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PHILOSOPHICAL CONCEPTS IN NATURAL SCIENCE

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PHILOSOPHICAL CONCEPTS IN NATURAL SCIENCE

S. Harrison

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CONTENTS

INTRODUCTION

The rapid progress of science which is steadily broadening and deepening our knowledge of nature, the limits of man's power over it, is exerting an ever stronger influence on the intellectual life of contemporary society. The many achievements of science, the revolutionary changes in its leading areas, the fundamental problems still awaiting their solution—all are the focus of a battle of opposing philosophical ideas and trends.

Researches into the methodological and ideological problems of modern science from the positions of Marxist-Leninist philosophy have made considerable headway in the USSR, especially in the last 15-20 years. The most characteristic feature of these researches is the consolidation and further development of the alliance, the importance of which was repeatedly stressed by Lenin, of Marxist philosophers and natural scientists. The interaction between the social, natural and technical sciences, the importance of which was stressed once again by the 25th Congress of the CPSU, is increasing. The resultant researches are a major contribution to the elaboration of Marxist-Leninist philosophy, to the offensive against bourgeois and revisionist concepts.

The present collection, devoted to an examination of some basic problems of the battle of ideas in the modern natural sciences, is based on the materials of the scientific conference held in Moscow in May 1975. In it are analysed the general principles of the Leninist approach to comprehending the latest achievements of science and the ways of applying these principles to the solution of the philosophical problems of the natural sciences. Eminent Soviet scientists and philosophers are among the collection's authors.

LENIN'S IDEAS IN THE STRUGGLE AGAINST ANTI-MATERIALIST VIEWS IN MODERN NATURAL SCIENCE

Academician Pyotr FEDOSEYEV

The rapid progress of natural science in the modern epoch has given rise to new methodological and ideological questions in this sphere, and these are now the subject of a most acute struggle between two opposite philosophical trends. The sharp break-up of natural scientific conceptions has ever more clearly demonstrated the dialectical character of the development of knowledge. Dialectical materialism, as Lenin demonstrated at the turn of the century, is the only method and ideology which is adequate to the natural science of our day and which is capable of correctly solving the philosophical problems it has raised. Present-day progress in the natural sciences has been providing fresh and convincing confirmation of this fundamental conclusion.

However, bourgeois philosophers have sought to interpret the development of 20th-century natural science in the light of the various idealistic trends. "The reactionary attempts are engendered by the very progress of science",[1] wrote Lenin when considering the complex and contradictory development of knowledge and the possibility of departures by natural scientists from materialism in consequence of the incorrect interpretation of scientific successes modifying their conceptions of the structure and forms of the motion of matter.

It is important to see and understand these contradictions in the development of scientific knowledge. Lenin wrote: "Modern physics... is advancing towards 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, unsteadily, and sometimes even with its back turned to it. Modern physics is in travail; 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 garbage 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."[2] The class interests of reactionary social groups fuel and entrench these reactionary impulses in natural science.

During the First World War, Lenin characterised imperialism as a swing towards reaction in every sphere of social life, and this swing necessarily affected natural science as well. In the course of the revolutionary changes in science since the early 20th century up until the present-day scientific and technological revolution, a great many diverse idealistic conceptions have been propounded both on general and on concrete problems in natural science. A large part of them is now dead and has been forgotten. The same is in store for any refurbished versions of such conceptions, because they are all irreconcilably antithetical with the actual content of modern science.

Today, decades later, the profound philosophical ideas which Lenin expressed in his analysis of the "latest revolution in natural science" have not been outdated. On the contrary, as natural science advances they tend to reveal ever new facets of their fertility.

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Let us consider some of the general principles underlying the approach to the philosophical interpretation of the latest achievements in natural science and the application of these principles to the solution of philosophical problems in natural science which are now the subject of the most acute ideological struggle. What are these principles?

First, the Leninist analysis of philosophical problems in natural science is closely bound up with the elaboration of materialist dialectics as a science. When advocating an alliance between materialist philosophers and natural scientists in the fight against hostile ideological trends and in the effort to sum up new scientific data in materialistic terms, Lenin urged a comprehensive elaboration of dialectics, without which, he warned, materialism cannot be militant materialism, while natural scientists will be impotent in their philosophical conclusions and generalisations.

These remarks of Lenin's have to be recalled because even today some philosophers are prepared to reduce philosophy to methodological conclusions from the latest data provided by the particular sciences, oblivious of the task of elaborating philosophical science itself. Such philosophers erroneously believed the alliance with natural scientists to imply a dissolution of philosophy in the individual sciences. This is an obvious concession to positivism, and is to the detriment of dialectical materialism. We still take guidance from Lenin's idea that neither natural science nor materialism can maintain its stand in the struggle against the onslaught of bourgeois ideas, without solid philosophical substantiation. There should be no indulgence of the positivists, who seek to demean the role of philosophy.

Second, a keynote of the Leninist analysis of philosophical problems in natural science and critique of idealism is the striking and, I should say, the most careful and exceptionally attentive treatment of the concrete achievements of science. Lenin constantly starts from recognition of the value of new scientific conceptions of his period,

never trying in any way to "adjust" natural science or to tackle concrete natural scientific problems for its benefit (or in place of it). We find him clearly bringing out for discussion philosophical questions and resolutely opposing any obsolete natural philosophic interference in the concrete workings of natural science.

However, that is precisely what is being done by the advocate of neo-Thomism, one of the most reactionary and influential trends in modern bourgeois philosophy, who seek to revive natural philosophy, a stage long since passed and gone. The neo-Thomists, speculating on the discontent of the natural scientists with the short philosophical rations on which the positivists sought to keep them for long years, insist on discussing above all the acute ideological problems, which they naturally interpret in the spirit of Catholic reaction. They seek to prove that natural science is limited, and that it needs to be supplemented with natural philosophy and also with faith and revelation. J.Maritain, one of the most prominent neo-Thomists, says that the concrete sciences call for natural philosophy, while the remarkable progress of modern physics restores the scientists to the mystical sense evoked by the atom and the Universe.[3]

An international collection entitled Integrative Principles of Modern Thought, published in 1972 by Gordon and Breach of New York and edited by Henry Margenau, contains an article in which its author, the well-known neo-Thomist and Sovietologist Siegfried Müller-Markus, even defines the "field of religion", depicting in a multidimensional mathematical space a special "dimension of faith". He operates with geometrical conceptions in a fairly blundering manner so as to create the impression of the scientific approach, and insists on recognition of this "new", religious "dimension" of reality.

We must carry on a resolute struggle against natural philosophical speculations, including neo-Thomist natural philosophy.

Third, a fundamental requirement of the Leninist analysis of natural science is relentless criticism of every form and species of anti-materialist views. Lenin consistently exposed the slightest vacillation towards any of the then "fashionable" trends in idealistic philosophy which some natural scientists of the turn of the century allowed and upon which the idealist philosophers were quick to seize. Lenin's critical analysis of the philosophical views of well-known scientists like Ernst Mach and Henri Poincaré, among others, remains for us a model of the militant Party approach. But there is need to add that Lenin took a totally different approach to the professional philosophers and the natural scientists who made confused (and even downright erroneous) philosophical statements.

It is one thing when an idealist philosopher declares that "matter has disappeared", and something else again when such a statement comes from a physicist. For the idealist philosopher the claim that "matter has disappeared" means a negation of objective reality and establishment of the primacy of the spirit. For the physicist, the same idea amounts to no more than an epistemologically helpless expression of the fact that the limits within which we knew matter until then have disappeared, and that new forms of motion of matter have been discovered. "When physicists say 'matter disappears' they mean that hitherto science reduced its investigations of the physical world to three ultimate concepts: matter, electricity and ether; now only the two latter remain. For it has become possible to reduce matter to electricity... Hence, natural science leads to the 'unity of matter'—such is the real meaning of the statement about the disappearance of matter."[4]

This aspect was most pronounced, for instance, in Lenin's attitude to the great German physicist Heinrich Hertz. In his Mechanics, Hertz formulated a number of philosophical propositions, some of which clearly smacked of idealism. It is not surprising that some idealist philosophers (Hermann Cohen, Hans Kleinpeter) were quick to seize upon these statements. Indeed, some not too thoughtful materialist critics could also have seized upon these statements to put Hertz down in the idealist department (in the past we have had such shortsighted "entries" among the idealists, for instance, of Albert Einstein, Niels Bohr and Norbert Wiener).

That is why, in this context Lenin's evaluation of Hertz is extremely instructive for us all. He wrote: "As a matter of fact, Hertz's philosophical preface to his Mechanics 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".[5]

We find, therefore, that while castigating the idealist philosophers, Lenin did not ignore the idealistic misconceptions of the leading natural scientists, exposed the sources of these gropings, and showed the way to overcome them.

Fourth, a key aspect of Lenin's approach to the critique of idealist speculations on natural science is a profound analysis of the social and epistemological roots of idealism. Every brand of idealism (and that speculating on science, in particular) relies on an inflation and absolutisation of this or that real aspect of our cognition of the external world. That is why idealism cannot be effectively criticised and overcome by simply discarding it, but only by reliance on a dialectico-materialist solution of the problems which idealism treats of in a distorted form. In other words, our critique of idealism always rests on a creative elaboration of scientific philosophy and the solution of the problems which stem from modern natural science, but which the various idealistic trends cannot cope with.

Lenin gave brilliant examples of this kind of approach. His critique of the idealistic conclusions about the "disappearance of matter" went hand in hand with his development of the dialectico-materialist conception of matter, his critique of philosophical relativism, his development of the dialectical conception of truth, and so on. This is the Leninist principle by which Soviet philosophers must be guided in the present-day ideological struggle in natural science. This makes Lenin's analysis of"the latest revolution in natural science" truly modern in our day as well.

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The problem of scientific revolutions should undoubtedly be classed among the key problems in the philosophy of science, which have aroused acute struggle between Marxist-Leninist philosophy and various non-Marxist trends. Let us recall that starting from the general dialectical conception of development Engels, and Lenin, in particular, worked out a consistent Marxist conception of scientific revolutions. Relying on the works of the Marxist-Leninist classics, Soviet scientists have made considerable advances in elaborating the dialectics of scientific development and analysing various key features of the scientific revolution. In short, the conception of scientific revolution and analysis of its structure is not novel to Marxism. This should be borne in mind when considering the peculiar philosophical "boom" caused over the past few years in the West by Thomas Kuhn's book The Structure of Scientific Revolutions. His ideas have been the subject of heated polemics, whose general course was summed up in a voluminous work published in Cambridge in 1970.[6] These works contain a number of propositions which deserve scrutiny.

First, many of those who took part in the discussion have come out, in one form or another, against the recently dominant positivist views. Dissatisfaction with these views arises from the fact that positivism has ignored the social, psychological and value aspects of science, having subjected it to excessive logisation and, in effect, ignoring the development of knowledge, and analysing merely the established theories. Second, some have also shown a definite gravitation towards some aspects of dialectical thinking.

But while remarking on these facts, one must emphasise that here the well-known aspects of dialectics are quite often given a metaphysical interpretation. Thus, when emphasising a number of socio-psychological factors in scientific development, Kuhn clearly hypertrophies them and arrives at what amounts to a negation of the objective character of scientific knowledge. He denies the existence of reasons rooted in the objective logic of scientific development, for which revolutions and crises appear. He introduces the concept of paradigm as a definite complex of scientific concepts and correctly emphasises the existence of the moment of stability in the development of scientific ideas, but his exaggeration of this, in effect, leads him to deny the innovatory tendency in science. The gist of the matter is that he fails to reckon with the dialectical unity of constancy and change, which is why his succession of paradigms becomes a purely psychological act which does not allow of any rational explanation.

There are many more such examples, and they all suggest the following conclusion: all these scientists lack a knowledge of dialectics, and this leads them to draw idealistic conclusions.

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Let us now consider some aspects of the philosophical struggle of ideas in modern physics. This science still has the key role to play in the progress of the natural sciences today. Physics makes a study of the deepest structures of the material world, and its methods have revolutionising effect on the development of all the other fields of natural science. It is well known that the present-day vast advances in chemistry, biology and astronomy, among other sciences, would have been quite impossible without their use of physical methods of research.

The "frontline" in physical science now runs through the solution of the fundamental problems in elementary-particle physics, where the most profound philosophical questions also arise. Of course, both physicists and philosophers now frequently return to the established and effective physical theories: the theory of relativity and quantum mechanics, but these questions are already being considered in the light of the further development and generalisation of these theories from the standpoint of knowledge in elementary-particle physics. There is a continued lively discussion of problems arising from the analysis of causality, determinism, reality, atomism, and so on, with special emphasis on the analysis of the nature of the new concepts characterised by a high degree of generality and abstractness. In the past few years, this has led some foreign physicists to draw erroneous philosophical conclusions in an effort to revive the Platonic idea of the primacy of mathematical forms.

Lenin believed that one of the epistemological causes of "physical" idealism was the extensive penetration of mathematics into physics and the tendency to regard the growing role of mathematics in absolute terms. Lenin believed that the very approximation of physics to homogeneous and simple elements of matter the laws of whose motion admit of their mathematical treatment, was a major success for natural science. But this led some to forget matter or to substitute mathematical formulas for it. Lenin summed up the substance of the idealistic conclusions from physics as follows: "'Matter disappears', only equations remain."[7] The absolutisation of mathematics and the tendency to forget about matter as the objective reality which Lenin noted is most pronounced, for instance, in one of the works of Werner Heisenberg, a leading physicist of our day. In this work, he resolutely objected to the metaphysical approach to elementary particles in an effort to find some kind of absolutely simple and structureless building bricks of everything that is. He wrote: "The original concept connected with this word <u>elementary particle</u> has completely

disappeared. By dividing matter over and over again we do not end up with some smallest fundamental particles, which cannot be divided any further; we end up instead by recognising that the process of division has lost its meaning. It is replaced by the other process of transmuting energy into matter".[8]

Let us leave aside Heisenberg's unexpected conclusion about the "transmutation of energy into matter", for after all, physics deals with the transmutation of material objects—particles—into each other. But Heisenberg was right in saying that the habitual conception of elementariness (the complex consists of the simple, the elementary) indeed tends to become meaningless. It is impossible to describe the structure of the so-called elementary particles in the everyday language of common sense, because its description requires the abstract language of mathematics. At this point Lenin's exposure of the idealistic conclusion fully applies: matter disappears—only equations remain.

In conclusion Heisenberg insisted: "... One may say that the most recent development of physics has turned from the philosophy of Democritos back to the philosophy of Plato. In fact it was Plato's conviction that when we divide matter over and over again we finally end up not at smallest particles but at mathematical objects defined by their symmetry, the Platonic bodies and the underlying triangles. The particles in present-day physics are mathematical representations of the fundamental symmetries."[9]

Here we witness, in our own day, the transformation of mathematical abstractions into specific ideal substances which determine material objects. Particles become mathematical abstractions which are actually abstract mathematical descriptions of objectively existing particles and their interactions. The inability to ascend from the metaphysical conception of elementary particles to their dialectical conception leads (via the absolutisation of mathematics) to a substitution of mathematical constructions for material formations.

However, the struggle against the absolutisation of mathematics should not in any sense result in a minimisation of the role of mathematics in the development of modern science. Mathematics, in its diverse ramifications, has an important role to play not only as a method for describing phenomena but also as a method for discovering new truths. Marx wrote: " A science is not really developed until it has learned to make use of mathematics".[10]

The development of modern astronomy is also marked by acute struggle between the philosophical trends. Let us consider only one of the most expressive examples, namely, the debate over whether the Universe is finite or infinite in time and space. Let us bear in mind that some models of the Universe put forward by present-day relativistic cosmology suggest that space may be finite and that time has had something like a beginning. Quite naturally such unusual ideas were immediately seized upon by philosophical idealism. The neo-Thomist Gustav Wetter wrote: "The understanding that our world has in fact had a beginning in time springs not only from the recognition of this Christian belief, but also accords even with the present-day state of science and follows directly... not only from Clausius's well-known conclusion about the eventual 'thermal death of the Universe' but also from data provided by modern astronomy."[11]

It would be extremely rash to follow Wetter in equating the "thermal death" idea and the "data provided by modern astronomy", meaning above all the theory of the "expanding Universe". Indeed, this theory claims that our Universe was formed (roughly 15,000-18,000 million years ago) from some superdense state of matter, and allows for models with finite space. The central issue, however, is whether the Universe, as an object of cosmology, can be identified with the integral conception of the whole material world. Alongside the conception that our Universe is unique, the opposite view is being developed in cosmology that it is not the whole material world but only its finite (and limited) area,

our Metagalaxy, that is expanding, for there are probably other similar systems in existence. From this it follows that the Metagalaxy is not the whole of world space, and even if subsequent research shows that the Metagalaxy is finite, this will not at all mean that the space of the whole material world is finite.

Besides, one should take account of the dialectics of the finite and the infinite. Modern research shows that the metric finiteness of space is relative in the sense of being dependent on the frame of reference. Space, which is finite under one frame of reference, turns out to be infinite under another. One should bear in mind that in all such lines of reasoning one has to deal with the space of concrete physical systems.

The whole aggregation of data provided by modern astronomy shows that our Universe (Metagalaxy) originated in the distant past, but in a process that had absolutely nothing in common with an "act of creation". The so-called original state of the Metagalaxy must have originated from some earlier states and forms of matter in motion.

In the light of this, the finiteness of time, as considered in modern cosmology, does not appear to be an absolute either, but implies that natural science is approaching the limits of a definite state of matter, something that indicates the need for radical changes in the concept of time itself.

The question of the so-called inevitable "thermal death of the Universe" is now also quite clear. The application of modern relativity thermodynamics in cosmology shows that there are no bounds to the development of the Universe, and that the state of equilibrium will not be attained even in infinite time. Here again we find the development of a concrete physical system.

The infiniteness of the material world is a question which goes beyond the framework of any concrete physical theory, and has to be dealt with only through philosophical analysis. Discussing the problem of the infiniteness of matter, Lenin saw it above all as one of inexhaustibility. He wrote: "The electron is as <u>inexhaustible</u> as the atom, nature is infinite..."[12]

The inexhaustibility of the material world depends above all on its infinite diversity (including the diversity of its spatio-temporal structures and their properties): it is also connected with the infinite development of human knowledge. Lenin's idea of the inexhaustibility of matter has now been brilliantly confirmed and expressed in concrete terms in all the natural sciences, including cosmology.

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The rapid development of cybernetics and the practical application of its achievements continues to be a subject of acute struggle between the philosophical trends, as more and more idealistic interpretations of its basic conceptions and principles appear. Over the past few years, these have been frequently backed up with attempts to present the methods of cybernetics and the theory of information as a new and universal methodology of science which has allegedly come to substitute philosophy. Thus, the well-known French physicist Léon Brillouin makes an attempt in his book, <u>Scientific Uncertainty and Information</u>, to interpret all the types of uncertainties arising in science within the framework of the theory of information. However, this approach comes out to be too narrow and one-sided, and so incorrect. There is, indeed, a connection between uncertainty and scientific information, but it can be explained only in the light of Lenin's theory of reflection, that is, in the light of philosophy and not of cybernetics or the theory of information.

Idealistic interpretations of the achievements in cybernetics over the past few years have frequently gone hand in hand with attacks on the philosophy of dialectical materialism, with H.Dahm, L.Kerschner, P.Kirschenmann and other

"Sovietologists" being most persistent in this field.

Thus, Kirschenmann claims in one of his books, <u>Cybernetics, Information, Reflection</u>[13], that Lenin's category of reflection as a universal property of matter does not help cybernetics in any way. Actually, however, it is the category of reflection, as a universal property of matter, that has provided the clue to the mysteries of information and helped to solve the methodological problems of cybernetics. Lenin's ideas, further developed by Marxist philosophers, have been expressed in concrete terms in present-day cybernetic theories, which have reached the conclusion that information is objective, and that it is closely bound up with reflection.

At present, biology has been steadily developing as a leading branch of natural science. One need merely consider the cracking of the genetic code, the artificial synthesis of the genes, and the development of the doctrine of the biosphere and its evolution, to realise the broad front of research in which modern biology is engaged. However, one cannot ignore the complicated situation that has taken shape in this science. This essentially revolutionary situation has also been paralleled by some unevenness in the development of various departments of biological knowledge, with success now and again leading to a state of "headiness" and, ultimately, to the development of erroneous conceptions from a methodological summing up of the results.

In this context, Lenin's analysis of the revolution in physics and the attendant crisis phenomena becomes increasingly meaningful. There is, of course, no need to draw a direct analogy between the revolution in physics and the state of affairs in modern biology. The distinction is that due to the extensive spread of the philosophy of dialectical materialism, biology has proved to be much better prepared methodologically and ideologically for the crisis situations which, as a rule, appear in periods of rapid scientific development. That is why there is no evidence now of any clear-cut formulation of "biological idealism" (like the physical idealism of the turn of the century). Still, in biology there has been a break-up of conceptions, and established principles are being reviewed. This process of cognition has its positive and negative aspects. The penetration into biology of the methods and conceptions of the exact sciences constituting the basis of the rapid development of biological knowledge goes to create epistemological premises for all manner of leanings towards idealism and metaphysics. Characteristically, it is molecular-biology data that have chiefly provided the basis for a revival of mechanistic and vitalistic tendencies in the interpretation of the substance and origins of life.

Our philosophical writers have already provided well-reasoned criticism of the conceptions propounded by prominent biologists like J.Monod, G.Schramm, and F.Haas. Their philosophical views are characterised by attempts to revive a modernised version of Cartesianism, which they deliberately contrast with the dialectical mode of cognition. The broad opportunities held out by the complex of physico-chemical and mathematical methods in solving the problem of the origins of life are used merely to show that no rational cognition of the dialectical leap from inanimate matter to life is possible, and to seek to show that the origination of life and its evolution was a matter of pure chance. The absence of any specific laws in the physics and chemistry of living matter, as modern science shows, impels these scientists, who have deliberately rejected the dialectical philosophy, to turn to the Platonic ideas (Schramm), to the "Gestalt-factor" as the residue following the "subtraction" of the sum-total of physico-chemical processes from living phenomena (Haas). Again and again the problem of integrity, which has been solved by dialectics in principle, becomes the stumbling block for scientists who do not think dialectically, thus producing a peculiar hodge-podge of mechanicism and vitalism.

Some biologists have sought to revive the anti-Darwinist tendencies on the basis of the latest data in various fields, including the promising study of the molecular basis of evolution. US biologists, among them M.Kamura, J.King, and Th.Jukes, have developed the conception of a "non-Darwinian" evolution which denies the leading role of natural selection and sets up as an absolute the role of chance in the evolutionary process as a whole. It is not right to ignore such attempts to undermine the most important methodological basis of modern theoretical biology, the principles of Darwinism. There is need to intensify research into the theoretical generalisation of the ever growing experimental data on the evolution of proteins and nucleic acids, and to tackle the methodological and ideological problems in this field of biological science.

The new aspects of the philosophical struggle of ideas are determined by biology's ever growing social role. The advances in the study of the molecular basis of heredity, and the emergence of "genetic engineering" give rise to important social and ethical problems. While "genetic engineering" still has a long way to go before it can actually interfere with the heredity of the higher organisms, including man, there is already an evident need to consider these questions. What will happen to the new discoveries in biology, and whether they are used to benefit or harm mankind depends on whether scientists can work out the right ideological and socio-humanistic attitudes.

We cannot ignore the fact that the new biological data are being used to preach reactionary philosophical and political ideas. One fashionable claim is that there is convergence in biological and social research, resulting in the emergence and broad spread of so-called social biology.
It treats of the connections between animal and plant species in terms of social life. Thus, one journal has suggested that altruism, conjugal fidelity, paternal loyalty to the younger generation and other similar forms of behaviour

are to be found among many species ranging from insects to mammals.[14] The social behaviour of species, the journal goes on, has the aim of maximising their genetic contribution to coming generations. On the other hand, it adds, the methods used in the study of the social behaviour of animals should have an effect on the study of men's social behaviour.

Refurbished versions of social-Darwinism have been proposed and the data of modern biology are being used to interpret problems of culture, ethics, social progress and the problems of the individual.

Susan Welch of the USA and Alan Booth of Canada assure their readers that overpopulation tends to stimulate various types of aggression both in the animal kingdom and in the human community.[15]

In his lifetime, Lenin strongly criticised the attempts to substitute biological analogy for an analysis of social phenomena and showed very well that there was a wide gap between Marxism and the "biological" trifles of the Machists: "The transfer of biological concepts in general to the sphere of the social sciences is phrase-mongering."[16] This is done either from thoughtlessness or, most frequently, with the aim of backing up false sociological conclusions.

The concrete approach to scientific and socio-philosophical ideas propounded by natural scientists, according to Lenin, makes it possible to give convincing criticism of various reactionary conclusions drawn from the latest biological advances, and at the same time helps to establish relations of solidarity with scientists taking a progressive attitude. There are growing numbers of such scientists in the capitalist countries as well. A.Szent-Györgyi, a well-known biochemist, Nobel lauriate (resident in the USA), has for many years sought to draw the attention of world opinion to the social consequences of the revolutionary advances in biology. He has resolutely criticised the militaristic use of science in the USA and has sounded the alarm over the

fact that the Pentagon has converted scientific achievements into instruments of destruction.[17] There is a growing conviction among progressive scientists that only in a society without man's exploitation of man is it possible to do away with the dependence of scientific research on self-seeking political aspirations, and to enable scientists to take part in determining progressive ways for the use of science.

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Among the problems facing mankind today that of man's interaction with the environment tends to acquire ever greater proportions, with man's relationships to nature changing substantially. Whereas in the past the depletion of natural resources appeared to be the most acute problem, today it is the problem of the diverse superflous effects exerted by man on the environment that comes to the fore. Under the scientific and technological revolution, man produces impressive changes within his habitat, and is largely subjected to their reciprocal effect. This produces the task of securing an optimal conjunction of the scientific, technical and production activity in society with the processes occurring in the biosphere. The very formulation of this task implies a heightened responsibility on the part of society for preserving the natural environment and keeping its transformations within the bounds of advisability. There is ever more urgency in the problems arising from the interaction between man equipped with modern technology and his habitat.

In the modern world,. ecological problems are becoming an object of acute ideological struggle. Many bourgeois scientists have sought to obscure the threat of ecological crisis that is a real prospect in the developed capitalist countries. Now and again, serious concern is expressed over the state of the natural environment and the prospects of its destructive modifications, but in the bourgeois consciousness this concern assumes distorted forms.

In this context, one could point, in particular, to the well-known report produced by the Club of Rome entitled The Limits to Growth, which was prepared by a group of US scientists led by Professor D.Meadows. It presents a "global model" of man's relationship with nature under which mankind, if it maintains the present rate of development and its old attitude to the biosphere, will face a global ecological disaster somewhere by the mid-21st century. Many other researchers into ecological problems have issued similarly pessimistic statements, with a somewhat different emphasis. Their "ecological pessimism" springs from their mistrust of scientific and technological progress, whence their attacks on science and technology, which, they claim, are responsible for the emergent environmental crisis. But it is not science or technology, but the capitalist attitude to man and nature, the drive for profits, the utilitarianism and pragmatism in the use of science and technology, and the chaotic organisation of production that go to create the ecological threat. This the Marxist classics were well aware of. In a letter to Engels à propos an ecological work, Marx wrote: "Cultivation when it progresses spontaneously and is not consciously controlled...leaves deserts behind it."[18]

Some bourgeois scientists, having failed to understand the real connection between modern scientific and technological development and the environment, and having failed to understand or deliberately ignored its socio-political aspects, suggest that even now environmental factors tend to operate as constraints on the progress of human society. The ecological pessimists claim that because the ecological crisis is global all the other problems--political, ideological and social--however acute, have to be pushed into the background. Characteristically, the Second Report to the Club of Rome prepared by M.Mesarovič of the USA and E.Pestel of the FRG, admits that the report prepared by the Meadows group was indeed abstract in the sense that it ignored the regional aspects of ecological problems, but while

presenting a scheme of ecological conditions in the various regions, the Second Report, entitled "Mankind at the Turning Point" remains abstract in the sense that it ignores the different social structures of society in the various regions, which makes for the specific features of the ecological problems in different socio-economic conditions. It will be easily seen that in this way the "ecological noise" helps the authors to obscure these socio-political and ideological problems, something the ideologists of capitalism need. But a truly profound Marxist-Leninist analysis shows that there is nothing fatal about the problem of society and the environment, for it can be and will be solved not through stagnation or a reversal of historical development, but through further progressive developments in the course of which mankind will overcome private-property relations.

The results of modern scientific research refute the reactionary bourgeois theory which insists that the world's natural resources are limited and are running out, and that an aggravation of the ecological crisis is inevitable. Science opens up new and unexpected potentialities and immensely greater resources than ever before in the past. Scientific progress under socialism serves humanistic ideals. In the USSR's developed socialist society, the protection of the environment is the business of the whole people. There is good reason why among the key problems of communist construction, the 24th Congress of the CPSU emphasised the great importance of combining further technological development with a thoughtful attitude to the environment. We are equal to this task and will fulfil it.

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To sum up I must emphasise that Lenin's philosophical ideas are having a powerful influence on the development of modern natural science. These ideas are consciously applied and developed in accordance with the achievements of socio-production practice and knowledge by scientists in the USSR and other socialist countries. Many scientists in the capitalist countries adopt these ideas spontaneously, instinctively feeling their beneficial influence on progress in the natural sciences and realising the futility of idealistic preconceptions.

Forward-looking scientists have voiced alarm over the spread of unscientific and mystical conceptions. One journal carried a special article against pseudo-science which helps to implant mysticism. Among the books, says the article, which are in great demand at university campus book shops are Chariots of the Gods? Gods from Outer Space, Limbo of the Lost, The Secret Life of Plants.[19] These are books which present fantastic inventions in the guise of science fiction. Thus, the authors of The Secret Life of Plants declare that science has no business trying to establish the cause of plant life. They suggest that plants have emotional properties originating from a supermaterial world of cosmic beings like fairies, elves and gnomes. The article quoted here resolutely stresses that this kind of fiction amounts to a specific intellectual poison.

There is need to realise that like philosophical idealism, the preaching of mysticism in the guise of science fiction is used to fight the scientific materialist world outlook in the interests of the reactionary social forces. That being so, our struggle against the anti-materialist views being propounded in various departments of modern natural science has to be ever more effective, vigorous and true in the Leninist Party spirit.

NOTES

[1] V.I.Lenin, Collected Works, Moscow, Vol.14, p.308.

[2] Ibid., p.313

[3] See J.Maritain, This Is My Philosophy, New York, 1957, p.253.

[4] V.I.Lenin, Collected Works, Vol.14, p.260.

[5] Ibid., pp.283-284.

[6] Criticism and the Growth of Knowledge, Cambridge, 1970.

[7] V.I.Lenin, Collected Works; Vol.14, p.308.

[8] See W.Heisenberg, "Development of Concepts in 20th Century Physics", Voprosy filosofii, No.1, 1975, p.87.

[9] Ibid., p.88.

[10] Reminiscences of Marx and Engels, Moscow, p.75.

[11] Dialektische Materialismus, Freiburg, 1960.

[12] V.I.Lenin, Collected Works, Vol.14, p.262.

[13] P.Kirschenmann, Kybernetik, Information, Widerspiegelung, Munich and Salzburg, 1969.

[14] Science, January 10, 1975, Vol.187, No.4171, p.51a.

[15] Social Science Information, 1974, XIII-4/5, pp.151-162.

[16] V.I.Lenin, Collected Works, Vol.14, p.329.

[17] A.Szent-Györgi, "Is It World Saving on Science?", Priroda, No.1, 1972.

[18] K.Marx, F.Engels, Selected Correspondence, Moscow, 1955, p.244.

[19] Science, 1974, Vol.184, No.4143.

