Joseph Diner-Denes, like the present writer, holds the view of the "rank-and-file Marxist," of whom our Machians speak with such haughty contempt. For instance, Mr. Yushkevich writes that "ordinarily, the average rank-and-file Marxist calls himself a dialectical materialist" (p. 1 of his book). And now this rank-and-file Marxist, in the person of J. Diner-Denes, has directly compared the recent discoveries in science, and especially in physics (X-rays, Becquerel rays, radium, etc.), with Engels' *Anti-Duhring*. To what conclusion has this com-

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parison led him? "In the most varied fields of natural science," writes Diner-Denes, "new knowledge has been acquired, all of which tends towards that single point which Engels desired to make clear, namely, that in nature 'there are no irreconcilable contradictions, no forcibly fixed boundary lines and distinctions,' and that if contradictions and distinctions are met with in nature, it is because we alone have introduced their rigidity and absoluteness into nature." It was discovered, for instance, that light and electricity are only manifestations of one and the same force of nature. Each day it becomes more probable that chemical affinity may be reduced to electrical proc-

esses. The indestructible and non-disintegrable elements of chemistry, whose number continues to grow as though in derision of the unity of the world, now prove to be destructible and disintegrable. The element radium has been converted into the element helium. "Just as all the forces of nature have been reduced to one force, so all substances in nature have been reduced to one substance " (Diner-Denes' italics). Quoting the opinion of one of the writers who regard the atom as only a condensation of the ether, the author exclaims: "How brilliantly does this confirm the statement made by Engels thirty years ago that motion is the mode of existence of matter." "All phenomena of nature are motion, and the differences between them lie only in the fact that we human beings perceive this motion in different forms.... It is as Engels said. Nature, like history, is subject to the dialectical law of motion."

On the other hand, you cannot take up any of the writings of the Machians or about Machism without encountering pretentious references to the new physics, which is said to have refuted materialism, and so on and so forth. Whether these assertions are well-founded is another question, but the

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connection between the new physics, or rather a definite school of the new physics, and Machism and other varieties of modern idealist philosophy is beyond doubt. To analyse Machism and at the same time to ignore this connection -- as Plekhanov does -- is to scoff at the spirit of dialectical materialism, i.e., to sacrifice the method of Engels to the letter of Engels. Engels says explicitly that "with each epoch making discovery even in the sphere of natural sci-

ence ["not to speak of the history of mankind"], materialism has to change its form" (*Ludwig Feuerbach*, Germ. ed., p. 19).[107] Hence, a revision of the "form" of Engels' materialism, a revision of his natural-philosophical propositions is not only not "revisionism," in the accepted meaning of the term, but, on the contrary, is demanded by Marxism. We criticise the Machians not for making such a revision, but for their purely revisionist trick of betraying the essence of materialism under the guise of criticising its form and of adopting the fundamental precepts of reactionary bourgeois philosophy without making the slightest attempt to deal directly, frankly and definitely with assertions of Engels' which are unquestionably extremely important to the given question, as, for example, his assertion that "... motion without matter is unthinkable" (*Anti-Duhring*, p. 50).[108]

1. THE CRISIS IN MODERN PHYSICS

In his book *Valeur de la science* [Value of Science], the famous French physicist Henri Poincaré says that there are "symptoms of a serious crisis" in physics, and he devotes a special chapter to this crisis (Chap. VIII, cf. p. 171). The crisis is not confined to the fact that "radium, the great revolutionary," is undermining the principle of the conservation of energy. "All the other principles are equally endangered" (p. 180). For instance, Lavoisier's principle, or the principle of the conservation of mass, has been undermined by the electron theory of matter. According to this theory atoms are composed of very minute particles called electrons, which are charged with positive or negative electricity and "are immersed in a medium which we call the ether." The experiments of physicists provide data for calculating the velocity of the electrons and their mass (or the relation of their mass to their electrical charge). The velocity proves to be comparable with the velocity of light (300,000 kilometres per

It goes without saying that in examining the connection between one of the schools of modern physicists and the rebirth of philosophical idealism, it is far from being our intention to deal with specific physical theories. What interests us exclusively is the epistemological conclusions that follow from certain definite propositions and generally known discoveries. These epistemological conclusions are of themselves so insistent that many physicists are already reaching for them. What is more, there are already various trends among

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the physicists, and definite schools are beginning to be formed on this basis. Our object, therefore, will be confined to explaining clearly the essence of the difference between these various trends and the relation in which they stand to the fundamental lines of philosophy.

second), attaining, for instance, one-third of the latter. Under such circumstances the twofold mass of the electron has to be taken into account, corresponding to the necessity of overcoming the inertia, firstly, of the electron itself and, secondly, of the ether. The former mass will be the real or mechanical mass of the electron, the latter the "electrodynamic mass which

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represents the inertia of the ether." And it turns out that the former mass is equal to zero. The entire mass of the electrons, or, at least, of the negative electrons, proves to be totally and exclusively electrodynamic in its origin. Mass disappears. The foundations of mechanics are undermined. Newton's principle, the equality of action and reaction, is undermined, and so on.

We are faced, says Poincaré, with the "ruins" of the old principles of physics, "a general debacle of principles." It is true, he remarks, that all the mentioned departures

from principles refer to infinitesimal magnitudes; it is possible that we are still ignorant of other infinitesimals counteracting the undermining of the old principles. Moreover, radium is very rare. But at any rate we have reached a "period of doubt." We have already seen what epistemological deductions the author draws from this "period of doubt": "it is not nature which imposes on [or dictates to] us the concepts of space and time, but we who impose them on nature"; "whatever is not thought, is pure nothing." These deductions are idealist deductions. The breakdown of the most fundamental principles shows (such is Poincaré's trend of thought) that these principles are not copies, photographs of nature, not images of something external in relation to man's consciousness, but products of his consciousness. Poincaré does not develop these deductions consistently, nor is he essentially interested in the philosophical aspect of the question. It is dealt with in detail by the French writer on philosophical problems, Abel Rey, in his book *The Physical Theory of the Modern Physicists (La Theorie physique chez les physiciens contemporains*, Paris, F. Alcan, 1907). True, the author himself is a positivist, i.e., a muddlehead and a semi-Machian, but in this case this is even a certain advantage, for he can

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not be suspected of a desire to "slander" our Machians' idol. Rey cannot be trusted when it comes to giving an exact philosophical definition of concepts and of materialism in particular, for Rey too is a professor, and as such is imbued with an utter contempt for the materialists (and distinguishes himself by utter ignorance of the epistemology of materialism). It goes without saying that a Marx or an Engels is absolutely non-existent for such "men of science." But Rey summarises carefully and in general conscientiously the extremely abundant literature on the subject, not only French, but English and German as well

(Ostwald and Mach in particular), so that we shall have frequent recourse to his work.

The attention of philosophers in general, says the author, and also of those who, for one reason or another, wish to criticise science generally, has now been particularly attracted towards physics. "In discussing the limits and value of physical knowledge, it is in effect the legitimacy of positive science, the possibility of knowing the object, that is criticised" (pp. i-ii). From the "crisis in modern physics" people hasten to draw sceptical conclusions (p. 14). Now, what is this crisis? During the first two-thirds of the nineteenth century the physicists agreed among themselves on everything essential. They believed in a purely mechanical explanation of nature: they assumed that physics is nothing but a more complicated mechanics, namely, a molecular mechanics. They differed only as to the methods used in reducing physics to mechanics and as to the details of the mechanism.... At present the spectacle presented by the physico-chemical sciences seems completely changed. Extreme disagreement has replaced general unanimity, and no longer does it concern details, but leading and fundamental ideas. While it would be an exaggeration to say that each scientist has his own peculiar tendencies,

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it must nevertheless be noted that science, and especially physics, has, like art, its numerous schools, the conclusions of which often differ from, and sometimes are directly opposed and hostile to each other....

"From this one may judge the significance and scope of what has been called the crisis in modern physics.

"Down to the middle of the nineteenth century, traditional physics had assumed that it was sufficient merely to extend physics in order to arrive at a metaphysics of matter. This physics ascribed to its theories an ontological value. And its theories were

all mechanistic. The traditional mechanism [Rey employs this word in the specific sense of a system of ideas which reduces physics to mechanics] thus claimed, over and above the results of experience, a real knowledge of the material universe. This was not a hypothetical account of experience; it was a dogma..." (p. 16).

We must here interrupt the worthy "positivist." It is clear that he is describing the materialist philosophy of traditional physics but does not want to call the devil (materialism) by name. Materialism to a Humean must appear to be metaphysics, dogma, a transgression of the bounds of experience, and so forth. Knowing nothing of materialism, the Humean Rey has no conception whatever of dialectics, of the difference between dialectical materialism and metaphysical materialism, in Engels' meaning of the term. Hence, the relation between absolute and relative truth, for example, is absolutely unclear to Rey.

"... The criticism of traditional mechanism made during the whole of the second half of the nineteenth century weakened the premise of the ontological reality of mechanism. On the basis of these criticisms a philosophical conception of physics was founded which became almost traditional in

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philosophy at the end of the nineteenth century. Science was nothing but a symbolic formula, a method of notation (reperage, the creation of signs, marks, symbols), and since the methods of notation varied according to the schools, the conclusion was soon reached that only that was denoted which had been previously designed (facilonné) by man for notation (or symbolisation). Science became a work of art for dilettantes, a work of art for utilitarians: views which could with legitimacy be generally interpreted as the negation of the possibility of science. A science which is a pure artifice for acting upon nature, a mere utilitarian technique, has no right to

call itself science, without perverting the meaning of words. To say that science can be nothing but such an artificial means of action is to disavow science in the proper meaning of the term.

"The collapse of traditional mechanism, or, more precisely, the criticism to which it was subjected, led to the proposition that science itself had also collapsed. From the impossibility of adhering purely and simply to traditional mechanism it was inferred that science was impossible" (pp. 16-17).

And the author asks: "Is the present crisis in physics a temporary and external incident in the evolution of science, or is science itself making an abrupt right-about-face and definitely abandoning the path it has hitherto pursued?..."

"If the [physical and chemical] sciences, which in history have been essentially emancipators, collapse in this crisis, which reduces them to the status of mere, technically useful recipes but deprives them of all significance from the stand point of knowledge of nature, the result must needs be a complete revolution both in the art of logic and the history of ideas. Physics then loses all educational value; the spirit

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of positive science it represents becomes false and dangerous." Science can offer only practical recipes but no real knowledge. "Knowledge of the real must be sought and given by other means.... One must take another road, one must return to subjective intuition, to a mystical sense of reality, in a word, to the mysterious, all that of which one thought it had been deprived" (p. 19).

As a positivist, the author considers such a view wrong and the crisis in physics only temporary. We shall presently see how Rey purifies Mach, Poincaré and Co. of these conclusions. At present we shall confine ourselves to noting the fact of the "crisis" and its significance. From the last words of Rey quoted by us it is quite clear what reactionary elements have taken ad-

vantage of and aggravated this crisis. Rey explicitly states in the preface to his work that "the fideist and anti-intellectualist movement of the last years of the nineteenth century" is seeking "to base itself on the general spirit of modern physics" (p. ii). In France, those who put faith above reason are called fideists (from the Latin *fides*, faith). Anti-intellectualism is a doctrine that denies the rights or claims of reason. Hence, in its philosophical aspect, the essence of the "crisis in modern physics" is that the old physics regarded its theories as "real knowledge of the material world," i.e., a reflection of objective reality. The new trend in physics regards theories only as symbols, signs, and marks for practice, i.e., it denies the existence of an objective reality independent of our mind and reflected by it. If Rey had used correct philosophical terminology, he would have said: the materialist theory of knowledge, instinctively accepted by the earlier physics, has been replaced by an idealist and agnostic theory of knowledge, which, against the wishes

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of the idealists and agnostics, has been taken advantage of by fideism.

But Rey does not present this replacement, which constitutes the crisis, as though all the modern physicists stand opposed to all the old physicists. No. He shows that in their epistemological trends the modern physicists are divided into three schools: the energeticist or conceptualist school; the mechanistic or neo-mechanistic school, to which the vast majority of physicists still adhere; and in between the two, the critical school. To the first belong Mach and Duhem; to the third, Henri Poincaré to the second, Kirchhoff, Helmholtz, Thomson (Lord Kelvin), Maxwell -- among the older physicists -- and Larmor and Lorentz among the modern physicists. What the essence of the two basic trends is (for the third is not inde-

pendent, but intermediate) may be judged from the following words of Rey's:

"Traditional mechanism constructed a system of the material world." Its doctrine of the structure of matter was based on "elements qualitatively homogenous and identical"; and elements were to be regarded as "immutable, impenetrable," etc. Physics "constructed a real edifice out of real materials and real cement. The physicist possessed material elements, the causes and modes of their action, and the real laws of their action" (pp. 33-38). "The change in this view consists in the rejection of the ontological significance of the theories and in an exaggerated emphasis on the phenomenological significance of physics." The conceptualist view operates with "pure abstractions ... and seeks a purely abstract theory which will as far as possible eliminate the hypothesis of matter.... The notion of energy thus becomes the substructure of the new physics. This is why conceptualist physics may most often be called energeticist physics,"

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although this designation does not fit, for example, such a representative of conceptualist physics as Mach (p. 46).

Rey's identification of energetics with Machism is not altogether correct, of course; nor is his assurance that the neo-mechanistic school as well is approaching a phenomenalist view of physics (p. 48), despite the profundity of its disagreement with the conceptualists. Rey's "new" terminology does not clarify, but rather obscures matters; but we could not avoid it if we were to give the reader an idea of how a "positivist" regards the crisis in physics. Essentially, the opposition of the "new" school to the old views fully coincides, as the reader may have convinced himself, with Kleinpeter's criticism of Helmholtz quoted above. In his presentation of the views of the various physicists Rey reflects the indefiniteness and vacillation of their philosophical views. The essence of the

crisis in modern physics consists in the breakdown of the old laws and basic principles, in the rejection of an objective reality existing outside the mind, that is, in the replacement of materialism by idealism and agnosticism. "Matter has disappeared"

2. "MATTER HAS DISAPPEARED"

Such, literally, is the expression that may be encountered in the descriptions given by modern physicists of recent discoveries. For instance, L. Houllevigue, in his book *The Evolution of the Sciences*, entitles his chapter on the new theories of matter: "Does Matter Exist?" He says: "The atom

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dematerialises, matter disappears."¹ To see how easily fundamental philosophical conclusions are drawn from this by the Machians, let us take Valentinov. He writes: "The statement that the scientific explanation of the world can find a firm foundation only in materialism is nothing but a fiction, and what is more, an absurd fiction" (p. 67). He quotes as a destroyer of this absurd fiction Augusto Righi, the well-known Italian physicist, who says that the electron theory "is not so much a theory of electricity as of matter; the new system simply puts electricity in the place of matter." (Augusto Righi, *Die moderne Theorie der physikalischen Erscheinungen* [The Modern Theory of Physical Phenomena], Leipzig, 1905, S. 131. There is a Russian translation.) Having quoted these words (p. 64), Mr. Valentinov exclaims:

"Why does Righi permit himself to commit this offence against sacred matter? Is it perhaps because he is a solipsist, an ideal-

-- one may thus express the fundamental and characteristic difficulty in relation to many of the particular questions, which has created this crisis. Let us pause to discuss this difficulty.

ist, a bourgeois critic, an empirio-monist, or even someone worse?"