PROBLEMS OF THE OBJECTIVE AND THE SUBJECTIVE IN MODERN PHYSICS

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Planck, Einstein, Bohr, and other men who did much to transform natural science were constantly concerned with the problem of the objective and the subjective in scientific cognition. Among others, this problem was considered by Born and Heisenberg in their latest works on the philosophy of physics. Various aspects of the problem have also been dealt with by scientists consciously taking the view of dialectical materialism.

Classical physics was also deeply concerned with this philosophical question: how is objective knowledge acquired? How is it possible to know that physical assertions are more than purely subjective constructions, while nature exists independently of experiment and the theory which stems from it?

Classical natural science took a fairly simple view of the answer. Natural scientists of the 18th and 19th centuries took for granted the recognition of the objective reality of the external world as reflected in physical theories. The phenomena they observed were explained on the basis of a mechanical macroscopic model. Conceptions expressing the measured properties of physical bodies and their movements

known at the time were not much more abstract than the conceptions worked out in everyday experience. Materialism and the mechanistic view dominated classical physics and were accepted by physicists, frequently in a philosophically unconscious form.

As physics moved deeper from the macroscopic objects perceived in everyday experience into the sphere of phenomena whose knowledge required, apart from the most refined and specialised experimental devices, non-classical theories with their abstractions that had been unknown to classical physics, the problem of the objective and the subjective in physical science became ever more complicated. In modern physics the problem of the objective and the subjective has acquired a form which differs substantially from that in which it appeared in Newtonian and Maxwellian physics. From the end of the 19th century, paradoxical situations began to develop in physics, when the data of observations failed to square with the existing theoretical schemes and notions. The theory of relativity and quantum mechanics emerged and developed, being established as non-classical theories, that is, as theories with a mathematical formalism unknown to classical physics and a totally different set of conceptions and principles (as compared with the classical).

The development of modern physics runs through transitions of one set of fundamental theories to another, which are more general and profound, and differ qualitatively from their predecessors. This kind of development necessarily involved the disappearance of some basic conceptions that had been essential for the initial theory, and the formation of new fundamental conceptions (without which the new theory cannot be regarded as a theory). Thus, the disappearance and emergence of basic conceptions is a coherent process in which the conceptions of the original theory (where these are in the nature of absolute conceptions, invariants) are subjected to a peculiar relativisation, to become aspects of new absolute conceptions, or invariants, in a theory on a deeper level. Thus, in the theory of relativity, the classical conceptions of absolute length and absolute duration gave way to the corresponding relativistic conceptions constituting the aspects of the most important invariant of the theory of relativity, the interval, in which length and duration are "combined" in a special way.

If we were to characterise in the plane of the theory of knowledge fundamental physical theories with a growing degree of generality--classical mechanics and electrodynamics, the theory of relativity and quantum mechanics, and quantum field theory (the theory of elementary particles) --we would have good grounds to say that the relativisation of the old absolute (invariant) conceptions and the introduction of new absolute (invariant) conceptions with the generalisation of theory and its transition to a new theory has meant its progressive advance from subjectivity to objective knowledge, and ever deeper and fuller cognition of objective reality in which the onesidedness and subjective constructions of individual physical theories that are inevitably attendant upon them are eroded, and the theories themselves, while retaining their content, which corresponds to objective reality, acquire a coherence of a higher rung.

That, I believe, is the philosophical meaning of the idea of invariance for the problem of the relationship between the objective and the subjective in modern physics. Thus, the theory of relativity and quantum mechanics have shown in concrete terms that the conceptions of classical mechanics and classical mechanics as a whole are approximate (while being absolute within the limits of their applicability). Thus, in considering the relationship of the indeterminacies, establishing the limits within which the classical conception of particle was applicable, it was taken into account that electrons, say, apart from "corpuscular" simultaneously had wave properties; beyond these limits the classical conception of particle had no objective significance.

In modern physics, Lenin's ideas of the relationship between matter and consciousness, between the objective and

the subjective have a key role to play. Matter and consciousness, the objective and the subjective remain absolutely antithetical only within the limits of the basic questions of philosophy. "To operate beyond these limits with the antithesis of matter and mind, of the physical and the mental, as though they were absolute opposites, would be a great mistake."[1]

Consequently, Lenin closely ties in the materialist answer to the basic question of philosophy with the dialectics of the process of cognition, with the question of how knowledge develops from non-knowledge, how this knowledge becomes ever deeper and fuller, reflecting the external world which exists independently of man. This is most pronounced in physical science, especially in non-classical physics.

Positivism--whether we consider Mach or the neopositivists--for which, let us recall, the question of the existence of the physical world independently of experience was at best a pseudo-problem, skirted round the problems of the source and origins of physical knowledge, and with them also the problems of its development. Mach gave an idealistic critique of Newton's theory of time and space, adopting in this matter an attitude of pure philosophical relativism, and ending up with a rejection of Einstein's theory of relativity. Later positivists--among them such prominent philosophers as Carnap and Reichenbach--accepted the theory of relativity and quantum mechanics, but regarded physical theories as being no more than a logical instrument for bringing observations into a system. Thus, Reichenbach ignored the real dialectical unity of the corpuscular and wave properties of matter, of which classical physics had no knowledge and which is considered in Bohr's conception of complementarity, subsequently elaborated by V.A.Fok and other scientists. Reichenbach allowed some assumptions concerning the "particle" and the "wave", which, he said, were neither true nor false, and in his philosophical reasonings on quantum mechanics put forward the theory of "equivalent descriptions" implying that under certain circumstances both the corpuscular and the wave interpretation "are admissible, and they say the same thing, merely using different languages".[2]

When considering the objective and the subjective in modern physics, it is important to bear in mind that Einstein, Bohr, Born and its other founders, despite their different philosophical views, took the same anti-positivistic stand on questions of cognition in physical science. Thus, Einstein kept emphasising that in their theories physicists dealt with nature, which existed independently of the cognising mind. While giving due credit to classical physics and paying high tribute to Newton, he regarded the theory of relativity as a new step in the development of physical knowledge. What is more, he expressed the view that the modern theory of relativity (meaning the theory of gravitation) should be regarded only as a marginal case of a more profound theory (still to be formulated). These considerations of the founder of the theory of relativity speak for themselves. There appears to be no need to cite similar statements on the question by Bohr, Born and the other great physicists of our epoch, who were opposed to positivism and subjectivism in science.

In the recent period, there have been clear signs that trust in positivism among the "philosophers of science" and natural scientists in the non-socialist world is being eroded. Without going into the reasons, let us note that there is a growing understanding in modern bourgeois philosophy of the problems of development of scientific knowledge, with research into this development gradually becoming a basis for comprehending the structure of science, its formulated theories, and the logical problems of established science. In contrast to positivism, which dealt with the logic of established knowledge, the latest trends in the bourgeois philosophy of science seek, so to say, to lay bare the forms and methods which help to show the developing content of scientific knowledge. In short, whereas the logic

of scientific revolutions--notably in physics, that is, the logic of transition from one fundamental theory in science to a deeper one--had been ignored by the positivists, with the post-positivists, the philosophical problems arising from such revolutions come to the fore. The earliest ideas in this context were expressed by Karl Popper. But these, including Popper's principle of falsification, went no further than consideration of the relevant problems (at any rate, in Popper's early works). For him, study of the regularities of development of scientific knowledge, and study of its logical structure turn out to be interconnected but different tasks.

Imre Lakatos, starting from Popper's ideas, suggests that the logic of science can be no more than a theory of its development, and reasons in great detail to the effect that any empirical refutation of theory (Popper's "falsification" principle) urges the need for specification and progressive change of theory. Lakatos seeks to clarify the rational reference points in the development of knowledge in the period of the scientific revolution.

Thomas Kuhn takes a different view of the problem of revolutions in science, as compared with Popper and Lakatos. He holds that in science there is a period in which established principles dominate to ensure "normal" functioning of science, and a period of crisis in which new "paradigms", that is, complexes of new principles, new scientific methods and approaches, are formed. He claims--in contrast to Lakatos--that the succession of paradigms defies rational, logical explanation, and seeks to substantiate his standpoint.

Without going any further into the views expressed by Popper, Lakatos, Kuhn and other allied Western philosophers concerning the development of scientific knowledge, let me merely emphasise that these philosophers have failed to solve the relevant problems arising from the most essential features of scientific development. Thus, while insisting on the antithesis between the theoretical and the empirical Popper has failed to find the way of resolving it. Kuhn rejected the regularities of transition between "paradigms". Lakatos's methodology of research programmes (which have a role to play in his reasoning about Kuhn's paradigms) is essentially nonconstructive.

All these and other negative aspects of the views of the Western adversaries of positivism concerning the development of science, which I have not considered here, can be explained from the Marxist positions. Present-day Western antipositivists ignore materialist dialectics, above all, the dialectics of the connection between the objective and the subjective, when considering problems in the development of scientific knowledge. The view of knowledge as a reflection of nature in man's mind, which cannot be considered outside the context of motion, without contradictions, and which has to be considered in the light of the perpetual process of motion, the origination of contradictions and their resolution[3] is the view that opens up a philosophical perspective for answering the question about scientific revolutions in the development of science. That is something present-day bourgeois philosophers fail to see.

The vast importance of the dialectics of the objective and the subjective in the philosophical problems of physical knowledge stands out when one considers the question, which is essential for modern physics, of the relationship between the abstract-logical and the visual, or the mathematical formalism of theory, and the data observed in experiment, as described by means of our conventional language. This is the question of the visual nature of conceptions and theories in modern physics. On this question, the materialist line implies recognition of the dialectical unity of sensual cognition and abstract thought, reflecting objective reality. The integration within a single whole of the mathematical formalism of physical theory and experimental data, as expressed in the conceptions of classical physics, corresponds to the line of dialectical materialism. Born was wrong when he claimed that dialectical materialism confined itself to "the objective

world of formulae, without regard for visual observation."[4]

On the question of visual observation, Einstein expressed an idea which is of important philosophical significance for physics. The gist of it is that the abstract-logical in physical theory does not yet in itself convey anything about objective reality; only visual observation and the abstract-logical (mathematical), that is, a unity of the abstract-logical and the visual in theory (and not each arbitrarily taken on its own) reflects objective reality and is the object for verification in experiment.[5]

The profoundly dialectical idea from the very outset rejects the conventionalist and the positivist scheme for solving this problem.

In this problem, the following idea expressed by Bohr is highly essential: "However far the phenomena transcend the scope of classical physical explanation, the account of all evidence must be expressed in classical terms."[6]

A closer consideration of this idea of Bohr's will show its materialist character to be most definite. Thus, quantum mechanics—like other non-classical theory—has grown up on the basis of experiment and has been confirmed by experiment. But this means that quantum mechanics must use classical, visual conceptions, because the truth of it is verified by experimental means constituting macroscopic objects, while the evidence of experimental means, or instruments, on the strength of which conclusions about atomic objects and phenomena are drawn, are comprehended by man. Nature, with which natural science has to deal, is matter in motion, and the cognition of matter is impossible unless it acts (directly or indirectly through instruments) on human sense organs. What would man have known about the atomic world existing independently of his mind, if this world had not, so to say, made itself known through the macrophenomena which man comprehends and which are in law-governed connection with microphenomena?

What then is the substance of the problem of visual observation in modern physics? The point is that the various fundamental physical theories (say, the theory of relativity or quantum mechanics) all make use of experimental data described in the language of classical conceptions, while the theories themselves--let us note--differ in content. The question is: In what form do the experimental data described in classical conceptions enter into non-classical theory: the task is not to describe the experimental data--that has been done--but to comprehend these in definite conceptions connected with definite physical assertions which are covered by a definite fundamental theory?

There is no consensus on this matter among the physicists. Many of them have failed to consider the question and assume that one can confine oneself to discovering still unknown observable data, on the strength of observations, and with the mathematical formalism of theory in mind, that is, that in non-classical theory there are no new fundamental physical conceptions. Incidentally, this half-conscious approach is, in effect, not such a very far cry from positivism, according to which physical theory is only a logical means for arranging observed facts into a system.

According to Heisenberg, in the case of the theory of relativity, a new situation with conceptions can best be described in mathematical language . Physicists, he believed, could either try to adapt their language to the mathematical formalism of the new theory (as is being done in the theory of relativity), or should rest content with the language of classical conceptions, realising that the latter has only a limited extent of applicability (as has occurred in quantum theory). Thus, Heisenberg did not even consider the question of new basic physical conceptions in a new fundamental theory, that is, conceptions whose content is determined by the basic physical laws of the new fundamental theory, and interprets the change of the basic classical conceptions in such a way as to obscure the change itself.

The change in fundamental conceptions when a new theory emerges from an old fundamental theory does not amount to an adaptation of old fundamental conceptions to the new mathematical formalism, or to their circumscription within a definite sphere of applicability, but the emergence of new fundamental conceptions (qualitatively different from the old) and with them the structuring of a new fundamental physical theory. Thus, the theory of relativity emerged at the junction of classical mechanics and classical electrodynamics as a result of the resolution of the antithesis between Galileo's principle of relativity and the principle that in a vacuum the speed of light does not depend on the motion of its source. The result was the emergence of a new set of axioms and new basic conceptions constituting the conceptual basis of Einstein's theory of relativity; from this standpoint, the conception of relative space, time and simultaneity in Einstein's theory is not an adaptation of similar classical conceptions to the mathematical formalism of theory, but a fundamentally new set of physical conceptions reflecting real space and time in their profound internal interconnection (the authenticity of which is evidenced by the practice of physical observations and experiments).

Questions of this kind have been fairly fully examined by natural scientists who consciously take the dialectical materialist view and by Marxist philosophers.[7] It is regrettable that Popper, Lakatos and Kuhn have, in effect, ignored the "dialectics" of physical conceptions, although one would think that in their writings on the "scientific revolutions" they should not and could not have done so; indeed, they do not even use the term "change of classical conception".

Let us now turn to the more concrete aspects of the problems under consideration. The conception of relativity, which has a direct bearing on our topic, is fairly frequently used in physics. Leaving aside for the moment the conception of relativity as used in classical mechanics and Einstein's theory, let us consider the conception of relativity in quantum mechanics, which, I think, is the highest point of development of this conception in physics. It concerns relativity with respect to the means of observation; in implicit form it occurs in Bohr's writings, and in explicit form has been formulated as a corresponding principle by V.A.Fok.[8]

This principle requires that any description of atomic-scale objects and phenomena should be made on the basis of the conception of relativity with respect to the means of observation. Let an electron beam pass through a crystal lattice allowing the observation of the diffraction pattern formed by the electrons; with respect to this means of observation the wave aspect of electron movement is manifested, that is, outside this relationship the conception of the electron's wave properties has no meaning. Let the electron impacts be determined on the photographic plate as darkened points on the photographic layer; with respect to these means of observation, the corpuscular aspect of electron motion is manifested, that is, outside the context of this relationship the conception of the electron's corpuscular properties has no meaning. Thus, the idea of relativity with respect to the means of observation makes the corpuscular-wave nature of electrons literally visible.

Considering that the means of observation, or the instruments, are a kind of extension of man's sense organs, while at the same time--as we have seen in research into atomic objects--they belong in a sense to the physical system under observation, it follows that no clear line of demarcation can be drawn between the objective and the subjective in experimental research, and that no absolute distinction between the object cognised and the cognising subject, between the observed system and the instrument can be established. In the process of experiment (observation, measurement, and so on) the distinction between the objective and the subjective is not absolute, not excessive, but relative and, in a sense, fluid.

Consequently, it would be wrong to separate the question of the relationship between the objective and the subjective in physics from the question of relativity with respect to the means of observation. In classical physics, that question was merely considered, instead of being tackled, without a bridge, so to say, having been built to connect the objective and the subjective in experimental research. Construction of such a bridge was started by Einstein's theory, but it was quantum mechanics with its conception of "relativity with respect to the means of observation" that provided the fullest solution to the problem of the relationship between the objective and the subjective in physical knowledge. It was Bohr who emphasised that in experiment it was wrong to draw a sharp line of division between the observed system and the experimental device. He analysed many aspects of this question, considering the idea that "in quantum physics the description of the effect of the measuring instrument is a necessary condition for determining the phenomenon itself". In this context, it is interesting to recall his illustration of this from everyday experience. He said: "If a stick is held freely, we feel it as an external object, but when tightly gripped, the sense of an alien body is lost and the sense of touch is localised directly at the point where the stick touches the analysed body."[9]

At the same time, the distinction between the objective and the subjective in experiment, between the object cognised and the cognising subject, which has been considered, is not only or exclusively a relative distinction; it is also latent with the absolute: after all, the source of the experiment is objective reality. The view of this distinction as being exclusively relative has become the philosophical pillar for the interpretation of quantum mechanics in which the idea of fundamental uncontrollability, the idea that the wave function is no more than a record of the observer's information, and so on, was enshrined by modern positivism and other idealistic trends. In an effort to blot out the dialectics of physical knowledge, all such ideas ultimately imply that no new basic conceptions in new fundamental theory, apart from the basic conceptions of classical physics, do or can exist in physics.

These problems are echoed in the question which I shall designate as that of the activity of human consciousness: in modern physics it has acquired a new philosophical meaning.

Lakatos says that there is "an important demarcation between" what he calls "passivist" and "activist" theories of knowledge. The passivists hold that "the true knowledge is Nature's imprint on a perfectly inert mind: mental activity can only result in bias and distortion. The most influential passivist school is classical empiricism." The activists hold "that we cannot read the book of Nature without mental activity, without interpreting it in the light of our expectations or theories". Lakatos then goes on to discourse on the "conservative activists", who hold "that we are born with our basic expectations; with them we turn the world into 'our world' but must then live for ever in the prison of our world. The idea that we live and die in the prison of our 'conceptual frameworks' was developed primarily by Kant; pessimistic Kantians thought that the real world is for ever unknowable because of this prison, while optimistic Kantians thought that God created our conceptual framework to fit the world. But revolutionary activists believe that conceptual frameworks can be developed and also replaced by new, better ones; it is we who create our 'prisons', and we oan also, critically, demolish them."[10]

We find similar statements in Heisenberg's writings, but with the distinctions bearing on what Heisenberg believes modern physics to contribute to knowledge. He believes that man does not describe and explain nature itself, but nature in the form in which it appears to man because of his approach to the problems and his methodology of research. Heisenberg put a high value on the assertion made by the

German physicist and philosopher C.F.Weizsäcker: "Nature came before man, but man came before natural science." We find Heisenberg saying: "The first part of this statement justifies classical physics with its ideal of complete objectivity. The second part explains why we cannot be free of the paradoxes of quantum theory and of the need to apply classical conceptions."[11]

One should assume that those who make such statements do not know or ignore the theory of knowledge of dialectical materialism. In cognising nature, man does not at all take a passive attitude to it; the embryo of the dialectical materialist theory of knowledge is contained, as everyone knows, in the Theses on Feuerbach, written by the young Marx. In his historical practice, man has dealt billions of times with macroscopic-scale objects and phenomena, with their motion and change, which occur at relatively low speeds (as compared with the speed of light). This practice provided the basis and confirmed the truth of classical physics, of which Newton's physics was the first expression.

However, as Lenin wrote, the criterion of practice can never, in the nature of things, either confirm or refute any human idea completely.[12] The relative nature of this criterion—when it comes to the development of physical science—will be seen from the fact that the practice of physical observations, experiments and discoveries, of which classical physics did not and could not know anything, has become the basis and confirmation of the truth of the theory of relativity and quantum theory. Physical knowledge has now become much fuller and richer than the physical knowledge of the 18th-19th centuries, a point well driven home by the scientific and technological revolution of our epoch.

It is wrong to claim that classical physics alone describes nature as objective reality in its pure form, whereas the emergence of quantum physics has established the view that natural science is a description of nature subjected to our methods of research. After all, the picture of nature in classical physics was not a complete reflection of nature; it was given in gross outline and idealised, and this has been proved, in their own terms, by the theory of relativity and quantum mechanics, which have given a fuller description and explanation of nature than classical theories. But then it is wrong to claim that classical physics describes and explains nature without considering us.

Considering the question in broader terms, we are entitled to say that the reflection of nature in the observations and abstractions of a theory tends in one way or another to idealise, oversimplify and engross what is being reflected; at the same time, the advance of knowledge, the development of theory of science as a whole help to overcome these idealisations and oversimplifications, which are inevitable in individual cognitive acts, in every individual theory and its assertions and conceptions. The development of physics from classical to relativity and quantum theory gives a fuller and deeper reflection of nature, without presenting the whole of it. This progress of physical knowledge, which is inconceivable without continued change of nature by cognising man, is a very far cry, indeed, from the one-sided exaggeration of the subjective in science at the expense of its objective content.

Thus, in the cognition of nature the objective and the subjective should not be contrasted or separated from each other, although Heisenberg, for instance, regards the distinctions between the objective and the subjective in classical physics as being exceptional, and in quantum physics, as being an exceptionally relative distinction. The steady development of scientific theories and science as a whole, ever more fully reflecting the material world, helps to overcome the onesidedness of the objective and the subjective. "Nature is both concrete and abstract, both phenomenon and essence, both moment and relation. Human concepts are subjective in their abstractness, separateness, but objective as a whole, in the process, in the sum-total, in the tendency, in the source."[13]

These ideas of Lenin's are expressed in remarkable relief in the development of physics, from classical theories to those of our own day.

In conclusion, let me sum up my considerations of the role of the instrument in the light of the problem of the objective and the subjective in modern physics.

The natural shortcomings and limitations of the sense organs which supply us with information about the external world are overcome through the cognition of nature by active thought. A material expression of this is that in his practice man creates instruments and uses them in his study of nature. Accordingly, the instrument, or the experimental means, appears as a kind of extension of man's sense organs, a peculiar organ of his brain.

The progress of science and technology has led to the creation of a system of instruments, or experimental means, joined together into an organic whole. Let us call this a developed experimental device, which includes definite elements, among which the registering device has the key role to play: it fixes the phenomena in the instrument to allow the observer to judge of the objects being studied.

Apart from the use of an instrument by means of which the object is being studied--the instrument proper--experimentation also implies that certain conditions need to exist or be realised if the object or phenomenon being studied is to be located. These conditions are either found in nature (when experimentation becomes observation), or are created by the experimenter by means of relevant experimental means. Such means may be called preparatory devices, and they are also a part of the developed experimental device. In quantum mechanics, the preparatory device fixes the conditions outside and independently of which there is no existence of the phenomena through which the corpuscular and wave aspects of the behaviour of the atomic object are cognised.

Thus, the instrument proper and the preparatory device are organically combined in the developed experimental device;

at the same time, as their definitions show, they are distinct from each other, and this is also expressed in the fact that in a sense the preparatory device belongs to the observed system, while the instrument proper is in a sense inseparable from the cognising observer. In other words, the distinction between the preparatory device and the instrument proper is not absolute but relative. This has been discussed above with the relevant illustrations.

To these let us add the consideration concerning Heisenberg's famous mental experiment of the γ-microscope. The precision with which the observer determines the position of the electron increases as the wave length shortens, that is, light with its wave properties serves the observer as a means of cognising the behaviour of the electron, but the quantum properties of light also make it a kind of inseparable part of the behaviour of the electron which is being cognised.

Thus, the dialectical materialist theory of knowledge, elevated by Lenin to the highest level of 20th-century science, helps to sift the idealistic views round modern physics, and to chart correct ways for solving its philosophical problems. The fact that Western scientists tend to ignore materialist dialectics in analysing these problems works against the science they represent, converting them into advocates and supporters of reactionary philosophy and religion. In this context, Heisenberg's latest writings are indicative. He says that whereas within the system of the conceptions of classical natural science it was hard to find a place for religion (for, according to Heisenberg, it was on the materialist path), in modern physics things are quite different: this has occurred because of the "liberation of our thinking through the development of physics over the past decades, showing the problematic nature of the conceptions of the 'subjective' and the 'objective'." He claimed that "Soviet philosophy... has found it hard to come to terms with the theory of relativity and quantum theory".[14]

There is no need to polemicise on these questions. The development of Marxist-Leninist philosophy and modern physics

has given a fitting rebuff to him and others who have wittingly or unwittingly opposed dialectical materialism.

Today philosophical problems of physics and science as a whole are the subject of a particularly sharp struggle between two principal philosophical trends, between the two principal parties in philosophy--materialism and idealism. Dialectical materialism is becoming the science of the 20th century, the leading philosophical system. The ideological source of the strength of science in the socialist world rests on the supreme tradition of its great teachers Marx, Engels and Lenin: to adhere, from beginning to end, to the Party spirit in philosophy, to pursue the line of materialism, consistently and fully against all kinds of idealistic obscurantism, against the ideology of the reaction.

In his speech at the celebration meeting on the occasion of the 250th anniversary of the USSR Academy of Sciences L.I. Brezhnev, General Secretary of the CC CPSU, noted the Party spirit of Soviet science. We conclude the article with a quotation from this speech:

"There is one matter on which I wish to dwell specially --the Party spirit of our science. Whatever the field in which Soviet scientists are working, they are always distinguished by one characteristic--communist consciousness and Soviet patriotism.

"The truly Soviet scientist proceeds in his entire research work from the scientific ideology of Marxism-Leninism, is an active fighter for the cause of communism, against all forces of reaction and obscurantism. Our scientists subordinate all their practical work to the task of implementing the noble ideals of Communism."[15]

NOTES

1 V.I.Lenin, Collected Works, Moscow, Vol.14, p.246.

2 Hans Reichenbach, The Direction of Time, Berkeley, 1971, p.218.

3 See V.I.Lenin, Collected Works, Vol.38, p.196.

4 Max Born, Werner Heisenberg und die Physik unserer Zeit, Braunschweig, 1961, p.106.

5 A.Einstein, Geometrie und Erfahrung in Mein Weltbild, Zürich, 1953, pp.160-161.

6 N.Bohr, Atomic Physics and Human Knowledge, New York, 1958, p.39.

7 See, for instance, the books in the series Dialectical Materialism and Modern Natural Science, (Nauka Publishers, Moscow, from 1962 to 1973). These books contain elaborate bibliographies (in Russian).

8 Among V.A.Fok's many works on this question, see his article, "The Principle of Relativity with Respect to the Means of Observation in Modern Physics" in Vestnik Akademii Nauk SSSR, No.4, 1971, Moscow.

9 Die Naturwissenschaften, 17th Yearbook, No.26, p.485.

10 I.Lakatos, "Falsification and the Methodology of Scientific Research Programmes" in Criticism and the Growth of Knowledge, 1970, p.104.

11 Werner Heisenberg, Physik und Philosophie, Stuttgart, 1959, p.40.

12 See V.I.Lenin, Collected Works, Vol.14, p.142.

13 Ibid., Vol.38, p.208.

14 W.Heisenberg, Der Teil und das Ganze, Munich, 1969, p.124; W.Heisenberg, "Naturwissenschaftliche und religiöse Wahrheit", Physikalische Blätter, 1973, No.8, p.346.

15 Social Sciences, Moscow, No.2, 1976, pp.10-11.

THE REVOLUTION IN CONTEMPORARY ASTRONOMY AND PROBLEMS OF WORLD OUTLOOK

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1. Natural Science and World Outlook

That science has become a major factor in our epoch is now generally recognised. It is intruding vigorously into literally all spheres of social life, transforming and, indeed, revolutionising them. A prominent role is played in this by natural science, which is not simply a system of developing knowledge about nature, but a specific form of social activity to produce knowledge and a direct productive force of society. In all these aspects natural science is now advancing at an unprecedented rate: it is deepening our knowledge of nature and extending the limits of our power over it.

The progress of natural science in our day has sharply increased its influence on other forms of social activity and on the entire intellectual life of society. Many of the problems raised by natural science today are becoming a battleground of philosophical ideas, trends, and world outlooks.

The concept of world outlook is complex and multi-faceted, as is the character of the problems it embraces.

World outlook is one of the most general forms of social self-consciousness, of the methods of "practically-spiritual mastering the world" by social man, to use Karl Marx's expression. It may be defined as the totality of notions, rules, and assessments expressing the attitude of man to the world and of the world to him. World outlook includes certain aspects of the "man and nature" problem--namely those that determine man's attitude to nature as the sphere of his being, the object of his cognitive and practically transforming activities. A most important feature of world outlook is its partisanship. Structurally, world outlook includes some of the most general notions about the world (nature, society), and they inevitably are refracted through the prism of the self-consciousness of social classes and groups. With two opposite social systems existing in the contemporary world, an acute struggle has developed over the problems of contemporary natural science between the bourgeois world outlook in its various forms and the world outlook of Marxism-Leninism.

A number of problems of world outlook have been posed by recent advances in astronomy. This most ancient of the sciences of nature has always been closely associated with the most profound of such problems. Suffice it to recall the dramatic struggle of world outlooks over the problem of man's place in the Universe, which was sparked off five centuries ago by the Copernican revolution. Many aspects of this problem have been raised perhaps no less acutely by contemporary astronomy.

2. The Revolution in Contemporary Astronomy

Astronomy has in recent decades become one of the spearhead areas of natural scientific advance. There is growing support for the standpoint that the science of the Universe is going through a new revolution.

Several basic points may be noted, which characterise various aspects of present-day advances in astronomy.

In addition to cardinal improvements in astronomy's traditional optical methods of research, several fundamentally new methods have come into being. These are, first, radio astronomy, and, second, extra-atmospheric methods of research, which have made it possible to register the X-ray, the remote ultraviolet and infrared, and the gamma-radiation from space, and which have also made it possible directly to study the Moon, the planets, and inter-planetary space.

The horizons of the observable Universe have been greatly broadened. Apart from the solar system and our Galaxy, astronomers are now concentrating their attention on studying the metagalaxy, a gigantic world of stellar systems and other extra-galactic objects. The most distant of these objects known to us today are at distances of the order of 15,000 million light years away. Major fundamental results have been obtained by systematically studying "conventional" astronomical objects, which make up cosmic systems--planets, small bodies of the solar system, stars, and the diffuse gas-dusty matter. What is most substantial, however, is that as our knowledge of the Universe rapidly becomes broader and deeper, we are not only discovering ever new, often surprising, properties of already known objects (e.g., the flare activity of many stars), but are also discovering objects qualitatively different from anything that astronomy dealt with before.

These are non-steady-state objects, in which there occur turbulent processes that often take the form of explosions, decay, and disintegration. Along with the phenomenon of the non-steady state of our Universe, the metagalaxy, a phenomenon discovered fairly long ago, mention should also be made, first of all, of the activity of the nuclei of galaxies. The nuclei of galaxies are bodies of a hitherto unknown type, in which there take place extremely violent non-steady-state processes, accompanied by the

generation of fantastic amounts of energy (10^{59}—10^{62} ergs, according to present-day evaluations). Mention should, furthermore, be made of the discovery of non-steady-state groups and clusters of galaxies, non-steady-state stellar groups—stellar associations and super-associations—and superdense stars, or pulsars.

It is thus a notable feature of the revolution in contemporary astronomy that the science of the skies has entered a period of most important discoveries, which are revealing fundamentally new and, furthermore, ever weirder phenomena.

Considerable success has been achieved in constructing well-substantiated theories and models of many phenomena, objects, and processes in the Universe, and in incorporating them in the general system of physical learning.

Astronomy is a proving ground for contemporary theoretical physics. Many scientists consider that the physical concepts, laws, and theories known today are in principle sufficient to interpret the entire diversity of conditions and phenomena in our Universe. Advances in extending the applicability of the laws and theories of contemporary physics are indeed highly impressive. Nevertheless, there is no denying that the construction of theories of many non-steady-state objects in the Universe (for example, active nuclei of galaxies and the processes taking place in them) invariably encounters difficulties. In their attempts to overcome these difficulties scientists are making use of theoretical lines of reasoning involving the most extraordinary and extravagant possibilities of relativistic and quantum physics (i.e., the idea of gravitational collapse). But these constructions, too, have so far been unsuccessful.

Should the theories of non-steady-state processes in the Universe be constructed within the framework of the fundamental laws of contemporary physics, they are certain to be so unconventional that there is every reason to conclude that the revolution in astronomy has spread to the sphere of theoretical notions about the Universe as well. But it cannot be excluded that the construction of adequate models and theories of the active nuclei of galaxies and the processes taking place in them will require evolving more general fundamental physical theories than are known today, theories, applicable to situations where gravitational, relativistic, and quantum phenomena are equally important. In that case the revolution in astronomy will have brought about new, revolutionary changes throughout the entire system of physical learning.

Contemporary astronomy has made an appreciable contribution to evolving a scientific picture of the world. Here we must note, first of all, the establishment of certain real features of the structure and, especially, of the evolution of the Universe. The evolving Universe--which is not only expanding, but literally "exploding"--is, probably, just as unlike the static Universe portrayed by astronomy at the beginning of our century as our contemporary notions of the variability and transmutation of atoms and elementary particles are unlike the indivisible atoms of classic physics.

What is more, astronomy has raised several complex problems that, by virtue of their very nature, can be solved only through the interaction of many sciences. One example is the problem of the possible existence of cosmic civilisations and of establishing contacts with them. Quite obviously, the solution of such problems will be of tremendous significance not only for astronomy itself, but also for the whole of natural science, since it will help to make the natural scientific picture of the world broader and deeper still.

Progress in studying the Universe is bound up indivisibly with profound, actually revolutionary, changes in the philosophical foundations of contemporary astronomy. Studies of the Universe--in some cases consciously, in many others spontaneously--are guided by the principles of materialistic dialectics. In the first place, these principles are applied here in a form specifically refracted through the prism of

the theoretical cognitive corrolaries of contemporary physics. In the second place, dialectics exerts an ever greater influence on the methodological principles of the study of the Universe (this has been considered in detail in several of our earlier papers[1]). Finally, in the third place, all the turning points in the evolution of astronomy have involved problems of world outlook. The struggle of philosophical trends over these problems, especially in recent decades, has been developing under the dominant influence of Marxism.

3. Relativistic Cosmology in the Mirror of the Struggle of World Outlooks

Acute clashes of world outlooks over contemporary astronomy flared up in connection with the emergence of relativistic cosmology. The picture of the space-time properties of the Universe on a large scale painted by relativistic cosmology drastically contradicted traditional views. Here are some of its basic features: the curvature of the space of the Universe--a property (described by non-Euclidean geometry) that cannot be visualised graphically; the possible closed, i.e., finite, character of space (although the notion of open, i.e., infinite, space is equally compatible with theory); the non-steady state of the Universe; the existence of a single "initial moment" on the cosmological time scale, which means that the "age of the Universe"--the interval of time since expansion began--cannot be infinitely great, and the expansion of the Universe from a small volume (formally even "from a point"). Relativistic cosmology required that several fundamental physical concepts--space, time, and infinity--be given more exact and general form.

It should be recalled that the radically new notion of the non-steady state of the large-scale Universe was given weighty support 25 years after the discovery of the destructibility and transmutation of atoms and practically simultaneously with the birth of quantum mechanics. For contemporaries these were closely interrelated links in a single chain of events, which had brought about a cardinal change in the old and the emergence of a new picture of the world.

Little wonder that many natural scientists and philosophers who, adhering to the school of "physical idealism", spoke of the "dematerialisation" of the atom, drew similar philosophical conclusions with respect to relativistic cosmology. Especially active in this respect were the well-known British astronomers James Jeans, Arthur Eddington, and Edward Milne, who invoked the expanding Universe to back up their religious beliefs. They were followed by numerous idealistic philosophers, theologians and other outright obscurantists. This interpretation of relativistic cosmology from the standpoint of the religious world outlook was based on the following premises: 1) the material Universe originated through an act of "creation" by a divine being (creationism) and 2) the evolution of the Universe is a process of continuous degradation. Without any particular changes, this "interpretation" of relativistic cosmology has survived to our day.

On the other hand, some materialists (who actually adhered to non-dialectical materialism) were unable to achieve a correct understanding of the essence of the changes that 20th-century astronomy had introduced into our knowledge of nature. They realised that the earlier, customary picture of the Universe had come into conflict with relativistic cosmology. But from this the advocates of these views drew the profoundly erroneous conclusion that relativistic cosmology contradicted the materialist outlook irreconcilably. They denied the second law of thermodynamics as a physical law because it supposedly leads to the "thermal death" of the Universe, etc.

It goes without saying that such a nihilistic approach to relativistic cosmology, far from following from materialistic dialectics, is profoundly alien to it. Our philosophy in no way imposes any "world scheme" on natural science, still less does it impose any notions founded on a mechanical

picture of the world or what is known as "common sense". Lenin pointed out: "It is, of course, sheer nonsense to say that materialism... necessarily professed a 'mechanical', and not an electromagnetic, or some other, immesurably more complex, picture of the world of <u>moving matter</u>."[2] The discovery of "weird" phenomena as a result of every new breakthrough into previously inaccessible areas of nature provides one of the most striking confirmations of the dialectical principle of the inexhaustibility of the material world. The non-steady state of the large-scale Universe and its expansion loom large on the list of such phenomena.

This would seem to be a matter scarcely requiring detailed consideration. But the point is that many of the opponents of materialism to this day ascribe to materialistic dialectics such views which have absolutely nothing in common with it. In many cases such attempts betray an obvious tendency to distort the Marxist world outlook as far as it concerns contemporary natural science. In certain other cases they are, probably, due simply to an inadequate acquaintance with our philosophy.

This appears to be the only possible explanation, for example, for the statement made in this sense by the outstanding physicist Werner Heisenberg. Quoting certain erroneous assertions made 25 years ago (<u>sic!</u>), Heisenberg claimed, without adducing any arguments, that "Soviet philosophy" was unable to "cope" with relativistic cosmology.[3] In actual fact, however, one no longer encounters practically any instances of a nihilistic attitude to relativistic cosmology in Soviet philosophical or scientific literature. Moreover, in the past too this was the approach of by no means the majority of our scientists, especially those familiar with the subject. On the contrary, in many papers relativistic cosmology was treated as an important new stage in studying the properties of the large-scale Universe. At the same time it was pointed out that the models of the homogeneous isotropic Universe constructed at the first stage of the development of relativistic cosmology were too simplistic. The Universe is in reality far more diverse and complex than these schemes.

In this sense what is needed and is natural is a critical (precisely critical rather than nihilistic or, conversely, "apologetic") approach to existing cosmological models and schemes. Relativistic cosmology as a definite trend of scientific exploration and as a promising research programme is one thing. The extent to which this programme can be realised today, on the basis of available observation data, is quite another.

A large number of "models of the Universe" have now been constructed—both within the framework of relativistic cosmology and on the basis of schemes in which relativistic cosmology is somehow generalised. Many of these models have proved very useful in framing opinions concerning the properties of the large-scale Universe. It is well known, however, that corollaries derived from a mathematical model always depend substantially on the initial assumptions made in constructing it. In cosmology the extent to which these premises are in keeping with objective reality can to a certain extent be verified by analysing the models of the Universe from the standpoint of the system of physical knowledge, grounded on preceding scientific progress (a certain role can be played in this by various intra-theoretical criteria and principles). But the basic, decisive factor was and remains the empirical criterion—the correlation of these models with the sum-total of established facts. Any of the mathematical "models of the Universe" claiming to correspond to the truth must take the fullest possible account of at least the fundamental facts concerning the Universe at the disposal of contemporary astronomy.

Unquestionably, many of the relativistic models of the Universe accord with the red-shift law, whereby the relative velocities at which metagalactic objects are receding from one another are proportional to the distances between them. At the same time most of these models are based on the assumption that the Universe is homogeneous. In other words,

they ignore the fact of the "insular" structure of our metagalaxy, of the discrete distribution of matter in it.

This discrete character is reflected in the extremely inhomogeneous distribution of stars in the galaxies. For their part, the galaxies themselves (which in most cases may be considered fairly autonomous, isolated systems) are not distributed in space at all uniformly—they form groups and clusters. In effect, the entire observable region of the metagalaxy consists of a gigantic number of such groups and clusters of galaxies. The often expressed viewpoint that the spatial distribution of these groups and clusters is rather conspicuously homogeneous, cannot be accepted. There are weighty grounds for considering that the clusters of galaxies form what are known as superclusters. Indeed, we may suspect the existence of inhomogeneities of even greater scale in the distribution of matter.

Models of a homogeneous Universe are thus opposed by the real Universe, whose fundamental property is an inhomogeneous distribution of matter. This is a fact that cannot be ignored.

From this it follows that models of the Universe built on such vulgar simplifications as the assumption concerning the homogeneous distribution of matter scarcely deserve to be treated as some fetish. Many corollaries from these models are by no means trustworthy, since they are due precisely to oversimplified initial assumptions made to facilitate calculations. The further development of relativistic cosmology, it seems to us, must proceed in the direction of describing the properties of the inhomogeneous Universe (interesting work in this respect has been done, for example, by the Soviet cosmologist A.L.Zelmanov).

Without in any way justifying mistaken interpretations of relativistic cosmology, it has to be noted that at the initial stage of its development a certain measure of sceptical attitude to it, paradoxically enough, was displayed even by scientists whose work contributed the most to progress in this area of science. Albert Einstein, who founded relativistic cosmology, at first described the conclusion concerning the non-steady state of the Universe as "suspect" (he later acknowledged his error). Edwin Hubble, who discovered the metagalaxy and the "red-shift law", also leaned towards the view that the metagalaxy is not expanding. These doubts entertained by eminent scientists had widespread repercussions, they were exaggerated by others, while less competent people (scientists and non-scientists alike) often turned them into a direct denial.

Scientists working within the framework of materialist dialectics have for several decades now been providing interpretations of relativistic cosmology that would make possible a well-founded critique of all forms of creationism.

These conceptions proceed from an analysis of the question: what is the Universe as an object of cosmology? In other words, the properties of what system (or, perhaps, what systems) are described by various cosmological models? This is by no means a simple question. After all, no empirical means (unlike the objects investigated by the overwhelming majority of other natural sciences) have isolated the object of cosmology: the Universe a whole. It can only be extrapolated.

The most widespread viewpoint today is the traditional one that the Universe as a whole comprises "everything existing" in a certain absolute sense or the "totality of all things", i.e., the entire material world viewed from the standpoint of its physical-astronomical properties (the global aspect of the material world). Ours is the sole Universe, there are no others. This means, for example, that the space-time "worlds" considered by cosmology encompass the whole of space-time, etc. This viewpoint may therefore be traced to the understanding of the Universe as a whole that Aristotle championed in his day.

According to another viewpoint, the Universe as an object of cosmology is "everything existing" not in some

absolutely general and final sense, but merely <u>from the standpoint of a certain stage of practice and cognition</u>. None of the "models of the Universe" will be able to encompass the global features of the inexhaustible material world. Every major "broadening of horizons" in astronomy (on the empirical or theoretical level) will compel us to expand the totality of physical objects that we consider to exist; in this way the concept of the "Universe as a whole" will be generalised again and again. Our Universe, the metagalaxy, is not the only one. It is quite possible to assume the existence of other Universes (metagalaxies), too--relatively autonomous or quasi-enclosed systems with the most diverse properties.

True, this gives rise to a difficulty of a terminological nature. The term "Universe" has for centuries been used to mean the "material world". Our viewpoint, evidently, requires rejecting that tradition. The term "Universe" is regarded as a generic cosmological term; it denotes a physical system of a maximum order and scale known to contemporary cosmology. The term "material world" is philosophical and is used in the sense of "matter". Such a separation of concepts is quite a customary procedure in science. The concept of matter was at one time associated with a historically transient level of cognition of its concrete properties (it was identical, say, to the term "substance"). Lenin, when analysing the lessons of revolution in 20th-century physics, gave a definition of the philosophical concept of matter freed from the constraint of a link with any concrete physical properties of material objects.[4]

Similarly the philosophical concept of causality in materialist dialectics is immeasurably richer and broader than Laplace's concept of determinism, which characterise only one of the forms of causality. In exactly the same way it proves necessary to distinguish the infinitely diverse, inexhaustible material world and those of its fragments that have entered the sphere of practice and cognition, the biggest of which (in scale and magnitude) is the Universe (Universes), studied by cosmology.

This standpoint is, in our view, confirmed, for example, by the interesting ideas concerning the connection between the micro- and mega-worlds (for example, the hypothesis of friedmons), which are now being developed with success by a number of physicists.

This generalises, as it were, the old idea about the multiplicity of worlds formulated by ancient thinkers. It now, however, implies not a multiplicity of worlds in the Universe, but a multiplicity of the Universes themselves. Of course, all these numerous Universes (apart from our own) are for the present purely hypothetical objects. However, the fact that their construction by means of theoretical physics is conceivable compels us to treat the idea of the multiplicity of Universes in earnest. This idea--as far as can be judged from the present-day situation--is slowly but surely gaining ground as one of the most substantial components of the picture of the world offered by natural science. But the dilemma of one or many Universes will ultimately be resolved only by new empirical data. For the present, we can, naturally, speak only of ways of formulating the problem.

Clearly, this dilemma has a most direct bearing on the problem of man's status in the world. Even in its simplest variant--the theory of a homogeneous isotropic Universe--relativistic cosmology has advanced further along the road of eliminating anthropocentrism, the first step along which was taken by Copernicus.

If our Earth is a rank-and-file planet revolving around a rank-and-file star situated in a peripheral region of a rank-and-file stellar system, the Galaxy, which, in turn, is only one of many thousands of millions of such systems, and if, furthermore, all points (and all directions) in the Universe are equal, any notions about the exclusiveness of our status in the Universe prove untenable. Indeed, the

concept of the multiplicity of Universes takes us much further. If the metagalaxy is not an all-embracing system, but merely one of many such systems, the status of our (as, for that matter, of any other) civilisation in the world proves even humbler.

The next important question is that of the extent to which cosmological models based on such simplifications as the principles (or postulates) of the homogeneity and isotropy of the Universe may be considered adequate reflections of objective reality. As stated earlier, many arguments--theoretical as well as empirical--compel us to take the view that these postulates represent a very rough approximation of reality, applicable only as a first step in constructing a cosmological theory. The further development of cosmology must result in our taking into account the structural nature of the Universe (its large-scale inhomogeneity). Such extremist conclusions as, for example, the concept of the "zero radius" of the Universe at an "initial moment" of time, which even now seem the result of little founded extrapolation, will then almost certainly be discarded as direct consequences of crude oversimplified assumptions.

Whichever of the above two viewpoints regarding the object of cosmology ultimately proves closer to reality, neither leaves any room in the Universe for any supernatural forces.

Let us assume that the viewpoint that proves correct is the one according to which the theory of the expanding Universe has as its object the entire totality of "all matter" (which, in our view, seems less probable). But even in that case there will be no grounds--needless to say, except prejudice seeking at any cost to "harness" cosmology to the dogmas of the creationists--for claiming that any "act of creation" took place. Fully applicable to the state of very high density at the "initial moment" (which gave rise in the course of further processes to the present structure of the Universe) are the following words of

Frederick Engels regarding Immanuel Kant's idea of primordial nebula: "It is primordial nebula, on the one hand, in that it is the origin of the existing celestial bodies, and on the other hand because it is the earliest form of matter which we have up to now been able to work back to. This certainly does not exclude but rather implies the supposition that before the nebular stage matter passed through an infinite series of other forms."[5] If, however, we accept the more logical standpoint that the metagalaxy embraces not the entire material world, but its finite and moreover limited region, the creationist speculation over contemporary cosmology appears even more scientifically unfounded.

Nor does the assertion about an inevitable "thermal death" of the Universe find any support in relativistic cosmology. Relativistic thermodynamics prompts the conclusion that the Universe will never reach the state of "thermal death", even should entropy increase boundlessly. The irreversible development of our Universe will never cease. Any of its states can prove final only in a relative sense—as the conclusion of a certain process of development, which will give rise to ever new states or forms of moving matter. The same, from our standpoint, must be true of other Universes, whose existence can be assumed, and even more so of the potentially infinite totality of such Universes.

This means that evolutionary, relativistic cosmology proves compatible, in terms of world outlook, only with the principle of the infinite self-development of matter, which is one of the "cornerstones" of materialism. But this does not exhaust its role in solving problems of world outlook. Highly substantial too is the fact that contemporary natural science is gradually discerning the links between the expansion of the Universe and the preparation of the conditions for the origin of life and intelligence. It is becoming apparent that life and intelligence can evidently develop in by no means any cosmological conditions. These conditions were lacking at the early stages in the evolution of our Universe. They must become less and less favourable in

oscillating Universes at the later stages of their compression. And since the birth of a cognitive subject requires definite conditions on a cosmological scale, it may well prove, as A.L.Zelmanov has pointed out, that certain processes in the Universe take place "without witnesses". But from this it does not at all follow that they are "unknowable". On the contrary, contemporary astronomy provides convincing proof that even phenomena and processes that took place thousands of millions of years ago or else in remote regions of the Universe, can be reconstructed in the system of scientific learning. This is achieved by carefully studying the "traces" they have left behind in the present state of the Universe or some specific cosmic system. Astrophysics furnishes numerous examples of this.

4. Astrophysics and World Outlook

The problems of world outlook raised by astrophysics are being solved under the dominant influence of the ideas of materialism and dialectics. However, here, too, opposite influences make themselves felt from time to time.

One such problem, discussed especially heatedly a few decades ago, was precisely the problem of whether the past (and future) of cosmic systems could be studied objectively.

The cosmogonic conception of James Jeans was at that time almost generally accepted. It followed from that conception that all stars and stellar systems had arisen approximately at the same time, at some distant epoch (perhaps, hundreds of thousands of millions or billions[6] of years ago) and are not formed any longer today. But if this were the case, obtaining any reliable knowledge about the processes of star formation was, as Jeans considered, practically out of the question. By studying the confused "traces" of these processes, more or less plausible hypotheses could, of course, be constructed. But they would always remain nebulous and rather subjective lines of reasoning—nothing more. What actually took place would never be learned at all reliably. According to an even more extreme viewpoint, the scientific solution of such problems ultimately results in impasse. Such candidly agnostic views nurtured creationist concepts. Advances in astrophysics have, however, completely demolished all such arguments.

Soviet astrophysicists have established that stars arise not individually, but in groups and clusters, and that various stellar groups and clusters differ in age. Some are old, their age being comparable to that of our entire stellar system, the Galaxy, while others are literally "new-born". The discoveries included that "centres of star formation"--stellar associations--followed by super-associations, moreover in other galaxies as well as our own. It became evident that the process of the formation of stars from pre-stellar matter can in principle be observed directly, and we now stand poised to accomplish this. Many of the laws governing star formation are already known. Unfortunately, the nature of pre-stellar matter and the mechanism of its transformation into stars has not yet been elucidated.

Two research programmes and, accordingly, two conceptions compete in this field: a) the traditional, or classic, conception, which is founded on the idea expressed in general philosophical form by the thinkers of ancient times, namely, that stars arise from diffuse matter as a result of its condensation, and b) the non-classic (sometimes referred to as the Byurakan) conception, namely, that stars and diffuse matter arise in the course of the directly opposite process: the disintegration of massive and dense or even superdense bodies. Similar conceptions compete with respect to galaxy formation. Our viewpoint is that all stars, stellar groups, and subsystems in galaxies arise through the activity of the nuclei of corresponding galaxies (the substance of the nuclei is in a state as yet little studied by physics). It is the diverse forms of the activity of nuclei that account for the emergence, inside galaxies, of bodies that turn into stars and diffuse nebulae.

Whereas the former conception is developing within the framework of the contemporary quantum-relativistic picture

of the world, and represents its extension to the area of astrophysical phenomena, the latter conception proceeds much further. In a certain sense it may be regarded as the "seed" of a new, not yet created picture of the world, which will be based on more general fundamental physical theories than are known today. Such a picture of the world will have to be developed in detail once it becomes evident that the active processes in the nuclei of galaxies (and, at any rate, some of the other non-steady-state processes in the Universe) cannot be accounted for by applying only the laws and theories of physics that we know today.

Some astrophysicists believe that the attempts to interpret these processes within the framework of known physical laws have not yet produced any obvious fundamental difficulties or contradictions. The conditions existing in all the astrophysical objects known to us today, they maintain, are not so extreme that adequate models cannot be constructed for all these objects without resorting to radically new explanations. A colossal amount of work to build models of the inner structure of various cosmic bodies has been carried out on the basis of this research programme. These models take into account part of the known facts characterising the real properties of corresponding objects. But, besides this, some more or less still hypothetic assumptions were made in constructing these models. For example, in constructing models of the inner structure of stars (many of which it is customary to consider fairly well founded), thermonuclear fusion reactions of this or that type were assumed to be the source of stellar energy. For the Sun in its present state what is known as the proton-proton reaction is considered to be the main mechanism of energy generation.

Until recently no direct verification of stellar models appeared possible. Such verification was limited to indirect procedures, moreover by no means guaranteeing reliable results--to "matching" the theoretical quantities characterising the mass, luminosity and radii of the models of stars at consecutive stages of evolution with the corresponding quantities obtained from observations.

But the astonishing advances of astrophysics in recent years have partly changed this state of affairs. The theory of the inner structure of stars predicts that the thermo-nuclear fusion reactions in the interior of stars must give rise to a neutrino flux of definite density. These particles must--practically without interacting with the substance of the star--emerge and disperse in space. It has now become possible to experimentally register the neutrino flux from the Sun. However, in the course of numerous and ever more refined experiments no neutrinos of solar origin have been registered. This has produced a glaring contradiction between the empirical data and contemporary models of the inner structure of the Sun.

One other contradiction should be noted. An extremely interesting investigation (whose results have already been published) was carried out recently at the Crimean Astro-physical Observatory under the supervision of Academician A.B.Severny. The crux of the matter is that this investiga-tion has revealed a pulsation of our Sun--true, not a very significant one--and determined its period. Pulsating stars have long been known in astrophysics, and their theory is well established. But in the case of our Sun the phenomenon of pulsation is entirely new and unexpected. It is also entirely at variance with the hitherto accepted models of the Sun's inner structure and casts a very dark shadow upon them.

Considerably more numerous and serious are the dif-ficulties and contradictions encountered in attempting to construct--on the basis of known physical laws and conven-tional notions--models of the active nuclei of galaxies and certain other "exotic" objects discovered by contemporary astrophysics. And although it cannot be ruled out completely that such attempts will succeed, this appears to be less and less likely. The new facts, far from helping to overcome existing difficulties and contradictions, often even tend to heighten them.

Also worth mentioning is what is known as the "paradox of mass", which has lately again attracted the attention of astrophysicists. This paradox consists in the following. If we assume that a cluster of galaxies is stable, we can evaluate the average masses of its constituent galaxies. These quantities (dynamic masses of galaxies) turn out to be unrealistically great, which is sharply in conflict with the estimates of the masses of galaxies obtained by other methods (say, from the luminosity of galaxies). The dis-crepancy is sometimes of the order of several ten-or even hundred-fold. Such a "mass paradox" is characteristic not only of clusters, but also of many double or multiple galaxy systems. Yet it can be accounted for fully if we assume that the initial premise about the stability of clusters is actually wrong, i.e., that clusters are not in the steady state, but are expanding and disintegrating systems.

This last conclusion, reached by Soviet astrophysicists as far back as the 1950s, has since received diverse support --amazing instances at the dynamic instability of many sys-tems of galaxies have been discovered. On the other hand, attempts have been made to refute this conclusion. It is assumed, for example, that within the clusters of galaxies there may exist enormous masses of "concealed", invisible matter. These masses were not taken into account in the papers that contained the conclusion concerning the instabil-ity of clusters. Hence, the "mass paradox".

Such considerations cannot, of course, be scrapped entirely. But they do seem rather artificial. In order to construct models of stable clusters of galaxies it is in some cases necessary to assume that about 99 per cent of the total mass of the clusters is concentrated in forms of matter that we do not observe.

What need is there to strain our imagination in this way? The fact is that if clusters of galaxies were formed by the condensation of diffuse matter, they would in all cases be stable systems. There consequently arises a con-tradiction between the conception of the formation of galaxies based on conventional ideas and what is one of the most fundamental conclusions of contemporary astrophysics. The quest for "concealed mass" in clusters of galaxies is evidently due, above all, to the wish to resolve this contradiction, or, at any rate, to make it less acute. But there are sufficiently many weighty grounds for considering that attempts to resolve the "mass paradox" in this way will prove ineffective. A different approach appears to us to hold out much greater promise. Astrophysics often comes up against unexpected phenomena and regularities, which could not be predicted on the basis of the existing system of knowledge and which do not always fit into the contemporary picture of the world. The detailed quantitative development of the model of this or that astrophysical object seems expedient only after its empirical characteristics have been studied sufficiently thoroughly and comprehensively. This makes it possible to construct a model of the object without too conjectural or arbitrary assumptions.

It is along this path that several fundamentally new facts and empirical laws have been discovered, which, it is becoming increasingly clear, can be explained only by generalising the system of known physical laws and constructing a new physical picture of the world.

Whichever of the two aforementioned conceptions proves correct (the emergence of entirely new ideas cannot, of course, be ruled out either), both are clearly based on the principles of the materialistic world outlook applied specifically to astrophysics. It is especially important that both conceptions are founded on the principle of the selfdevelopment of matter, whose motive force is the interaction and conflict of contradictions. These conceptions differ not in the world outlook in which they are rooted, but in their connections with different natural scientific pictures of the world. They are of added value in solving problems of world outlook because the study of the processes of cosmic evolution brings us right up to gaining an understanding of the concrete conditions in which life and intelligence arose in the Universe.

5. Man and the Universe: the Problem of Extraterrestrial Civilisations

Many important problems of world outlook have been raised in connection with the proposals to seek extraterrestrial civilisations and the debate over the possibility of establishing contacts with them. For the present we must confine ourselves to formulating these problems and to the most initial attempts at tackling their solution. Actually, we stand on the threshold of understanding how deep and, at the same time, how complex these problems are.

At first glance, discussing any problems of this kind may seem a rather sterile occupation. After all, no extraterrestrial civilisation has yet been discovered; what is more, it is unknown whether they exist in general. Nevertheless, it has to be admitted that problems of world outlook connected with this multifaceted trend of scientific enquiry unquestionably deserve attention.

Even in the (almost incredible) case of all quests for extraterrestrial civilisations proving ultimately completely unsuccessful, the discussion of these problems can still be of great benefit. The point is that all such discussions have a most direct bearing upon our own civilisation. When, for example, it is estimated how many other intelligent civilisations there may be in our Galaxy capable of establishing contact with us, inevitably such estimates are based on an assumption of their anthropomorphic character and on a similarity of the course of their technological development with that of our own civilisation. Whoever estimates the probability of the origin of life on planets orbiting other stars of the Galaxy inevitably "has to" bear in mind the conditions in which life arose on Earth. When discussing the problems of the origin of intelligence (and civilisation), we likewise adopt as our initial premise the assumption that extraterrestrial intelligence possesses essential features of our own intelligence. Finally, when we consider the problems of the technological development of cosmic civilisations, we inevitably analyse contemporary and possible future features of our own technology. When speaking of the problems of world outlook connected with extraterrestrial civilisations, we thus inevitably view, as it were, "from the sidelines" or "from a cosmic standpoint" our own civilisation and the prospects of its development.

This approach is, therefore, highly limited. To us, dialectical materialists, it seems almost obvious that in actual fact there may exist a great diversity of forms of life and intelligence, and types of civilisations and technologies, in the Universe. Furthermore, the concept of an extreme diversity of life forms being possible in the Universe (specifically, non-protein life forms) is fully shared by many natural scientists in other countries, whose philosophical views are not Marxist. It is extremely indicative that not only science-fiction writers, but many specialists in the most diverse fields of the learning have in recent years earnestly analysing these problems.

One of the most important groups of problems raised by this trend of enquiry is that of analysing the very concept of "cosmic civilisation", and of the possible laws and rates of their development. These problems are usually likewise considered by extrapolating the general trends of the development of our own civilisation. This part of the problem of extraterrestrial civilisations is particularly intimately connected with the most topical problems of our times. A whole series of parameters characterising the development of our civilisation are now increasing exponentially (as functions of time). Such growth can scarcely continue without limit. Theories are now put forward abroad to the effect that the technological development of society will inevitably in future assume a different character, that it will reach a steady state, as it were. The sum-total of the parameters determining the level of technological

development will be maintained constant in time. In connection with the problem of extraterrestrial civilisations such views have been expressed, for example, by Professor Gunther Stent of the United States, who also considers that in future the prevailing trend will be one of "reconciliation" with nature rather than the tendency to dominate it. Such an extreme standpoint actually predicts an end to the technological development of society and has to be subjected to a detailed critical analysis. It would appear quite rational to assume that the exploration of outer space and the harnessing of its resources will help to mitigate the difficulties that may arise before society in maintaining a process of continuous technological development according to some law probably differing from the exponential. (In speaking of the process of space exploration, which has a decisive effect on many substantial features of the contemporary scientific and technological revolution, use is often made of the term "cosmisation". But it is usually forgotten that this is merely one aspect of a contradictory process, whose other aspect is the "humanisation" of outer space, its incorporation in the sphere not only of the cognitive, but of the practical activities of the human race, including its production activities).

Another question often raised in connection with the problem of extraterrestrial civilisations is that of the time boundaries of the epoch of the technological development of society. The well-known American astrophysicist S.von Hoerner considers that this epoch is very brief (of the order of tens or hundreds of thousands of years, or possibly a few million, and ends inevitably in the "suicide" of society). A different viewpoint has also been voiced, namely, that the technological development of society is limited only by cosmogonic and cosmological factors, that is, that it can continue thousands of millions of years. Konstantin Tsiolkovsky put forward a third viewpoint—that society is possibly immortal. He considered that a change in the conditions of life of any civilisation or the exhaustion of the resources for its technological development will prompt it to resettle in some other region of the Universe where the necessary conditions and resources are available. There will also be mutual assistance between various cosmic civilisations (at the high level of development they will have attained their social system will be communist). The problem of the development time of cosmic civilisations is likewise highly interesting in terms of the conflict of world outlooks and requires further consideration.

It is clear that any one of the aforementioned standpoints constitutes not so much a "final" solution of this problem as some possible "projection" into the future of our present-day notions concerning the prospects of the development of mankind. A reliable foundation in terms of world outlook for approaching such problems is, naturally, provided only by Marxist-Leninist philosophy.

A final remark concerning the problem of contacts with extraterrestrial civilisations. Undoubtedly, the discovery of the very first extraterrestrial civilisation may be of tremendous importance for the scientific and technological progress of humanity. This will be an event of the same order as the launching of the first artificial Earth satellite or the achievement of a nuclear reaction, if not more important. The question arises, however: will we be able to understand each other in the course of such a contact and to exchange meaningful information? It would be naive to think that such mutual understanding will be achieved simply and easily. Quite possibly each cosmic civilisation has its own mode of reflecting the world, so that our pictures of the world will by no means necessarily coincide (incidentally, this is another reason why anthropocentrism is unfounded). Meaningful contact will be further hampered by language and certain other difficulties. For the present we are at the stage where it is difficult to choose even the approach to these problems. It seems to us that in the matter of choosing the correct scientific

approach to them a very useful role will be played by philosophical considerations founded on the creative application of materialist dialectics.

* * *

Thus the revolution in contemporary astronomy has raised a whole series of fundamental problems of world outlook; we have been able to dwell (briefly of necessity) on only some of them. Unquestionably only Marxist-Leninist world outlook, the only scientific world outlook, makes it possible to find new ways of advancing natural science and solving its problems of world outlook in conflict with anti-materialistic speculation. Accordingly, we would like to conclude our paper with Lenin's fine words: "...For the materialist the world is richer, livelier, more varied than it seems, for with each step in the development of science new aspects are discovered."[7]

NOTES

[1] See Social Sciences No.4, 1971, and No.2, 1973.