This remark, which seems to Mr. Valentinov to annihilate the materialists by its sarcasm, only discloses his virgin innocence on the subject of philosophical materialism. Mr. Valentinov has no suspicion of the real connection between philosophical idealism and the "disappearance of matter." The "disappearance of matter" of which he speaks, in imitation of the modern physicists, has no relation to the epistemological distinction between materialism and idealism. To make this clear, let us take one of the most consistent and

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clearest of the Machians, Karl Pearson. For him the physical universe consists of groups of sense-impressions. He illustrates "our conceptual model of the physical universe" by the following diagram, explaining, however, that it takes no account of relative sizes (*The Grammar of Science*, p. 282):

¹ L. Houllevigue, *L'evolution des sciences* [The Evolution of the Sciences], Paris (A. Collin), 1908, pp. 63, 87, 88; cf. his article: "Les idees des physiciens sur la matiere " [The Physicists' Ideas of Matter], in *L'annee psychologique*, [109] 1908.

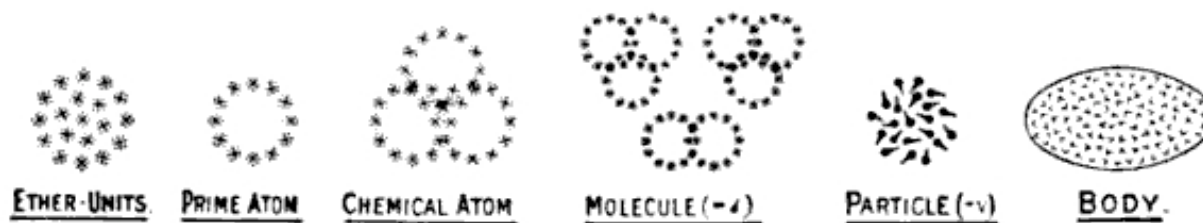


FIG. 21.

In order to simplify his diagram, Karl Pearson entirely omits the question of the relation between ether and electricity, or positive electrons and negative electrons. But that is not important. What is important is that from Pearson's idealist standpoint "bodies" are first regarded as sense-impressions, and then the constitution of these bodies out of particles, particles out of molecules and so forth affects the changes in the model of the physical world, but in no way affects the question of whether bodies are symbols of perceptions, or perceptions images of bodies. Materialism and idealism differ in their respective answers to the question of the source of our knowledge and of the relation of knowledge (and of the "mental" in general) to the physical world; while the question of the structure of matter, of atoms and electrons, is a question that concerns only this "physical world." When the physicists say that "matter is disappearing," they mean that hitherto science reduced its investigations of the physical world to three ultimate concepts: mat-

world from scores of elements to two or three elements (inasmuch as positive and negative electrons constitute "two essentially distinct kinds of matter," as the physicist Pellat says -- Rey, *op. cit.*, pp. 294-95). Hence, natural science leads to the "unity of matter" (*ibid.*)² -- such is the real meaning of the statement regarding the disappearance of matter, its replacement by electricity, etc., which is leading so many people astray. "Matter is disappearing" means that the limit within which we have hitherto known matter is vanishing and that our knowledge is penetrating deeper; properties of matter are likewise disappearing which formerly seemed absolute, immutable, and primary (impenetrability, inertia, mass, etc.) and which are now revealed to be relative and characteristic only of certain states of matter. For the sole "property" of matter with whose recognition philosophical materialism is bound up is the property of being an objective reality, of existing outside our mind.

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ter, electricity and ether; whereas now only the two latter remain. For it has become possible to reduce matter to electricity; the atom can be explained as resembling an infinitely small solar system, within which negative electrons move around a positive electron with a definite (and, as we have seen, enormously large) velocity. It is consequently possible to reduce the physical

² Cf. Oliver Lodge, *Sur les electrons*, Paris, 1906, p. 159. "The electrical theory of matter," the recognition of electricity as the "fundamental substance," is "an approximate accomplishment of that to what the philosophers strove always, that is, the unity of matter"; cf. also Augusto Righi, *Ueber die Struktur der Materie* [On the Structure of Matter], Leipzig, 1908; J. J. Thomson, *The Corpuscular Theory of Matter*, London, 1907; P. Langevin, "La physique des electrons" [The Physics of the Electrons], *Revue generale des sciences*, [110] 1905, pp. 257-76.

The error of Machism in general, as of the Machian new physics, is that it ignores this basis of philosophical materialism and the distinction between metaphysical materialism and dialectical materialism. The recognition of immutable elements, "of the immutable substance of things," and so forth, is not materialism, but metaphysical, i.e., anti-dialectical, materialism. That is why J. Dietzgen emphasised that the "subject-matter of science is endless," that not only the in finite, but the "smallest atom" is immeasurable, unknowable to the end, inexhaustible, "for nature in all her parts has no beginning and no end" (*Kleinere philosophische Schriften*, S. 229-30). That is why Engels gave the example of the discovery of alizarin in coal tar and criticised mechanical materialism. In order to present the question in the only correct way, that is, from the dialectical materialist standpoint, we must ask: Do electrons, ether and so on exist as objective realities outside the human mind or not? The scientists will also have to answer this question unhesitatingly; and they do invariably answer it in the affirmative, just as they unhesitatingly recognise that nature existed prior to man and prior to organic matter. Thus, the question is decided in favour of materialism, for the concept matter, as we already stated, epistemologically implies nothing but objective reality existing independently of the human mind and reflected by it.

But dialectical materialism insists on the approximate, relative character of every scientific theory of the structure of matter and its properties; it insists on the absence of absolute boundaries in nature, on the transformation of moving matter from one state into another, which is to us apparently irreconcilable with it, and so forth. However bizarre from the standpoint of "common sense" the transformation of imponderable ether into ponderable matter and vice versa may

appear, however "strange" may seem the absence of any other kind of mass in the electron save electromagnetic mass, however extraordinary may be the fact that the mechanical laws of motion are confined only to a single sphere of natural phenomena and are subordinated to the more profound laws of electromagnetic phenomena, and so forth -- all this is but another corroboration of dialectical materialism. It is mainly because the physicists did not know dialectics that the new physics strayed into idealism. They combated metaphysical (in Engels', and not the positivist, i.e., Humean, sense of the word) materialism and its one-sided "mechanism," and in so doing threw the baby out with the bathwater. Denying the immutability of the elements and the properties of matter known hitherto, they ended in denying matter, i.e., the objective reality of the physical world. Denying the absolute character of some of the most important and basic laws, they ended in denying all objective law in nature and in declaring that a law of nature is a mere convention, "a limitation of expectation," "a logical necessity," and so forth. Insisting on the approximate and relative character of our knowledge, they ended in denying the object independent of the mind and reflected approximately-correctly and relatively-truthfully by the mind. And so on, and so forth, without end.

The opinions expressed by Bogdanov in 1899 regarding "the immutable essence of things," the opinions of Valentinov and Yushkevich regarding "substance," and so forth -- are similar fruits of ignorance of dialectics. From Engels' point of view, the only immutability is the reflection by the human mind (when there is a human mind) of an external world existing and developing independently of the mind. No other "immutability," no other "essence," no other "absolute substance," in the sense in which these concepts were depicted

by the empty professorial philosophy, exist for Marx and Engels. The "essence" of things, or "substance," is also relative; it expresses only the degree of profundity of man's knowledge of objects; and while yesterday the profundity of this knowledge did not go beyond the atom, and today does not go beyond the electron and ether, dialectical materialism insists on the temporary, relative, approximate character of all these milestones in the knowledge of nature gained by the progressing science of man. The electron is as inexhaustible as the atom, nature is infinite, but it infinitely exists. And it is this sole categorical, this sole unconditional recognition of nature's existence outside the mind and perception of man that distinguishes dialectical materialism from relativist agnosticism and idealism.

Let us cite two examples of the way in which the new physics wavers unconsciously and instinctively between dialectical materialism, which remains unknown to the bourgeois scientists, and "phenomenalism," with its inevitable subjectivist (and, subsequently, directly fideist) deductions.

This same Augusto Righi, from whom Mr. Valentinov was unable to get a reply on the question which interested him about materialism, writes in the introduction to his book: "What the electrons, or electrical atoms, really are remains even now a mystery; but in spite of this, the new theory is perhaps destined in time to achieve no small philosophical significance, since it is arriving at entirely new hypotheses regarding the structure of ponderable matter and is striving to reduce all phenomena of the external world to one common origin.

"For the positivist and utilitarian tendencies of our time such an advantage may be of small consequence, and a theory is perhaps regarded primarily as a means of conveniently

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ordering and summarising facts and as a guide in the search for further phenomena.

But while in former times perhaps too much confidence was placed in the faculties of the human mind, and it was considered too easy to grasp the ultimate causes of all things, there is nowadays a tendency to fall into the opposite error" (op. cit., p. 3).

Why does Righi dissociate himself here from the positivist and utilitarian tendencies? Because, while apparently he has no definite philosophical standpoint, he instinctively clings to the reality of the external world and to the recognition that the new theory is not only a "convenience" (Poincaré), not only an "empirio-symbol" (Yushkevich), not only a "harmonising of experience" (Bogdanov), or whatever else they call such subjectivist fancies, but a further step in the cognition of objective reality. Had this physicist been acquainted with dialectical materialism, his opinion of the error which is the opposite of the old metaphysical materialism might perhaps have become the starting point of a correct philosophy. But these people's whole environment estranges them from Marx and Engels and throws them into the embrace of vulgar official philosophy.

Rey too is entirely unfamiliar with dialectics. But he too is compelled to state that among the modern physicists there are those who continue the traditions of "mechanism" (i.e., materialism). The path of "mechanism," says he, is pursued not only by Kirchhoff, Hertz, Boltzmann, Maxwell, Helmholtz and Lord Kelvin. "Pure mechanists, and in some respects more mechanist than anybody else, and representing the culmination (l'aboutissant) of mechanism, are those who follow Lorentz and Larmor in formulating an electrical theory of matter and who arrive at a denial of the constancy of mass, declaring it to be a function of motion. They are all mechan-

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ists because they take real motion as their starting point" (Rey's italics, pp. 290-91).

"... If, for example, the recent hypotheses of Lorentz, Larmor and Langevin were,

thanks to certain experimental confirmation, to obtain a sufficiently stable basis for the systematisation of physics, it would be certain that the laws of present-day mechanics are nothing but a corollary of the laws of electromagnetism: they would constitute a special case of the latter within well-defined limits. Constancy of mass and our principle of inertia would be valid only for moderate velocities of bodies, the term 'moderate' being taken in relation to our senses and to the phenomena which constitute our general experience. A general recasting of mechanics would result, and hence also, a general recasting of the systematisation of physics."

"Would this imply the abandonment of mechanism? By no means. The purely mechanist tradition would still be followed, and mechanism would follow its normal course of development" (p. 295).

"Electronic physics, which should be ranked among the theories of a generally mechanist spirit, tends at present to impose its systematisation on physics. Although the fundamental principles of this electronic physics are not furnished by mechanics but by the experimental data of the theory of electricity, its spirit is mechanistic, because: (1) It uses figurative (figures), material elements to represent physical properties and their laws; it expresses itself in terms of perception. (2) While it no longer regards physical phenomena as particular cases of mechanical phenomena, it regards mechanical phenomena as particular cases of physical phenomena. The laws of mechanics thus retain their direct continuity with the laws of physics; and the concepts of mechanics

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remain concepts of the same order as physico-chemical concepts. In traditional mechanism it was motions copied (calques) from relatively slow motions, which, since they alone were known and most directly observable, were taken... as a type of all possible motions. Recent ex-

periments, on the contrary, show that it is necessary to extend our conception of possible motions. Traditional mechanics remains entirely intact, but it now applies only to relatively slow motions.... In relation to large velocities, the laws of motion are different. Matter appears to be reduced to electrical particles, the ultimate elements of the atom.... (3) Motion, displacement in space, remains the only figurative (figuré) element of physical theory. (4) Finally, what from the standpoint of the general spirit of physics comes before every other consideration is the fact that the conception of physics, its methods, its theories, and their relation to experience remains absolutely identical with the conception of mechanism, with the conception of physics held since the Renaissance" (pp. 46-47).

I have given this long quotation from Rey in full because owing to his perpetual anxiety to avoid "materialist metaphysics," it would have been impossible to expound his statements in any other way. But however much both Rey and the physicists of whom he speaks abjure materialism, it is nevertheless beyond question that mechanics was a copy of real motions of moderate velocity, while the new physics is a copy of real motions of enormous velocity. The recognition of theory as a copy, as an approximate copy of objective reality, is materialism. When Rey says that among modern physicists there "is a reaction against the conceptualist [Machian] and energeticist school," and when he ranks the physicists of the electron theory among the representatives of

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this reaction (p. 46), we could desire no better corroboration of the fact that the struggle is essentially between the materialist and the idealist tendencies. But we must not forget that, apart from the general prejudices against materialism common to all educated philistines, the most outstanding theoreticians are handicapped by a complete ignorance of dialectics.

3. IS MOTION WITHOUT MATTER CONCEIVABLE?

The fact that philosophical idealism is attempting to make use of the new physics, or that idealist conclusions are being drawn from the latter, is due not to the discovery of new kinds of substance and force, of matter and motion, but to the fact that an attempt is being made to conceive motion without matter. And it is the essence of this attempt which our Machians fail to examine. They were unwilling to take account of Engels' statement that "motion without matter is unthinkable." J. Dietzgen in 1869, in his *The Nature of the Workings of the Human Mind*, expressed the same idea as Engels, although, it is true, not without his usual muddled attempts to "reconcile" materialism and idealism. Let us leave aside these attempts, which are to a large extent to be explained by the fact that Dietzgen is arguing against Buchner's non-dialectical materialism, and let us examine Dietzgen's own statements on the question under consideration. He says: "They [the idealists] want to have the general without the particular, mind without matter, force without substance, science without experience or material, the absolute without the relative" (*Das Wesen der menschlichen Kopfarbeit*, 1903, S. 108). Thus the endeavour to divorce mo-

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tion from matter, force from substance, Dietzgen associates with idealism, compares with the endeavour to divorce thought from the brain. "Liebig," Dietzgen continues, "who is especially fond of straying from his inductive science into the field of speculation, says in the spirit of idealism: 'force cannot be seen'" (p. 109). "The spiritualist or the idealist believes in the spiritual, i.e., ghostlike and inexplicable, nature of force" (p. 110). "The antithesis between force and matter is as old as the antithesis between idealism and materialism" (p. 111). "Of course, there is no force

without matter, no matter without force; forceless matter and matterless force are absurdities. If there are idealist natural scientists who believe in the immaterial existence of forces, on this point they are not natural scientists... but seers of ghosts" (p. 114).