[2] V.I.Lenin, Collected Works, Moscow, Vol.14, p.280.

[3] Werner Heisenberg, "Naturwissenschaftliche und religiöse Wahrheit", Physikalische Blätter, 1973, No. 8, p.346.

[4] See V.I.Lenin, Collected Works, Vol.14, p.129.

[5] Frederick Engels, Anti-Dühring, Moscow, 1954, p.84.

[6] The term "billion" is used here in the British sense as meaning a million millions.--Ed.

[7] V.I.Lenin, Collected Works, Vol.14, p.129.

CONTEST OF PHILOSOPHIES IN BIOLOGY

Academician Nikolai DUBININ

The philosophical contest in biology has special significance because biology concerns human and biospheric problems.

The principal concepts of the opponents of Marxist-Leninist philosophy in science are neo-positivism, metaphysical materialism, and theoretical constructions derived from idealism.

Neo-positivism—a widespread, subjective-idealistic trend in bourgeois philosophy—lays claim to having established a special "logic of science", supposedly superior to materialism and idealism. The goal proclaimed by neo-positivism is the "salvation" of science from the diktat of philosophy through developing the logic of language; neo-positivism seeks to project itself as a philosophical basis for "scientific empiricism".

Metaphysics in contemporary biology primarily takes the form of extending the laws governing the lower forms of motion to the higher, rejecting the structural-systems principle, and treating the living cell as a machine. This has been expressed most articulately in recent years in the philosophical writings of the well-known French molecular biologist Jacques Monod.[1] Monod, oblivious of the qualitative distinctive features of the biological form of motion, treats the problem of life and the problem of man from the standpoint of metaphysical materialism.

Tremendously important to biological problems is the study of the essence of genetic information, an area in which there have developed objective-idealistic approaches. The Catholic philosopher Ewald Wasmuth,[2] in an examination of the principle of information, claims that information possesses Aristotle's "forms", i.e., eternity and immutability, which distinguish it from other objects and phenomena.

There are many such examples, for the ideological front in biology is exceptionally broad. It embraces the problem of the essence of life, the fundamentals of evolution in the organic world, and the problem of man. Major methodological and social principles, and also associated practical recommendations, are treated differently depending upon the philosophical postures of the scientists concerned. As focal points of this ideological struggle of our day I would single out the differences over the problem of human genetics and the basic approaches to understanding the essence of life.

Philosophical and Social Aspects in the Problems of Human Genetics

The problem of man is a most acute contemporary problem. Man is a product of history, his consciousness is shaped by the concrete historical experience of mankind. These principles of Lenin's teachings concerning man have been given weighty backing by the present-day analysis of the relationship between the social and the biological. In his biological features man is part of nature. The social, on the other hand, concerns the suprabiological sphere, it is inherited from generation to generation outside the sphere of genetical information encoded in DNA molecules.

Claims that a spiritually new man is created by a change in his social status encounter frenzied resistance.

Of course, no one denies the influence of the environment on the development of the human personality—in this sense both heredity and the environment are recognised as valid influences. Everything, however, hinges on the problem of what has to be changed to mould a new man—heredity, the environment, or both?

It is the very essence of the biologising approach that its supporters, behind a smokescreen of statements about the combined influence of heredity and the environment, claim that without changing heredity it is impossible to change the spiritual nature of man as he exists today.

Konrad Lorenz[3] and others declare that there is no such thing as a humane man on our planet. He can be created, they claim, only provided man's genetic make-up is changed.

Biologising approaches to man have a remarkable survival capacity. The reason for this has class roots. These approaches arose in the epoch of slavery and colonialism; in the epoch of 19th-century capitalism they assumed the form of race theory, social-Darwinism, and eugenics. In our day these approaches are directed against the great goal of moulding a new man by changing the social conditions of his life. And they are trying to find support in the advances of the new genetics.

The past century saw the birth of eugenics, which set itself the aim of breeding superior races of men in the same way that a stock farmer creates new strains of animals. Racial theory divided people into superior, or leading, races and inferior races. Social-Darwinism maintained that people's social standing reflects their biological qualities and is the result of natural selection among people differing biologically.

Throughout the 20th century the question of improving man genetically—since human nature supposedly depends upon man's genes and social conditions are powerless in this respect—has been raised in the most diverse forms. The darkest episode in this history was the use of eugenics and racial theory in the preachings and practices of Hitlerism.

It is noteworthy that the advocates of the biologisation of man have always pounced on the latest scientific advances. When genetics appeared at the beginning of the

20th century, eugenics attempted to find a scientific basis in the laws of Mendel. Later, with the progress of general genetics and the genetics of man, it was argued continually that these advances created a scientific basis for developing methods of human selection to breed superior races.

In our day the idea of eugenics seeks support in the advances of population thinking and in the new vistas opened up by the achievements of genetic engineering.

The Population Concept and the Moulding of a Spiritually New Man

Population genetics began to develop following S.S.Chetverikov's discoveries in 1926. This scientific trend produced a synthesis of genetics and Darwinism, altering biological thinking on the problem of species.

Population genetics showed that the systematists were mistaken in their old typological approach, whereby judgement concerning a species was formed on the strength of the characters of a single specimen. Such an organismo-centric approach afforded no possibility of evaluating the scope or significance of individual distinctions within a population. It was shown that evolution implies changes not in individuals, but in complex, diversified hereditary population systems, with genotypic distinctions of individuals as their elements. This gave rise to the population style of thinking in evolutionary theory, in genetics, and in ecology.

But while in zoology and in botany the population style of thinking proved exceptionally promising, its absolute transfer to man produces wrong results. The reason for this is that biological foundations of populations in the case of man are characterised by qualitatively new features. Animal and plant species continually adapt to their environment through natural selection. Man, on the other hand, creates his environment himself. This fundamental difference is ignored by the prominent American evolutionary zoölogist E.Mayr, who, in defending the applicability of zoological population approaches to man, arrived at a number of reactionary conclusions.[4]

The most important thing, according to Mayr, for man's further biological development is the existence of intra-population individual distinctions. He believes that in the past mankind owed its progress to the genes of outstanding heroes (tribal chieftains), who in the conditions of polygamy handed down these genes to a large progeny. Today this process has been drastically slowed down by monogamy.

It is because of this, according to Mayr, that present-day human populations do not produce a new race of supermen.

On the strength of such population thinking, Mayr claims that his is a new approach to the problem of human races. He points out that individual variability is very great and goes on to say that it is unforgivable to attribute to individuals characters that are averages for races. However, at the same time he considers possible the existence of average distinctions in the genetic foundations of intelligence in different races. Paraphrasing this, one could say that it is a mistake to claim that every Black is less intelligent than every White; but on the average Whites have genes of intelligence in appreciably larger numbers. In this way, his population approach leads Mayr to conclude that there exist superior and inferior races.[5]

Mayr declares that to neglect population thinking is to court disaster. His solution is to improve man through genetic selection. On the strength of the very same theory of "genes of heroes", he proposes specific measures based on the assumption that people who succeed in this or that sphere of activity in capitalist conditions possess superior genes.

Mayr proposes changing taxation policy to encourage successful people to have more children. This should apply to schools, where, he maintains, high tuition fees should be imposed on the worst pupils and lower fees on the good pupils. Since the children of well-to-do parents receive better pre-school training, naturally the burden of higher tuition fees would fall on the lower-paid sections of the population.

In support of the concept that people's freedom consists in realising their genetic distinctions, Mayr puts forward the principle of formal bourgeois equality in law as the basis of social being.

Humanism has its supreme expression in the formula "from each according to his ability, to each according to his need". Accordingly, as far as the individual features of people are concerned, the object should be not to make a fetish of man's development according to his genotype, but to assure the harmonious allround development of the individual. As for the actual equality of people, no development of hereditary inclinations can bring this about under capitalism. Genuine equality of people will be achieved only under communism, with its social equality.

Mayr hopes to use the press of taxation to make selection heighten the biological distinctions supposedly existing between successful and unsuccessful people under capitalism. Scientifically this amounts to bluffing; socially, to a new racism.

A number of striking facts established in our day demonstrate the possibilities of experimental intervention into human biology and genetics. Human fertilisation has been effected in a test-tube, with an embryo developing for a week. To use a metaphor, this testifies to the possibility of producing babies in vitro.[6]

There are methods for establishing the sex of a foetus and also for detecting the presence of any of 60 severe hereditary defects before birth. In principle, many ova can be obtained from "valuable" women, fertilised in a test-tube with spermatozoa from "valuable" men, and then implanted in the wombs of genetically "less valuable" nursing women. By artificial insemination thousands of descendants can be obtained from a single "valuable" man.[7]

Frogs have been used to develop techniques for cloning the genotype of a selected individual.[8] The nuclei of intestinal epithelium cells are introduced into ova without nuclei. All such individuals repeat the genotype of the initial individual. This technique, it has been declared, can be used to clone human geniuses.

Genetic engineering techniques at the level of genes and individual molecules make it possible to alter the genetic features of cells and organisms. In one experiment it has been shown that the introduction of a definite functionally active gene from a bacterium cures the cells of a sick person.[9] This is indicated in the case of galactosemia, a severe ailment resulting in feeble-mindedness and numerous physical defects.

Thus, the "old wine" of eugenics and racism is being poured in the "new casks" of "genetic engineering". Just as the old selection approach of eugenics, so too the arguments about improving man by genetic engineering assume that genetic methods can create a human being who is humane or endowed with other forms of social behaviour. All such approaches are, however, pseudo-scientific. The human personality is shaped through the interaction of environment and heredity. However, man's spiritual make-up belongs to his suprabiological sphere, which is not encoded in his genes and is not subject to genetic evolution.

Such a solution of the problem in no way frees scientists from responsibility in matters of human genetics. In present-day conditions, in which social factors have halted the moulding influence of natural selection and in which environmental pollution by mutagenes threatens heredity, there arises a new genetics of man. It raises enormous problems, which require close links between genetics, medicine, and the theory of the biosphere. Upon its successes depends the future of man's physical being, and it has tremendous social implications.

Metaphysics or Dialectics in the Problem of the Essence of Life

In the past few years Jacques Monod has made attempts to "expose the errors" of dialectical materialism in biology.

Monod himself has adopted a posture of metaphysical materialism. The mistakenness of his approach is obvious and may be illustrated by citing the problem of mutations in the study of the essence of life.

In the matter of mutations Monod is clearly lagging behind contemporary science and clinging to views 30-40 years old. In accordance with such obsolete views, Monod absolutises the randomness of the emergence of new hereditary deviations of organisms (mutations). He writes that the emergence of mutations is supposedly "embedded in the quantum structure of matter. A mutation is in itself a ...quantum event....An event which is hence and by its very nature essentially unpredictable."[10] According to Monod, the most important thing in the characteristic of the gene is its invariant nature. He argues: "Lysenko accused geneticists of maintaining a theory radically at odds with dialectical materialism, and therefore necessarily false. Despite the disclaimers of the Russian geneticists, Lysenko was perfectly right; the theory of the gene as the hereditary determinant from generation to generation and even through hybridisations, is indeed completely irreconcilable with dialectical principles."[11]

It seems to Monod that by espousing the theory of the invariability of heredity from generation to generation, he--together with Lysenko, who adhered a diametrically opposite position--has shown the incompatibility of the theory of the gene with dialectical materialism. However, neither Monod nor Lysenko has succeeded in bringing dialectics into conflict with the theory of the gene. Monod accepts old, long rejected views in the theory of the gene.

Present-day molecular genetics has shown that every mutation is not an event unpredictable in its essence, but, on the contrary, a fully predetermined reaction, which leads to definite, in many cases predictable, chemical changes in the DNA molecules. Their causes are external factors and changes in the cell metabolism. The mutation rate is so great that in the cells there are mechanisms of natural enzymatic defence, which constantly repair damage arising in the DNA molecules.

The phenomenon of the relative stability of heredity appears, in the light of contemporary findings, to be not an eternal invariant, but a result of continual contradictory movement. Present-day molecular genetics has not only rejected the old argument that mutations are unpredictable in principle. It is exploring the problem of controlling hereditary variability and even of the directed production of mutations.

As for the problem of the essence of life, here Monod adheres to reductionist positions. In his opinion it is futile to study a system on the basis of the properties of integrity. The scientific method producing results in contemporary science, according to Monod, is analysis. Monod thinks in terms of the old central dogma of molecular biology, according to which it was assumed that information in the cell is transmitted only from DNA to RNA and then to proteins. This dogma has now been proved wrong: there is a direct feedback from RNA to DNA and RNA. Without taking these new facts into account, Monod insists that the cell is a conservative, closed system, incapable of receiving information from the outer world. In his opinion, the picture of the flow of information inside the cell "defies any 'dialectical' description. It is not Hegelian at all, but thoroughly Cartesian: the cell is indeed a machine."[12]

Viewed from such a position, the task of molecular biology consists in the maximum dismemberment of the cell into non-living objects and the study of their nature and properties. As far as molecular biology as a whole is concerned, it is supposedly a consequence of reductionism.

In actual fact, contrary to Monod's assurances, the new advances in studying the essence of life by the methods of molecular biology and genetics have clearly shown the relevance of the philosophy of dialectical materialism.

The present stage of molecular research in biology was ushered in by the establishment of the nature of the DNA molecules. This is accomplished by analysing the chemistry and physics of these molecules, and synthesising all the data concerning DNA on the basis of the theory of the gene.

The vast amount of data obtained by molecular genetics show concretely that the phenomenon of life cannot be reduced to physics and chemistry. The fact that gene organisation reflects the paramount feature of the biological form of the movement of matter constitutes an express condition for an indissoluble unity in the development of molecular biology and molecular genetics.

The phenomenon of life is founded on the trinity of matter, energy, and information. Information in a living system is a property of the matter constituting the genetic apparatus of the cell. In this case a general property of matter in the form of reflection assumes the specific form of recording in letters--nitrogenous bases in the DNA molecule. The distinctive features of this recording in DNA are reproduced in the processes of protein synthesis. The diversity of material recordings in DNA is concretely reproduced in reflection in the synthesis of many proteins. Such a characteristic of information in the living system shows how unsubstantiated are the idealistic interpretations of this matter and refutes the claim that the concept of information is at variance with the Marxist direction of scientific development.[13]

The theory of genetic information as a property of material elements in a living system and recognition that genetic information as a category is an inalienable property of a qualitatively distinct biological form of the movement of matter point to the significance of the philosophical principles of materialist dialectics for biology.

We have every reason to say that the development of contemporary molecular studies has truly led to a triumph of dialectics.

Neo-positivism assumes that philosophical analysis does not concern the material essence of objects and phenomena, and is limited to direct experience and language. The study of living systems at a molecular level brings us to an understanding of the essence of life as a specific form of the movement of matter.

Metaphysics and idealism in the form of persistent emphasis on the contention about invariant genes, views concerning the supposedly unpredictable character of mutations in principle, the attemps to reduce the integrity of the living system merely to the properties of its components, metaphysics and idealism in interpreting the essence of information in the living, attempts to reject the qualitative distinctions of the biological form of the movement of matter, and other methodological errors are being overcome by present-day biology, which is indeed developing along the lines of materialist dialectics.

A brief comment on the present-day critics of the ideology of Soviet biologists.

A couple of years ago there occured a minor, but relatively acute episode in the ideological struggle on the biological front. On February 16, 1975, the Los Angeles Times in the United States printed an article by Robert C.Toth, which was later reprinted by other publications abroad.

The writer of the article attacked the ideology of Soviet biologists, trying to make it appear as if Soviet genetics were dominated by politics to the detriment of scientific progress. Typical in this respect was the subtitle of the article: "Top Man in the Field Appears to Place Politics Before Science". Such articles are intended to sow differences between Soviet biologists. The fact that Soviet scientists stand firmly on the ground of Marxism-Leninism, are dedicated to building socialism, and speak of this is represented as the domineering of politics over science, as something incompatible with the research of a "true scientist".

At the end of 1974 the American journal Bioscience (No.10, pp.583-589) printed a lengthy review of my book Vechnoye dvizheniye (Perpetual Motion). The reviewer, I.L.Kosin, acknowledged the factual contents of the book and its analysis of developments in genetics in the Soviet Union over the past 50 years. The concluding sentence of the review, however, stated: "Those readers who are concerned with the question of basic integrity in science can only welcome Dubinin's contribution, even though his analyses or views are not always acceptable or palatable."

In what way are these views unacceptable?

This, it turns out, concerns the ideological theme of the book. As soon as the reviewer touches upon this matter, he bristles. He claims, for example, that the "quintessence" of Dubinin's "well worn rhetoric of official propaganda" is well illustrated by a paragraph in the book, in which I described my return to Moscow from Tokyo and drew a contrast between the two cities--between what I felt to be the serene dignity of Moscow and the feverishness of Tokyo. This the reviewer deemed incompatible with the work of a true scientist.

Yet at the same time Marxist-Leninist ideology on the offensive is exerting a most appreciable influence on progressive intellectuals in the USA and in other capitalist countries.

Conclusion

The philosophical struggle in science proceeds not only openly. In many cases philosophical controversies outwardly appear to be ideologically neutral, they seem to be far removed from direct practice or from politics. However, on closer scrutiny, it is not hard to discern the features of ideological struggle behind this. What is under attack is the philosophy of dialectical materialism in the sphere of nature, which is inseparable from historical materialism. And it is a fact of basic importance that the development of biology in its main areas is fundamentally associated with the philosophical foundations of biology.

One of the most important problems of sociology, natural science, philosophy, and politics in the ideological struggle is the problem of man. A number of biologists distort this problem from a biologising standpoint.

The successes of natural science require a radical change in the philosophical activities of scientists and their advance in this respect to new frontiers. Just as in the whole of natural science, Soviet scientists working in biology must develop partisan, class-rooted ideological principles. This work must provide a guiding stimulus to efforts to learn the nature of life and control it. We have to concentrate our efforts on acute ideological problems, realising their significance in the struggle for the Marxist-Leninist world outlook and for building a communist society.

In his speech in Alma Ata in August 1973, L.I.Brezhnev spoke on the need for "people working in... ideological institutions to be more prompt in responding to events, ...to give a well-substantiated explanation of the Party's policy".[14] Such work requires of biologists, who are in the front lines of modern science, a profound and well substantiated analysis of the errors of our ideological opponents, an analysis from partisan positions and with a knowledge of the subject.

The tremendous importance of working on problems of world outlook, which are organically connected with the ideological struggle between the bourgeois and communist outlooks, was emphasised at the 25th Congress of the Communist Party of the Soviet Union. The communist world outlook is based on Marxist-Leninist philosophy. In our day of the scientific and technological revolution, the role of philosophical knowledge increases sharply both for science itself and for associated problems of the ideological struggle. Soviet scientists must join efforts in working on the Marxist-Leninist methodology in biology. This will promote fundamental trends in biology, and the cause of the struggle for a partisan philosophy, for its connection with politics, and for a profound unity of theory and practice.

NOTES

1 Jacques Monod, Chance and Necessity, New York, 1972.

2 See Ewald Wasmuth, Der Mensch und die Denkmaschine, Cologne and Olten, 1955.

3 See Konrad Lorenz, Das Sogennante Böse. Zur Naturgeschichte der Agression, Vienna, 1965.

4 See E.Mayr, "Man as a Biological Species", Priroda, Moscow. No.12, 1973, pp.36-44, and No.2, 1974, pp.36-44.

5 See ibid., No.2, 1974, p.39.

6 See R.G.Edwards, "Aspects of Human Reproduction", The Social Impact of Modern Biology, London, 1971, pp.108-121.

7 See H.J.Muller, "The Guidance of Human Evolution", Studies of Genetics, 1962, p.590.

8 See J.B.Gurdon, "Nuclear Transplantation and the Control of Gene Activity in Animal Development", Proceedings of the Royal Society, No.1044, 1970. pp.303-314.

9 See C.R.Merril, M.R.Geler, J.C.Petriociani, "Bacterial Virus Gene Expression in Human Cells", Nature, No.5319, 1971, Vol.233, pp.398-400.

10 Jacques Monod, op.cit., pp.114-115.

11 Ibid., p.40.

12 Ibid., pp.110-111.

13 See H.Dahm, Kybernetic als Problem Kommunistischer Philosophie, Tübingen, 1967.

14 L.I.Brezhnev, Our Course: Peace and Socialism, Moscow, 1974, pp.118-119.

IDEOLOGICAL STRUGGLE TODAY: ALLIANCE OF PHILOSOPHY AND NATURAL SCIENCE

Academician Mark MITIN

The deep-going progressive processes now running across the world of social relations have been acquiring a global character. The on-going scientific and technological revolution tends to add unprecedented dimensions to more and more new theoretical problems which require consistent philosophical generalisation. In these conditions, the alliance between the philosophy of dialectical materialism and natural science, the close alliance between Marxist philosophers and natural scientists is of the utmost importance.

Soviet philosophers have worked and continue to work tirelessly to strengthen and improve this alliance, as Lenin had urged them, and have achieved important successes in this respect.

The alliance of philosophy and natural science, which Lenin proclaimed in his brilliant work, On the Significance of Militant Materialism, springs from the ideological substance of Marxist philosophy. Lenin's idea was a reflection of the profound objective regularities of social cognition and the development of philosophical science. It is the strategic line in theoretical, epistemological, ideological and practical terms, in the senses that it promotes the ideological education of Soviet intellectuals and musters all its forces for the construction of communist society.

The alliance of philosophy and natural science is an organic part of the policy of the CPSU, whose multifaceted activity rests on a strictly scientific basis. The Communist Party does not conceive of its guiding and inspiring role, of any aspect of its activity without constant reliance on science. This alliance is a pivotal line of Party activity. It is also an expression of the high Party spirit of the philosophy of dialectical materialism, of its genuine scientific value and its powerful educational importance.

The theoretical aspects of the alliance of philosophy and natural science are highly diverse. They are connected with philosophical generalisation, deep-going philosophical analysis of the processes going forward in science, with the struggle against idealistic views, against all manner of reactionary vacillations which occur in science on the basis of its achievements.

The alliance of philosophy and natural science is of especial importance for the ideological education of intellectuals as conscious and ideologically convinced adherents of dialectical materialism. When putting forward the idea of such an alliance, Lenin established a direct connection between it and the struggle between materialism and idealism which runs in natural science. Elaborating this question he continued the line which he had developed in his book, Materialism and Empirio-Criticism. Lenin wrote quite clearly about the need for an alliance with natural scientists who were not only inclined to materialism but were afraid to stand up and advocate materialism in the fight against "fashionable" philosophical trends. Lenin said that there was need to follow the revolution in natural science in order to be able to rebuff idealistic vacillations in due time.

At the end of the 1920s and in the early 1930s, interest in Marxist-Leninist philosophy in the USSR had grown unusually: thousands of scientists began actively to study dialectical materialism, and many universities for scientific workers were set up. Prominent Soviet scientists, those who made Soviet science famous, among them S.Vavilov, A.Yoffe, V.Komarov, A.Fersman, I.Michurin and many others, were influenced by Lenin's ideas and took the dialectico-materialist stand to carry on an active struggle against all manner of idealistic and positivistic theories and attitudes. That was a fine expression of the profound interest in Marxism-Leninism, of confidence in the Leninist Party and an expression of Soviet patriotism on the part of the leading workers in Soviet science.

However, let us see how the alliance of philosophers and natural scientists has taken shape, developed and grow, and what its scientific importance is in discovering contemporary processes in science.

In this context, let us consider the scientific session of the Institute of Philosophy of the Communist Academy which met to mark the 25th anniversary of Lenin's work, Materialism and Empirio-Criticism, in June 1934, that is, more than 40 years ago, and which was addressed by Academicians Yoffe and Vavilov on the problems: "Contemporary Natural Science" and "Dialectical Materialism". **In his report on the development of atomistic views in contemporary physics Yoffe said:** "In conclusion I should like to say the following: I see before me the slogan of 'Long Live the Alliance Between Materialist Dialecticians and Natural Scientists for the Struggle Against Idealism!' Not only on my own part, but also on behalf of the overwhelming mass of the physicists of our Union I can say that we welcome this alliance in every way. I think not only in word but also in deed have we already shown that we strive for it.

"Why do I say this? I say this because I feel that there is need for much greater boldness, and it is the Bolsheviks-Communists who are in need of it. It is the main duty of the Communist Academy in matters of methodology, in questions of the philosophy of epistemology, in the theory of knowledge to go forward and to take over advanced

positions. We are very willing to fight idealism, and we are very well aware of its dangers and its harm.... We are prepared to fight idealism, because we clearly see its tremendous harm for science.... But how are we to fight it? I think that to be afraid of new ideas because they may be idealistically tainted and for that reason not to advance is a method by means of which it is impossible to vanquish anyone. It is necessary to advance, it is necessary to create new theories of one's own in contrast to idealistic theories, to produce one's own understanding of new ideas which undermines the soil for any idealistic attempts. To illumine the way with the headlights of correct theory is the best way to dispel the mystic fog of idealism."

These are profound and remarkable words by a most prominent representative of Soviet science! Yoffe went on to say:

"In the remarkable book to which our session is devoted we shall also find precepts for the present moment as well. It turns out that Lenin had such a good knowledge of physics as it would be well for many of its modern critics to have. He had a knowledge of some things that were strange from the standpoint of 'common sense', of which I spoke earlier on. Nevertheless, you will not find a single line in the whole of his book in which he says that Abraham is an idealist because he said that mass was apparent, or that Planck is an idealist because he ascribed mass to radiant energy and believed it to be no more than a coefficient. On the contrary, Lenin regarded every new and extended, though unusual, understanding of physical phenomena as a brilliant confirmation of the dialectical course of development, as the absence of any rigid norms, and as an expression of the vast diversity of Nature which makes scientists modify their views. That is the merit, the main advantage of the dialectical method. Lenin said that, of course, physicists were materialists because they were engaged in the study of the external world. To believe that this world is created by us, that it does not exist in reality, and still go on to study its properties is an altogether thankless task for the physicist, and anyone so engaged is bound to become a philosopher. Why should he deal with physics? Why study the world when you can structure it yourself as you wish, which is much more interesting?"[1]

Yoffe ended his report with these words:

"We need boldly to advance, unafraid of mistakes, because we have an excellent instrument which forewarns us against them. Our theory is not structured in a vacuum, we create a theory of the actually existing world, and the method of verification by practice gives us the real expression of this world, the reflection which it makes in our sensations. Our experience, practice, provides the guarantee that we shall not build an abstract idealistic scheme but that our theories will increasingly approximate the knowledge of the real world which we want to know and change."[2]

Such were the ideas expressed by one of the leading Soviet physicists, and they are still an excellent indicator for our own day.

In his report Academician Vavilov gave a dialectico-materialist analysis of the development of the conceptions of Nature in the history of physical science. His report provided vivid evidence that dialectical materialism had become an ideological and methodological instrument of Soviet natural scientists. At the time we were able to note with tremendous satisfaction that the philosophy of Marxism-Leninism had scored ideological victories, and that the alliance of philosophers and natural scientists was being given a sound scientific foundation.

Such were the fine pages testifying to the fact that Lenin's precepts on the alliance between philosophy and natural science were being realised.

Let us note, however, that this alliance was not a process that was either straightforward or unilinear. It did

not run without any hitches. And along its course there were various mistakes and shortcomings. However, on the whole, the process steadily advanced.

Let us add that many prominent scientists in the West are aware of the role and importance of this process. J.D.Bernal wrote: "Throughout the twentieth century, what may be called the phenomenon of Lenin has been the dominating factor, not only of world economics and politics, but also of world natural science. We seem to have come a long way from Lenin, but luckily his impulse has endured and has set for a whole new generation the tone of science, and that not only in the Soviet Union but all over the world. Thanks to that inspiration, it can no longer be maintained, even by its worst enemies, that scientific and technical progress is incompatible with socialism as built on the model of Lenin's work. On the contrary, socialism furthers science and it has helped enormously to enlarge its scale and make it a basic part, not only of the economy but of its ideas."[3] This is a striking indication of the strong influence of Lenin's ideas. However, some scientists still question the alliance of philosophy and natural science as having outlived itself.

The methods used by bourgeois thinkers to infiltrate the socialist consciousness are well described by the Czechoslovak scientist W.Nemec, in his book The Importance of Lenin's Militant Materialism.

He stressed that in the case of most Czechoslovak philosophers in the late 1960s the close alliance between the Communists and non-Party scientists began to give way to an uncritical adoption of non-Marxist and frequently even anti-Marxist bourgeois doctrines, an unprincipled eclecticism, and a loss of the Party principle in philosophy. In the 1960s, the "Marxist theorists" in Czechoslovakia tried to "modernise" Marxist philosophy by means of various ideas propounded by "fashionable" bourgeois thinkers. This led them to forget their scientific understanding of social development, since revisionism, idealism, spiritualism and irrationalism strengthened their positions and sought to separate Marxist philosophy from the revolutionary movement. In this way, philosophical revisionism combined with political reaction.

The idea of the alliance between philosophy and natural science is still an issue in the ideological struggle against the opponents of dialectical materialism today. Putting forward all manner of incorrect and unscientific ideas and false assertions, they seek to undermine, and denigrate the alliance between philosophy and natural science or to distort it. In these conditions, any sort of vacillation on the question of the alliance between philosophy and natural science tends objectively to play into the hands of our opponents and to spread confusion in the understanding of highly important Leninist ideas.

In the recent period, there have been more and more attacks by Western scientists on materialist dialectics. Thus, a leading specialist in molecular biology and Nobel Prize Winner, Jacques Monod, has written a great deal about dialectical materialism in his book, Le hasard et la nécessité. Essai sur la philosophie naturelle de la biologie modern (Paris, 1970). What he says, unfortunately, shows that he knows little about dialectical materialism and that he has drawn his information about Marxist philosophy from hearsay. Being a major specialist in his field, Monod has decided to criticise dialectical materialism of which he has no knowledge—an unrewarding task. Thus, he says that Engels had "imposed" dialectics on Nature in order to "fit" the development of Nature within the laws of historical development established by Marx. Monod himself says that there are no dialectical regularities in Nature, and that chance and necessity are absolutely antithetical concepts.

These anti-dialectical attitudes lead him to make a number of erroneous assertions even in his own special field, which are sharply criticised by other molecular biologists.

Some contemporary natural scientists have variously attacked the ideas of dialectical materialism. One cannot ignore the wild attack by the Swiss physical chemist M.Thürkauf, which fits within the framework of the general ideological struggle. He came to the Soviet Union as a tourist, visited Leningrad, and travelled from Moscow along the Trans-Siberian railway and back, and upon his return to Switzerland published a book in 1974 entitled, By Railway Across Dialectical Materialism, Travel Notes from the Soviet Union. This is a patently anti-Soviet book and abounds in unscientific attacks on dialectical materialism, which the author treats in the spirit of mechanistic materialism, as some "mechano-deterministic contemplation". He does not like, for example, the law of transition of quantity into quality. He says that because the Marxist classics did not understand natural science, Marx and Lenin acted on the "erroneous assumption" that the quality of the world obtained from an adequate amount of quantity. The author waxes eloquent about his good will for Russia and the Russian people, describing at great length their "blue eyes", "the melodious Russian language which is ready-made for the poets", about the generosity and cordiality of the Russians, the charm of the Russians, of the Russian lady-guides and the friendliness of the militiamen, and so on. Behind this screen, he smuggles in his main idea of convergence (he calls the bourgeois world "capimat", and the Soviet world the "diamat"). He says: "When world industry requires so much fuel, and the oil of the Atlantic runs dry, diamat and capimat will join hands."[4] Such is this peculiar anti-Soviet invention about convergence.

These examples show that even today philosophical problems in natural science are sharp ideological issues. The views of our opponents are a combination of ignorance of the philosophy of Marxism and distortion of its basic tenets, with reactionary political aims. These are attempts to use scientific achievements to fight materialism, socialism and the Soviet system.

Our task is to expose such erroneous and harmful methods and views of our opponents, and constructively and positively to elaborate the philosophical questions of science, producing a dialectico-materialist generalisation of scientific development.

NOTES

1 A.F.Yoffe,"The Development of Atomistic Views in the 20th Century", 25th Years of Lenin's "Materialism and Empirio-Criticism",Moscow, 1934, p.230 (in Russian).

2 Ibidem.

3 J.D.Bernal, "Lenin and Science" in the collection Lenin and Modern Natural Science, Moscow, 1969, p.28 (in Russian).

4 M.Thürkauf, Mit der Eisenbahn durch den dialektischen Materialismus. Reiseskitzen aus der Sowjetunion, Bern, Hallwag, 1974, p.152.

PHILOSOPHICAL PRINCIPLES IN THE THEORETICAL FOUNDATIONS OF NATURAL SCIENCE

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The philosophical principles underlying the ideological and methodological propositions of theory organically determine its whole content and meaning. On these principles largely depends the future of a theory, the extent to which it accords with reality, and its place within the overall system of scientific knowledge. Theories based on the dialectico-materialist approach to reality have immensely more chances of turning out to be true than those which start from ideological and metaphysical assumptions in the interpretation of the world and methods of its study. After all, the dialectico-materialist principles are an expression of the universal laws of being and cognition which will be found in the great multiplicity of concrete phenomena, including those which still have to be studied. They serve as important methodological propositions for moving from the known to the unknown, and give a general notion of the key attributes and laws of motion which may be inherent in matter even beyond the areas of the world which are empirically perceived. Being a generalisation of all the achievements of science and socio-historical practice, the principles of dialectical materialism are being steadily deepened and perfected with the progress of scientific knowledge, so reflecting reality with ever greater precision.

By contrast, the idealistic and metaphysical propositions about the world and ways of cognising it are distorted and fantastic, which makes them akin to all the religious and speculative metaphysical systems of the past. In themselves, these propositions never lead one to the truth, but clash with reality and so act as a drag on the advance of knowledge. If some idealist-minded scientists have achieved outstanding results in cognising the world and making major discoveries, they have done so not in consequence of their idealism, but for totally different reasons, notably their individual talents, their ability to carry on new experiments and give them profound theoretical interpretation, their originality and depth of prediction, and the creative power of their intellect. Apart from its philosophical foundations, every concrete scientific theory also has a system of other theoretical and empirical foundations. Under certain conditions, success in elaborating these may move one close to true knowledge even despite false philosophical propositions. In the formulation of new theoretical conceptions, correct dialectico-materialist foundations are absolutely necessary but not adequate for achieving the truth. There is also a need for new experimental research, theoretical analysis of the facts, discovery of the laws which hold them together, the creation of an integral system of knowledge, and so on. In the absence of all this, even correct dialectico-materialist propositions will not yield the desired results. But all other things being equal, idealistic premises will not result in any advance either, but will yield nothing but a negative result by leading the scientific inquiry into a dead end.

Every scientific theory has a definite system of foundations. These are above all empirical foundations, which include the aggregation of the key experimental facts and observations, the basis proper of any theory. In abstract theoretical systems, like mathematics, philosophy and the general theory of systems, the empirical foundations may include experimental facts and observations not only from

the subject area of the given science, but also the empirical and largely theoretical content of other natural and social sciences, which provide a basis for the further development of mathematics and philosophy.

But empirical facts and observations do not in themselves constitute a theory. There is a need for their theoretical comprehension and understanding, which is achieved after the discovery of laws that unite all these facts and that make it possible authentically to predict similar new phenomena. At first, laws are formulated empirically in the form of rules and qualitative formulations describing the general tendency or orientation of the process. Then, as advance is made into the depths of the substance of the phenomena being analysed, it is possible theoretically to formulate a law in the form of some functional relation uniting two, three or more variables. The greater the number of factors the given formula reckons with, the more precise the reflection given to reality by the corresponding law. Every law is a form of stable, ordered and functional connection between definite phenomena or magnitudes, which may be the properties of the same object, the properties of different objects and the objects themselves in a system, a set of objects and systems in an even more general system, various states of the systems or stages of their change, sets of events and objects of the most diverse kind, and the laws themselves held together by some even more general law. If all these phenomena or elements cohere into some stable connection in the form of a functional relation, so that changes in some phenomena make it possible authentically to predict changes in others, we have a theoretically formulated law reflecting an objective and law-governed order of things. The aggregation of theoretical and empirical laws integrated within a coherent system of knowledge constitutes the framework of a theory. These may be defined as the nomological foundations of theory ("nomos", the Greek for law). Sometimes they are also called the <u>proper</u> theoretical foundations of theory.

In addition, every theory has its logical foundations, constituting an aggregation of the most important logical principles which bring together experimental facts and theoretical laws into a coherent system of knowledge and which lend them a definite consistency and subordination. Some of these logical principles are brought into the theory from formal and dialectical logic (for instance, the principle of no contradiction, the principle of the concreteness of truth, the unity of the logical and the historical, and so on). In this sense, they are the non-proper foundations of theory. But other logical principles governing the formulation of a theory spring from its own content and course of historical development. They reflect the level achieved in the coherent knowledge of nature, in accordance with which the logical structure of a theory is formulated. The latter may change with the advance of knowledge, and indeed very substantially. Thus, at the early stages in the development of empirical theories they are usually set forth in inductive and historical terms, so that the logical frequently coincides with the historical, while the exposition of parts of a theory largely corresponds to the sequence of their historical origination and development. But as a theory is improved and new experimental facts and laws of ever greater generality and information value are discovered, the logical structure of the theory begins to change, with the deductive structuring of the theory coming to the fore, when very general and information-intensive laws are formulated at the beginning of its various sections, from which more particular laws and propositions are then deduced. This kind of exposition helps to order the logical structure of the theory and to shed many of the historical details which have become less than meaningful.

But the complex of fresh empirical facts is introduced into the theory with subsequent inductive generalisations, and this goes on until the discovery of fundamental theoretical laws makes it possible to return to a deductive structuring of this part of the theory and the ordering of its logical

structure. Consequently, the logical foundations and the structure of the theory, like the system of its other foundations, tend to change with the advance of knowledge.

In addition, every concrete scientific theory may have extratheoretical and metatheoretical foundations. Extratheoretical foundations include the principles of the more general fundamental science which are used to explain the objects and processes being studied by the given science. Thus, the principles of theoretical physics (quantum mechanics, electromagnetic field theory, etc.) are used to explain the nature of chemical bonds and the substance of the chemical form of motion; the principles of thermodynamics are used to explain the kinetics of chemical reactions. As a result, border-line subjects—physical chemistry, chemical physics, the quantum theory of chemical bonds, etc., arise at the conjunction of physics and chemistry. Similarly, the theoretical content of physics and chemistry is used to explain the processes proceeding in living organisms, and this has provided the basis for the emergence of biophysics, biochemistry, molecular biology and other subjects which help to explain new aspects of the substance of life. In all these cases, when any science makes a detailed study of the laws of a more common and general form of motion or more general properties of matter, its theoretical content may be used to substantiate other more particular sciences. This process of fundamentalisation is a concrete form of integration of scientific knowledge.

The metatheoretical substantiation of a theory is effected on the basis of a definite metatheory, a subject dealing with the more general and global laws of the structural organisation and change of material systems, which also includes more general methods of analysis. Mathematics also has a metatheoretical function, and its methods and content have increasingly penetrated into almost every other branch of knowledge. Such a function is also vested in the general theory of systems, which seeks to bring out the laws governing the structural organisation and change of every type of natural, technical and control systems, and to express these laws in the form of functional relations. The theoretical content which it has elaborated is of much importance for the metatheoretical substantiation of many principles of cybernetics, theoretical biology, systems technology and a number of other subjects.

The philosophy of dialectical materialism is the most general metatheory with respect to the whole complex of natural and social sciences. It has for its subject the study of the most general laws of being and cognition, and the inter-relationship between them. It investigates the key properties, laws of structural organisation, change and development of every type of natural and social systems, and also the systems of man's cognitive and creative activity. Its whole theoretical content is of much methodological importance for the various sciences, because it gives more clear-cut, concentrated and precise expression to the most important achievements resulting from the elaboration of the philosophical foundations of the natural and social sciences over the centuries, but which are not adequately formulated by individual scientists.

The philosophical foundations of a theory include ideological, epistemological and sociological principles. Ideological principles help to characterise the surrounding world, man's place in it, the properties and laws of the being of matter, man's attitude to the world, the ways and purposes of social development, and so on. In dialectical materialism these are the principles of the material unity of the world, the conservation of matter and motion, the eternity of the world in time and its infinity in space, the principles of the development of matter, of its primary nature with respect to consciousness, and the dialectical laws of the being of matter.

Epistemological principles characterise the substance of the process of cognition and its regularities, the interconnection between the principal methods of cognition, the

inter-relationship of old and new scientific theories in their development, and the regularities governing the differentiation and integration of scientific knowledge.

Sociological principles express the social status and functions of the given science, its role in the development of the productive forces and of society as a whole, the social purpose and place within the general system of scientific knowledge, the motive forces and the social regularities of its development.

A distinction should be drawn between philosophical problems and the philosophical principles of science, for the former are a complex of ideological, epistemological and sociological problems arising in the development of science in the very forefront of research and having a fundamental importance not only for the given concrete science, but for all the other sciences as well. Their solution is highly important for the whole ideology and methodology of scientific research. The philosophical principles of science do not include philosophical problems in themselves, but above all the results of their constructive solution, that is, the substantive knowledge obtained in the process, which goes to enrich not only the given science, but also dialectico-materialist philosophy itself. The more elaborate a scientific theory, the greater is its awareness of its philosophical principles, of the methods and regularities of its development and also the limits within which its laws may be extrapolated.

On the content of the philosophical principles of theory organically depends its general meaning, the interpretation of the laws being formulated within it, its place within the overall system of scientific knowledge and the limits within which it may be applied. Speculative idealistic and metaphysical approaches may direct scientific thought along a false path and engender pseudoproblems and fake solutions, while the correct, dialectico-materialist theory, which takes account of the need to elaborate the systems of other empirical and theoretical principles, can serve as a true reference point on the way to the scientific solution of a given problem. A retrospective view of the history of science shows the operation of the following important regularity: all the fundamental propositions and laws of science which are of principled ideological and methodological importance, have always been initially formulated as philosophical hypotheses on the basis of materialist and dialectical conceptions, and only then substantiated in concrete scientific terms and elaborated on the basis of natural science and social theories. Such was the history of the atomistic notions concerning the structure of matter, the preservation of matter and motion, the material unity of the world, the continuity of matter, space and time, the principle of development in astronomy, geology, biology and the social sciences, the principle of causality, the idea of the structural heterogeneity of matter and the diversity of the laws of its being. Within the framework of the Marxist-Leninist philosophy these propositions were put forward and substantiated: on the structural inexhaustibility and infinity of matter, on the qualitative peculiarity of the laws and forms of its motion at the various structural levels, on the infinite self-development of matter, on the diversity of the forms of interconnection and determination in the world, on the open nature of any concrete scientific theory of the world and the unlimited nature of the process of its cognition, on the principle of the concreteness of truth, and the local applicability of any concrete scientific theory. At the same time, dialectical materialism helped to formulate the universal laws of the being of matter and the process of cognition, which serve as methodological reference points for movement from the known to the unknown, and which helped to integrate the whole of scientific knowledge.

On the strength of the principle that truth is concrete, reflecting the structural heterogeneity of matter, and its quantitative and qualitative inexhaustibility, Lenin, in his **Materialism and Empirio-Criticism**, showed the causes behind

the crisis of the mechanistic picture of the world provided by classical physics and the need to substitute for it a qualitatively new and more perfect picture of the world as matter in motion, a process in which the physical picture of the world is constantly deepened over the whole of its subsequent development. Lenin's idea about the inexaustibility of the atom and the electron provides an important methodological indication for all present-day studies of the structure of elementary particles and sounds a warning against the dogmatic absolutisation of concrete scientific notions. The critique by Engels and Lenin of mechanistic determinism helped to show the diversity of the forms of the causal nexus in the world and to comprehend the objective foundations of probability determination in the development of complex systems. Materialist dialectics points to the need for a comprehensive approach to the study of all phenomena and the application of all the methods of cognition as a unity. It emphasises the inadmissibility of absolutising any single method, which is precisely characteristic of the metaphysical approach. This important requirement is concretely embodied and developed in the systems structural method of analysis, which has been broadly applied and elaborated in modern science, and in the theory and practice of structuring ever more complex information and control systems.

The philosophical foundations of science have been steadily developing under the influence of the multistage integration of science, the advance of materialist dialectics and its penetration into the structure of science as it solves new philosophical problems. Progress in the sphere of philosophical foundations results both from the development of the given science itself, from its application of the principles of dialectical materialism, and also from the key methodological accomplishment of other sciences. All the metaphysical and idealistic trends in present-day bourgeois philosophy cannot, in principle, provide a philosophical foundation of science. At one time, it was empirio-criticism that laid claim to being the "latest philosophy of 20th-century natural science". But Lenin showed very well that that philosophy was, in fact, alien to the spirit and trends in modern natural science, and it soon had to leave the scene. Neopositivism, as a further modification of empirio-criticism, also sought to become the methodological foundation of modern science. But it denied the ideological problems and content of philosophy and also the possibility of cognising the objective substance of things, so reducing the tasks of every science merely to bringing out the functional relations between complexes of measurements and observations by the subject, and this killed the objective meaning and purpose of science. If the neopositivist programme had been realised, each science would not be giving us a knowledge of the world but of the psycho-physiological emotions of the subject when observing the world. This kind of limitation of the tasks of philosophy and the particular sciences could not be accepted as the philosophical foundation for the elaboration of theories. It is not surprising, therefore, that after a short "boom" in the 1920s and 1930s, neopositivist influence on scientists rapidly declined and is now fairly insignificant.

As for the conceptions of neo-Thomism, existentialism, pragmatism, personalism and various other trends in present-day bourgeois philosophy, these can no longer objectively claim any elaboration of philosophical problems and principles in modern science, because they have lagged far behind its actual achievements and purposes. At one time, Thomism proclaimed the dual nature of truth, and the parallelism and the equality of the scientific and the religious cognition of the world, but these propositions turned out to be untenable. While science has achieved tremendous progress in the cognition and practical development of the world over the past century, religion still starts from the most naive, ignorant and absurd notions of the world as a whole and the concrete natural phenomena, which were formulated in the myths of hoary antiquity. But neo-Thomism, existentialism, personalism and

pragmatism now, in effect, no longer lay claim to a new scientific explanation of nature but set themselves the task of explaining man's spiritual world, the meaning of life, and claim the role of providing guidance in everyday activity. But even these purposes have turned out to be beyond their reach, because all these areas of human life and activity are now being successfully studied by the complex of social and humanitarian sciences in close alliance with natural science. No wonder, therefore, that bourgeois ideologists have increasingly sought to contrast science and philosophy, regarding the latter as being something intermediate between science and religious myth. This contrast has produced the absurd charge of "scientism" against dialectical materialism for its methodological role in science, a charge which shows that its authors have very little understanding of the greatest achievements of modern science and its role in the development of society. Theirs is an attitude of "enlightened" obscurantism, which is self-complacent and which has no need of a scientific foundation for philosophy.

The content of the philosophical principles constituting the foundation of a theory determines its general meaning and purpose most explicitly when the theory deals with the study of very general laws of being and cognition, of global ideological and methodological problems. Indicative in this respect is the present state of cosmology, which seeks to discover the laws underlying the structural organisation, change and development of matter in the part of the Universe around us. Cosmology has advanced many models of the Universe that compete with one another. All of these are based on the same empirical data on the existence of the red-light shift in the galaxies, testifying to their movement away from each other and expansion of the surrounding area of the Universe. Account is also taken of the relict radio-wave radiation, discovered in the past few years, as an echo of the great processes of expansion of the visible Universe from the superdense state of matter as it existed roughly 15-20 thousand million years ago. Calculations have been made of the possible value of the average density of matter in the Universe, which together with the data on the growing speed of the movement of the galaxies away from each other and the distances to them are substituted in the gravitation equations of the general theory of relativity, so yielding various solutions and the corresponding models.

There is a model of the "hot Universe" which contains the assumption that its expansion from the superdense state of matter, initially concentrated within a marginally small volume, has continued without limits and is irreversible, while space itself appears to emerge in the process of expansion. This is contrasted by another model in which the observable expansion is regarded as a local process ranging over only an infinitely small area of the whole Universe--the Metagalaxy, beyond whose limits there may be countless cosmic systems with the most diverse states of matter and forms of its change.

Then there is a model of the "oscillating Universe" which, like the model of the "hot Universe", contains the assumption that the whole of the Universe is now expanding, but that this process will slow down in the course of time, and at a definite stage will give way to a compression of matter, a concentration of it in a relatively small area with transition to a superdense state (gravitational collapse), which will then once again give way to expansion, then again to compression, and so on. Given such pulsation, all the physical processes appear to be running in circles, while the "radius of the Universe" tends to change in the course of time.

The model of a "pulsating Universe" contains the idea of time flowing in reverse at the stages of compression, which then gives way to the normal passage of time from past to future at the stages of expansion. But this hypothesis is absolutely artificial.

Each of these and other models of the Universe is based on a definite philosophical idea. The assumption of definite values for the average density of matter in the Universe and for the growing speeds of the movement of the galaxies away from each other as the distance to them increases, the operation with modifications of the gravitational equations and many other additional assumptions are used to back up a basic philosophical idea. There are also clearly idealistic interpretations of the models of the Universe, which contain the assumption that it was created by God in the form of a gigantic "father-atom" whose explosion gave birth to the expanding Universe. Some theologists add that God created two Universes, one consisting of conventional matter, and the other of antimatter, and that these Universes are bilaterally symmetrical.

Dialectical materialism holds that in elaborating a scientific model of the observable finite area of the Universe there is need above all to start from well-established observed data and physical theories, from the principle of the conservation of matter and motion, which expresses the eternal existence of matter in time, from the principle of the structural inexhaustibility and infinity of matter and its unflagging self-development and qualitative transformations. There is also a need to take account of other general properties and dialectical laws of the motion of matter (the law of causality, unity, interaction and struggle of opposites, the law of the spiral character of development, and so on). Cosmological theory based on these principles, which have been confirmed by the whole of socio-historical practice, starts from the fact that the observable expansion of the Metagalaxy is a local process in the world, and that countless numbers of other material systems can exist with their own specific laws of structural organisation, time-and-space properties and forms of development. In quantitative and qualitative terms matter is infinite.

But apart from the correct philosophical stand, the scientific solution of the problem also requires many other foundations: empirical, logical, theoretical and metatheoretical, and also the necessary creative capabilities and intense effort on the part of the researcher. On this fundamental question, the stand of dialectical materialism is antithetical to the conceptions of the old nature-philosophy, which started from the assumption that general philosophical propositions predetermined all the concrete solutions of the problem and helped to obtain these solely on the basis of logical deduction. Such an approach has almost never yielded any correct results and has, in fact, produced speculative "systems of nature" in which invented laws and causal connections were substituted for the actual ones, so that the whole theoretical construction turned out to be illusory.

It has fairly frequently occurred in the development of scientific theories that the same experimental data and theoretical laws gave rise to different interpretation models explaining natural phenomena. The content of these models largely depends on the initial philosophical premises. Such a situation arose, for instance, in the interpretation of the physical meaning of gravitational equations in the general theory of relativity, in the quantum theory of gravitation, in the interpretation of the meaning of the wave function in quantum mechanics, in the explanation of the objective grounds of probability laws, and so on. New theoretical problems constantly arise in science for whose solution the whole of the available theoretical and experimental material is used. And it frequently happens that a new philosophical idea, however particular, suddenly opens up fresh horizons for research and leads to the formulation of a theoretical model closely approximating reality.

Dialectical materialism exerts a growing influence on modern science through the elaboration of the system of its philosophical foundations. For its part, it is constantly perfected by integrating within its content the philosophical meaning of discoveries in the natural and social sciences. This constant interaction and interpenetration of dialectical materialism and the modern sciences is a powerful source of their further development.

THE PROBLEM OF DETERMINISM IN MODERN NATURAL SCIENCE

Yuri SACHKOV, D.Sc.(Philos.)

The problem of determinism is of key importance within the system of Marxist-Leninist philosophy. The doctrine of determinism expresses, in a sufficiently coherent and systematised form, the scientific notions of the character of connections and dependences within the material world, whose key aspects are expressed in the categories of causality, regularity, necessity, chance, purposefulness, level of organisation and various others. Our understanding of determinism is closely linked with our way of interpreting the phenomena analysed by science, formulating scientific forecasts and grasping the tendencies in the further development of knowledge. It is also well known that the development of the doctrine of determinism has always been attended with acute philosophical struggle. Idealistic philosophers have used the scientific discovery of new forms of determinism and new classes of regularity to deny causality and also the materialistic traditions of science in general.

Present-day development and summing-up of determinism involves an analysis of two sets of questions:

What are the grounds on which probability and, therefore, chance, are included in the structure of scientific knowledge?

What is the significance for the doctrine of determinism of the present development of the notions concerning the purpose and purposeful functioning of complex governing systems?

An analysis of these questions is of primary importance in bringing out the basic features of the present stage in the advance of knowledge, and these are the questions on which the most acute philosophical discussions and struggle over the doctrine of determinism have been carried on.

These problems of determinism are being extensively considered by Western writers on the philosophy of science. The characteristic thing is that those who oppose the ideas of dialectical materialism in fact have a very distorted view of it. Virtually in every case they proceed from the assumption that dialectical materialism is inseparable from the notions of classical (Laplace's, rigid, mechanical) determinism, with its denial of the fundamental importance of chance in the structure of knowledge and its inevitable drift into fatalism. This kind of reading is given to dialectical materialism in J.Monod's book, <u>Chance and Necessity</u>, and it is characteristic of many modern Western writers on the philosophical foundations of modern physics, above all, those dealing with quantum theory. This applies to the writings of well-known physicists like J.M.Jauch's <u>Are Quanta Real? A Galilean Dialogue</u> (Indiana University Press, Bloomington, 1973, second printing 1974) and Bernard d'Espagnat's <u>Conceptual Foundations of Quantum Mechanics</u> (Benjamin Publishers, Menlo Park, California, 1971).

It is not only a distorted notion of dialectical materialism and an actual ignorance of its writings that are characteristic of those who criticise this philosophy. They also frequently lack any positive programme or solution for the given methodological problems in modern science. In Western writings on the philosophy of science we do not find any serious effort to develop the doctrine of determinism. At best there are attempts to structure concepts of chance and purpose within the scientific apparatus, but there are often no earnest efforts to understand and substantiate the objective nature and content of these key categories of modern science. In this connection much importance attaches to an analysis of present-day generalisations of the doctrine of determinism in the light of dialectical materialism. Let us briefly consider the generalisations of determinism taking shape in the writings of those who accept dialectical materialism in their analysis of the foundations of probability methods in research and, accordingly, in their analysis of the nature of chance.

The highly important role of probability-theory methods of research is now broadly recognised, and they lie at the very root of the leading fundamental theories and lines of research in modern natural science. These include above all quantum theory, statistical physics, the doctrine of evolution, genetics and cybernetics (as a research programme in elaborating the general theory of control). The growing role of probability ideas in modern science gives rise to this philosophico-methodological question: how are we to understand and explain this most important line in the development of modern science? The answer usually runs as follows: the probability theory is a science of chance, while the growing role and importance of this theory is an indication of the growing role and importance of chance in modern science. Hence this question: how are we to understand the category of chance itself?

Chance is still fairly frequently regarded as being the result of our less than adequate knowledge. It is claimed that we turn to notions of chance when we do not or cannot know all the causes behind this or that process. In that case, chance is regarded as a purely subjective category. Such an approach to the nature of chance was criticised in Marxist philosophy at the time of its origination. One need merely recall Engels's treatment of the concept of chance, especially in relation to Darwin's theory of evolution.

The materialist approach to the question of probability was hammered out through the criticism of the subjectivist view of probability, but for a fairly long time chance was treated as a category characterising the external, sideline and secondary aspects of a process, and as being irrelevant to any characteristic of its inner structure and substance. Accordingly, the ideas and methods of the probability theory were regarded as being temporary and inferior. But such an approach to chance and probability is wrong. To see this one need only to consider the application of the probability idea to natural science. In classical statistical physics--the theory of gases--use is made of the conceptions of chance to characterise the relation of the molecules to each other, that is, to characterise their inner structure. Similarly, in genetics the conceptions of chance is used to characterise the relations between mutations within their systems, that is, to characterise the inner structure of the mutation process. The conceptions of chance are even more "substantial" in the analysis of microprocesses: elementary quantum processes have a probability-chance character in terms of inner structure.

What has been said implies that the treatment of chance as a category characterising the external and secondary aspects of processes is far from adequate. The modern understanding of the content and meaning of this category is shown very well in the development of the general theory (conceptions) of complex governing systems. Let us recall that complex governing systems are systems with a relatively independent, autonomous behaviour of subsystems (elements), with a high internal activity and selectivity, and purposefulness in the functioning (behaviour) of the system as a whole. These systems are open-ended, are in constant interaction with the environment, and are in principle capable of solving highly diverse classes of problems (acting in highly diverse circumstances). Of course, it is now still too early to speak of a fully established theory of complex governing systems, but there is no doubt that we have here a general programme of research stimulating the formulation of a multiplicity of problems. As the programme is elaborated, a number of propositions which are of key importance for modern ideology and methodology are elaborated and summed up. Thus, of much importance for the modern understanding of chance is the general ideas like that of relative independence (autonomy) in the behaviour of material systems, and the idea of levels in their structure and organisation. The important thing to note here is that this view of chance is closely bound up with the view of the role and importance of probability distributions, as the basic concept in the structure of the theory of probability and its applications.

The discovery of the nature of chance is connected above all with the role and importance of the conceptions of independence in cognition. Relations between objects, events or elements of a set are also characterised as chance relations when direct, immediate and interconditioned ties and relations among the elements are virtually non-existent or have an inessential role to play. Independence means that the state or behaviour of the objects of research does not depend on the state or behaviour of other objects which are "akin" to it or which surround it, and is not determined by them. But how is such independence possible? How is independence possible in a world where the origination and being of every object and phenomenon are inconceivable outside their interrelation and connection with the material environment?

The concept of independence characterises above all some massive phenomena, and definite systems formed by an exceptionally large number of objects. It expresses the given structure of these systems. However, these massive phenomena themselves depend on the conditions of their existence or origination. In other words, independence itself is meaningful only in the presence of definite integral characteristics of the systems expressing the unity of these systems. The important thing to stress when

considering the unity of the given systems is that we are, in effect, characterising a certain new level of their structure and organisation.

The above was an adumbration of the view of chance which is taking shape in the writings of those who accept dialectical materialism. Consideration of independence and the conceptions of levels indicatesthe profound dialectical content of the category of chance. The foundations of the modern view of purpose and purposefulness, whose analysis and generalisation also involve present-day development of determinism, are even more interesting and complex.

In the "exact" natural sciences, the idea of probability has fully established the conceptions of the independence and autonomy of elements constituting probability systems. The conceptions of purpose and purposefulness lead to further generalisation: autonomy and independence are regarded as necessary premises for showing the nature of the highly productive and efficient functioning of governing systems as a whole. Autonomy and independence are important not in themselves but only for definite purposes and acts. A definite principle of choice and mode of clarifying relative values is imprinted on the diversity of possibilities which reflects the probabilities.

What has been said suggests the conclusion that the present-day development of determinism, as expressed in the writings of those who accept dialectical materialism, is highly important in the comprehension and substantiation of the basic and determining features of contemporary natural sciences.

CYBERNETICS AND LENIN'S THEORY OF REFLECTION

Boris UKRAINTSEV, D.Sc.(Philos.)

A century ago Engels said that in structuring their main theories natural scientists could not do without philosophy, and the whole point was that they should be guided by a truly good, that is, scientific, philosophy.

The emergence of new and unconventional fundamental ideas in science as a rule produces a situation of some crisis which can be overcome on the basis of the scientific world outlook and the scientific method, that is, the dialectico-materialist philosophy.

In the process of cognition there has always existed and will apparently always exist the danger of some researchers setting up various scientific concepts as dogmas and absolutes, taking a one-sided approach to the problem, with ill-considered idealisation of the object of cognition in the form of excessive oversimplification of objective bonds and relations, and laws governing the change of things and phenomena.

Lenin said that among the epistemological roots of idealism there have been and are "rectilinearity and one-sidedness, woodenness and petrification, subjectivism and subjective blindness"[1] in the thinking of individual scientists or even a whole generation of scientists.

The inflation of one aspect of cognition into an absolute produced "mechanicism" in the new period, and "physical" idealism at the turn of the century, which it took much effort to overcome, and which is still a problem of considerable urgency.

The emergence of cybernetic ideas and cybernetics as a scientific field amazed the imagination not only of many scientists but also of large masses of people taking an interest in modern science. The explosion of "cybernetic enthusiasm", the impassioned discussions, the broad popularisation of cybernetic ideas by those with a knowledge of the subject and, regrettably, also by those ignorant of the subject, the scientifically based visions and fantasies and the science-fiction stories, on the one hand, helped to recruit many minds for the elaboration of theoretical and practical problems of a highly important line in science and technology, and on the other hand, had a negative influence, engendering, because of an excessive absolutisation of truths which were correct within certain limits, a peculiar "cybernetic mechanicism" and "cybernetic" idealism.

Below we use the term "mechanicism" to designate not only the absolutisation of the laws of mechanics and excessive idealisation of the subject of cognition, as expressed in far-reaching oversimplifications of the real bonds and relations between things and phenomena of the objective world, but in general attempts to vulgarise concepts reflecting various aspects of complex phenomena, and their one-sided explanations, when guidance is taken only from the well-known regularities governing simpler phenomena, while the role of the dialectical leap in the formation of new quality is misunderstood and ignored.

The history of the struggle against mechanicism as a phenomenon of oversimplification and one-sidedness in the process of cognition is a history of struggle against a form of metaphysical thinking. Just as the metaphysical method inevitably links up with idealism, so mechanicism in science also inevitably paves the way for idealistic mistakes.

The cybernetic truth, one could say, has been making its way in the struggle not only of special but also of philosophical ideas, and this struggle is in no sense confined to the problems of cybernetics, but also involves other problems, including those in the theory of knowledge, sociology, biology and the problem of the world outlook as a whole.

Let us stress that Soviet philosophy (with the exception of some philosophers) was methodologically prepared for a theoretical analysis and correct interpretation of the new ideas of cybernetics because it was equipped with the materialist dialectical method and Lenin's theory of reflection.

This cannot be said of Western idealist philosophy, whose representatives have made dishonest use of cybernetic ideas to predict an apocalyptic future for mankind, which would allegedly fall under the power of the machines they themselves invested with intelligence. There is no need specially to comment on the class purposes of such predictions.

Western idealist philosophers reject Lenin's theory of reflection, without understanding its great scientific and heuristic power. It is not surprising that they have attacked the writings of Soviet philosophers who have analysed the general ideas of cybernetics in the light of Lenin's theory of reflection.But they fail to muster any arguments,confining themselves to the flat denial, according to the formula applied by a Chekhov character,who claimed that "this cannot be because it can never be". That is precisely the approach of the West German philosopher Kirschenmann, now resident in the USA.

What then are the issues in the ideological, philosophical struggle over the formation of cybernetic knowledge? We shall confine ourselves to only two questions: the philosophical interpretation of fundamental cybernetic concepts like "information" and "control", and the philosophical interpretation of the potentialities of the "artificial intelligence".