We thus see that scientists who were prepared to grant that motion is conceivable without matter were to be encountered forty years ago too, and that "on this point" Dietzgen declared them to be seers of ghosts. What, then, is the connection between philosophical idealism and the divorce of matter from motion, the separation of substance from force? Is it not "more economical," indeed, to conceive motion without matter?

Let us imagine a consistent idealist who holds that the entire world is his sensation, his idea, etc. (if we take "nobody's" sensation or idea, this changes only the variety of philosophical idealism but not its essence). The idealist would not even think of denying that the world is motion, i.e., the motion of his thoughts, ideas, sensations. The question as to what moves, the idealist will reject and regard as absurd: what is taking place is a change of his sensations, his ideas come and go, and nothing more. Outside him there is nothing. "It moves" -- and that is all. It is impossible to conceive

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a more "economical" way of thinking. And no proofs, syllogisms, or definitions are capable of refuting the solipsist if he consistently adheres to his view.

The fundamental distinction between the materialist and the adherent of idealist philosophy consists in the fact that the materialist regards sensation, perception, idea, and the mind of man generally, as an image of objective reality. The world is the movement of this objective reality reflected by our consciousness. To the movement of

ideas, perceptions, etc., there corresponds the movement of matter outside me. The concept matter expresses nothing more than the objective reality which is given us in sensation. Therefore, to divorce motion from matter is equivalent to divorcing thought from objective reality, or to divorcing my sensations from the external world - in a word, it is to go over to idealism. The trick which is usually performed in denying matter, and in assuming motion without matter, consists in ignoring the relation of matter to thought. The question is presented as though this relation did not exist, but in reality it is introduced surreptitiously; at the beginning of the argument it remains unexpressed, but subsequently crops up more or less imperceptibly.

Matter has disappeared, they tell us, wishing from this to draw epistemological conclusions. But has thought remained? -- we ask. If not, if with the disappearance of matter thought has also disappeared, if with the disappearance of the brain and nervous system ideas and sensations, too, have disappeared -- then it follows that everything has disappeared. And your argument has disappeared as a sample of "thought" (or lack of thought)! But if it has remained -- if it is assumed that with the disappearance of matter, thought (idea, sensation, etc.) does not disappear, then you have surrepti-

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tiously gone over to the standpoint of philosophical idealism. And this always happens with people who wish, for "economy's sake," to conceive of motion without matter, for tacitly, by the very fact that they continue to argue, they are acknowledging the existence of thought after the disappearance of matter. This means that a very simple, or a very complex philosophical idealism is taken as a basis; a very simple one, if it is a case of frank solipsism (I exist, and the world is only my sensation); a very complex one, if instead of the thought, ideas and sensations of a living person, a

dead abstraction is posited, that is, nobody's thought, nobody's idea, nobody's sensation, but thought in general (the Absolute Idea, the Universal Will, etc.), sensation as an indeterminate "element," the "psychical," which is substituted for the whole of physical nature, etc., etc. Thousands of shades of varieties of philosophical idealism are possible and it is always possible to create a thousand and first shade; and to the author of this thousand and first little system (empirio-monism, for example) what distinguishes it from the rest may appear to be momentous. From the standpoint of materialism, however, the distinction is absolutely unessential. What is essential is the point of departure. What is essential is that the attempt to think of motion without matter smuggles in thought divorced from matter -- and that is philosophical idealism.

Therefore, for example, the English Machian Karl Pearson, the clearest and most consistent of the Machians, who is averse to verbal trickery, directly begins the seventh chapter of his book, devoted to "matter," with the characteristic heading "All things move -- but only in conception." "It is therefore, for the sphere of perception, idle to ask what moves and why it moves" (*The Grammar of Science*, p. 243).

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Therefore, too, in the case of Bogdanov, his philosophical misadventures in fact began before his acquaintance with Mach. They began from the moment he put his trust in the assertion of the eminent chemist, but poor philosopher, Ostwald, that motion can be thought of without matter. It is all the more fitting to pause on this long-past episode in Bogdanov's philosophical development since it is impossible when speaking of the connection between philosophical idealism and certain trends in the new physics to ignore Ostwald's "energetics."

"We have already said," wrote Bogdanov in 1899, "that the nineteenth century

did not succeed in ultimately ridding itself of the problem of 'the immutable essence of things.' This essence, under the name of 'matter,' even holds an important place in the world outlook of the foremost thinkers of the century" (*Fundamental Elements of the Historical Outlook on Nature*, p. 38).

We said that this is a sheer muddle. The recognition of the objective reality of the outer world, the recognition of the existence outside our mind of eternally moving and eternally changing matter, is here confused with the recognition of the immutable essence of things. It is hardly possible that Bogdanov in 1899 did not rank Marx and Engels among the "foremost thinkers." But he obviously did not understand dialectical materialism.

"... In the processes of nature two aspects are usually still distinguished: matter and-its motion. It cannot be said that the concept matter is distinguished by great clarity. It is not easy to give a satisfactory answer to the question -- what is matter? It is defined as the 'cause of sensations' or as the 'permanent possibility of sensation'; but it is evident that matter is here confused with motion...."

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It is evident that Bogdanov is arguing incorrectly. Not only does he confuse the materialist recognition of an objective source of sensations (unclearly formulated in the words "cause of sensations") with Mill's agnostic definition of matter as the permanent possibility of sensation, but the chief error here is that the author, having boldly approached the question of the existence or non-existence of an objective source of sensations, abandons this question half-way and jumps to another question, the question of the existence or non-existence of matter without motion. The idealist may regard the world as the movement of our sensations (even though "socially organised" and "harmonised" to the highest degree); the materialist regards the world as the movement of an objective

source, of an objective model of our sensations. The metaphysical, i.e., anti-dialectical, materialist may accept the existence of matter without motion (even though temporarily, before "the first impulse," etc.). The dialectical materialist not only regards motion as an inseparable property of matter, but rejects the simplified view of motion and so forth.

"... The most exact definition would, perhaps, be the following: 'matter is what moves'; but this is as devoid of content as though one were to say that matter is the subject of a sentence, the predicate of which is 'moves.' The fact, most likely, is that in the epoch of statics men were wont to see something necessarily solid in the role of the subject, an 'object,' and such an inconvenient thing for static thought as 'motion' they were prepared to tolerate only as a predicate, as one of the attributes of 'matter.'"

This is something like the charge Aki-mov brought against the Iskraits, namely, that their programme did not contain the word proletariat in the nominative case! Whether we

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say the world is moving matter, or that the world is material motion, makes no difference whatever.

"... But energy must have a vehicle -- say those who believe in matter. Why? -- asks Ostwald, and with reason. Must nature necessarily consist of subject and predicate?" (p. 39)

Ostwald's answer, which so pleased Bogdanov in 1899, is plain sophistry. Must our judgments necessarily consist of electrons and ether? -- one might retort to Ostwald. As a matter of fact, the mental elimination from "nature" of matter as the "subject" only implies the tacit admission into philosophy of thought as the "subject" (i.e., as the primary, the starting point, independent of matter). Not the subject, but the objective source of sensation is eliminated, and sensation becomes the "subject," i.e.,

philosophy becomes Berkeleyan, no matter in what trappings the word "sensation" is afterwards decked. Ostwald endeavoured to avoid this inevitable philosophical alternative (materialism or idealism) by an indefinite use of the word "energy," but this very endeavour only once again goes to prove the futility of such artifices. If energy is motion, you have only shifted the difficulty from the subject to the predicate, you have only changed the question, does matter move? into the question, is energy material? Does the transformation of energy take place outside my mind, independently of man and mankind, or are these only ideas, symbols, conventional signs, and so forth? And this question proved fatal to the "energeticist" philosophy, that attempt to disguise old epistemological errors by a "new" terminology.

Here are examples of how the energeticist Ostwald got into a muddle. In the preface to his Lectures on Natural

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Philosophy³ he declares that he regards "as a great gain the simple and natural removal of the old difficulties in the way of uniting the concepts matter and spirit by subordinating both to the concept energy." This is not a gain, but a loss, because the question whether epistemological investigation (Ostwald does not clearly realise that he is raising an epistemological and not a chemical issue!) is to be conducted along materialist or idealist lines is not being solved but is being confused by an arbitrary use of the term "energy." Of course, if we "subordinate" both matter and mind to this concept, the verbal annihilation of the antithesis is beyond question, but the absurdity of the belief in sprites and hobgoblins, for instance, is not removed by calling it "energetics." On page 394 of Ostwald's *Lectures* we read: "That all external events may be presented as an interaction of en-

ergies can be most simply explained if our mental processes are themselves energetic and impose (auftragen) this property of theirs on all external phenomena." This is pure idealism: it is not our thought that reflects the transformation of energy in the external world, but the external world that reflects a certain "property" of our mind! The American philosopher Hibben, pointing to this and similar passages in Ostwald's Lectures, aptly says that Ostwald "appears in a Kantian disguise": the explicability of the phenomena of the external world is deduced from the properties of our mind! "It is obvious therefore," says Hibben, "that if the primary concept of energy is so defined as to embrace psychical phenomena, we have no longer the simple concept of energy as understood and recognised in scientific circles or even

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among the *Energetiker* themselves..."⁴ The transformation of energy is regarded by science as an objective process independent of the minds of men and of the experience of mankind, that is to say, it is regarded materialistically. And by energy, Ostwald himself in many instances, probably in the vast majority of instances, means material motion.

And this accounts for the remarkable phenomenon that Bogdanov, a disciple of Ostwald, having become a disciple of Mach, began to reproach Ostwald not because he does not adhere consistently to a materialistic view of energy, but because he admits the materialistic view of energy (and at times even takes it as his basis). The materialists criticise Ostwald because he lapses into idealism, because he attempts to reconcile materialism and idealism. Bogdanov criticises Ostwald from the idealist standpoint. In 1906 he wrote: "... Ostwald's energetics, hostile to atomism

³ Wilhelm Ostwald, *Vorlesungen über Naturphilosophie*, 2 Aufl., Leipzig, 1902, S. viii.

⁴ J. G. Hibben, "The Theory of Energetics and Its Philosophical Bearings," *The Monist*, Vol. XIII, No. 3, April 1903, pp. 329-30.

but for the rest closely akin to the old materialism, enlisted my heartiest sympathy. I soon noticed, however, an important contradiction in his *Naturphilosophie*: although he frequently emphasises the purely methodological significance of the concept 'energy,' in a great number of instances he himself fails to adhere to it. He every now and again converts 'energy' from a pure symbol of correlations between the facts of experience into the substance of experience, into the 'world stuff'" (*Empirio-Monism*, Bk. III, pp. xvi-xvii).

Energy is a pure symbol! After this Bogdanov may dispute as much as he pleases with the "empirio-symbolist" Yushkevich, with the "pure Machians," the empirio-critics, etc. -- from the standpoint of the materialist it is a dispute be-

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tween a man who believes in a yellow devil and a man who believes in a green devil. For the important thing is not the differences between Bogdanov and the other Machians, but what they have in common, to wit: the idealist interpretation of "experience" and "energy," the denial of objective reality, adaptation to which constitutes human experience and the copying of which constitutes the only scientific "methodology" and scientific "energetics."

"It [Ostwald's energetics] is indifferent to the material of the world, it is fully compatible with both the old materialism and pansychism" (i.e., philosophical idealism?) (p. xvii). And Bogdanov departed from muddled energetics not by the materialist road but by the idealist road.... "When energy is represented as substance it is nothing but the old materialism minus the absolute atoms -- materialism with a correction in the sense of the continuity of the existing" (ibid.). Yes, Bogdanov left the "old" materialism, i.e., the metaphysical materialism of

the scientists, not for dialectical materialism, which he understood as little in 1906 as he did in 1899, but for idealism and fideism; for no educated representative of modern fideism, no immanentist, no "neo-critic," and so forth, will object to the "methodological" conception of energy, to its interpretation as a "pure symbol of correlation of the facts of experience." Take Paul Carus, with whose mental make-up we have already become sufficiently acquainted, and you will find that this Machian criticises Ostwald in the very same way as Bogdanov: "... Materialism and energetics are exactly in the same predicament" (*The Monist*, Vol. XVII, 1907, No. 4, p. 536). "We are very little helped by materialism when we are told that everything is matter, that bodies are matter, and that thoughts are merely a function of matter, and Professor Ost-

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wald's energetics is not a whit better when it tells us that matter is energy, and that the soul too is only a factor of energy" (p. 533).

Ostwald's energetics is a good example of how quickly a "new" terminology becomes fashionable, and how quickly it turns out that a somewhat altered mode of expression can in no way eliminate fundamental philosophical questions and fundamental philosophical trends. Both materialism and idealism can be expressed in terms of "energetics" (more or less consistently, of course) just as they can be expressed in terms of "experience," and the like. Energeticist physics is a source of new idealist attempts to conceive motion without matter -- because of the disintegration of particles of matter which hitherto had been accounted non-disintegrable and because of the discovery of heretofore unknown forms of material motion.

4. THE TWO TRENDS IN MODERN PHYSICS AND ENGLISH SPIRITUALISM

In order to illustrate concretely the philosophical battle raging in present-day literature over the various conclusions drawn from the new physics, we shall let certain of the direct participants in the "fray" speak for themselves, and we shall begin with the English. The physicist Arthur W. Rucker defends one trend -- from the standpoint of the natural scientist; the philosopher James Ward another trend -- from the standpoint of epistemology.