As a scientific line, cybernetics brings together, by means of fundamental general concepts, a number of closely allied subjects describing various aspects of the functioning of a large class of self-governing systems: the theory of control, the theory of information, the theory of games, and the theory of operations, among others.

The fundamental concepts of cybernetics are common to all these within the boundaries of the said scientific area, but they are not universal because they are natural only for describing self-governing systems organised in a specific way, which include all living systems, social systems and artificial self-governing systems, to the extent to which all these systems have common features of self-governance. Beyond these limits the common concepts of cybernetics become meaningless because they cease to correspond to the things in which the processes of self-governance and information communication are not inherent. For that reason, the sciences of inorganic matter and the forms of its motion had no need of concepts like "information" and "control". At any rate, physics has made great advances to become the leader in natural science without having any cybernetic concepts.

Cybernetics has in a sense abstracted itself from the concrete material substratum of the various self-governing systems, which is why it was able to put forward fruitful ideas about the general principles of control. But it was wrong to deduce from the success of this abstraction that the conclusions and general concepts of cybernetics are totally independent of the level of the structure and specifics of the material substratum in real processes of self-governance and information communication. Unfortunately, such a conclusion was drawn by some scientists, who hastened to proclaim the universality of the concepts of "control" and "information", and began to look for them where they did not exist, namely, in inorganic nature and even in "extramaterial" spheres, as the English scientist Eric Ashby has done. Whatever their intentions, their conclusions are mechanistic and lead to hylozoism and even idealism.

Lenin used to say that "philosophical idealism is a one-sided exaggerated... development (inflation, distention) of one of the features, aspects, facets of knowledge into an absolute, divorced from matter".[2] In this case, the one-sided exaggeration and inflation of an abstraction that is necessary when applied fairly, and neglect of the material substratum of the processes of self-governance and information communication, neglect of what is most important in the phenomenon of information, namely, its content, for which the communication is established, and the phenomenon of information arises at a definite historical stage in the development of material systems, inevitably result in idealistic interpretations of the basic cybernetic concepts. Let us recall that a warning against such a danger was sounded back in 1948 by Claude Shannon, not a philosopher, but a mathematician and a founder of the theory of information, when he wrote that the concept of information could not play the part of a universal clue to all the mysteries of nature.

Most Soviet philosophers have reached the correct conclusion that the phenomenon of information is derivative from the processes of reflection of reality and of reflection itself. Some of these philosophers believe that information also exists in inorganic nature as a product of the primitive forms of reflection. Others believe--and I share their view--that information is derivative from the highly active reflection of reality by specially organised self-governing systems, that the content of information in any form is the external world actively reflected by the self-governing system and its own internal state, and finally, that information arises wherever information communication is established between the elements of such a system or between self-governing systems for the purpose of transmitting the content of

reflection. Studies by both groups of philosophers have promoted not only the scientific analysis of the concepts of information, information communication and control, but also further development of Lenin's theory of reflection in the light of the advances in modern natural science.

Now, a few words about the "artificial intelligence" and the speculations it has produced. Achievements in the manufacture of instruments of mental labour in the form of three generations of computers and the elaboration of superhigh-speed fourth generation computers have given occasion for dubious hypotheses claiming that sooner or later computers would acquire an intellect that would be independent of and more powerful than the human intellect, which would enable them to reproduce themselves and constitute a community without man's participation and independently of man.

Those who spin out such hypotheses quite obviously fall into the mechanistic error of failing to reckon with the qualitative level in the development of biological systems and social man. Science in general and Marxist philosophy, Lenin's theory of reflection have long since demonstrated that human consciousness is above all the product of long social development of man and society as a whole, with its most intricate relations among individuals, social groups and classes.

There is no doubt that the computer can calculate a thousand times faster than the most capable and skilled mathematician. But it has to calculate according to a programme, including the self-programming programme, devised by man. However, in terms of its instrumental substance, it does not differ from the engines of supertankers, giant presses and other machines which are a million times more powerful than man, or from supersonic jets and space-ship carrier-rockets, which develop speeds that are 500 and 8,000 times greater than that of the pedestrian, and which are the instruments of manual labour. The only difference is that computers, instruments of mental labour, while excelling in calculation speeds, do not possess the properties of the human intellect which we call creative. They are simple instruments designed to release man from labour-intensive and uncreative operations of the intellect.

One should also add that the figures used to devise a computer programme cannot express all of man's emotions, thoughts and visions. That is why it is in principle wrong to identify the process of cogitation and computation. Computers help man only within the limits within which man himself is able to reflect the properties of the external world by means of mathematical equations. Beyond these limits the computer is powerless, like, say, the caterpillar, to understand and evaluate Hamlet's "to be or not to be".

Some ask: should we worry about some scientists' believing it to be possible that a machine cleverer than man can be developed? After all, if they are wrong, their efforts will still help to develop better computers. This may indeed be inessential, if one takes the narrowly pragmatic and purely technical approach. But let us recall the efforts that have been wasted by would-be inventors of the perpetual-motion machine. In science not only potentialities but also constraints, like the constraint imposed by the law of the conservation of matter and energy,also have a heuristic role to play. A clear view of what we can and cannot do in virtue of the objective laws of nature makes us free to act with a knowledge of what we are about, including freedom from the useless expenditure of effort by hundreds or thousands of men.

But when we leave the pragmatic field for the higher spheres of knowledge, we find that such mechanistic ideas hamper the development of the scientific outlook as a whole. One may well ask why there is need to penetrate the mysteries of the brain, the origins of consciousness, the psyche, the formation of communist morality, and so on, if a machine intellect superior to the intellect of man and even of

society as a whole may be "simply" created by means of electronics.

Such mechanistic claims and their irresponsible popularisation facilitate the appearance of an over-simplified approach to philosophy's eternal problem, that of the relation between the material and the ideal, of a superficial and ignorant interpretation of the categories of the "ideal" and "psychic", to the problem of man, the individual and society, to the most acute problems of ideology and ideological struggle and many other questions which are of fundamental importance in the life of society and of every individual. Indeed, the mechanistic mistakes which ultimately lead to an idealistic distortion of reality are not so harmless after all.

NOTES

1 V.I.Lenin, Collected Works, Moscow, Vol.38, p.363.

2 Ibidem.

ON THE PHILOSOPHICAL SUBSTANTIATION OF PHYSICAL THEORIES

Vladimir GOTT, D.Sc.(Philos.)

Despite the assertion widely made in the bourgeois world that sciences that are unconnected with ideology and world outlooks can exist, the ideological struggle between the two systems is ever more involving the natural and the technical sciences. A wide range of conceptions referring to ideological and political neutrality in natural science exists, but such conceptions are all aimed at creating an impression of natural science's neutrality, that with the purpose of utilising natural science for the struggle against dialectical materialism as the theoretical foundation of a coherent scientific and communist world outlook, as the method of up-to-date science.

Individual natural scientists, even those that have made a major contribution to the advancement of science, find it possible, in interpreting successes in various areas, for example in physics and biology, to make claims that are directed against materialism. Bourgeois ideologists, as representatives of idealistic philosophy, exploit such erroneous claims by scientists of high repute, and assert that dialectical materialism has been disproved by advances in science. They thereby try to cast aspersion on the theoretical foundations of the working class's world outlook.

Here is what Werner Heisenberg wrote in his Physik und Philosophie: "The present-day understanding of atomic phenomena bears very little resemblance to the understanding of the atom in previous materialist philosophy. Moreover, it may be said that present-day atomic physics has pushed natural science off the materialist road on which it stood in the 19th century."[1]

While the first part of the statement can be agreed with, the second is erroneous.

And here is what we read in another of this scientist's work: "Thanks to Dirac's discovery, physics has been obliged to go over from the philosophy of Democritus to that of Plato. Democritus's philosophy proceeds from the atom as the smallest indivisible structure and adheres to the formula: 'In the beginning was the particle'. Plato's philosophy is based on the formula: 'In the beginning was symmetry'."[2]

Indeed, present-day physics has shown that the atom is divisible, and revealed the complex structure of the atom and its nucleus; however, it has also confirmed their materiality, the independence of their existence from the cognising subject. However, Werner Heisenberg had no right to identify the materialism of Democritus with the question of the atom's structure and variability, as well as of all elementary particles. He had no right to identify such metaphysical materialism with dialectical materialism. Despite the logic in the development of science, he has gone over (and that, far from consistently) to the stand of Plato's objective idealism.

Attempts to strengthen the positions of idealism and religion are also linked with the advances in nuclear power engineering which is based on the well-known correlation $\Delta E = \Delta T C^2$, one that is regarded in Western physical and especially philosophical literature as evidence of the equivalence of matter and energy and as a possibility of the destruction of matter.

Fritz Larsen, one of the theorists of present-day neo-Thomism has written that atomic energy has revealed the hollowness of materialism, so that the poor communists, who have believed in the materiality of the world, no longer have any ground to stand on. If God so wishes, He will be able to turn any amount of substance on Earth into flaming energy, since all atomic nuclei are hard energy, and therefore matter can turn into fire.[3]

After substituting the particular scientific notion of "substance" for the philosophical notion of "matter", and then--already unlawfully from the standpoint of physics--identifying mass and matter and proclaiming the disappearance of the latter, F.Larsen expressed sympathy for the "poor communists"; however, it is he himself who deserves sympathy, since all his manipulation of notions is scientifically unethical and essentially hostile to science.

Present-day Catholic philosophers have proclaimed the laws of Nature an expression of the Divine will and consequently spiritual in nature. That is why they are adherents of the rigorous determinism of physical laws, understanding by the determinism of such laws the existence of transcendental nature in mobile beings, which ultimately ascend to God as the Absolute Being.

The striving to "reconcile" science and religion is a kind of defence of religion and idealism, and a variety of the ideological struggle. It is a trend that is being unmasked by Marxists throughout the world. "They (the neo-Thomists--V.G.) have placed collaboration on the agenda, but anyone can understand that such collaboration can only be to the advantage of religion," says Georges Cogniot, the French Marxist. "Science has absolutely no need of such 'support' from religion; on the contrary, even the slightest contamination by elements of religious mysticism (as well as of idealism, we shall add--V.G.) is most harmful to any science at any stage of its development."[4]

The founders of present-day physical theories drew closer in an intuitive and groping way to a dialectico-materialistic understanding of the relation of empirical and theoretical--and especially mathematical--knowledge in the construction of new theories.

To quote Albert Einstein: "Fundamental ideas play the most essential role in forming a physical theory. Books on physics are full of complicated mathematical formulae. But thought and ideas, not formulae, are the beginning of every physical theory. The ideas must later take the mathematical form of a quantitative theory, to make possible the comparison with experiment."[5]

Thoughts and ideas appear as a result of a reflection, in man's mind, of the material world about him. This is not a simple, mirror-like or dead reflection but a highly complex process, whose mechanism is far from having been studied. What has been firmly established is the origin of ideas, notions and the formation of models that replace objects of reality in the process of cognition; what has been shown is the decisive part played in cognition by practice, by experiment.

A scientific theory is a form of thinking that ensures the achievement of overall and generalised knowledge of the reality studied by any science, and therefore operates as the result of the transition from abstract knowledge to concrete knowledge.

Theory, as Karl Marx pointed out, is an ascent to the concrete. "The concrete," he wrote, "is concrete because it is a synthesis of many definitions, and consequently a unity of the multiform. It, therefore, operates in thinking as a process of synthesis and as a result, and not as a point of departure, although it is an actual point of departure and, because of that, also a point of departure in contemplation and representation. On the first road, a full representation evaporates to the degree of an abstract definition; on the second road, abstract definitions lead to a reproduction of the concrete through the medium of thinking."[6]

The following foundations are used in the construction of a physical theory: a) the data of experiments and observations; b) fundamental physical principles and laws, for example the law of the conservation and transformation of energy; the principle of the invariance of symmetry, etc.; c) logical apparatus; d) philosophical principles and laws. Fundamental philosophical principles play an important part in relating the content of a physical theory to objective reality, i.e. in the interpretation of the theory that has taken or is taking shape.

If there are a number of interpretations, then the selection of one of them is often made by the scientist even subconsciously, on the foundations of his philosophical ideas.

It should be borne in mind that the scientist's philosophical views, his world outlook, ultimately influence his choice of the line of research, and the relation between, and appraisal of, experimental data and abstract concepts. According to Frederick Engels, it is only from positions of a scientific world outlook that it is possible "to arrive at a 'system of nature' sufficient for our time".[7]

When addressed to the practice of cognition, a scientific world outlook acquires a methodological role.

Max Planck was right when he stated, in his paper on "Physics in the Struggle for a World Outlook", that the researcher's Weltanschauung will always determine the direction of his work. Unfortunately, prejudice against dialectical materialism and ignorance of it hinder the achievement of scientific truths even by outstanding scientists of the capitalist world.

Albert Einstein frequently wrote of the strong influence exerted on him by such philosophers as Hume and Kant.

F.S.C.Northrop, the well-known US researcher into Albert Einstein's scientific heritage, has written that, as Einstein himself admitted, the latter held back publication of his researches into the general theory of relativity because he considered them contradictory to the principle of causality in its Humist interpretation. It was only later when, at a cost of great efforts, Einstein realised that Hume's interpretation was erroneous, he continued work on his general theory of relativity, and published the results obtained.[8]

The present-day stage in the development of science is marked by an extensive synthesis of scientific knowledge; it demands that scientists should arrive at a profound understanding of the way new theories come into being and why old theories have their limitations. In this connection the genuine physicist cannot but be guided by a scientific philosophy, whether he wishes to or not. Referring to this objective trend, Lenin wrote that "...natural science is progressing so fast and is undergoing such a profound revolutionary upheaval in all spheres that it cannot possibly dispense with philosophical deductions".[9]

The scientific nature of the Marxist methodology has been borne out in practice. Scientists who are guided by the basic principles of Marxist philosophy are able, not only to arrive at correct generalisations but also to foresee the course of events and give correct orientation to further scientific search. An important part in the latter is played by the dialectico-materialist understanding of the links between practice, experiment and theory.

A correct understanding of results obtained is indubitably hampered by the enhanced role of abstractions and the ever greater mathematisation in present-day physics. This has led to many scientists seeking for some innate physical essence and contraposing it to the mathematical form of theory. Such contraposition, however, is groundless. Indeed, what sense is there in asserting that a definite physical theory explains a definite range of phenomena. That sense lies in the fact that all links between the phenomena under examination can be reflected with the aid of the notions and conceptions of a given theory, for which purpose no introduction of additional notions and conceptions is necessary. That is the exact meaning of the word "to explain" in physics. "To explain" is only possible within the terminology of a given theory.

In this connection, one might recall Newton's reply to a question on his theory of gravity, a question which ended with the words: "After all it explains nothing." To this, Newton replied that his theory told how bodies move, and that should be enough. He had said how they move, not why.

What are the means required for the creation of a new theory in physics.

For that new information is indubitably needed regarding the properties of matter, information that will be obtained with the aid both of old and new experimental means. However, theory is a reflection of objective and law-governed patterns in Nature; it is the taking of a cast from Nature, but not a simple immediate, mirror-like and dead act; it is a complex, bifurcated, and zigzag act which contains the possibility and the necessity of imagination.

It is that necessity of permanent advance which is often ensured by mathematics and the development of its methods. "Our feeble attempts at mathematics", P.A.M.Dirac wrote, "enable us to understand a bit of the universe, and as we proceed to develop higher and higher mathematics, we can hope to understand the universe better. This view provides us with another way in which we can hope to advances in our theories. Just by studying mathematics we can hope to make a guess at the kind of mathematics that will come into the physics of the future.. .Sooner or later there will be a new Heisenberg who will be able to pick out the important features of this information and see how to use them in a way similar to that in which Heisenberg used the experimental knowledge of spectra to build his matrix mechanics."[10]

Can such a synthesis of experiment and mathematics lead to the appearance of an ultimate physical theory that will make new theories unnecessary? The reply to this question is provided by materialist philosophy: a synthesis of physical experiments and developing mathematics--a synthesis enriched by the dialectico-materialist theory of knowledge--will create ever new physical theories and physical pictures of the world.

Einstein was right in saying that "our conceptions of Physical Reality can never be definitive", and that "the belief in an external world independent of the percipient subject is the foundation of all science".[11]

Einstein arrived at these conclusions quite independently; he did not suspect that they were in full accord with Lenin's ideas: "Man cannot comprehend=reflect=mirror nature as a whole, in its completeness, its 'immediate totality', he can only eternally come closer to this, creating abstractions, concepts, laws, a scientific picture of the world, etc., etc." "...and these concepts, laws, etc. (thought, science='the logical Idea') embrace conditionally, approximately, the universal law-governed character of eternally moving and developing nature."[12]

The development of physical theories is an endless process, since the objects of physical science are inexhaustible in their properties, which reveal themselves in the infinite possibilities of relations between an infinite number of "nascent" and "disappearing" objects of the material world.

The development of cognition provides ever new scientific arguments in favour of dialectical materialism, arguments, which have to be used still more extensively in the ideological struggle.

NOTES

1 Werner Heisenberg, Physik und Philosophie, Stuttgart, 1959, p.43.

2 Naturwissenschaftliche Rundschau, No.9, 1968, p.389.

3 See Dialog, Copenhagen, No.2, 1955, p.10.

4 Georges Cogniot, La religion et la science, Paris, 1960, pp.43-44.

5 Albert Einstein and Leopold Infeld, The Evolution of Physics, New York, 1954, p.291.

6 See Karl Marx, Grundrisse der Kritik der politischen Ökonomie, (Rohentwurf), 1857-1858, Berlin, 1953, pp.21-22.

7 See Karl Marx and Frederick Engels, Selected Works, Vol.3, Moscow, 1970, p.365.

8 See F.S.C.Northrop,"Einstein's Conception of Science", Albert Einstein: Philosopher-Scientist, New York, 1951, pp.407-408.

9 V.I.Lenin, Collected Works, Moscow, Vol.33, p.234.

10 P.A.M.Dirac, "The Evolution of the Physicist's Picture of Nature", The Scientific American, No.5, May 1963, New York, Vol.208, p.53.

11 Quoted from James Clark Maxwell. A Commemoration, (1831-1931), Cambridge, 1931, p. 66.

12 V.I.Lenin, Collected Works, Vol.38, p.182.

LENIN'S IDEA OF THE INEXHAUSTIBILITY OF MATTER AND THE STRUCTURE OF MICRO-OBJECTS IN MODERN PHYSICS

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Physics is a department of science which deals with phenomena, images and concepts relating to the most advanced area of natural science, to the most minute distances and durations, on the one hand, and great metagalactical processes, on the other. For that reason, physics is most closely interwoven with philosophy. There is now perhaps no fundamental physical question that is not at the same time a philosophical problem. The relationship between the elementary and the complex, the structure of "the most elementary particles", microcausality and super-light generalisations of the theory of relativity, the possibility (or impossibility) of describing objective reality irrespective of the instruments of observation, and so on--those are only some of the comprehensive problems which are simultaneously physical and philosophical.

We agree entirely with Academician Mitin, who stressed that the alliance of philosophy and natural science, far from having lost its importance, has, in effect, become even more necessary, especially since with the development of physics some philosophical questions which had appeared to have become less important, tend again to become the subject of debate and discussion. The wrong answer to these questions could lead to far-reaching methodological errors.

An example is the question of the inexhaustibility of Nature. At first glance, hardly anyone will doubt that Nature is inexhaustible both in quantitative and qualitative terms, a truth that everyone comes to realise at school. Still, in recent years, this has been the subject of a sharp discussion, which is still far from over. The point is that for the first time in the history of physics we face a situation in which it is possible, in principle, to reduce the whole diversity of known physical phenomena to the regularities of only four basic types of interaction: gravitation, weak, electromagnetic and strong (nuclear) interactions. Each of these interactions is characterised by a finite number of fundamental constants, which is why the time required to find the relationships which determine these constants should, in the opinion of some authors, also be finite. In other words, this will lead to complete and exhaustive knowledge of all the fundamental physical laws, so that it will remain for the scientists to confine themselves to studying the quantitative aspects of physical phenomena and analysing the regularities governing the more complex derivative forms of motion: chemical, biological, and so on.[1]

The higher forms of motion cannot be entirely reduced to the simpler, physical forms. This will be seen from the fact that even the conventional statistical mechanics of particles cannot be reduced to Neutonian laws, although the latter constitute its basis. But is it actually right to say that the number of fundamental physical laws is finite and that, consequently, the phenomena and material objects of the surrounding world are inexhaustible only in quantitative terms, in the sense that their inner and external ties are quantitatively immense?

The history of science shows that very definite objects and laws correspond to each stage of its development, and that these are regarded as being primary and elementary. Indeed, one could say that the various definitions of the elementary are milestones in our understanding of Nature.

At one time, it was the molecule that played the part of the most elementary element, then came the atom, the atomic nucleus and finally, the micro-objects, which we now designate as elementary particles. Where do we go from here? Nowhere, some scientists have suggested (see the work by A.S.Kompaneyets quoted above); or do we mount yet another rung in the long ladder of structural levels leading into the depths of matter?

At the level of elementary particles we find essentially new and paradoxical features of the elementary. Whereas in the past it was self-evident that the part is always smaller and simpler than the whole (the consistent application of this criterion step-by-step determined the "most elementary" objects which were further irreducible), each of the particles, which we now call elementary, contains within itself parts which are as complex as the particle itself. Thus, the nucleon contains within itself mesons, which, for their part, can disintegrate into nucleons, antinucleons and other particles. Here, the question is which of these particles is more elementary becomes meaningless. The concept of the elementary turns out to be applicable only to a large group of interconvertible objects, and means only that, first, none of these objects may be ascribed a greater degree of elementary than any other, and second, that all these objects taken together determine the structure of atoms, their nuclei and all the other more complex material objects.

Another essentially new feature of the modern concept of elementarity is that all the elementary particles have a complex internal structure, which for the time being cannot be described in non-contradictory terms through any of the earlier known time-space images.[2] Time-and-space descriptions turn out to be more or less suitable only for the peripheral areas of elementary particles, while the concept of the structure of its central part has only a formal meaning, namely that the experimental expressions describing the dispersal of particles differ from the corresponding theoretical formulas for point particles in some phenomenological functions, known as form-factors, which are regarded as the characteristics of particle structure. These form-factors depend on the energy and impulse of interacting particles, but it has not yet been possible to find their time-and-space interpretation.

The difficulties are also compounded by the fact that the number of types of elementary particles turns out to be very great: their number now runs to many scores.

Such a state of the problem of elementarity cannot, of course, but be a source of dissatisfaction.

We do not yet know how to overcome these difficulties. Various approaches are being studied, but they all produce equal difficulties.

One line which is now being intensively developed entails attempts to reduce in some way or altogether to abandon, in the sphere of very small time-and-space dimensions, the constraints imposed by the requirement of relativity invariance. In that event one could assume the existence of particles with speeds exceeding the speed of light, and the possibility of superlight interaction. In the macroscopic spheres of time and space such an assumption at once produces insoluble contradictions with the principle of causality, and for that reason has to be discarded. But within the framework of ultrasmall time-and-space dimensions there may be processes for which not only the concepts of right and left but also those of past and future are unequivocal. In these conditions, the habitual formulations of causality worked out on the basis of macroscopic phenomena turn out to be inapplicable, so that the answer to the question of whether superlight phenomena exist in nature can be obtained only through experiment.

In the past few years a large number of experiments was conducted to discover superlight particles. Some of these experiments, their authors believe, have shown signs of the presence of such particles. Unfortunately, the interpretation

of all these experiments is still highly ambiguous, and they can be explained without the use of superlight particles when some additional assumptions are made.

The hypothesis of superlight microphenomena is still embryonic in theoretical terms. A detailed study has only been made of so-called nonlocal theories in which superlight interactions are described in purely phenomenological terms by introducing into the theory certain functions which "spread out" the point interaction of conventional theory along the small time-and-space area. There are other more subtle ways of phenomenological introduction of nonlocality, but, generally speaking, they are all ultimately equivalent to this simple idea.

Analysis shows that all these theories produce serious difficulties, despite the fact that through the efforts of many theorists their formulation has been brought to a high degree of perfection, when even a specialist frequently finds it hard to identify these difficulties. This has been achieved through more complex theoretical formulations, which have become so fanciful and recipe-like that now and again it is no longer theory but "nonlocal schemes" that are considered. All of this suggests that such a phenomenological approach has no prospects. The weak point of nonlocal theories is that the introduction of a radically new element--superlight speed--does nothing to change the remaining physical basis of the conventional relativity-invariance local theory of field. There is need here for substantially new ideas.

As for the idea of superlight microphenomena, the search for such a generalisation of the theory of relativity is fully justified both in general methodological and purely physical terms.

About ten years ago, some theoretical works claimed to have discovered the next, deeper level of the material world lying beyond elementary particles, namely that of the quarks.

It appears that among the scores of elementary particles known today, it is possible to identify some families each of whose members may be regarded as being a different state of one and the same particle, just as, for instance, the proton and the neutron are two states of the nucleon. In this way, it becomes possible considerably to reduce the list of existing elementary objects and to arrange something like a periodical table of elementary particles, where the simplest element that can be used formally to build all other particles (just as all the atomic nuclei can be built of nucleons) is the quark, a hypothetical particle which for some reason has not been identified in the numerous experiments staged to detect it. Only in the recent period have some experiments provided indirect confirmation of the theoretical predictions that the proton and the neutron consist of three quarks in different quantum states "stuck together". The size of the quarks are roughly an order smaller than the size of the nucleon.

All the nonlocal theories considered above are logically very perfect schemes, but from these no new prediction has, in effect, followed to allow verification in experiment, while the quark model, which, at first sight, is a "tangle" of contradictory facts and hypotheses, is exceptionally rich in physical predictions, many of them being confirmed remarkably in experiments. One is left with the impression that we are on the threshold of producing a new picture of the structure of matter, which is considerably deeper and more general than that which we have known until now, but which requires a totally new conceptual apparatus for its expression.

Will the new level of the structure of matter at whose threshold modern physics now stands finally turn out to be the last one, or yet another stage leading into the inner depths? On the strength of the quantitative and qualitative inexhaustibility of matter, the answer appears to be quite clear. But actually it is not so simple. The inexhaustibility of Nature does not necessarily have to be realised through unlimited division, for there can be another way in which

individual micro-objects appearing in outer space as elementary particles, inside constitute infinite macroscopic formations. The model of "Fridman universes", compressed under the impact of their own gravitational attraction, elaborated in the past few years by Academician Markov, shows that such a possibility cannot be ruled out, in theoretical terms, at any rate.

The important thing to stress is that this is not just a bold nature-philosophical hypothesis of which there have been many in history. Modern gravitational theory strictly predicts that under certain conditions the Universe can indeed move into a stage of compression and appear to the external observer as a very small object. For the time being, it is not yet clear how far into the sphere of microdimensions these predictions can be extrapolated, because gravitation theory does not take account of quantum effects. But vast methodological and natural-science interest lies in the very prospect of such a "global approach" to the structure of our world, when its inexhaustibility is realised through a diversity of intertransforming micro- and macro-objects.

We find that modern physics is running through a painful process of developing totally new conceptions of the structure of the universe both in terms of ultrasmall and of maximum time-and-space dimensions. We have no grounds at all to postulate the end of physics as a science cognising qualitatively distinct regularities of the material world. On the contrary, the development of physical science, as of the whole of natural science, confirms Lenin's well-known idea of the "inexhaustibility of the electron".

NOTES

1 See, for instance, A.S.Kompaneyets, Can Physical Science Reach an End?, Moscow, 1967 (in Russian).

2 See V.S.Barashenkov's article in the collection Philosophical Problems of Quantum Physics, Moscow, 1970, p.191. (in Russian).

PHILOSOPHICAL CONCEPTS OF THE DEVELOPMENT OF CHEMISTRY

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Two trends are clearly discernible in the world literature on scientific progress. One of them leads to a certain integrated form of learning, which has come to be known as the "science of science" and which is concerned with the comprehensive study of this phenomenon by organically combining historical, philosophical, economic, sociological, psychological, and other methods. Such study is prompted by the need to build up a single concept of scientific progress as a multifaceted system for solving the practical problems of directing scientific activities in conditions of the present-day scientific and technological revolution. The other trend leads to a sharp polarisation of views on the most important problems concerning the factors and motive forces behind scientific development, a polarisation primarily due to a difference of ideologies and to the philosophical conflict of ideas.

We are concerned here with the second of these trends and with the methods by which problems concerning the laws governing the development of science may be solved from the Marxist standpoint.

Questions concerning the factors behind scientific progress began to receive fundamentally different answers even within the classic history of natural science between

the end of the 19th and the beginning of the 20th century. In the 1930s this distinction took the form of two conflicting trends, one of which--the "immanent", or "internalist", trend--sought to explain all the laws governing the movement of scientific learning merely as the inner logic of science itself, while the other--the "externalist" trend--recognised various socio-historical factors "external" with respect to science. At present the "internalist" trend is represented primarily by the writings of those bourgeois scholars (A.Koire, G.Canguilhem, R.Hall, and others) who describe the history of science as a history of the unfolding of man's spiritual nature. The founder of this trend Alexandre Koire bluntly called himself an idealist and expressed emphatic disagreement with the Marxist conception of social consciousness. The "internalists" deny any interaction between science and technology, or else consider it irrelevant to scientific progress. Practical activity, in their opinion, far from giving rise to new theories, more often "acts as an impediment" for fundamental science (Koire).[1]

The trend treating the development of science as a socially determined process--and often, therefore, called "externalist"--is at present represented by an immeasurably broader front of research. It includes, first, so-called cultural-historical works, which link science with the entire intellectual life of society, with politics, but fence it off from social production. The best known of these works are those of the prominent American historian of science G.Sarton and his followers. This front embraces, secondly, the studies of many bourgeois scholars who, although fearing charges of sympathising with Marxism, have espoused a substantial part of the Marxist conception of scientific progress and see in it, at the same time, both "science as thought" and "science as action applied to material things", linking its development with socio-historical and economic factors. The most representative of these works belong to A.Crombie (Britain), and R.Merton and H.Guerlac (USA).

Historiographers abroad usually also include in this trend works based on the Marxist interpretation of the history of science. Quite obviously, however, the name "externalist" does not fit such works, since they synthesise notions concerning both external and internal factors in the development of science. The most significant of these studies have been made by scientists in the Soviet Union and in other socialist countries, and also by the eminent British natural scientist and one of the founders of the science of science J.D.Bernal, by the British historian of science S.Lilley, the American geometrician D.J.Struik, and certain other scientists who were greatly influenced by studying Marxism and by analysing scientific progress in the USSR. Clearly, the name "externalist" does not apply to these works, which synthesise notions concerning external and internal factors in the development of science.

A truly scientific conception, making possible the most adequate interpretation of the nature of scientific knowledge and a study of the laws governing its development, was first worked out by Karl Marx and Frederick Engels. Science, according to this conception, is <u>in its fundamental part</u> one of the spheres of social consciousness, i.e., a sphere of the ideal activities of man. But these activities, firstly, are governed by material requirements, and, secondly, represent the birth of such a theoretical arsenal of science that reflects the external material world, i.e., the same material world, but transplanted into man's mind and transformed in it. The transition of the material to the ideal, or cognition of the laws of nature, is necessary for man subsequently to embody his scientific knowledge in technical devices, to materialise science and turn it into a material productive force of society. The reverse transition of the ideal into the material constitutes the most substantial of the functions of science as a social institution.

In accordance with this conception, the Marxist literature devoted to analysing scientific knowledge has

up to now pointed to two sets of factors governing scientific progress. The first of these are the requirements of the production of material wealth; the second, the factors relating to the object of science, or the object of studies. The former factors are regarded as the major motive force in the development of natural science; the latter, as something in the nature of a pattern according to which the structure of natural science takes shape. This means that the process whereby the system of science is formed is subordinated to that logical sequence of the emergence of various branches of natural science--mechanics, physics, chemistry, biology--which is dictated by the hierarchy of the forms of the motion of matter (mechanical displacement of bodies, physical motion, chemical interaction, life) as a result of the evolution of nature.

The fruitfulness of such an approach to studying the laws governing the development of science is obvious, and it was demonstrated most strikingly in the speeches by scientists from the socialist countries at the latest international congresses on the logic, methodology, and philosophy of science, and at the International Symposium of the Member Countries of the Council for Mutual Economic Assistance on Managing Scientific Research.[2] At the same time it cannot be said that this approach solves all problems or that it can be mechanically extended to analysing the development of any scientific system. Whereas the regularities in the differentiation and integration of sciences, and the birth of new scientific problems and new branches of natural science, can effectively be established by studying the evolution of the object of science, the mechanism whereby the social conditions of life influence the rate and directions of scientific progress is very difficult to determine. It is well known how formidable are the difficulties often encountered by the historians of natural science when they attempt to discover the connections between the scientific events they describe--even if they are "epoch-making" events--and socio-historical factors.

It is well known too that, owing to these difficulties, the historians of science sometimes even give up any attempt to analyse the connections between the development of this or that branch of natural science and the history of material culture, choosing, instead, to derive all the laws of scientific progress merely from the "inner logic of scientific progress" and brushing aside the operation of "external factors".

These difficulties can, however, be overcome by something in the nature of a problems approach to analysing the development of science. An example of that approach is given in this paper.[3] The empiric basis for this approach is provided by the results of systematic studies of the history of chemistry, and in this respect this approach represents conclusions from history rather than a discussion of any viewpoints.

This or that science can be defined most adequately—and consequently, its past, present, and future can be studied most successfully—only provided its object is treated not simply as a piece of nature transplanted in the process of cognition into the human mind, but as an object to which man's practical activities are applied. This means that we can regard as the object of a given science only that part of nature with which man has entered into interaction in the process of production and whose objective laws will be learned by him within the framework of purposeful transformation of nature for production. The object of a given science is by such an approach co-ordinated with a definite area of man's practical socio-historical activities, and the science itself is co-ordinated with a definite sphere of the production of material wealth. That being so, the social factors behind the development of science prove to be not so "external" after all: they are bound up with the object of science. Scientific progress then appears as a dual process of: 1) the continuous cognition and isolation of ever new aspects of an inexhaustible object, or, in other words, the evolution of the subject of the science, and

2) the continuous materialisation of scientific knowledge or its embodiment in corresponding technical devices, i.e., its conversion into means of production.

<u>Proceeding from these general premises of the unity of socio-historical and objective factors in the development of science</u>, let us attempt to consider the concrete process of the development of chemistry.

The history of chemistry shows that among all the chemical problems it is possible to distinguish fairly clearly those problems that are transient, arising at some stages and disappearing at others, and those problems that have existed in chemistry at all the stages in its development, changing only in accordance with the level of chemical knowledge attained.

A special position among the problems of the second type is occupied by that of the genesis of the properties of substances as a key to preparing substances with certain desired, or pre-set, properties. This problem is indeed not a transient one. It has been developing together with the development of chemistry from the very origins of that science to the present day, constituting a pivot, or invariant nucleus, of chemistry.

The main feature distinguishing this problem is the fact that two distinct poles of a single purpose may be discerned in it: preparing substances with required properties, which is the aim of man's productive activities, and determining the methods whereby a substance with desired properties can be prepared, which is the object of scientific cognitive activities. One aspect of the problem is therefore connected with the characteristics of chemistry as a direct productive force; the other, with the definition of chemistry as one of the forms of social consciousness.

This problem, which thus serves as a focal point for both the ideal and the material, links the production of substances having pre-set properties, which is part of the production of material wealth, with the object of chemical research as the sum-total of the objects of work. Another highly important feature of this problem is the fact that it has only four or five methods of solution, these being the most general methods of solving the problem of the qualitative diversity of matter, rather than any particular methods of studying their properties. Just as different production methods are associated by Marxism with different socio-economic formations in the development of society, so the different methods of solving this problem can be associated with different stages in the development of chemistry. The production of substances is, after all, the most important component in the general production of material wealth.

<u>The first method</u> of solving the problem of the genesis of properties arose in ancient natural philosophy and survived for over two thousand years—until Robert Boyle's time. The problem itself throughout this period was to find an explanation for the infinite qualitative diversity of bodies encountered by man in interacting with nature. Some philosophers attributed this diversity to different combinations of the atoms of the world's protomatter; others, to the interpenetration of such primordial elements as fire, air, water, and earth, which were assumed to make up all bodies. Despite the abundance of such explanations, all of them, in the final analysis, fitted into one scheme:

Substance • ⟶ • Accident (Scheme 1),

which actually reflects the historically first method of solving the main problem of chemistry.

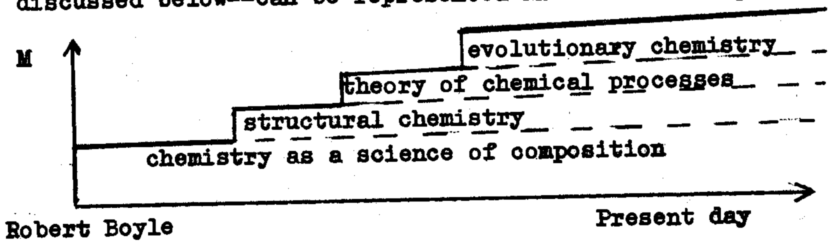
The distinguishing features of this method are: 1) speculative reasoning, which acquires great power as abstract thinking, but lacks an empiric basis; 2) logical deduction, which lays claim to a universality of explanation, but in actual fact does not rest on the criterion of practice at all, and 3) the universality and multiple meaning of the object, which is matter rather than a specific qualitatively changing substance, in short, all that which characterises natural philosophy itself, within which this method arose

and developed. Even from this it is easy to see that the connections of this natural philosophical method of explaining the nature of bodies with production, specifically with the chemical crafts of ancient times and the Middle Ages, are clearly one-sided. Undoubtedly, the method itself was entirely determined by the requirements of practical activities. But it is equally certain that this method of solving the problem of the qualitative diversity of bodies for two thousand years performed no useful practical work in terms of feedback benefiting production. What could practical production benefit from the substance-accident scheme besides stimuli encouraging further meditation concerning substances or alchemical attempts at the transmutation of elements? It was for this reason that another feature of this method, typical of it alone, was its historically moribund nature. Having arisen somewhere in the remote past, it vanished completely with the emergence of new methods of solving the same problem, methods capable of providing a more reliable explanation of the qualitative diversity of bodies and practically useful prescriptions for purposefully changing substances qualitatively.

<u>The second method</u> of solving the problem of the origin of properties arose in the latter half of the 17th century through the work of Robert Boyle. The changes in the sphere of production that took place in the epoch of the Renaissance, along with the progressive changes in economic and political life, gave rise to the need for fundamental changes in natural science too. One such change was the downfall of the first—and practically sterile—method of solving the problem of the genesis of properties, and the emergence, <u>in its stead</u>, of a new method, which resulted from a synthesis of the knowledge that had accumulated in the field of natrochemistry and technical chemistry in the 14-17th centuries with a fundamentally new experimental approach to the study of nature. This new method can be expressed by the scheme:

Composition • ⟶ • Properties (Scheme 2).

It was this that marked the beginning of experimental chemistry, giving it shape as a science of the composition of substances, or "the science of the chemical elements and their compounds" (Dmitry Mendeleyev). And although a science of composition was primarily analytical, it nevertheless at the same time laid the foundations of a synthetic trend: the knowledge of concrete elements and the laws of their combination into "compound bodies" made possible confident actions to prepare new substances. The science of composition that arose in this way was to have an infinite lifetime. It became the first conceptual system of chemistry, i.e., the first relatively independent field of chemical learning (rules, laws, and theories), which had the purpose of solving any—naturally, lying within its capacity—problems of qualitative chemical changes in terms of composition—properties, or else by changing the elementary composition of chemical compounds. This system of chemistry—along with three other conceptual systems to be discussed below—can be represented in the following way:



(M is the mass of scientific information accumulated)

(Fig.1)

The third method of solving the basic problem of chemistry was engendered by the transition from the manufactory stage of capitalism, with its manual labour and limited range of implements, to the factory system of capitalist production, based on machine technology and new supplies of raw materials. This transition stimulated the processing of a vast amount of substances of vegetable and animal origin, whose qualitative diversity is staggeringly

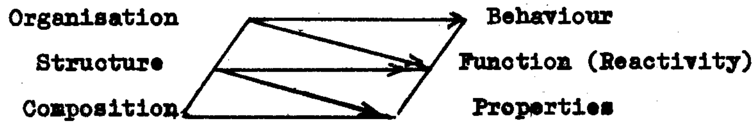
great and whose composition is extremely uniform. It was primarily in this connection—and also through the discovery of isomerism and polymerism—that there appeared a new method of solving the problem of the genesis of properties—according to structure:

(Fig.2)

In the 1850-70s this method gave rise to a whole set of theories—theories having much in common and characterised by a high degree of abstraction, extraordinarily heuristic and practically valuable—which laid the foundations of a second conceptual system: structural chemistry (see Fig.1). Chemistry was thus transformed from a primarily analytical science into a primarily synthetic science. The period of the establishment of structural chemistry (the 1860s-80s) has been described by historians as the "triumphant march of organic synthesis". By the 1870s-90s chemistry had already responded to those requirements of industrial development that had given rise to this method by synthesising all sorts of azo-dyes for the textile industry, the most diverse preparations for the pharmaceutical industry, artificial silk for industrial and domestic needs, and, at the beginning of the 20th century, synthetic rubber for the early motor cars.

This response of chemistry was quite astounding, since prior to this all the above-mentioned materials could be produced only in limited amounts and at the cost of enormous expenditures of inefficient, primarily agricultural labour. But the astonishment at the successes of structural chemistry was short-lived. The intensive development of the automobile industry, aviation, power engineering, and instrument-making in the 20th century dictated altogether extraordinary requirements in the materials field: what were needed were materials of strictly specified properties and on an unprecedented scale—high-octane motor fuel, special lubricants, special types of rubber and plastics, highly resistant insulators, refractory organic and inorganic polymers, and semi-conductors.

These new requirements of production gave rise to the next, fourth method of solving the problem of the genesis of properties and of the qualitative transformation of substances:[4]



(Fig.3)

This method served as a basis for a new, third conceptual system of chemistry—the theory of chemical processes (see Fig.1), which provided an immeasurably more adequate and comprehensive reflection of the object of chemistry. This object was represented as a process of the transformation of substances and not as a finished substance. The subject of chemistry came to be based no longer on the structure of molecules, but on the chemical organisation of a kinetic system, in which the structure of the molecules was merely a particular feature. The dialectisation of chemical ideas had attained a new level, and this made them still more effective practically: the ideal and the material became most intimately connected, owing to which the process of the production of material wealth came to be "not something subordinated to the direct skill of the worker, but a technological application of science".[5] More specifically this proposition had the result that the new chemistry radically and on a global scale transformed both the object and implements of work. Thanks to the new method of solving the basic problem of chemistry, the world-wide production of synthetic rubber, plastics, artificial fibres, detergents and other such materials came to be based on petroleum raw materials, and the production of nitrogen fertilisers, on the nitrogen of the air.

The character of this restructuring of the production of material wealth through the influence of chemistry may be judged, for example, from the fact that as recently as the 1930s such materials as leather, furs, rubber, fibres, detergents, drying oil, acetic acid, varnishes, and ethyl alcohol were produced from animal and vegetable raw materials, specifically from foodstuffs, fats, raw hides, etc. Today, in the 1970s, all industrial solvents, detergents, drying oils and varnishes, about one-third of all fibres, 65 per cent of all rubber, and no less than one-fifth of leather materials are manufactured from petroleum and gas raw materials. Imitation furs are produced on the same basis. But apart from all this, the chemical industry of the 1970s not only declines to use agricultural products as raw material, but also supplies agriculture every year with thousands of tons of urea and microba protein fodder made from petroleum and hundreds of thousands of tons of fertilisers and growth promoters, which at least double grain and vegetable harvests.

But even this is by far not the limit of what is possible. In response to the requirements of the most highly advanced method of producing material wealth, chemistry is now approaching a new, fifth method of solving its basic problem, which paves the way to producing materials by using the most highly organised chemical systems possible in pre-biological evolution. It is beginning to utilise the catalytic experience of living nature. This method is forming the basis of the fourth and last conceptual system of chemistry—evolutionary chemistry (see Fig.3).

The conclusion that the entire history of chemistry can be represented as the consecutive emergence and development of four conceptual systems is of fundamental significance for the theory of the development of chemistry. Firstly, it makes it possible, on the basis of a single principle, to embrace and systematise the entire vast factual material of this science, defining it as an integral system of scientific knowledge with a single structure. This fact is extremely important, since bringing "the individual spheres of knowledge into correct connection with one another"[6] is precisely the basis upon which theory rests. Secondly, this conclusion points to the hierarchy of conceptual systems, for the first time opening up the possibility of determining the levels of scientific research, and, hence, the prospects for the development of chemistry.

NOTES

1 In greater detail this is considered by S.R.Mikulinsky and L.A.Markova in Basic Methodological Trends in the History of Science Abroad, Moscow, 1971 (in Russian).

2 "The Management, Planning and Organisation of Scientific and Technical Research", Proceedings of the International Symposium of the Member Countries of the Council for Mutual Economic Assistance and the Socialist Federal Republic of Yugoslavia, Moscow, May 1968, in five volumes, Moscow, 1970 (in Russian).

3 See also V.I.Kuznetsov, A.A.Pechonkin, "Concerning the Subject of Science and the Logic of Its Development" in the collection Philosophy and Natural Science, Moscow, 1974; and V.I.Kuznetsov, The Dialectics of the Development of Chemistry, Moscow, 1973 (both in Russian).

4 Regarding the schemes given in this paper see V.I.Kuznetsov and A.A.Pechonkin, "Conceptual Systems in Chemistry", Voprosy filosofii, 1971, No.1, pp.46-56.

5 K.Marx, F.Engels, Collected Works, Vol. 46, p.206. See K.Marx, Grundrisse der Kritik der politischen Ökonomie (Rohentwurf), 1857-1858, Berlin,1953,p.587.

6 Frederick Engels, Dialectics of Nature, Moscow, 1954, p.58.

SOCIAL ASPECTS OF GENETIC ENGINEERING

Academician Alexander BAYEV

Science, and particularly fundamental science, has been bitterly attacked in capitalist countries in recent years. These attacks reflect the feeling of confusion and disillusionment caused by events of the past few decades. Science is accused of being wasteful (it really does absorb a large portion of the national income in the developed countries), useless, and even harmful to the health, well-being and morals of the people. It is accused of an even more serious crime, that of complicity in aggression, tyranny, and violence.

The latest attack has been sparked by a new trend in molecular biology--genetic engineering. It is indeed a new trend emerging in 1973 when molecular genetic hybrids were first produced.

The accusations against science are dictated by related motives and are based, in the final analysis, on oversimplified conceptions of the social nature of science. I do not intend to defend science against all these accusations--this is a broad subject that calls for special approaches. I simply want to examine concrete events linked with genetic engineering.

Genetic engineering studies laboratory methods of obtaining a system of heredity of living substances--microbes, animals and plants. In fact, man has already long been creating organisms--breeds of domestic animals and plant cultures. They were produced by means of cross-breeding and selection, which man used empirically before he learned their true nature.

In genetic engineering it is a different matter: the naturalist sets himself the task of artificially producing a hereditary substance--the carrier of genetic information--and then proceeds from it to create organisms. The prospects and possibilities of genetic engineering can be more clearly defined if we briefly retrace the history and logic of the development of this very promising branch of experimental biology.

Its basic prerequisite is to discover the nature of heredity, which was accomplished in this century by explaining what a gene is.

The characteristics of a living creature are determined by the peculiarities of its metabolism which depends, first and foremost, on enzymes, the biological catalysts directing it. All enzymes without exception are proteins, and the problem of heredity, in the first approximation, boils down to the question of how to copy the set of proteins which is invariably, or almost invariably, reproduced from generation to generation. The gene, the nature of which caused much debate, is a segment of DNA corresponding to a specific protein-enzyme. When a cell divides, a doubling of the DNA molecules takes place, and each daughter cell receives one copy of the maternal DNA with a definite set of hereditary signs.

It follows from this that if the experimenter intends to communicate a new hereditary characteristic to the organism he must introduce the corresponding gene or genes into that organism.

Genes, however, do not exist in the organism in the form of separate structures, but rather form the genetic system of the cell: simple--in the form, for example, of

a DNA thread enclosed in a ring in micro-organisms; more complex in higher plants and animals--in the form of a chromosome, the delicate structure of which has not yet been completely uncovered. Even in the simplest of organisms as, for example, bacteria, the genetic system, except the genes programming the synthesis of proteins, contains parts which regulate its own activity. They coordinate the work of the separate genes and link the cell's genetic system with the environment.

This regulatory section of the genetic system attains its utmost refinement in multicellular organisms which undergo a complicated development from a single fertilised cell to a mature organism consisting of many billions of different cells.

During the last 25 years the molecular mechanisms of the hereditary processes taking place on the way from a DNA molecule to a complete organism with all the peculiarities of its structure, physiological functions and behaviour, have been studied. Research on simple subjects--bacteria and viruses--which make up the basis of molecular genetics, was particularly successful. At the same time chemical and physical approaches were developed as well as methods of isolating from living cells DNA and other formations related to genetic processes without loss of their biological properties.

In 1949 a gene related to the assimilation of lactose, was isolated from Bacillus coli. In 1971 chemical synthesis of the gene of ala-type transfer RNA was completed, and this event became a triumph of synthetic chemistry even though the product obtained turned out to be biologically inactive. Since then new successes in isolating genes and in their chemical and biological synthesis have been achieved.

But possibly most important contribution was made by enzymology--the enzymic theory. Research in this field radically changed our conceptions of the nature of genetic processes. To begin with, it became clear that DNA is not simply an inert storehouse for the cell's genetic information, but an active component of the cell itself, figuring in the complex system of processes of cellular metabolism. Secondly, all the material processes of heredity turned out to be enzymatic. At present, many enzymes from different sources have been isolated and studied, which carry out various transformations of nucleic acids—their synthesis and their lysis, reconstruction of damaged segments, exchange by segments of their chains, etc. This stage became a most important link in the development of genetic engineering as the researcher obtained those very instruments which nature uses in order to carry out the processes of heredity.

Like most of the new sciences, genetic engineering appeared at the junction of trends (mentioned earlier) which had hitherto developed autonomously.

What is the modern molecular biologist capable of creating? He can produce in a test-tube so-called recombinants from fragments of DNA of various origin, structure and functions. An important and the most intricate part of the recombinant is the vector obtained from bacteria or viruses with the help of specially devised methods. Its function is to give the recombinant the ability to multiply in a bacterial cell and make it dynamically stable: such a molecule is capable of existing for a long time in a biological environment not because it is long-lived in itself but because of its ability for limitless (in proper conditions) multiplication.

The second component of the recombinant is the gene or genes constituting, according to the intention of the researcher, the aim of the entire genetic manipulation. They do not have to play an active role like the vector but serve only as a matrix for producing an unlimited quantity of copies with the help of the vector.

These preparatory operations are concluded by the "suturing" of the two above-mentioned segments of DNA in a test-tube. For this, special enzymes obtained from bacterial

cells where they perform the same role under different conditions that the researcher prepared for them in the laboratory, are used.

The recombinants produced in this manner are introduced with the help of simple methods into a cell of Bacillus coli, where they begin to multiply as bacteria divides (here the number of copies per cell may be considerable). The recombinants or the products of their metabolism can be further isolated and used. More often than not, not just one particular type but a whole set of recombinants is used in an experiment. Special methods have been devised to isolate homogeneous molecules.

The choice of DNA to be used for inclusion in recombinants depends to a considerable extent not on the wishes of the researcher but rather on its availability. Apart from a few types of DNA which can be considered model objects, some genes of bacteria, viruses, fruit flies (Drosophila) and sea urchin were introduced into recombinants. It was proved that genes, even those of animal origin, multiply in a bacterial cell and form proteins which they code (though in relation to the genes of higher organisms there is no such certitude). This is already an important step towards achieving beneficial results.

There can be no doubt that the technique of producing recombinants is not only a success of experimental research. It also opens up new vistas for genetic studies. There will now be a possibility of producing a material which up to now was available in diminishing quantities. However, notwithstanding the multitude of still unresolved questions of method and principle, exceptionally favourable conditions for studying the functions and structures of genomes are being created.

Prospects for the applied use of recombinants are beginning to appear. The most evident is the application of recombinants for modifying industrial micro-organisms and for producing highly-productive strains. Ways are being contemplated for producing microbiological proteins having a medicinal application, as well as a number of hormones of a protein nature; we can now think about eliminating hereditary metabolic defects and about a number of genetic manipulations important to agriculture.

Today's possibilities of genetic engineering in the applied field are as yet modest. But this should not mislead one. Genetic engineering of bacteria and viruses is only taking its first steps. In their experiments researchers take everything they can from nature—enzymes and nucleic acids, bacteria and viruses. After all, the very process of hybridisation of molecules is only an imitation of nature.

However, it is indisputable that man has for the first time succeeded in combining genetic structures existing separately in nature into a single whole in a test-tube. Their blending was not the result of a chance collision of molecules but rather the result of a conscious choice and a thought-out plan. It would be unreasonable to expect more from genetic engineering at the present time.

After all, the new in science and technology often appears in a very modest form and is not always properly evaluated at the very beginning. The laws of genetics established by G.Mendel were not taken heed of by his contemporaries and had to be rediscovered 40 years later. The significance of the fission of the uranium atom was only truly evaluated by the more discerning physicists, while the general public began to become acquainted with this branch of physics only after the radioactive dust caused by the explosions of the atom bombs over Hiroshima and Nagasaki had settled.

Recombination allows scientists to produce genetically modified bacteria which can be considered to be new organisms. As yet these are Bacillus coli, the physiological properties of which do not particularly differ from the initial bacteria.Some day, most probably in the near future,

varieties of Bacillus coli or other bacteria radically differing from their prototypes will be produced by fundamentally the same methods. In principle, the task of forming species in the laboratory has been accomplished. Now it is a matter of increasing the possibilities.

The experience of recent decades has shown how quickly research can develop if it is based on correct theory and uses reliable methods. And this is exactly the case in molecular biology and molecular genetics.

In assessing the future possibilities of genetic engineering one must not limit oneself to recording achievements only in the field of recombination, as kindred branches exist in experimental biology which are elaborating new approaches in genetics and the biology of development. I have in mind experiments in the hybridisation of animal and plant cells which allow for creating unusual chimeras by the combining, for example, of human and frog's cells. Embryologists have developed a technique for separating cells of the embryo in the early stages of development, when each cell is capable of producing an independent organism; all the descendants of the initial embryo will be identical. And conversely—in the early stages of development the cells of the embryos of various species can be combined, giving so-called mosaic entities. True, embriological methods are successful only in a few species and are not general.

Parallel development of research in several branches of experimental biology will sooner or later lead to a joining of efforts by molecular biologists and geneticists, embriologists and cytologists, and to a considerable broadening of experimental possibilities in the area of creating genetically modified organisms.

The anxiety that organisms with properties harmful to man and the environment might appear as a result of laboratory operations seemingly harmless at first glance, is therefore quite natural.

In particular, Bacillus coli, that favourite and in general peaceful object of laboratory experiments, is related to micro-organisms that are almost omnipresent: it inhabits the intestines of man and animals and lives in sewage and in the soil. No one knows as yet how genetically modified variants of Bacillus coli will behave as regards conditions of habitat. It is possible that their stableness in regard to outside influences and their zone of habitation might become different (though this has not been proven).

The physiology of genetically modified bacteria might change in the direction of the development of pathogenic properties. The meek disposition of that very Bacillus coli has become unreliable recently: it is known to cause diseases in man and in animals. It cannot be ruled out that its pathogenic properties will increase as a result of genetic manipulations. And it might find its way out of the laboratory into the environment.

A raising of the resistance of Bacillus coli, as well as of other bacteria, to antibiotics and drugs used for treating the diseases caused by them is also possible.

As soon as the possibility of creating DNA recombinants was established voices of warning were immediately raised: the possible danger of these discoveries by modern geneticists was stated at the 1973 Gordon Conference (USA). Its participants drew up a letter asking the National Academy of Sciences of the USA to study the question. A little later a committee headed by Paul Berg was set up. In July 1974 it addressed an appeal to the scientists of the USA and other countries proposing that pending any decisions they should voluntarily take part in a moratorium on recombination research which could be dangerous to man and the environment. Everything connected with these events had wide public response: some scientists in the USA refused to conduct research on genetic engineering, and the press, radio and TV network joined the campaign.

The Conference on the Ethical Aspects of Genetic Engineering held in Davos (Switzerland, October 1974) and the Conference on DNA Recombinants in Asilomar, Pacific Grove, California (USA, February 1975) were important events. In Davos the audience was a mixed one--journalists, representatives of various societies, students, businessmen, and even clergymen. There were few specialists. Of course, such a meeting could not offer any solution to the problem. The timid voices of condemnation heard there were drowned out by a solid defence of the position of genetic engineering.

It was different in Asilomar, where 139 scientists (86 from the USA and 53 from other countries) gathered. There were very few "outsiders" and only 16 journalists were permitted to attend. Although opinion at the conference was not unanimous—many participants had their own specific views on the subject and scientific approach—this did not prevent the adoption of certain recommendations.

The moratorium proposed in July of 1974 on some categories of research on genetic engineering was called off. Generally speaking, it never did have the power of compulsion and was only an appeal to scientists. The moratorium was seen as a temporary measure until agreement on the real danger of hereditarily altered organisms, above all viruses and bacteria, could be reached. The conference achieved this thus cancelling the need for a moratorium.

Another consideration (not clearly expressed) was that the announced moratorium actually did not block recombination research though, possibly, it did restrict it. Its positive influence was felt rather in the moral sphere.

Finally, the last and main consideration was that recombination research could not be halted since, as is generally admitted, it is now the main direction of development of molecular genetics.

The conference admitted that genetically modified micro-organisms produced with the help of recombination are potentially dangerous to man and other living creatures. It proceeded in this from the assumption that the physiological and ecological properties of micro-organisms hitherto harmless might change in an unpredictable manner. Unpredictability is the result of our ignorance of what changes in the properties and behaviour of a micro-organism might be caused by the introduction of alien genetic information into it. It was considered reasonable to expect the worst, that is, that in recombining genetic material, micro-organisms dangerous to man might appear. The nature of this danger was described above. It should be stressed, however, that the danger of genetically modified micro-organisms is purely hypothetical, since this question has yet to be experimentally investigated. A small series of tests was conducted on the survivability in the human organism of laboratory strains of Bacillus coli, and the results obtained showed their poor adaptability to these conditions.

The recommendations of the conference speak of four levels of danger, depending on the nature of the micro-organism which received new genetic information in the form of DNA recombinants.

This classification is rather vague and, in the final analysis, it is the researcher, who must be sufficiently competent and have a sense of responsibility, who must decide on the degree of risk.

The danger of genetically modified micro-organisms to laboratory personnel and the public at large was discussed. The latter is threatened by chance leakage of pathogenic materials from the laboratory and resultant contamination of the environment. The situation does not differ in principle from the conditions existing in micro-biological laboratories engaged in the diagnostics of infectious diseases or at enterprises producing vaccines and serums and dealing with considerable quantities of pathogenic micro-organisms.

The measures recommended by the conference can prevent completely the contamination of laboratory personnel and the leakage of pathogenic material into the environment if, of

course, we exclude accidents. It is considered that first of all precautions, defined as "physical barriers", must be taken. These include isolated rooms and cubicles, special hoods, adjustable ventilation, inlet and outlet filters, anti-aerosol protection, etc. The necessity of wearing smocks and rubber gloves and of using automatic pipettes is insistently emphasised; it is forbidden to eat, drink or smoke in the laboratory; admittance should be restricted. Of course, the choice of precautions depends on the nature of the work and on the degree of risk.

Other precautions are also possible. Molecular biology has at its disposal particularly effective, so-called "biological barriers". They consist in using in recombination experiments with DNA molecules of such bacteria and viruses that are known to be inviable in the environment and (in some cases at least) in the human organism. For example, usual bacteria can be replaced with varieties which do not develop in the temperature of the human body or which require culture medium that is non-existent in the atmosphere or that appears only by chance. Defective vectors can also be used which act as a directing force in the multiplication of recombinants in a bacterial cell, but which, in addition, demand conditions possible only in a laboratory. Biological barriers, if used systematically and correctly, can completely avert the possible dangers of genetically modified micro-organisms, especially if combined with physical protection.

A different situation arises when ill-will meddles in genetic engineering. In this case the danger boundaries extended and precautionary measures cease to be effective. Is it possible to create micro-organisms dangerous to man by methods of genetic engineering? Apparently it is, though it is not known whether anyone has tried to turn, say, Bacillus coli into a pathogenic micro-organism. It is perhaps much easier to increase the destructive properties of any infectious micro-organism than to create it anew. It is very possible that someone somewhere is carrying on tests which exceed the bounds of scientific experiment. Such activities would be contradicting the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) Weapons and Toxins and on Their Destruction, signed by a majority of countries, including the USSR, and adopted by the UN General Assembly on December 16, 1971. They contradict the moral code of science and belong to the sphere of destructive and maniacal ideas and political and military adventurism.

What has science to do with that? Is it guilty of complicity in evil in this or in other cases as the participants of the anti-science campaign in Western countries assert?

It cannot be denied that some grounds for such an attitude do exist—mankind will hardly soon forget the tragedy of Hiroshima. And the bomb that destroyed that Japanese city was created by scientists. People talk about thalidomide, carcinogenic compounds, insecticides, DDT and other products of modern chemistry which have served as the source of great misfortunes difficult to remedy. Without sufficient competence it is hard to overcome emotional reactions and calmly reason out such a complex problem as science in modern society.

Often a role in developing such attitudes, which are expressed with particular force in the countries of developed capitalism, is played by the instinctive, and sometimes even conscious striving to explain the flaws and misfortunes of modern capitalist society not by the contradictions inherent in it, but rather by the inner properties of science, the moral qualities of people, or other circumstances of a local or chance nature.

Science procures knowledge; this is its mission. A desire to cognise the surrounding world is inherent in man and is a priceless gift of nature.

The criteria of good and evil are not applicable to nature. But science is a social institution, and scientists do not exist outside of society, outside of history and definite social conditions.

Therefore knowledge, not only at its birth but even when it exists in the mind of the scientist as a conception or a hypothesis, becomes a social phenomenon tied by invisible threads to a concrete historical situation. Hence the dual evaluation of science: one by the scientist for whom truth and the process of its attainment are more important than anything else, and the other by the detached on-looker, to whom the practical consequences of science are important—the consequences of any discovery or invention and their reflection in society.

Science does not lead an independent existence in the depths of society, nor does it raise itself above the interests and needs of people or possess a demonic power over them. Society, social conditions and the interests of states, classes and parties determine in the final analysis the fate of science, scientific discoveries and of scientists themselves. There is no need to deny the importance of scientific development, the personality of the scientist or of moral criteria; they exist and act in conjunction with social factors and must be taken into account in an analysis of specific situations. It would be unreasonable to consider social factors an automatically operating mechanism or to ignore the professional and moral make-up of the scientist and release him from moral responsibility for his actions and convictions. The scientist is under obligation to warn society of the consequences of his discoveries and to be able to foresee them. This is the minimum demanded of him.

Applied to the subject under discussion everything said above means that there is nothing fatal for mankind in recombination and genetic engineering. If genetically modified micro-organisms really do turn out to be dangerous, this will entirely depend on how much the welfare of man is taken into account in the actions that subsequently follow.