At the meeting of the British Association held in Glasgow in 1901, A. W. Rucker, the president of the physics section, chose as the subject of his address the question of the value

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of physical theory and especially the doubts that have arisen as to the existence of atoms, and of the ether. The speaker referred to the physicists Poincaré and Poynting (an English man who shares the views of the symbolists, or Machians), who raised this problem, to the philosopher Ward, and to E. Haeckel's famous book and attempted to present his own views.⁵

"The question at issue," said Rucker, "is whether the hypotheses which are at the base of the scientific theories now most generally accepted, are to be regarded as accurate descriptions of the constitution of the universe around us, or merely as convenient fictions." (In the terms used in our controversy with Bogdanov, Yushkevich and Co.: are they a copy of objective reality, of moving matter, or are they only a "methodology," a "pure symbol," mere "forms of organisation of experience"?) Rucker agrees that in practice there may prove to be no difference between the two theories; the direction of a river can be determined as well by one who examines only the blue streak on a map or diagram

as by one who knows that this streak represents a real river. Theory, from the standpoint of a convenient fiction, will be an "aid to memory," a means of "producing order" in our observations in accordance with some artificial system, of "arranging our knowledge," reducing it to equations, etc. We can, for instance, confine ourselves to declaring heat to be a form of motion or energy, thus exchanging "a vivid conception of moving atoms for a colourless statement of heat energy, the real nature of which we do not attempt to

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define." While fully recognising the possibility of achieving great scientific successes by this method, Rucker "ventures to assert that the exposition of such a system of tactics cannot be regarded as the last word of science in the struggle for the truth." The questions still force themselves upon us: "Can we argue back from the phenomenon displayed by matter to the constitution of matter itself; whether we have any reason to believe that the sketch which science has already drawn is to some extent a copy, and not a mere diagram of the truth?"

Analysing the problem of the structure of matter, Rucker takes air as an example, saying that it consists of gases and that science resolves "an elementary gas into a mixture of atoms and ether.... There are those who cry 'Halt!'; molecules and atoms cannot be directly perceived; they are mere conceptions, which have their uses, but cannot be regarded as realities." Rucker meets this objection by referring to one of numberless instances in the development of science: the rings of Saturn appear to be a continuous mass when observed through a telescope. The mathematicians proved by calculation that this is impossible and spectral analysis corroborated the conclusion reached on the basis of the calculations. Another objection: properties are attributed to atoms and ether such as our senses do not disclose in ordinary matter.

⁵ The British Association at Glasgow, 1901. Presidential Address by Professor Arthur W. Rucker, in *The Scientific American*. Supplement, 1901, Nos. 1345 and 1346.

Rucker answers this also, referring to such examples as the diffusion of gases and liquids, etc. A number of facts, observations and experiments prove that matter consists of discrete particles or grains. Whether these particles, atoms, are distinct from the surrounding "original medium" or "basic medium" (ether), or whether they are parts of this medium in a particular state, is still an open question, and has no bearing on the theory of the existence of atoms. There is

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no ground for denying a priori the evidence of experiments showing that "quasi-material substances" exist which differ from ordinary matter (atoms and ether). Particular errors are here inevitable, but the aggregate of scientific data leaves no room for doubting the existence of atoms and molecules.

Rucker then refers to the new data on the structure of atoms, which consist of corpuscles (electrons) charged with negative electricity, and notes the similarities in the results of various experiments and calculations on the size of molecules: the "first approximation" gives a diameter of about 100 millimicrons (millionths of a millimetre). Omitting Rucker's particular remarks and his criticism of neo-vitalism, we quote his conclusions:

"Those who belittle the ideas which have of late governed the advance of scientific theory, too often assume that there is no alternative between the opposing assertions that atoms and the ether are mere figments of the scientific imagination, and that, on the other hand, a mechanical theory of the atoms and the ether, which is now confessedly imperfect, would, if it could be perfected, give us a full and adequate representation of the underlying realities. For my part I believe that there is a via media." A man in a dark room may discern objects dimly, but if he does not stumble over the furniture and does not walk into a looking-glass instead of through

a door, it means that he sees some things correctly. There is no need, therefore, either to renounce the claim to penetrate below the surface of nature, or to claim that we have already fully unveiled the mystery of the world around us. "It may be granted that we have not yet framed a consistent image either of the nature of the atoms or of the ether in which they exist, but I have tried to show that in spite of the tentative nature of some of our theories, in spite of many

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outstanding difficulties, the atomic theory unifies so many facts, simplifies so much that is complicated, that we have a right to insist -- at all events until an equally intelligible rival hypothesis is produced -- that the main structure of our theory is true; that atoms are not merely aids to puzzled mathematicians, but physical realities."

That is how Rucker ended his address. The reader will see that the speaker did not deal with epistemology, but as a matter of fact, doubtless in the name of a host of scientists, he was essentially expounding an instinctive materialist standpoint. The gist of his position is this: The theory of physics is a copy (becoming ever more exact) of objective reality. The world is matter in motion, our knowledge of which grows ever more profound. The inaccuracies of Rucker's philosophy are due to an unnecessary defence of the "mechanical" (why not electromagnetic?) theory of ether motions and to a failure to understand the relation between relative and absolute truth. This physicist lacks only a knowledge of dialectical materialism (if we do not count, of course, those very important social considerations which induce English professors to call themselves "agnostics").

Let us now see how the spiritualist James Ward criticised I this philosophy: "Naturalism is not science, and the mechanical theory of Nature, the theory which serves as its foundation, is no science either.... Nevertheless, though Naturalism

and the natural sciences, the Mechanical Theory of the Universe and mechanics as a science are logically distinct, yet the two are at first sight very similar and historically are very closely connected. Between the natural sciences and philosophies of the idealist (or spiritualist) type there is indeed no danger of confusion, for all such philosophies necessarily involve criticism of the epistemological assump-

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tions which science unconsciously makes."⁶ True! The natural sciences unconsciously assume that their teachings reflect objective reality, and only such a philosophy is reconcilable with the natural sciences!" ... Not so with Naturalism, which is as innocent of any theory of knowledge as science itself. In fact Naturalism, like Materialism, is only physics treated as metaphysics.... Naturalism is less dogmatic than Materialism, no doubt, owing to its agnostic reservation as to the nature of ultimate reality; but it insists emphatically on the priority of the material aspect of its Unknowable."

The materialist treats physics as metaphysics! A familiar argument. By metaphysics is meant the recognition of an objective reality outside man. The spiritualists agree with the Kantians and Humeans in such reproaches against materialism. This is understandable; for without doing away with the objective reality of things, bodies and objects known to everyone, it is impossible to clear the road for "real conceptions" in Rehmke's sense! ...

"When the essentially philosophical question, how best to systematise experience as a whole [a plagiarism from Bogdanov, Mr. Ward!], arises, the naturalist ... contends that we must begin from the physical side. Then only are the facts precise, determinate, and rigorously concatenated: every thought that ever stirred the

human heart ... can, it holds, be traced to a perfectly definite redistribution of matter and motion.... That propositions of such philosophic generality and scope are legitimate deductions from physical science, few, if any, of our modern physicists are bold enough directly to maintain. But many of them consider that their science

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itself is attacked by those who seek to lay bare the latent metaphysics, the physical realism, on which the Mechanical Theory of the Universe rests.... The criticism of this theory in the preceding lectures has been so regarded [by Rucker].... In point of fact my criticism [of this "metaphysics," so detested by all the Machians too] rests throughout on the expositions of a school of physicists -- if one might call them so -- steadily increasing in number and influence, who reject entirely the almost medieval realism.... This realism has remained so long unquestioned, that to challenge it now seems to many to spell scientific anarchy. And yet it surely verges on extravagance to suppose that men like Kirchhoff or Poincaré -- to mention only two out of many distinguished names -- who do challenge it, are seeking 'to invalidate the methods of science.' ... To distinguish them from the old school, whom we may fairly term physical realists, we might call the new school physical symbolists. The term is not very happy, but it may at least serve to emphasise the one difference between the two which now specially concerns us. The question at issue is very simple. Both schools start, of course, from the same perceptual experiences; both employ an abstract conceptual system, differing in detail but essentially the same; both resort to the same methods of verification. But the one believes that it is getting nearer to the ultimate reality and leaving mere appearances behind it; the other believes that it is only substituting a generalised descriptive scheme that is intellectually manageable, for the complexity of concrete facts.... In

⁶ James Ward. *Naturalism and Agnosticism*, 1906, Vol. I, p. 303.

either view the value of physics as systematic knowledge about [Ward's italics] things is unaffected; its possibilities of future extension and of practical application are in either case the same. But the speculative difference between the two is

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immense, and in this respect the question which is right becomes important."

The question is put by this frank and consistent spiritualist with remarkable truth and clarity. Indeed, the difference between the two schools in modern physics is only philosophical, only epistemological. Indeed, the basic distinction is only that one recognises the "ultimate" (he should have said objective) reality reflected by our theory, while the other denies it, regarding theory as only a systematisation of experience, a system of empirio-symbols, and so on and so forth. The new physics, having found new aspects of matter and new forms of its motion, raised the old philosophical questions because of the collapse of the old physical concepts. And if the people belonging to "intermediate" philosophical trends ("positivists," Humeans, Machians) are unable to put the question at issue distinctly, it remained for the outspoken idealist Ward to tear off all veils.

"... Sir A. W. Rucker ... devoted his Inaugural Address to a defence of physical realism against the symbolic interpretations recently advocated by Professors Poincaré and Poynting and by myself" (pp. 305-06; and in other parts of his book Ward adds to this list the names of Duhem, Pearson and Mach; see Vol. II, pp. 161, 63, 57, 75, 83, etc.).

"... He [Rucker] is constantly talking of 'mental pictures,' while constantly protesting that atoms and ether must be more than these. Such procedure practically amounts to saying: In this case I can form no other picture, and therefore the reality must be like it.... He [Rucker] is fair enough to allow the abstract possibility of a different mental picture.... Nay, he allows 'the

tentative nature of some of our theories'; he admits 'many outstanding difficulties.' After all, then, he is only defending a working hypothesis,

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and one, moreover, that has lost greatly in prestige in the last half century. But if the atomic and other theories of the constitution of matter are but working hypotheses, and hypotheses strictly confined to physical phenomena, there is no justification for a theory which maintains that mechanism is fundamental everywhere and reduces the facts of life and mind to epiphenomena -- makes them, that is to say, a degree more phenomenal, a degree less real than matter and motion. Such is the mechanical theory of the universe. Save as he seems unwittingly to countenance that, we have then no quarrel with Sir Arthur Rucker" (pp. 314-15).

It is, of course, utterly absurd to say that materialism ever maintained that consciousness is "less" real, or necessarily professed a "mechanical," and not an electromagnetic, or some other, immeasurably more complex, picture of the world of moving matter. But in a truly adroit manner, much more skillfully than our Machians (i.e., muddled idealists), the outspoken and straightforward idealist Ward seizes upon the weak points in "instinctive" natural-historical materialism, as, for instance, its inability to explain the relation of relative and absolute truth. Ward turns somersaults and declares that since truth is relative, approximate, only "tentative," it cannot reflect reality! But, on the other hand, the question of atoms, etc., as "a working hypothesis" is very correctly put by the spiritualist. Modern, cultured fideism (which Ward directly deduces from his spiritualism) does not think of demanding anything more than the declaration that the concepts of natural science are "working hypotheses." We will, sirs, surrender science to you scientists provided you surrender epistemology, philosophy to us -- such is

the condition for the cohabitation of the theologians and professors in the "advanced" capitalist countries.

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Among the other points on which Ward connects his epistemology with the "new" physics must be counted his determined attack on matter. What is matter and what is energy? -- asks Ward, mocking at the plethora of hypotheses and their contradictoriness. Is it ether or ethers? -- or, perhaps, some new "perfect fluid," arbitrarily endowed with new and improbable qualities? And Ward's conclusion is: "... we find nothing definite except movement left. Heat is a mode of motion, elasticity is a mode of motion, light and magnetism are modes of motion. Nay, mass itself is, in the end, supposed to be but a mode of motion of a something that is neither solid, nor liquid nor gas, that is neither itself a body nor an aggregate of bodies, that is not phenomenal and must not be noumenal, a veritable *apeiron* [a term used by the Greek philosophers signifying: infinite, boundless] on which we can impose our own terms" (Vol. I, p. 140).

The spiritualist is true to himself when he divorces motion from matter. The movement of bodies is transformed in nature into a movement of something that is not a body with a constant mass, into a movement of an unknown charge of an unknown electricity in an unknown ether -- this dialectics of material transformation, performed in the laboratory and in the factory, serves in the eyes of the idealist (as in the eyes of the public at large, and of the Machians) not as a confirmation of materialist dialectics, but as evidence against materialism: "... The mechanical theory, as a professed explanation of the world, receives its death-blow from the progress of mechanical physics itself" (p. 143). The world is matter in motion, we reply, and the laws of its motion are reflected by mechanics in the case of moderate velocities and by the electromagnetic theory in the case

of great velocities. "Extended, solid, indestructible atoms have always been the

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stronghold of materialistic views of the universe. But, unhappily for such views, the hard, extended atom was not equal to the demands which increasing knowledge made upon it" (p. 144). The destructibility of the atom, its inexhaustibility, the mutability of all forms of matter and of its motion, have always been the stronghold of dialectical materialism. All boundaries in nature are conditional, relative, movable, and express the gradual approximation of our mind towards the knowledge of matter. But this does not in any way prove that nature, matter itself, is a symbol, a conventional sign, i.e., the product of our mind. The electron is to the atom as a full stop in this book is to the size of a building 200 feet long, 100 feet broad, and 50 feet high (Lodge); it moves with a velocity as high as 270,000 kilometres per second; its mass is a function of its velocity; it makes 500 trillion revolutions in a second -- all this is much more complicated than the old mechanics; but it is, nevertheless, movement of matter in space and time. Human reason has discovered many amazing things in nature and will discover still more, and will thereby increase its power over nature. But this does not mean that nature is the creation of our mind or of abstract mind, i.e., of Ward's God, Bogdanov's "substitution," etc.

"Rigorously carried out as a theory of the real world, that ideal [i.e., the ideal of "mechanism"] lands us in nihilism: all changes are motions, for motions are the only changes we can understand, and so what moves, to be understood, must itself be motion" (p. 166). "As I have tried to show, and as I believe, the very advance of physics is proving the most effectual cure for this ignorant faith in matter and motion as the inmost substance rather than the most abstract

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symbols of the sum of existence.... We can never get to God through a mere mechanism" (p. 180).

Well, well, this is exactly in the spirit of the Studies "in" the Philosophy of Marxism

5. THE TWO TRENDS IN MODERN PHYSICS, AND GERMAN IDEALISM

In 1896, the well-known Kantian idealist Hermann Cohen, with unusually triumphant exultation, wrote an introduction to the fifth edition of the *Geschichte des Materialismus*, the falsified history of materialism written by F. Albert Lange. "Theoretical idealism," exclaims Cohen (p. xxvi), "has already begun to shake the materialism of the natural scientists, and perhaps in only a little while will defeat it completely." Idealism is permeating (*Durchwirkung*) the new physics. "Atomism must give place to dynamism...." "It is a remarkable turn of affairs that research into the chemical problem of substance should have led to a fundamental triumph over the materialist view of matter. Just as Thales performed the first abstraction of the idea of substance, and linked it with speculations on the electron, so the theory of electricity was destined to cause the greatest revolution in the conception of matter and, through the transformation of matter into force, bring about the victory of idealism" (p. xxix).

Hermann Cohen is as clear and definite as James Ward in pointing out the fundamental philosophical trends, and

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does not lose himself (as our Machians do) in petty distinctions between this and that energeticist, symbolist, empirio-critic, empirio-monist idealism, and so forth. Cohen takes the fundamental philosophical trend of the school of physics that is now associated with the names of Mach, Poincaré and others and correctly describes this trend as idealist. "The transformation of matter into force" is here for Cohen the most important triumph of idealism, just as

! Mr. Ward, you ought to address yourself to Lunacharsky, Yushkevich, Bazarov and Bogdanov. They are a little more "shame-faced" than you are, but they preach the same doctrine.

it was for the "ghost-seeing" scientists -- whom J. Dietzgen exposed in 1869. Electricity is proclaimed a collaborator of idealism, because it has destroyed the old theory of the structure of matter, shattered the atom and discovered new forms of material motion, so unlike the old, so totally uninvestigated and unstudied, so unusual and "miraculous," that it permits nature to be presented as non-material (spiritual, mental, psychical) motion. Yesterday's limit to our knowledge of the infinitesimal particles of matter has disappeared, hence -- concludes the idealist philosopher -- matter has disappeared (but thought remains). Every physicist and every engineer knows that electricity is (material) motion, but nobody knows clearly what is moving, hence -- concludes the idealist philosopher -- we can dupe the philosophically uneducated with the seductively "economical" proposition: let us conceive motion without matter....

Hermann Cohen tries to enlist the famous physicist Heinrich Hertz as his ally. Hertz is ours -- he is a Kantian, we sometimes find him admitting the a priori, he says. Hertz is ours, he is a Machian -- contends the Machian Kleinpeter -- for in Hertz we have glimpses of "the same subjectivist view of the nature of our concepts as in the case of Mach."⁷

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This strange dispute as to where Hertz belongs is a good example of how the idealist philosophers seize on the minutest error,

⁷ *Archiv fur systematische Philosophie*, Bd. V, 1898-99, S. 169-70.

the slightest vagueness of expression on the part of renowned scientists in order to justify their refurbished defence of fideism. As a matter of fact, Hertz's philosophical preface to his *Mechanik*⁸ displays the usual standpoint of the scientist who has been intimidated by the professorial hue and cry against the "metaphysics" of materialism, but who nevertheless cannot overcome his instinctive conviction of the reality of the external world. This has been acknowledged by Kleinpeter himself, who on the one hand casts to the mass of readers thoroughly false popularly-written pamphlets on the theory of knowledge of natural science, in which Mach figures side by side with Hertz, while on the other, in specifically philosophical articles, he admits that "Hertz, as opposed to Mach and Pearson, still clings to the prejudice that all physics can be explained in a mechanistic way,"⁹ that he retains the concept of the thing-in-itself and "the usual standpoint of the physicists," and that Hertz still adheres to "a picture of the universe in itself," and so on.¹⁰

It is interesting to note Hertz's view of energetics. He writes: "If we inquire into the real reason why physics at the present time prefers to express itself in terms of energetics, we may answer that it is because in this way it best avoids talking about things of which it knows very little.... Of course, we are now convinced that ponderable matter

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consists of atoms; and in certain cases we have fairly definite ideas of the magnitude of these atoms and of their motions. But the form of the atoms, their connection, their motions in most cases, all these are entirely hidden from us.... So that our con-

⁸ Heinrich Hertz, *Gesammelte Werke*, Bd. III, Leipzig, 1894, esp. S. 1, 2, 49.

⁹ *Kantstudien*, VIII, Band, 1903, S. 309.

¹⁰ *The Monist*, Vol. XVI, 1906, No. 2, p. 164; an article on Mach's "Monism."

ception of atoms is therefore in itself an important and interesting object for further investigations, but is not particularly adapted to serve as a known and secure foundation for mathematical theories" (*op. cit.*, Vol. III, p. 21). Hertz expected that further study of the ether would provide an explanation of the "nature of traditional matter ... its inertia and gravitational force" (Vol. I, p. 354).

It is evident from this that the possibility of a non-materialist view of energy did not even occur to Hertz. Energetics served the philosophers as an excuse to desert materialism for idealism. The scientist regards energetics as a convenient method of expressing the laws of material motion at a period when, if we may so express it, physicists had left the atom but had not yet arrived at the electron. This period is to a large extent not yet at an end; one hypothesis yields place to another; nothing whatever is known of the positive electron; only three months ago (June 22, 1908), Jean Becquerel reported to the French Academy of Science that he had succeeded in discovering this "new component part of matter" (*Comptes rendus des seances de l'Academie des Sciences*, p. 1311). How could idealist philosophy refrain from taking advantage of such an opportunity, when "matter" was still being "sought" by the human mind and was therefore no more than a "symbol," etc.

Another German idealist, one far more reactionary than Cohen, Eduard von Hartmann, devoted a whole book to the world outlook of modern physics (*Die Weltanschauung der modernen Physik*, Leipzig, 1902). We are, of course, not in-

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terested in the specific arguments of the author in favour of his own variety of idealism. For us it is important only to point out that this idealist notes the same phenomena as Rey, Ward and Cohen. "Modern physics had grown up on a realist basis," says Hartmann, "and it was only the Neo-

Kantian and agnostic movement of our own time that led it to re-interpret its data in an idealist spirit" (p. 218). According to Hartmann, three epistemological systems constitute the basis of modern physics -- hylo-kinetics (from the Greek hyle -- matter, and kinesis -- motion -- i.e., the recognition of physical phenomena as matter in motion), energetics, and dynamism (i.e., the recognition of force without substance). Of course, the idealist Hartmann favours "dynamism," from which he draws the conclusion that the laws of nature are world-thought, in a word, he "substitutes" the psychical for physical nature. But he is forced to admit that hylo-kinetics has the majority of physicists on its side, that it is the system that "is most frequently employed" (p. 190), that its serious defect is "materialism and atheism, which threaten from pure hylo-kinetics" (p. 189). This author quite justly regards energetics as an intermediary system and calls it agnosticism (p. 136). Of course, it is an "ally of pure dynamism, for it dethrones substance" (pp. vi, 192), but Hartmann dislikes its agnosticism as a form of "Anglomania," which is incompatible with the genuine idealism of a true-German reactionary.

It is highly instructive to see how this irreconcilable partisan idealist (non-partisans in philosophy are just as hopelessly thick-headed as they are in politics) explains to the physicists what it means to follow one epistemological trend or another. "Only a very few of the physicists who follow this fashion," writes Hartmann in reference to the idealist interpretation

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of the latest results in physics, "realise the full scope and implications of such an interpretation. They have failed to observe that physics with its specific laws has retained significance only in so far as, despite its idealism, it has adhered to realistic basic propositions, viz., the existence of things-in-themselves, their real mutability in time, real causality.... Only by granting

these realistic premises (the transcendental validity of causality, time and three-dimensional space), i.e., only on the condition that nature, of whose laws physics speaks, coincides with a ... realm of things-in themselves, can one speak of natural laws as distinct from psychological laws. Only if natural laws operate in a realm independent of our mind can they serve as an explanation of the fact that the logically necessary effects of our images are always images of the natural-historically necessary effects of the unknown which they reflect or symbolise in our consciousness" (pp. 218-19).

Hartmann rightly feels that the idealism of the new physics is nothing but a fashion, and not a serious philosophical turn away from natural-historical materialism; and he, therefore, correctly explains to the physicists that in order to transform the "fashion" into consistent, integral philosophical idealism it is necessary radically to modify the doctrine of the objective reality of time, space, causality and natural law. We cannot regard only atoms, electrons and ether as mere symbols, as a mere "working hypothesis": time, space, the laws of nature and the whole external world must also be proclaimed a "working hypothesis." Either materialism, or the universal substitution of the psychical for the whole of physical nature; those anxious to confound the two are legion, but we and Bogdanov are not of their number.

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Among the German physicists, Ludwig Boltzmann, who died in 1906, systematically combated the Machian tendency. We have already pointed out that as against those who were "carried away by the new epistemological dogmas" he simply and clearly reduced Machism to solipsism (see above, Chap. I, §6). Boltzmann, of course, was afraid to call himself a materialist and even explicitly stated that he did not deny

the existence of God.¹¹ But his theory of knowledge is essentially materialistic, and expresses -- as is admitted by S. Gunther,¹² the historian of natural science in the nineteenth century -- the views of the majority of scientists. "We know," says Boltzmann, "of the existence of all things solely from the impressions they make on our senses" (op. cit., p. 29). Theory is an "image" (or copy) of nature, of the external world (p. 77). To those who say that matter is only a complex of sense-perceptions, Boltzmann points out that in that case other people are only the sensations of the speaker (p. 168). These "ideologues," as Boltzmann sometimes calls the philosophical idealists, present us with a "subjective picture of the world" (p. 176), whereas the author prefers a "simpler objective picture of the world." "The idealist compares the assertion that matter exists as well as our sensations with the child's opinion that a stone which is beaten experiences pain. The realist compares the assertion that one cannot conceive how the mental can be formed from the material, or even from the play of atoms, with the opinion of an uneducated person who asserts that the distance between the sun and the earth cannot be twenty million miles, for he

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cannot conceive it" (p. 186). Boltzmann does not deny that the ideal of science is to present mind and volition as "complex actions of particles of matter" (p. 396).

L. Boltzmann frequently polemicised against Ostwald's energetics from the standpoint of a physicist, and argued that Ostwald could neither disprove nor eliminate the formula of kinetic energy (half the mass multiplied by the square of velocity)

¹¹ Ludwig Boltzmann, *Populare Schriften*, Leipzig, 1905, S. 187.

¹² Siegmund Gunther, *Geschichte der anorganischen Naturwissenschaften im 19. Jahrhundert* [History of the Inorganic Sciences in the Nineteenth Century], Berlin, 1901, S. 942 und 941.

and that he was revolving in a vicious circle by first deducing energy from mass (by accepting the formula of kinetic energy) and then defining mass as energy (pp. 112, 139). This reminds me of Bogdanov's paraphrase of Mach in the third book of his *Empirio-Monism*. "In science," writes Bogdanov in reference to Mach's *Mechanik*, [111] "the concept matter is reduced to the coefficient of mass as it appears in the equations of mechanics, upon accurate analysis, how ever, the coefficient of mass proves to be the reciprocal of the acceleration when two physical body-complexes interact" (p. 146). It is evident that if a certain body is taken as a unit, the motion (mechanical) of all other bodies can be expressed as a mere relation of acceleration. But this does not at all mean that "bodies" (i.e., matter) disappear or cease to exist independently of our mind. When the whole world is reduced to the movement of electrons, it will be possible to eliminate the electron from all equations, because it will be everywhere assumed, and the correlation between groups or aggregates of electrons will reduce itself to their mutual acceleration, if the forms of motion prove to be as simple as those of mechanics.

Combating the "phenomenalist" physics of Mach and Co., Boltzmann maintained that "those who believe atomism to have been eliminated by differential equations, cannot see the wood for the trees" (p. 144). "If we do not wish to

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entertain illusions as to the significance of a differential equation ... we cannot doubt that this picture of the world (expressed in differential equations) must again by its nature be an atomic one, i.e., an instruction that the changes in time of a vast quantity of things arranged in three-dimensional space must be thought of in accordance with definite rules. The things can, of course, be similar or dissimilar, unchangeable or changeable," etc. (p. 156). "If we are perfectly clear," said Boltzmann in an

address delivered to the Congress of Scientists held in Munich in 1899, "that the phenomenologists cloaked in differential equations likewise base themselves on atom-like discrete units (Einzelwesen) which they have to picture as possessing now certain properties now others for each group of phenomena, the need for a simplified, uniform atomism will soon again be felt" (p. 223). The electron theory "is developing into an atomic theory of electricity as a whole" (p. 357). The unity of nature is revealed in the "astonishing analogy" between the differential equations of the various realms of phenomena. "The same equations can be regarded as solving the problems of hydro-dynamics and of the theory of potentials. The theory of vortices in fluids and the theory of friction in gases (Gasreibung) reveal a most astonishing analogy to the theory of electromagnetism, etc." (p. 7). Those who accept "the theory of universal substitution" cannot escape the question: Who was it that thought of "substituting" physical nature so uniformly?

As if in answer to those who brush aside "the physicist of the old school," Boltzmann relates in detail how certain specialists in "physical chemistry" are adopting an epistemological position contrary to that of Machism. Vaubel, the author of "one of the best" comprehensive works of 1903 (according to Boltzmann), "takes up a definitely hostile atti-

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tude towards the so-called phenomenism so often recommended today" (p. 381). "He tries rather to obtain as concrete and clear an idea as possible of the nature of atoms and molecules and of the forces and agencies acting between them, and this idea he attempts to bring into conformity with the most recent experiments in this field [ions, electrons, radium, Zeeman effect, etc.].... The author strictly adheres to

the dualism of matter and energy,¹³ which have this in common that each has a special law of conservation. In regard to matter, the author also holds fast to the dualism between ponderable matter and ether, yet regards the latter as material in the strictest sense" (p. 381). In the second volume of his work (theory of electricity) the author "from the very outset takes the view that the phenomena of electricity are determined by the interaction and movement of atom-like entities, the electrons" (p. 383).

Hence, we find that what the spiritualist James Ward admitted to be true of England applies also to Germany, namely, that the physicists of the realistic school systematise the facts and discoveries of recent years no less successfully than the physicists of the symbolist school and that the essential difference between them consists "only " in their epistemological points of view.¹⁴

¹³ Boltzmann wishes to say that the author does not attempt to conceive motion without matter. To speak of dualism here is ridiculous. Philosophical monism and dualism consist respectively in a consistent or inconsistent adherence to materialism or idealism.

¹⁴ The work of Erich Becher, *Philosophical Premises of the Exact Sciences* (Philosophische Vorträge der exakten Naturwissenschaften, Leipzig, 1907), with which I became acquainted only after my book had been completed, confirms what has been said in this paragraph. Holdin, closest of all to the epistemological point of view of Helmholtz and Boltzmann, that is, to a "shamefaced" and incompletely thought-out materialism, the author devotes his work to a defence and interpretation of the fundamental premises of physics and chemistry. This defence naturally becomes converted into a fight against the fashionable but increasingly-resisted Machian trend in physics (cf. p. 91, etc.). E. Becher correctly characterises this tendency as "subjective positivism" (p. iii) and reduces the central point of his objection to it to a proof of the "hypothesis" of the external world (Chapters II-VII), to a proof of its "existence independently of human perceptions" (vom Wahrgenommenwerden unabhängige Existenz). The denial of this "hypothesis" by the Machians frequently leads the latter to solipsism (pp. 78-82, etc.). "Mach's view that sensations

and complexes of sensations, and not the external world" (p. 138), are the only subject matter of science, Becher calls "sensationalist monism" (Empfindungsmonismus) and classes it with the "purely conscientialistic tendencies." This clumsy and absurd term is constructed from the Latin word conscientia -- consciousness, and means nothing but philosophical idealism (cf. p. 156). In the last two chapters of the book E. Becher quite skilfully compares the old mechanical theory with the new electrical theory of matter and world-picture (the "kinetico-elastic," as the author puts it, with the "kinetico-electric" conception of nature). The latter theory, based on the electron theory, is a step forward in

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knowledge of the unity of the world; according to this theory the "elements of the material world are electrical charges" (Ladungen, p. 223). "Every purely kinetic conception of nature knows nothing save a certain number of moving objects, whether they are called electrons or something else. The state of motion of these objects in successive time intervals is consistently determined by their position and state of motion in the preceding time interval" (p. 225). The chief defect of Becher's book is his absolute ignorance of dialectical materialism. This ignorance frequently leads him into confusion and absurdity, on which it is impossible to dwell here.

6. THE TWO TRENDS IN MODERN PHYSICS AND FRENCH FIDEISM

In France, idealist philosophy has seized upon the vacillations of Machian physics with no less determination. We have already seen how the neo-critics greeted Mach's *Mechanik* and how they immediately discerned the idealist character of the principles of Mach's philosophy. The French Machian, Henri Poincaré, was even more successful in this respect. The most reactionary idealist philosophy, the implications of which were definitely fideistic, immediately seized upon his theory. An adherent of this philosophy, Le Roy, argued thus: the truths of science are conventional signs, symbols; you have abandoned the absurd, "metaphysical" claims to knowledge of objective reality -- well then, be logical and agree with us that science has practical significance only for one sphere of human activity and that religion has a no less real significance for another sphere of activity; "symbolic," Machian science has no right to deny theology. H. Poincaré was abashed by these conclusions and in his book *La valeur de la science* made a special attack on them. But just see what epistemological position he was obliged to adopt in order to rid himself of allies of the type of Le Roy. He

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writes: "M. Le Roy regards the intellect as incurably impotent only in order to give greater place to other sources of knowledge, for instance, the heart, sentiment, instinct and faith" (pp. 214-15). "I do not go to the limit," he says. Scientific laws are conventions, symbols, but "if scientific 'recipes' have a value as rules of action, it is because we know that, in general at least, they are successful. But to know this is already to know something; and if so, how can you say that we can know nothing?" (p. 219).

H. Poincaré resorts to the criterion of practice. But he only shifts the question without settling it; for this criterion may be interpreted in a subjective as well as in an objective way. Le Roy also admits this criterion for science and industry; all he denies is that this criterion proves objective truth, for such a denial suffices him for admitting the subjective truth of religion along with the subjective truth of science (i.e., as not existing apart from mankind). Poincaré realises that one cannot limit oneself to a reference to practice in arguing against Le Roy, and he passes to the question of the objectivity of science. "What is the criterion of its objectivity? Well, it is exactly the same as the criterion of our belief in external objects. These objects are real in as much as the sensations they evoke in us (qu'ils nous font

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éprouver) appear to be united by some sort of indestructible cement and not by an ephemeral accident" (pp. 269-70).

The author of such a remark may well be a great physicist, but it is absolutely indisputable that only the Voroshilov-Yushkeviches can take him seriously as a philosopher. Materialism is declared to have been destroyed by a "theory" which at the first onslaught of fideism takes refuge under the wing of materialism! For it is the purest materialism to say that sensations are evoked in us by real objects and that "belief" in the objectivity of science is the same as "belief" in the objective existence of external objects.

"... It can be said, for instance, that ether has no less reality than any external body" (p. 270).

What an outcry our Machians would have raised had a materialist said that! How many feeble witticisms would have

been uttered at the expense of "ethereal materialism," and so forth. But five pages later the founder of recent empirio-symbolism declares: "Everything that is not thought is pure nothing, since we can think nothing but thought" (p. 276). You are mistaken, M. Poincaré your works prove that there are people who can only think what is entirely devoid of thought. To this class of people belongs the notorious muddler, Georges Sorel, who maintains that the "first

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two parts" of Poincaré's book on the value of science are written in the "spirit of Le Roy" and that therefore the two philosophers can be "reconciled" as follows: the attempt to establish an identity between science and the world is an illusion; there is no need to raise the question whether science can have knowledge of nature or not, for it is sufficient that science should correspond with the mechanisms created by us (Georges Sorel, *Les préoccupations métaphysiques des physiciens modernes* [Metaphysical Preoccupations of the Modern Physicists], Paris, 1907, pp. 77, 80, 81).

But while it is sufficient merely to mention the "philosophy" of Poincaré and pass on, it is imperative to dwell at some length on the work of A. Rey. We have already pointed out that the two basic trends in modern physics, which Rey calls the "conceptualist" and the "neo-mechanistic," reduce themselves to the difference between the idealist and the materialist epistemologies. We must now see how the positivist Rey solves a problem which is diametrically opposed to that broached by the spiritualist James Ward and the idealists Cohen and Hartmann, the problem, namely, not of seizing upon the philosophical mistakes of the new physics, its leanings towards idealism, but of rectifying these mistakes and of proving the illegitimacy of the idealist (and fideist) conclusions drawn from the new physics.

A thread that runs through the whole of Rey's work is the recognition of the fact that the new physical theory of the "conceptualists" (Machians) has been seized upon by fideism (pp. 11, 17, 220, 362, etc.) and "philosophical idealism" (p. 200), scepticism as to the rights of the intellect and the rights of science (pp. 210, 220), subjectivism (p. 311), and so forth. Therefore, Rey quite rightly makes the analysis

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of the "opinions of the physicists on the objective validity of physics" (p. 3) the centre of his work.

And what are the results of this analysis?

Let us take the basic concept, the concept of experience. Rey assures us that Mach's subjectivist interpretation (for the sake of simplicity and brevity we shall take Mach as the representative of the school which Rey terms conceptualist) is a sheer misunderstanding. It is true that one of the "outstanding new features of the philosophy of the end of the nineteenth century" is that "empiricism, becoming ever subtler and richer in nuances, leads to fideism, to the supremacy of faith -- this same empiricism that was once the great war engine of scepticism against the assertions of metaphysics. Has not at bottom the real meaning of the word 'experience' been distorted, little by little, by imperceptible nuances? Experience, when returned to the conditions of existence, to that experimental science which renders it exact and refined, leads us to necessity and to truth" (p. 398). There is no doubt that all Machism, in the broad sense of the term, is nothing but a distortion, by means of imperceptible nuances, of the real meaning of the word "experience"! But how does Rey, who accuses only the fideists of distortion, but not Mach himself, correct this distortion? Listen. "Experience is by definition a knowledge of the object. In physical science this definition is more in place than anywhere else.... Experience is that over which our

mind has no command, that which our desires, our volition, cannot control, that which is given and which is not of our own making. Experience is the object that faces (en face du) the subject" (p. 314).

Here you have an example of how Rey defends Machism! What penetrating genius Engels revealed when he

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dubbed the latest type of adherents of philosophical agnosticism and phenomenalism "shamefaced materialists." The positivist and ardent phenomenalist, Rey, is a superb specimen of this type. If experience is "knowledge of the object," if "experience is the object that faces the subject," if experience means that "something external (quelque chose du de hors) exists and necessarily exists" (se pose et en se posant s'impose -- p. 324), this obviously amounts to materialism! Rey's phenomenalism, his ardent and emphatic assertion that nothing exists save sensations, that the objective is that which is generally valid, etc., etc. -- all this is only a fig-leaf, an empty verbal covering for materialism, since we are told:

"The objective is that which is given from without, that which is imposed (imposé) by experience; it is that which is not of our making, but which is made independently of us and which to a certain extent makes us" (p. 320). Rey defends "conceptualism" by destroying conceptualism! The refutation of the idealist implications of Machism is achieved only by interpreting Machism after the manner of shame-faced materialism. Having himself admitted the distinction between the two trends in modern physics, Rey toils in the sweat of his brow to obliterate all distinctions in the interests of the materialist trend. Rey says of the neo-mechanist school, for instance, that it does not admit the "least doubt, the least uncertainty" as to the objectivity of physics (p. 237): "Here [in regard to the doctrines of this school] one feels remote from the detours one was obliged to make from the

standpoint of the other theories of physics in order to arrive at the assertion of this objectivity."

But it is such "detours" of Machism that Rey conceals by casting a veil over them in his exposition. The fundamental characteristic of materialism is that it starts from the objec-

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tivity of science, from the recognition of objective reality reflected by science, whereas idealism needs "detours" in order, in one way or another, to "deduce" objectivity from mind, consciousness, the "psychic." "The neo-mechanist [i.e., the prevailing] school in physics," says Rey, "believes in the reality of the physical theory just as humanity believes in the reality of the external world" (p. 234, § 22: Thesis). For this school "theory aims at being a copy (le décalque) of the object" (p. 235).

True. And this fundamental trait of the "neo-mechanist" school is nothing but the basis of materialist epistemology. No attempts of Rey to dissociate himself from the materialists or to assure us that the neo-mechanists are also in essence phenomenologists, etc., can mitigate this basic fact. The essence of the difference between the neo-mechanists (materialists who are more or less shamefaced) and the Machians is that the latter depart from this theory of knowledge, and departing from it inevitably fall into fideism.

Take Rey's attitude to Mach's theory of causality and necessity in nature. Only at first glance, Rey assures us, does it appear that Mach is "approaching scepticism" and "subjectivism" (p. 76); this "ambiguity" (equivoque, p. 115) disappears if Mach's teaching is taken as a whole. And Rey takes it as a whole, quotes a series of passages from the *Warmelehre* [112] and the *Analyse der Empfindungen*, and specially deals with the chapter on causality in the former book, but ... he takes care not to quote the decisive passage, Mach's declaration that there is no physical necessity,

but only logical necessity! All that one can say of such a procedure is that it does not interpret Mach but adorns him, that it obliterates the differences between "neo-mechanism" and Machism. Rey's conclusion is that "Mach adopts the analysis

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and conclusions of Hume, Mill and all the phenomenologists, according to whom the causal relation has no substantiality and is only a habit of thought. He has also adopted the fundamental thesis of phenomenism, of which the doctrine of causality is only a consequence, namely, that nothing exists save sensations. But he adds, along a purely objectivist line, that science, analysing sensations, discovers in them certain permanent and common elements which, although abstracted from these sensations, have the same reality as the sensations themselves, for they are taken from sensations by means of perceptual observation. And these permanent and common elements, such as energy and its various forms, are the foundation for the systematisation of physics" (p. 117).

This means that Mach accepts Hume's subjective theory of causality and interprets it in an objectivist sense! Rey is shirking the issue when he defends Mach by referring to his inconsistency, and by maintaining that in the "real" interpretation of experience the latter leads to "necessity." Now, experience is what is given to us from without; and if the necessity of nature and its laws are also given to man from without, from an objectively real nature, then, of course, all difference between Machism and materialism vanishes. Rey defends Machism against the charge of "neo-mechanism" by capitulating to the latter all along the line, retaining the word phenomenism but not the essence of that trend.

Poincaré, for instance, fully in the spirit of Mach, derives the laws of nature -- including even the tri-dimensionality of space -- from "convenience." But this does not at

all mean "arbitrary," Rey hastens to "correct." Oh no, "convenient" here expresses "adaptation to the object" (Rey's italics, p. 196). What a superb differentiation between the two schools and what a superb "refutation" of materialism! "If Poin-

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caré's theory is logically separated by an impassable gulf from the ontological interpretation of the mechanist school [i.e., from the latter's acceptance of theory as a copy of the object] ... if Poincaré's theory lends itself to the support of philosophical idealism, in the scientific sphere, at least, it agrees very well with the general evolution of the ideas of classical physics and the tendency to regard physics as objective knowledge, as objective as experience, that is, as the sensations from which experience proceeds" (p. 200).

On the one hand, we cannot but admit; on the other hand, it must be confessed. On the one hand, an impassable gulf divides Poincaré from neo-mechanism, although Poincaré stands in between Mach's "conceptualism" and neo-mechanism, while Mach, it would appear, is not separated by any gulf from neo-mechanism; on the other hand, Poincaré is quite compatible with classical physics which, according to Rey himself, completely accepts the standpoint of "mechanism." On the one hand, Poincaré's theory lends itself to the support of philosophical idealism; on the other hand, it is compatible with the objective interpretation of the word experience. On the one hand, these bad fideists have distorted the meaning of the word experience by imperceptible deviations, by departing from the correct view that "experience is the object"; on the other hand, the objectivity of experience means only that experience is sensation ... with which both Berkeley and Fichte agree!

Rey got himself muddled because he had set himself the impossible task of "reconciling" the opposition between the materialist and the idealist schools in the new

physics. He seeks to tone down the materialism of the neo-mechanist school, attributing to phenomenalism the views of physicists

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who regard their theory as a copy of the object.¹⁵ And he seeks to tone down the idealism of the conceptualist school by pruning away the more emphatic declarations of its adherents and interpreting the rest in the spirit of shamefaced materialism. How far-fetched and fictitious is Rey's disavowal of materialism is shown, for example, by his opinion of the theoretical sig-

¹⁵ The "conciliator," A. Rey, not only cast a veil over the formulation of the question at issue as made by philosophical materialism but also ignored the most clearly expressed materialistic declarations of the French physicists. He did not mention, for example, Alfred Cornu, who died in 1902. That physicist met the Ostwaldian "destruction [or conquest, Ueberwindung] of scientific materialism" with a contemptuous remark regarding pretentious journalistic treatment of the question (see *Revue generale des sciences*, 1895, pp. 1030-31). At the international congress of physicists held in Paris in 1900, Cornu said: "... The deeper we [cont. onto p. 359. -- DJR] penetrate into the knowledge of natural phenomena, the more does the bold Cartesian conception of the mechanism of the universe unfold and define itself, namely, that in the physical world there is nothing save matter and motion. The problem of the unity of physical forces ... has again come to the fore after the great discoveries which marked the end of this century. Also the constant concern of our modern leaders, Faraday, Maxwell, Hertz (to mention only the illustrious dead), was to define nature more accurately and to unravel the properties of this elusive matter (*matiere subtile*), the receptacle of world energy.... The rever-

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sion to Cartesian ideas is obvious...." (*Rapports presentes au congres international de physique* [Reports Made at the International Physics Congress], Paris, 1900, t. 4-me, p. 7.) Lucien Poincaré, in his book *Modern Physics*, justly remarks that this Cartesian idea was taken up and developed by the Encyclopaedists of the eighteenth century (*La physique moderne*, Paris, 1906, p. 14). But neither this physicist nor A. Cornu knew that the dialectical materialists Marx and Engels had freed this fundamental premise of materialism from the one-sidedness of mechanistic materialism.

nificance of the differential equations of Maxwell and Hertz. In the opinion of the Machians, the fact that these physicists limit their theory to a system of equations refutes materialism: there are equations and nothing else -- no matter, no objective reality, only symbols. Boltzmann refutes this view, fully aware that he is refuting phenomenalist physics. Rey refutes this view thinking he is defending phenomenalism! He says: "We could not refuse to class Maxwell and Hertz among the 'mechanists' because they limited themselves to equations similar to the differential equations of Lagrange's dynamics. This does not mean that in the opinion of Maxwell and Hertz we shall be unable to build a mechanical theory of electricity out of real elements. Quite the contrary, the fact that we represent electrical phenomena in a theory the form of which is identical with the general form of classical mechanics is proof of the possibility ... " (p. 253). The indefiniteness of the present

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solution of the problem "will diminish in proportion as the nature of the quantities, i.e., elements, that figure in the equations are more precisely determined." The fact that one or another form of material motion has not yet been investigated is not regarded by Rey as a reason for denying the materiality of motion. "The homogeneity of matter" (p. 262), not as a postulate, but as a result of experience and of the development of science, "the homogeneity of the object of physics" -- this is the condition that makes the application of measurement and mathematical calculations possible.

Here is Rey's estimate of the criterion of practice in the theory of knowledge: "Contrary to the propositions of scepticism, it seems legitimate to say that the practical value of science is derived from its theoretical value" (p. 368). Rey prefers not to speak of the fact that these propositions of scepticism are unequivocally accepted by Mach, Poincaré and their entire school.

"They [the practical value and theoretical value of science] are the two inseparable and strictly parallel aspects of its objective value. To say that a law of nature has practical value ... is fundamentally the same as saying that this law of nature has objectivity. To act on the object implies to modify the object; it implies a reaction on the part of the object that conforms to the expectation or anticipation contained in the proposition in virtue of which

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we acted on the object. Hence, this expectation or anticipation contains elements controlled by the object and by the action it

7. A RUSSIAN "IDEALIST PHYSICIST"

Owing to certain unfortunate conditions under which I am obliged to work, I have been almost entirely unable to acquaint myself with the Russian literature of the subject under discussion. I shall confine myself to an exposition of an article that has an important bearing on my theme written by our notorious arch-reactionary philosopher, Mr. Lopatin. The article appeared in the September-October

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issue of *Problems of Philosophy and Psychology*, [113] 1907, and is entitled "An Idealist Physicist." A "true-Russian" philosophical idealist, Mr. Lopatin bears the same relation to the contemporary European idealists as, for example, the "Union of the Russian People" does to the reactionary parties of the West. All the more instructive is it, therefore, to see how similar philosophical trends manifest themselves in totally different cultural and social surroundings. Mr. Lopatin's article is, as the French say, an *éloge* -- a eulogy -- of the Russian physicist, the late N. I. Shishkin (died 1906). Mr. Lopatin was fascinated by the fact that this cultured man, who was much interested in Hertz and the new physics generally, was not only a Right-

undergoes.... In these diverse theories there is thus a part of objectivity" (p. 368). This is a thoroughly materialist, and only materialist, theory of knowledge, for other points of view, and Machism in particular, deny that the criterion of practice has objective significance, i.e., significance that does not depend upon man and mankind.

To sum up, Rey approached the question from an angle entirely different from that of Ward, Cohen, and Co., but he arrived at the same result, namely, the recognition that the materialist and idealist trends form the basis of the division between the two principal schools in modern physics.

Wing Constitutional Democrat (p. 339) but a deeply religious man, a devotee of the philosophy of Vladimir Solovyov, and so on and so forth. However, in spite of the fact that his main line of "endeavour" lies in the borderland between philosophy and the police department, Mr. Lopatin has also furnished certain material for a characterisation of the epistemological views of this idealist physicist. Mr. Lopatin writes: "He was a genuine positivist in his tireless endeavour to give the broadest possible criticism of the methods of investigation, suppositions and facts of science from the standpoint of their suitability as means and material for the construction of an integral and perfected world outlook. In this respect N. I. Shishkin was the very antipode of many of his contemporaries. In previous articles of mine in this periodical, I have frequently endeavoured to explain the heterogeneous and often shaky materials from which the so-called scientific world outlook is made up. They include established facts, more or less bold generalisations, hypotheses that are convenient at the given moment for one or another field of

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science, and even auxiliary scientific fictions. And all this is elevated to the dignity of incontrovertible objective truths, from the standpoint of which all other ideas and all other beliefs of a philosophical and religious nature must be judged, and everything in them that is not indicated in these truths must be rejected. Our highly talented natural scientist and thinker, Professor V. I. Vernadsky, has shown with exemplary clarity how shallow and unfounded are these claims to convert the scientific views of a given historical period into an immobile, dogmatic system obligatory for all. And it is not only the broad reading public that is guilty of making such a conversion [footnote by Mr. Lopatin : "For the broad public a number of popular books have been written, the purpose of which is to foster the conviction that there exists such a scientific catechism providing an answer to all questions. Typical works of this kind are Buchner's *Force and Matter* and Haeckel's *The Riddle of the Universe*"] and not only individual scientists in particular branches of science; what is even more strange is that this sin is frequently committed by the official philosophers, all of whose efforts are at times directed only to proving that they are saying nothing but what has been said before them by representatives of the several sciences, and that they are only saying it in their own language.

"N. I. Shishkin had no trace of prejudiced dogmatism. He was a convinced champion of the mechanical explanation of the phenomena of nature, but for him it was only a method of investigation ..." (p. 341). So, so ... a familiar refrain! "He was far from believing that the mechanical theory reveals the true nature of the phenomena investigated; he regarded it only as the most convenient and fertile method of unifying and explaining them for the purposes

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of science. For him, therefore, the mechanical conception of nature and the ma-

terialist view of nature by no means coincide." Exactly as in the case of the authors of the Studies "in" the Philosophy of Marxism! "Quite the contrary, it seemed to him that in questions of a higher order, the mechanical theory ought to take a very critical, even a conciliatory attitude."

In the language of the Machians this is called "overcoming the obsolete, narrow and one-sided" opposition between materialism and idealism. "Questions of the first beginning and ultimate end of things, of the inner nature of our mind, of freedom of the will, the immortality of the soul and so forth, cannot in their full breadth of meaning come within its scope -- since as a method of investigation it is confined within the natural limits of its applicability solely to the facts of physical experience" (p. 342). The last two lines are an undoubted plagiarism from A. Bogdanov's *Empirio-momsm*.

"Light can be regarded" -- wrote Shishkin in his article "Psycho-Physical Phenomena from the Standpoint of the Mechanical Theory" (*Problems of Philosophy and Psychology*, Bk. 1, p. 127) -- "as substance, as motion, as electricity, as sensation."

There is no doubt that Mr. Lopatin is absolutely right in ranking Shishkin among the positivists and that this physicist belonged body and soul to the Machian school of the new physics. In his statement on light, Shishkin means to say that the various methods of regarding light are various methods of "organising experience" (in A. Bogdanov's terminology), all equally legitimate from different points of view, or that they are various "connections of elements" (in Mach's terminology), and that, in any case, the physicists'

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theory of light is not a copy of objective reality. But Shishkin argues very badly. "Light can be regarded as substance, as motion..." he says. But in nature there is neither substance without motion nor motion without substance. Shishkin's first "apposi-

tion" is meaningless.... "As electricity...." Electricity is a movement of substance, hence Shishkin is wrong here too. The electromagnetic theory of light has shown that light and electricity are forms of motion of one and the same substance (ether). "As sensation...." Sensation is an image of matter in motion. Save through sensations, we can know nothing either of the forms of substance or of the forms of motion; sensations are evoked by the action of matter in motion upon our sense-organs. That is how science views it. The sensation of red reflects ether vibrations of a frequency of

approximately 450 trillions per second. The sensation of blue reflects ether vibrations of a frequency of approximately 620 trillions per second. The vibrations of the ether exist independently of our sensations of light. Our sensations of light depend on the action of the vibrations of the ether on the human organ of vision. Our sensations reflect objective reality, i.e., some thing that exists independently of humanity and of human sensations. That is how science views it. Shishkin's argument against materialism is the cheapest kind of sophistry.

8. THE ESSENCE AND SIGNIFICANCE OF "PHYSICAL" IDEALISM

We have seen that the question of the epistemological deductions that can be drawn from the new physics has been raised and is being discussed from the most varied

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points of view in English, German and French literature. There can be no doubt that we have before us a certain international ideological current, which is not dependent upon any one philosophical system, but which is the result of certain general causes lying outside the sphere of philosophy. The foregoing review of the facts undoubtedly shows that Machism is "connected" with the new physics, but at the same time reveals that the version of this connection spread by our Machians is fundamentally incorrect. As in philosophy, so in physics, our Machians slavishly follow the fashion, and are unable from their own, Marxist, standpoint to give a general survey of particular currents and to judge the place they occupy.

A double falsity pervades all the talk about Mach's philosophy being "the philosophy of twentieth-century natural science," "the recent philosophy of the sciences," "recent natural-scientific positivism" and so forth. (Bogdanov in the introduction to *Analysis of Sensations*, pp. iv,

xii; cf. also Yushkevich, Valentinov and Co.) Firstly, Machism is ideologically connected with only one school in one branch of modern science. Secondly, and this is the main point, what in Machism is connected with this school is not what distinguishes it from all other trends and systems of idealist philosophy, but what it has in common with philosophical idealism in general. It suffices to cast a glance at the ideological current in question as a whole in order to leave no shadow of doubt as to the truth of this statement. Take the physicists of this school: the German Mach, the Frenchman Henri Poincaré, the Belgian P. Duhem, the Englishman Karl Pearson. They have much in common: they have the same basis and are following the same direction, as each of them rightly acknowledges. But what they have in com-

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mon includes neither the doctrine of empirio-criticism in general, nor Mach's doctrine, say, of the "world-elements" in particular. The three latter physicists even know nothing of either of these doctrines. They have "only" one thing in common -- philosophical idealism, towards which they all, without exception, tend more or less consciously, more or less decisively. Take the philosophers who base themselves on

this school of the new physics, who try to ground it epistemologically and to develop it, and you will again find the German immanentists, the disciples of Mach, the French neo-critics and idealists, the English spiritualists, the Russian Lopatin and, in addition, the one and only empirio-
monist, A. Bogdanov. They all have only one thing in common, namely, that they all -- more or less consciously, more or less decisively, either with an abrupt and precipitate slant towards fideism, or with a personal aversion to it (as in Bogdanov's case) -- are vehicles of philosophical idealism.

The fundamental idea of the school of the new physics under discussion is the denial of the objective reality given us in our sensation and reflected in our theories, of the doubt as to the existence of such a reality. Here this school departs from materialism (inaccurately called realism, neo-mechanism, hylo-kinetism, and not in any appreciable degree consciously developed by the physicists), which by general acknowledgment prevails among the physicists -- and departs from it as a school of "physical" idealism.

To explain this last term, which sounds very strange, it is necessary to recall an episode in the history of modern philosophy and modern science. In 1866 L. Feuerbach attacked Johannes Muller, the famous founder of modern physiology, and ranked him with the "physiological idealists" (*Werke*, Vol. X, p. 197). The idealism of this physiolog-

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ist consisted in the fact that when investigating the significance of the mechanism of our sense-organs in relation to sensations, showing, for instance, that the sensation of light is produced as the result of the action of various stimuli on the eye, he was inclined to arrive from this at a denial that our sensations are images of objective reality. This tendency of one school of scientists towards "physiological idealism," i.e., to-

wards an idealist interpretation of certain data of physiology, was very accurately discerned by L. Feuerbach. The "connection" between physiology and philosophical idealism, chiefly of the Kantian kind, was for a long time after that exploited by reactionary philosophy. F. A. Lange made great play of physiology in support of Kantian idealism and in refutation of materialism; while among the immanentists (whom Bogdanov so incorrectly places midway between Mach and Kant), J. Rehmke in 1882 specially campaigned against the allegation that Kantianism was confirmed by physiology.¹⁶ That a number of eminent physiologists at that time gravitated towards idealism and Kantianism is as indisputable as that today a number of eminent physicists gravitate towards philosophical idealism. "Physical" idealism, i.e., the idealism of a certain school of physicists at the end of the nineteenth century and the beginning of the twentieth century, no more "refutes" materialism, no more establishes the connection between idealism (or empirio-criticism) and natural science, than did the similar efforts of F. A. Lange and the "physiological" idealists. The deviation towards reactionary philosophy manifested in both cases by one school of scientists in one branch

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of science is a temporary deflection, a transitory period of sickness in the history of science, an ailment of growth, mainly brought on by the abrupt breakdown of old established concepts.

The connection between modern "physical" idealism and the crisis of modern physics is, as we have already pointed out, generally acknowledged. "The arguments of sceptical criticism levelled against modern physics" -- writes A. Rey, who is referring not so much to the sceptics as to the

¹⁶ Johannes Rehmke, *Philosophie und Kantianismus* [Philosophy and Kantianism], Eisenach, 1882, S. 15, et seq.

outspoken adherents of fideism, like Brunetiere -- "essentially amount to the proverbial argument of all sceptics: a diversity of opinions" (among the physicists). But this diversity "proves nothing against the objectivity of physics." "In the history of physics, as in history generally, one can distinguish great periods which differ by the form and general aspect of theories.... But as soon as a discovery is made that affects all fields of physics because it establishes some cardinal fact hitherto badly or very partially perceived, the entire aspect of physics is modified; a new period sets in. This is what occurred after Newton's discoveries, and after the discoveries of Joule-Mayer and Carnot-Clausius. The same thing, apparently, is taking place since the discovery of radioactivity.... The historian who later sees things from the necessary distance has no trouble in discerning a steady evolution where contemporaries saw conflicts, contradictions, and divisions into various schools. Apparently, the crisis which physics has undergone in recent years (despite the conclusions drawn from it by philosophical criticism) is no different. It even excellently illustrates the typical crisis of growth (*crise de croissance*) occasioned by the great modern discoveries. The undeniable transformation of physics which will result (could there be evolution or

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progress without it?) will not perceptibly alter the scientific spirit" (*op. cit.*, pp. 370-72).

Rey the conciliator tries to unite all schools of modern physics against fideism. This is a falsity, well meant, but a falsity nevertheless; for the trend of the school of Mach-Poincaré-Pearson towards idealism (i.e., refined fideism) is beyond dispute. And the objectivity of physics that is associated with the basis of the "scientific spirit," as distinct from the fideist spirit, and that Rey defends so ardently, is nothing but a "shamefaced" formulation of material-

ism. The basic materialist spirit of physics, as of all modern science, will overcome all crises, but only by the indispensable replacement of metaphysical materialism by dialectical materialism.

Rey the conciliator very often tries to gloss over the fact that the crisis in modern physics consists in the latter's deviation from a direct, resolute and irrevocable recognition of the objective value of its theories. But facts are stronger than all attempts at reconciliation. The mathematicians, writes Rey, "in dealing with a science, the subject matter of which, apparently at least, is created by the mind of the scientist, and in which, at any rate, concrete phenomena are not involved in the investigation, have formed too abstract a conception of the science of physics. Attempts have been made to bring it ever closer to mathematics, and the general conception of mathematics has been transferred to the conception of physics.... This is an invasion of the mathematical spirit into the methods of judging and understanding physics that is denounced by all the experimenters. And is it not to this influence, none the less powerful because at times concealed, that are often due the uncertainty, the wavering of mind regarding the objectivity of physics, and

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the detours made or the obstacles surmounted in order to demonstrate it? ..." (p. 227).

This is excellently said. "Wavering of mind" as to the objectivity of physics -- this is the very essence of fashionable "physical" idealism.

"... The abstract fictions of mathematics seem to have interposed a screen between physical reality and the manner in which the mathematicians understand the science of this reality. They vaguely feel the objectivity of physics.... Although they desire above all to be objective when they engage in physics; although they seek to find and retain a foothold in reality, they are

still haunted by old habits. So that even in the concepts of energetics, which had to be built more solidly and with fewer hypotheses than the old mechanism -- which sought to copy (decalquer) the sensible universe and not to reconstruct it -- we are still dealing with the theories of the mathematicians.... They [the mathematicians] have done everything to save objectivity, for they are aware that without objectivity there can be no physics.... But the complexity or deviousness of their theories nevertheless leaves an uneasy feeling. It is too artificial, too far-fetched, too stilted (édifié); the experimenter here does not feel the spontaneous confidence which constant contact with physical reality gives him.... This in effect is what is said by all physicists who are primarily physicists or who are exclusively physicists -- and their name is legion; this is what is said by the entire neo-mechanist school.... The crisis in physics lies in the conquest of the realm of physics by the mathematical spirit. The progress of physics on the one hand, and the progress of mathematics on the other, led in the nineteenth century to a close amalgamation between these two sciences.... Theoretical

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physics has become mathematical physics.... Then there began the formal period, that is to say, the period of mathematical physics, purely mathematical; mathematical physics not as a branch of physics so to speak, but as a branch of mathematics cultivated by the mathematicians. Along this new line the mathematician, accustomed to conceptual (purely logical) elements, which furnish the sole subject matter of his work, and feeling himself cramped by crude, material elements, which he found insufficiently pliable, necessarily always tended to reduce them to abstractions as far as possible, to present them in an entirely non-material and conceptual manner, or even to ignore them altogether. The elements, as real, objective

data, as physical elements, so to speak, completely disappeared. There remained only formal relations represented by the differential equations.... If the mathematician is not the dupe of his constructive work, when he analyses theoretical physics ... he can recover its ties with experience and its objective value, but at a first glance, and to the uninitiated person, we seem faced with an arbitrary development.... The concept, the notion, has everywhere replaced the real element.... Thus, historically, by virtue of the mathematical form assumed by theoretical physics, is explained ... the ailment (le malaise), the crisis of physics, and its apparent withdrawal from objective facts" (pp. 228-32).

Such is the first cause of "physical" idealism. The reactionary attempts are engendered by the very progress of science. The great successes achieved by natural science, the approach to elements of matter so homogeneous and simple that their laws of motion can be treated mathematically, encouraged the mathematicians to overlook matter. "Matter disappears," only equations remain. In the new stage of

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development and apparently in a new manner, we get the old Kantian idea: reason prescribes laws to nature. Hermann Cohen, who, as we have seen, rejoices over the idealist spirit of the new physics, goes so far as to advocate the introduction of higher mathematics in the schools -- in order to imbue high-school students with the spirit of idealism, which is being extinguished in our materialistic age (F. A. Lange, *Geschichte des Materialismus*, 5. Auflage, 1896, Bd. II, S. xlix). This, of course, is the ridiculous dream of a reactionary and, in fact, there is and can be nothing here but a temporary infatuation with idealism on the part of a small number of specialists. But what is highly characteristic is the way the drowning man clutches at a straw, the subtle means whereby representatives of the educated bourgeoisie

artificially attempt to preserve, or to find a place for, the fideism which is engendered among the masses of the people by their ignorance and their downtrodden condition, and by the wild absurdities of capitalist contradictions.

Another cause which bred "physical" idealism is the principle of relativism, the relativity of our knowledge, a principle which, in a period of breakdown of the old theories, is taking a firm hold upon the physicists, and which, if the latter are ignorant of dialectics, is bound to lead to idealism.

The question of the relation between relativism and dialectics plays perhaps the most important part in explaining the theoretical misadventures of Machism. Take Rey, for instance, who like all European positivists has no conception whatever of Marxist dialectics. He employs the word dialectics exclusively in the sense of idealist philosophical speculation. As a result, although he feels that the new physics has gone astray on the question of relativism, he nevertheless flounders helplessly and attempts to differentiate

between moderate and immoderate relativism. Of course, "immoderate relativism logically, if not in practice, borders on actual scepticism" (p. 215), but there is no "immoderate" relativism, you see, in Poincaré. Just fancy, one can, like an apothecary, weigh out a little more or a little less relativism and thus save Machism!

As a matter of fact, the only theoretically correct formulation of the question of relativism is given in the dialectical materialism of Marx and Engels, and ignorance of it is bound to lead from relativism to philosophical idealism. Incidentally, the failure to understand this fact is enough to render Mr. Berman's absurd book, *Dialectics in the Light of the Modern Theory of Knowledge*, utterly valueless. Mr. Berman repeats the old, old nonsense about dialectics, which he has entirely failed to under-

stand. We have already seen that in the theory of knowledge all the Machians, at every step, reveal a similar lack of understanding.

All the old truths of physics, including those which were regarded as firmly established and incontestable, have proven to be relative truths -- hence, there can be no objective truth independent of mankind. Such is the argument not only of all the Machians, but of the "physical" idealists in general. That absolute truth results from the sum-total of relative truths in the course of their development; that relative truths represent relatively faithful reflections of an object existing independently of man; that these reflections become more and more faithful; that every scientific truth, notwithstanding its relative nature, contains an element of absolute truth -- all these propositions, which are obvious to anyone who has thought over Engels' *Anti-Duhring*, are for the "modern" theory of knowledge a book with seven seals.

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Such works as Duhem's *Theory of Physics*,¹⁷ or Stallo's,¹⁸ which Mach particularly recommends, show very clearly that these "physical" idealists attach the most significance to the proof of the relativity of our knowledge, and that they are in reality vacillating between idealism and dialectical materialism. Both authors, who belong to different periods, and who approach the question from different angles (Duhem's speciality is physics, in which field he has worked for twenty years; Stallo was an erstwhile orthodox Hegelian who grew ashamed of his own book on natural philosophy, written in 1848 in the old Hegelian spirit), energetically combat the atomistic-mechanical conception of nature. They

¹⁷ P. Duhem, *La theorie physique, son objet et sa structure*, Paris, 1906.

¹⁸ J. B. Stallo. *The Concepts and Theories of Modern Physics*, London, 1882, There are French and German translations.

point to the narrowness of this conception, to the impossibility of accepting it as the limit of our knowledge, to the petrification of many of the ideas of writers who hold this conception. And it is indeed undeniable that the old materialism did suffer from such a defect; Engels reproached the earlier materialists for their failure to appreciate the relativity of all scientific theories, for their ignorance of dialectics and for their exaggeration of the mechanical point of view. But Engels (unlike Stallo) was able to discard Hegelian idealism and to grasp the great and true kernel of Hegelian dialectics. Engels rejected the old metaphysical materialism for dialectical materialism, and not for relativism that sinks into subjectivism. "The mechanical theory," says Stallo, for instance, "in common with all metaphysical theories, hypostases partial, ideal, and, it may be, purely conventional groups of attributes, or single attributes, and

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treats them as varieties of objective reality" (p. 150). This is quite true, if you do not deny objective reality and combat metaphysics for being anti-dialectical. Stallo does not realise this clearly. He has not understood materialist dialectics and therefore frequently slips, by way of relativism, into subjectivism and idealism.

The same is true of Duhem. With an enormous expenditure of labour, and with the help of a number of interesting and valuable examples from the history of physics, such as one frequently encounters in Mach, he shows that "every law of physics is provisional and relative, because it is approximate" (p. 280). The man is hammering at an open door! -- will be the thought of the Marxist when he reads the lengthy disquisitions on this subject. But that is just the trouble with Duhem, Stallo, Mach and Poincaré, that they do not perceive the door opened by dialectical materialism. Being unable to give a correct formulation of relativism, they slide from the latter into idealism. "A law of physics,

properly speaking, is neither true nor false, but approximate" -- writes Duhem (p. 274). And this "but" contains the beginning of the falsity, the beginning of the obliteration of the boundary between a scientific theory that approximately reflects the object, i.e., approaches objective truth, and an arbitrary, fantastic, or purely conventional theory, such as, for example, a religious theory or the theory of the game of chess.

Duhem carries this falsity to the point of declaring that the question whether "material reality" corresponds to perceptual phenomena is metaphysics (p. 10). Away with the question of reality! Our concepts and hypotheses are mere signs (p. 26), "arbitrary" (p. 27) constructions, and so forth. There is only one step from this to idealism, to the "physics

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of the believer," which M. Pierre Duhem preaches in the Kantian spirit (Rey, p. 162; cf., p. 160). But the good Adler (Fritz) -- also a Machian would-be Marxist! -- could find nothing cleverer to do than to "correct" Duhem as follows: Duhem, he claims, eliminates the "realities concealed behind phenomena only as objects of theory, but not as objects of reality."¹⁹ This is the familiar criticism of Kantianism from the standpoint of Hume and Berkeley.

But, of course, there can be no question of any conscious Kantianism on the part of Duhem. He is merely vacillating as is Mach, not knowing on what to base his relativism. In many passages he comes very close to dialectical materialism. He says that we know sound "such as it is in relation to us but not as it is in itself, in the sound-producing bodies. This reality, of which our sensations give us only the external and the veil, is made known to us by the theories of acoustics. They tell us that where our perceptions register only this appearance which we call sound, there

¹⁹ Translator's note to the German translation of Duhem, Leipzig, 1908, J. Barth.

really exists a very small and very rapid periodic movement," etc. (p. 7). Bodies are not symbols of sensations, but sensations are symbols (or rather, images) of bodies. "The development of physics gives rise to a constant struggle between nature, which does not tire of offering new material, and reason, which does not tire of cognising" (p. 32). Nature is infinite, just as its smallest particle (including the electron) is infinite, but reason just as infinitely transforms "things-in-themselves" into "things-for-us." "Thus, the struggle between reality and the laws of physics will continue indefinitely; to every law that physics may formulate, reality will

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sooner or later oppose a rude refutation in the form of a fact; but, indefatigable, physics will improve, modify, and complicate the refuted law" (p. 290). This would be a quite correct exposition of dialectical materialism if the author firmly held to the existence of this objective reality independent of humanity. "... The theory of physics is not a purely artificial system which is convenient today and unsuitable tomorrow ... it is a classification, which becomes more and more natural, a reflection, which grows clearer and clearer, of the realities that the experimental method cannot contemplate face to face" (p. 445).

In this last phrase the Machian Duhem flirts with Kantian idealism: it is as if the way is being opened for a method other than the "experimental" one, and as if we cannot know the "things-in-themselves" directly, immediately, face to face. But if the theory of physics becomes more and more natural, that means that "nature," reality, "reflected" by this theory, exists independently of our consciousness -- and that is precisely the view of dialectical materialism.

In a word, the "physical" idealism of today, just as the "physiological" idealism of yesterday, merely means that one school of natural scientists in one branch of natu-

ral science has slid into a reactionary philosophy, being unable to rise directly and at once from metaphysical materialism to dialectical materialism.²⁰ This step is being made, and will

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be made, by modern physics; but it is making for the only true method and the only true philosophy of natural science not directly, but by zigzags, not consciously but instinctively, not clearly perceiving its "final goal," but drawing closer to it gropingly, hesitatingly, and sometimes even with its back turned to it. Modern physics is in tra-

²⁰ The famous chemist, William Ramsay, says: "I have been frequently asked: 'But is not electricity a vibration? How can wireless telegraphy be explained by the passage of little particles or corpuscles?' The answer is: 'Electricity is a thing ; it is (Ramsay's italics) these minute corpuscles, but when they leave an object, a wave, like a wave of light, spreads through the ether, and this wave is used for wireless telegraphy'"

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(William Ramsay, *Essays, Biographical and Chemical*, London, 1908, p. 126). Having spoken about the transformation of radium into helium, Ramsay remarks: "At least one so-called element can no longer be regarded as ultimate matter, but is itself undergoing change into a simpler form of matter" (p. 160). "Now it is almost certain that negative electricity is a particular form of matter; and positive electricity is matter deprived of negative electricity -- that is, minus this electric matter" (p. 176). "Now what is electricity? It used to be believed, formerly, that there were two kinds of electricity, one called positive and the other negative. At that time it would not have been possible to answer the question. But recent researches make it probable that what used to be called negative electricity is really a substance. Indeed, the relative weight of its particles has been measured; each is about one seven hundredth of the mass of an atom of hydrogen.... Atoms of electricity are named 'electrons' " (p. 196). If our Machians who write books and articles on philosophical subjects were capable of thinking, they would understand that the expression "matter disappears," "matter is reduced to electricity," etc., is only an epistemologically helpless expression of the truth that science is able to discover new forms of matter, new forms of material motion, to reduce the old forms to the new forms, and so on.

vail; it is giving birth to dialectical materialism. The process of child-birth is painful. And in addition to a living healthy being, there are bound to be produced certain dead products, refuse fit only for the gar-

bage-heap. And the entire school of physical idealism, the entire empirio-critical philosophy, together with empirio-symbolism, empirio-monism, and so on, and so forth, must be regarded as such refuse!