Events linked with genetic engineering prove that all the talk about the despotic subordination of society to science is groundless. Even before any alarming events have occurred, the scientists at the conference in Asilomar have themselves determined the possible dangers of genetic manipulations and established the degree of such dangers and measures for preventing them. Any unexpectedness here is excluded and further research is open to complete control on the part of the scientists themselves, the state, and society.

These are the views of Soviet scientists engaged in genetic engineering. We in the Soviet Union do not have any fear of the future nor any misgivings that some powerful and blind forces are capable of directing scientific research in genetic engineering along the path of evil despite the intentions and wishes of the people. We are convinced that reason and good-will will triumph, in our socialist country at any rate.

The gloomy forecasts one reads about in the general press and specialised publications in capitalist countries, though exaggerated, are quite understandable.

This mood is supported by phenomena of capitalist reality: the increase in violence and terrorism, the outbreaks of hostility and armed conflicts, organised crime, the activities of powerful persons and corporations not subject to community control. Of course, all this gives rise to a feeling of uncertainty and the fear that scientific discoveries might be used for evil purposes and bring mankind new misfortunes instead of benefit. Unfortunately such a turn of events will little depend on those progressive scientists who are now fighting to use scientific discoveries for the benefit of society.

In trying to prove that science in itself cannot be a source of evil you find yourself in the position of a person trying to force an open door. All this was already clear long, long ago. Nineteen centuries ago Pliny the Elder wrote in his Historia Naturalis: "The following needs to be said of the metal called iron, of the most useful and yet, at the same time, the most dangerous metal in the hands of man. With the help of iron we dig up the earth, plant trees,...

restore grapevines their youth by clipping off dry shoots. With its help we build homes, crush rocks and do many other things essential for life. But iron also serves war, murder and robbery....It is only just to remove from Nature the accusation which should be turned against man himself."

What more can be added to these eloquent words?

A CRITICAL ANALYSIS OF IDEALISTIC CONCEPTS IN THE STUDY OF THE BRAIN

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In the recent period, more and more scientists are coming to realise that advances in the knowledge of nature and society are being made despite idealistic and metaphysical conceptions. At the same time, representatives of trends hostile to materialism, have stepped up their activity even in a field like the complex of sciences studying the brain, including neurophysiology, neurology, psychology, psychiatry, and so on. Here, the idealist philosophers have sought to speculate on the difficulties arising in the development of modern science, distorting its objective content and clutching at any erroneous statements by natural scientists in an effort to interpret new discoveries and theories in the spirit of idealism and metaphysics, something that is largely promoted by the philosophical incompetence of some Western scientists.

An illustration of this comes from the solid works of H.Kuhlenbek, a well-known student of the comparative anatomy of the brain,[1] in which he tries to substantiate anti-collectivism, individualism, and the dualism of body and mind. All of this is being artificially tied in with a body

of very valuable and scientifically reasoned facts, from which such conclusions do not in any sense follow. Let us recall, in this context, Lenin's warning that while bourgeois professors are capable of providing the most valuable research in special fields of knowledge they are not to be trusted when it comes to philosophy.

Of course, in most instances the idealistic and dualistic views expressed by natural scientists in the capitalist countries are much more refined and pseudoscientific in form, but, as one of our philosophers put it very well, this "does nothing to prevent the fettering of scientific thought".[2]

Dualistic traditions are most firmly established among the neurophysiologists and psychologists in the capitalist countries, for they are more "convenient" because they leave enough leeway for retreating from materialist conclusions and falling back on idealist ones. Since most natural scientists are at root spontaneous materialists, dualism is frequently a form of diffident materialism, when the natural scientist remains on the ground of materialism in the course of his concrete research and abandons it only when he tries to tie in his results with his credo, with the "metaphysical" principles which he believes always to lie beyond the bounds of scientific knowledge.

This situation has been most clearly described by the prominent Canadian neurophysiologist and neurosurgeon W.Penfield, who said: "The dualist believes that there is in each individual something additional to the body and its living energy. He may call it a conscious spirit which is the active accompaniment of brain activity and, thus, is present from birth to death, except, perhaps, in states of deep sleep and coma. He may also believe that this spirit continues its existence after the death of the body, and that it is somehow one with God. By such belief, he extends the dualism of the individual to a dualism of the Universe. The time has passed when the church need, necessarily, look upon intellectualism as hostile to faith,"[3] because it does not, allegedly, prevent the scientist from strictly adhering to the facts in his field, that is, remaining on the ground of natural-science materialism. In other words, positive research is one thing, and the scientist's "metaphysical" convictions are something else again. Unfortunately, such illusions are shared by many foreign neurophysiologists and psychoneurologists, although one would imagine that this illusion should disappear as soon as they got down to their theoretical activity.

What is more, some foreign neurophysiologists and psychoneurologists have adopted the old view that truth has a dual character, a view that is being increasingly modernised in the recent period. It has been most explicitly expressed in psychiatry, notably in the writings of the neo-Thomist K.Schneider, the existentialists K.Jaspers, R.Saurot, R.Carballo and others.

At one point in time, the doctrine of the duality of truth allowed science some autonomy, while the latter-day scholastic Duns Scott, said Marx, made theology itself preach materialism. But times have changed and some modern neurophysiologists and psychiatrists are trying to make science preach theology.

Let us note that many neurophysiologists and psychoneurologists in the capitalist countries taking an attitude of spontaneous materialism rely on the materialist traditions of natural science and philosophy, while some have consciously adopted dialectical materialism. In contrast to their views are the numerous variants of the idealistic conceptions in neurophysiology and psychoneurology. Many neurophysiologists and psychoneurologists (like V.Samuel, J.Eccless, W.R.Hess and others) take an eclectic approach in an effort to reconcile idealism and materialism, as "a party of the middle". All of this explains the complexity and contradictory nature of the development of the present-day complex of science dealing with the brain.

The differences between the materialists and the idealists in this field of knowledge apply above all to problems like the relationship between matter and mind, the spirit and the body, the problem of the relation between the natural and the social in the structure and behaviour of the individual, the problem of the essence of neuroses and psychoses, and so on. Thus, a central problem in present-day bourgeois psychology is that of the individual, notably, aspects of the problem like the relationship of the natural and the social in the structure and the behaviour of the individual. The need to elaborate the problem sprang above all from the exceptional importance of taking account of the attitudes, values, purposes, and motives of the individual in the organisation of various types of his activity and relationships with other individuals. At the same time, the functionalist approach to the human psyche, including a study of various psychic processes of the individual, regardless of his requirements and attitude to various real phenomena, has recently turned out to be theoretically inadequate and untenable. Without listing the various views and schools in present-day psychology and psychoneurology working on the problem of the individual, one could say, in sum, that virtually all these conceptions are based on one and the same methodological approach, which gives the individual virtual primacy with regard to society, and at any rate assumes its parallel existence and self-sufficient essence. As a result, the individual is inevitably anthropologised and psychologised.

In contrast to this attempt to sever the individual and society, psychologists and psychoneurologists taking the Marxist approach regard the individual as a component of society, the world's most highly organised system, whose regularities determine the specific features of all of human nature, of man's behaviour and his psychological structure.

While not denying the influence exerted by society on the individual, the two are regarded as independent elements by representatives of earlier trends, like Gestaltpsychology (K.Lewin, and others), neo-behaviourism (N.Miller, and J.Dollard), and modern trends (G.Allport's theory of self-realisation, A.Maslow's conception of self-actualisation, K.Rodgers's theory of the "ego", G.Murphy's biosocial theory, H.Murrey's personology and the factorial theories of R.B.Cattell, H.Eysenk and J.P.Guilford).[4] By contrast, the idea that man's mentality is socially conditioned and that the individual is subjected to a process of socialisation has been widely accepted in the psychology and psychoneurology of the capitalist countries. Social relations are accepted as a factor constituting both the specifically human structure of the psyche (arising as a result of the interiorisation of social relations) and of the higher personal entities of "ego" or "self". Thus, according, to the Freudian (and also the neo-Freudian) view of the individual, the influence of society is impressed or interiorised in the formation of a "super-ego". But the point is how social relations, society and the socialisation of the individual are regarded. In most of these theories of the individual, there is an abstract extra-historical "society in general", in which only some of the general conditions of man's social existence are brought out.

One of the specific features in the development of present-day psychoneurology abroad is the strong influence of voluntarism and the recognition of the primacy of blind energetism of instinctive forces, of irrationalism and teleologism. While the various idealistic trends differ in their views, they are at one in taking a hostile attitude to materialism, so that different idealistic trends frequently act together. Psychomorphologism, psychoanalysis and psychosomatics frequently join hands in their efforts to analyse the nature of the psyche and the character of the development of psychoses. A typical example of this comes from the latest trend in Western medicine which has the paradoxical name of "anti-psychiatry".

The "anti-psychiatrists" object to the principles of psychiatry which they present as follows: the placement of lunatics in hospitals (their isolation from healthy persons); constraint as a system of eliminating external expressions of psychoses; induced irresponsibility, notably, the declaration of non compos mentis; the non-communicability of inmates of psychiatric hospitals in consequence of limitations on the information reaching the hospital.

One of the "classics" of anti-psychiatry, R.Laing, for instance, regards psychoses as an expression of nature and health, as a phenomenon in man's life through which the "sick" seek to annul the repression effected over them by family and society. Thus, the sick allegedly return to an epoch preceding the repression, that is, a period before their emergence in the world. This is like a trip into the past, which Laing calls "metanoia".

Laing and Cooper hold that the "mental patient" is a being to whom violence is being done, so that his "insanity is an attempt to regain his freedom".[5] If a man is plastic and capable of resisting "violence", in a psychosis he attains a state which is very close to "genuine" mental health and a state of internal and interpersonal freedom. They believe that the family and society seek forcibly to eliminate the "anormality" of those who are capable of evading what is designated as the "social norm". That is the purpose, they say, for which psychiatry has been invented. Psychiatry is synonymous with "officialised" violence donning the mask of medicine and science. Foucault substantiates the correlation between the socio-economic structures and the criterion of psychiatric evaluations as follows: in every period, men rejecting the prescriptions of religion and the state were declared to be "insane", were isolated, and released only after a public avowal of their "guilt" and "errors".[6]

The anti-psychiatrists believe that the mental patient is a victim of the social system, of a "pathogenic society", which "secretes" insanity in order to survive. The Italian anti-psychiatrist Basaglia claims that the mental patient labours under the oppression of society which is why his treatment should consist above all in the "political treatment of society".[7] Elaborating these ideas, Cooper says that what he wants above all is the emancipation of the mental patient who comes to consult him. [8] This may assume various forms.

Anti-psychiatry starts from the philosophy of existentialism, psychoanalysis and the Anglo-American empirical sociology. Existentialism assumes that science is incapable of expressing human freedom and that its contours are dissolved in the mystery of creativity, love and nonconformism. Consequently, the resort to the unscientific methodology is the epistemological root of the denial by anti-psychiatry of the scientific approach to mental patients.

One of the specific features of present-day psychoneurology abroad is the struggle over the deterministic, nosological principle.[9] Most psychoneurologists taking the idealist attitude also take an extreme anti-nosological stand. This applies above all to those of them who share the views of pragmatism, a logical positivism and semantics opposed to the principle of determinism in psychoneurology. Psychoanalysts and psychoneurologists who take the existentialist attitude do not regard the nosological principle so negatively but approach the substance of psychic disorders and the forms of their expression in subjective idealistic terms, believing psychoses to be changes of "existence" or explaining psychic disorders in the spirit of a blind alogical voluntarism. For instance, the anti-psychiatrists fiercely oppose nosology in psychiatry and claim that the "nosological forms" have been invented by the psychiatrists. From the standpoint of the anti-psychiatrists there are no mental diseases, which means that there are no mental patients. Having rejected the medical (psychiatric) tradition in tackling this highly important problem in human life, the problem of the borderline between mental health and disease, the anti-psychiatrists confine themselves to an intuistic-subjectivist assessment of the human consciousness,

which leads them to absurd and anti-humanistic conclusions. Thus, the Italian anti-psychiatrist, Basaglia, says that one should not prevent a person from committing suicide.

On the whole, one must note that the expressions of idealism in psychoneurology in the various capitalist countries have their specific features. In the USA, for instance, there is a very strong influence of psychoanalysis and its present-day variety, neo-Freudism, and also of psychobiology, which springs from pragmatism; in Spain, the FRG and especially in Switzerland there is a marked influence of existentialism; in Italy and partly in France there is an influence of neo-Thomism, which is also having some influence among psychoneurologists in the USA.

The openly hostile attitude to Pavlov's materialist doctrine on the part of the idealist-minded psychoneurologists is a prominent feature of psychoneurology in foreign countries today. The main idea of the conception propounded by the existentialist E.Strauss is that sensation is not a form of reflection or cognition. He has come out openly against the psychophysiology of Descartes and Pavlov's doctrine. At the same time, one should note that there is evidence of the growing influence of Pavlov's ideas in neurophysiology and psychoneurology in foreign countries and a switch by some progressive neurophysiologists and psychoneurologists to the Pavlov theory and dialectical materialism and evidence of a merger of Pavlov's doctrine with national materialist traditions, and this applies to K.Pribram, C.Herric (USA), J.O'Leary (Britain), A.E.Fessard, H.Gastaut (France), I.Seabra-Denis (Portugal), and others.

At the same time, many present-day neurophysiologists and psychoneurologists in the capitalist countries tend to take a middle-of-the-road, eclectic stand, seeking to reconcile materialism and idealism. The materialist line in present-day French psychiatry is characterised, for instance, by the study of etiology, the pathophysiological approach to pathogenesis and a study of the material substratum of the psyche and of mental disease. At the same time, psychoanalysis and H.Bergson's ideas exert a great influence in French psychiatry. The Swiss psychoneurologist R.W.Sperri warned against claiming that the era of materialism has outlived itself, while emphasising the need to build up idealistic positions in psychiatry. There is also the fact that V.Mayer-Gross, E.Slater and M.Roth, representing the nosological, deterministic trend, have sharply opposed psychoanalysis and psychobiology.

Consequently, the development of present-day neurophysiology and neuropsychology in the capitalist countries appears as an intricate and contradictory process. In these conditions, the achievements of Soviet science and of science in the socialist countries in the natural-science study of the functions of the brain, and the theoretical principles underlying the knowledge of brain activity, together with the methodological approach on which these theoretical constructions are based, have been exerting an ever more revolutionising and beneficial influence on the development of materialistic tendencies in the study of the brain. Just as in the political struggle going on in the capitalist countries, "the example of victorious socialism is revolutionising the minds of the working people of the capitalist world, it inspires them to fight against imperialism and greatly facilitates their struggle",[10] successes scored by the Soviet Union in the field of science invigorate scientists in the fight against idealism.

What has been said about science in general equally applies to the science of the brain. The main line of development in this science is now largely determined by the achievements of scientists in the socialist countries and the attractive influence of the ideas of Marxism-Leninism.

NOTES

1 H.Kuhlenbek, Brain and Consciousness. Some Prolegomena to an Approach of the Problem, Basel-New York, 1957.

2 D.I.Dubrovsky, Psychic Phenomena and the Brain, Moscow, 1971, p.63 (in Russian).

3 W.Penfield, L.Roberts, Speech and Brain Mechanisms, Princeton, New Jersey, 1959, p.9.

4 See L.I.Antsyferova,"Some Questions in the Study of the Individual in Present-Day Psychology in the Capitalist Countries", in the collection The Theoretical Problems of the Psychology of the Individual, Moscow, 1974 (in Russian).

5 See R.Laing, D.Cooper, Reason and Violence, London, 1961.

6 See M.Foucault, Folie `et deraison, Paris,1961, p.654.

7 See F.Basaglia, L'instituizone negata, Turin, 1968.

8 See J.P.Rumen, La MEF, Paris, 1971, No.42, p.39.

9 The clinico-nosological trend in foreign psychoneurology has, on the whole, developed as a spontaneously materialist deterministic trend, that is, one aimed at cognising the material factors and causes underlying various neuropsychic diseases.

10 Programme of the Communist Party of the Soviet Union, Moscow, 1961, p.34.

ENVIRONMENT, SCIENTIFIC AND TECHNOLOGICAL REVOLUTION AND ECOLOGY

Academician Yevgeny FYODOROV

Writers in sociology, economics and natural science have been carrying on an intense discussion about the prospects of mankind's development, and essentially about whether humanity is to survive at all. This problem springs from the concern over the depletion of natural resources and the possible negative consequences of man's growing impact on the environment.

As various researchers have switched from a simple extrapolation of the rates at which resources are being consumed and the environment polluted to attempts at a comprehensive analysis of mankind's development in its interaction with nature, the depletion and impact problem has produced a different question which deserves much attention: how is mankind further to develop on this globe?

Everyone must have heard of Jay Forrester's World Dynamics and The Limits to Growth, written by a group of scientists from the Massachusetts Institute of Technology led by D.Meadows, and other prominent books of this kind. Some of these studies have been financed by the Club of Rome, a small international social organisation, set up specifically to consider the possible ways of mankind's development.

The main idea on which these works are based is fairly obvious: the Earth with all its resources is limited and for that reason unlimited growth in population, energy and production in general is impossible.

Applying the methods of a systems analysis and seeking to comprehend all the aspects of society's activity as a complex, Forrester, Meadows and some other authors arrive at the discouraging conclusion that if mankind continues to develop at the same pace and in the same way as it does today, within no more than 50-70 years it will have run into a grave conflict with the environment and perhaps face disaster in view of the depletion of natural resources and intolerable environmental contamination. They say that the only way out for mankind is to move into a state of "global equilibrium", which implies no growth or development of any aspect of mankind's activity. This would require an equalisation of the birth and death rate, a halt to industrialisation and urbanisation, and so on. Such a slow-down of progress would mean above all a freezing of the present level of the developing countries.

The writings of Forrester and Meadows have certain flaws in characterising the parameters and connections between the various aspects of mankind's activity, but their main mistake, I think, is that they apply to the whole of mankind the regularities of present-day capitalist society, thereby obscuring the fundamental distinction between the tendencies, purposes and nature of development of two social systems existing in the world. Scientists taking the Marxist view of things have drawn attention to this fact, and like many specialists and political leaders in the developing countries they have criticised the idea of freezing--virtually for ever--the great gap between the levels of social, economic and technical development of the various regions and countries of the world.

The Club of Rome has taken account of these and other critical remarks, and the second paper produced for it by

M.D.Mesarovič of the USA and E.Pestel of the FRG—Mankind at the Turning Point—contains a different conception.

It recognises the need and inevitability of development for human society, which must be "organic", meaning that the growth of the various parts of mankind, of the various countries of the world must be concerted within the framework of the whole globe and, in particular, those that have lagged must develop faster, while the more developed will have to reduce their rate of growth.

In contrast to Meadows, its authors consider separately parts of the modern world like the developed capitalist countries, the socialist countries and the developing countries, and seek to convince the reader that concerted and coordinated development of mankind within the framework of the whole globe is not just the only possible prospect but is also the one which best meets the interests of each of the regions and each country of the world (not in the light of their current requirements and private advantages but of the long-term interests of each country and each social system).

One could hardly question the need for concerted development and any other concerted activity. But how is it to be achieved? How is one to switch to an "organic" type of development? Who is to take the necessary measures?

In their opinion, that is something on which the governments of all countries, multinational monopolies and international organisations should agree, and that it is the task of scientists to explain that it is impossible to live otherwise, if mankind is to survive.

The Club of Rome then brought together a group of scientists headed by Jan Tinbergen (and financed by the government of the Netherlands), which is trying to work out some concrete recommendations for switching to organic development and organising human society on rational lines.

They have taken account of a UN General Assembly resolution on the need to work out and establish a new economic order to regulate international trade and economic cooperation on a just basis.

However, Tinbergen believes, this is not enough for there is need to elaborate and set up a system of universal regulation of development and interaction of all the regions, social systems and countries of the world within the framework of all mankind. Tinbergen and his assosiates believe that the transition to such an order may be achieved through the regulation of the pace and character of economic development of all the countries within an integral global credit and financial system.

It is felt that the main obstacle in the way is the excessively developed sovereignty, whose relaxation by the individual countries would help to make a supra-national system of regulation sufficiently effective.

There are other similar works abounding in the West whose authors consider the use of natural resources, the impact on the environment and measures to avert a possible ecological crisis, but those mentioned above appear to be the most important ones.

What do they indicate?

I feel that they all have more or less the following propositions in common:

The continuation of the existing organisation (rather lack of organisation) and tendencies in the development of society (some authors explicitly say—capitalist society) will result in a great crisis within 50 or 100 years.

The crisis can be avoided, but this calls for a radical transformation of industry, agriculture and the whole of the economy (many realise that the social structure should also be changed) and activity within the countries and also in their relations with each other.

Mankind must become an integral system acting in concert within the framework of the whole globe and capable of pursuing certain clearly designated purposes and governing its development.

Consequently, some scientists, who do not in any sense take the Marxist view, and who consider only one aspect of mankind's activity, namely, the interaction between society and nature (mainly the use of natural resources and the impact on the environment) have reached some interesting conclusions which we should not regard with indifference.

These works contain quite a number of dubious and erroneous assumptions. Thus, they clearly reveal the tendency to "improve" not just any system but the capitalist system, obscuring the fundamental distinctions in the regularities of development and, in particular, in the attitudes to nature on the part of the capitalist and the socialist system, while some urge a mode of action leading to the stagnation of society. The restriction of the sovereignty of some individual countries and their subordination to a supra-national credit and monetary system, even if this urge is dictated by a most sincere concern for the future of mankind, can by no means meet the interests of peoples in the epoch of the struggle between the two opposing systems. It is wrong to consider the development and transformation of society in the light of only one aspect of its activity and in isolation from all the others, like the class struggle, the national liberation movement, and so on. It is equally wrong to ignore the role of wars, the preparation for wars, the arms race, the intolerable waste of natural resources and the degradation of the environment.

The members of the Club of Rome, among others, seek to convince all the decision-makers of the justice of their ideas and proposals. But who is to put through these ideas? And what are the immediate concrete aims from which this effort is to start?

Most of the Western researchers, as was said above, prefer not to note how differently the capitalist and the socialist countries treat nature. The achievement of optimal interaction between man and nature is a necessary feature of socialist society, and it was envisaged by Marx and Engels. More than one hundred years ago Marx wrote that "cultivation when it progresses spontaneously and is not consciously controlled...leaves deserts behind it".[1]

It is being systematically translated into life by the Soviet socialist state, beginning with the earliest laws and measures taken to protect nature on Lenin's initiative and including the latest in this series, namely, the law on the rational use of minerals and protection of the mineral wealth of the country recently passed by the USSR Supreme Soviet.

Most Western researchers, as I have said, prefer not to notice the fundamental difference in the attitude to nature on the part of the capitalist and the socialist system.

In view of the rapidly growing scale, under the scientific and technological revolution, of all the manifestations of human activity and the close interdependence of the countries within the world community, the rational use of resources and protection of the environment against the negative effects of human activity has long since become a global problem of international importance.

The solution insistently requires close international cooperation. War and everything attendant on war quite obviously rules out any optimisation of relations between society and nature. Lasting peace and cooperation are a necessary condition for such optimisation, and only an end to the arms race and disarmament can yield the means required for transforming the economy in ecologically acceptable forms.

That is why despite the above-mentioned erroneous propositions which we find in some Western writings, their authors' anxiety for the future of mankind, admission of present-day capitalist society's lack of prospects and their calls for urgent measures to establish rational interaction with nature on a global scale are of major importance.

Of course, the Earth, limited as it is in size and resources, cannot maintain a population without limits, but a society organised and capable of governing its own development will have essentially different potentialities and limits of development.

It is impossible to deal with this question at greater length here. Let me note merely that mankind's growing capability of transforming matter and recycling raw materials vastly expands the volume of nonrenewable resources. The perspectives of transforming natural balances just as considerably extends the possibilities of using renewable natural resources, a circumstance the above-mentioned authors do not reckon with. Finally, the population of the Earth and the size of mankind, when considered across the centuries and millennia, appear to be different concepts.

In conclusion, let me note that the problem of interaction between society and nature has recently acquired an important social and political significance and has come to play a noticeable role in the ideological struggle. Soviet scientists should seriously tackle this problem in social, political, philosophical and natural-science terms.

NOTES

[1] K.Marx, F.Engels, Selected Correspondence, Moscow, 1955, p.244.

PHILOSOPHICAL QUESTIONS OF SPACE EXPLORATION

Arkady URSUL, D.Sc.(Philos.)

The exploration of space and the use of space instruments for economic purposes have become a key line in the rapid scientific and technological progress which we call the scientific and technological revolution. The launching of spacecraft and their use for mankind's terrestrial needs have become part and parcel of the modern scene.

The extension of mankind's activity in space and of international cooperation in this sphere under international détente has generated a growing interest in the problems of space exploration among philosophers and sociologists belonging to various schools and trends. The socio-philosophical writings in the capitalist countries include many works seeking to comprehend the phenomenon of space navigation, to explain man's urge to penetrate into outer space and prognosticate space exploration in the future.

What leaps to the eye in the bourgeois interpretation of the space age is the sharp polarisation of the advocates and opponents of cosmonautics. Why is this so, and what are the ideological assumptions of these two ostensibly hostile doctrines which have originated within bourgeois ideology?

For all the nuances of their attitudes, those who advocate the exploration of space in the capitalist countries (and among them we include R.Anderson, H.K.Afshar, H.Lasswell, H.G.Stever, D.Michael, L.Proctor, and others) have some common assumptions. They tend sharply to exaggerate and frequently even to absolutise the positive results which cosmonautics has already achieved and is still to achieve. There are some grounds for this approach: space exploration has already yielded a mass of valuable information, while space technology is now being used in industry and agriculture. Many tasks in the development of science, technology and production could not have been fulfilled without the help of cosmonautics, which is now a powerful accelerator of the scientific and technological revolution.

Still, there is considerable danger in absolutising the achievements and potentialities of cosmonautics, as there is in any absolutisation, for it involves a one-sided exaggeration and inflation of the features and tendencies in the development of science and technology, which have a positive and important role to play only when they are a component of the whole of science, of technology and of society. Society needs space exploration only to the extent to which it helps to solve the problems arising in the course of historical development, but it could divert efforts and resources from the highroad of progress if it is converted into a self-advertisement and an end in itself, or is set up as allegedly being the only means of overcoming all the scientific, technical and social difficulties in development.

The fact is that such a notion of cosmonautics as a cure-all, as the latest universal means of solving all the social problems is characteristic of the "space optimists". One is left with the impression that cosmonautics is capable of side-stepping all the social factors and carrying society to universal happiness and prosperity.

But has cosmonautics been developing in an abstract society without class and other social distinctions and contradictions? Of course, it has not. The launchings of spacecraft have come from concrete--socialist, capitalist or developing--countries, and it is quite clear that the

"trajectory" of space knowledge and space technology in society is not determined by physical but by social factors and conditions. Space technology pursues the purposes which society that has created and made use of it sets itself, which means that the use of space technology depends on the character of the social relations of production.

The latter leave their imprint on the development of cosmonautics and engender not only good but also evil, of which the "space pessimists" have much to say. The "optimists" are inspired by the space contracts won by the corporations they represent, and by the distribution of the benefits in their favour from the exploration of space, which is why they regard space and cosmonautics through the rose-coloured glasses of earnings and profits from space technology. They either fail to see or deliberately ignore the negative consequences of space exploration within the framework of bourgeois society, namely, the militaristic orientation of many space projects, the ideological subversions mounted by means of communications satellites, the pressures on the noncosmic countries, and so on. The "space optimists" fail or refuse to see the fact that the development of space science and technology under capitalism has done nothing to advance the solution of its vital problems, or to eradicate its social ills. That is why one-time NASA Director Thomas Paine was forced to admit that it is easier to send men to the Moon than to solve the problems of poverty and malnutrition. That is why the presentation of cosmonautics as a cure-all is no more than an illusion which goes to benefit those who manage to redistribute the income of the whole of society in their own favour and to make fabulous profits on the impoverishment and starvation of others.

The conception propounded by the "space optimists" in the capitalist countries, is as a rule, identical with the official view of the ruling circles and the monopolies engaged in the practical exploration of space. Their "space optimism" is another form of apology for the capitalist system and way of life, in which the ostensible omnipotence of space technology provides a screen for the defects of the society doomed to disappear in the course of history.

The philosophical sources of this conception have no link at all with cosmonautics, which is no more than a pretext for galvanising ideas which originated and developed in the precosmic age and which sprang in a society which was, in general, characterised by a dehumanisation of technology that oppresses and enslaves man. Scientism and technicism, positivism and pragmatism are the ideological sources of the "space optimism" originating on the social soil of the last antagonistic formation. The emergence of cosmonautics merely led to a cosmic renaissance of these conceptions in which the cosmic form covers up the old antihumanistic content, whose purpose is to safeguard bourgeois society and its ideology in a modernistic spirit that is consonant with mankind's stellar accomplishments.

The contradiction between these neoctechnicist conceptions and reality engenders their crisis, and the emergence of the next versions and forms of social pessimism which transfer to cosmonautics the dissatisfaction with scientific and technical development in bourgeois society. This gives rise to the alternative of the one-sided cosmotechnicism, the critique of the "heartless cosmic technology" and disappointment over man's urge to explore the Universe.

The "space pessimists" (M.Borne, A.Weinberg, W.Pickering, F.Hoyle, H.Sharply, L.Eisley, A.Etzioni and others)--among them leading specialists in physics, astronomy, and space rocketry--have sharply contrasted man's terrestrial deeds and his cosmic achievements. The main idea of the "space pessimists" is that the man's emergence in space and its intensive exploration is a mistake and a whim, involving totally unjustified waste. Space travel is a triumph of human thought but a tragic defeat for human reason, says Max Borne in a paradox that has been reported by the world press as expressing the attitude of the "space pessimists".

The pseudoradical criticism of cosmonautics and emphasis on the negative consequences of the development of space technology (as a rule, without any indication that these consequences arise solely in bourgeois society) is a characteristic feature of the cosmophobic doctrine, which outwardly appears to be in opposition to the official technocratic standpoint, but turns out to be nothing but a more refined apology of capitalist reality. The cosmophobes insist that since the causes of social evil are rooted in technology, without which society cannot exist, this evil cannot be eliminated, for it dominates the world not only down here, but also up there. This switch of attention to space, as allegedly the next source of social injustice and man's enslavement by space technology, is designed to divert attention from the immediate terrestrial causes of man's tragic condition in a society dominated by man's exploitation of man and his oppression by technology. This becomes especially clear when one looks at the "positive" programme of the "space sceptics".

What do they offer in place of space exploration? Nothing, it turns out, except the suggestion of tackling more urgent terrestrial affairs (although there is again a strong division on the issue of which affairs are to be tackled) and to get down to the self-improvement of man's spiritual world or even to accept religion. This implies an abandonment of the new ways of resolving terrestrial problems by cosmic means, which have already justified themselves both in economic and other social aspects. While the critical part of the cosmophobic conception may to some extent be acceptable (of course, with the exception of the effort to identify the destiny of capitalism with the destiny of civilisation as a whole), the positive part of their conception is altogether unacceptable. Abandonment of space exploration now appears as an archaism and an illusion, a myth invented by those who think that mankind can and must advance only along the capitalist way. But whatever the postindustrial forms capitalism may assume in the futurological scenarios of its advocates, there is no future either for a repudiation of cosmonautics or its use to perpetuate the bourgeois system, way of life, mentality and world outlook.

"Space pessimism", which has gripped the minds of many outstanding scientists in the West, is a natural reaction not only to the opposite technocratic doctrine but is also an ideological response to the impotence of the antagonistic society in tackling the problem of man and technology and directing the development of this technology for the welfare of man and society as a whole. Its philosophical foundation consists of abstract humanism, existentialism and philosophical anthropology, antiscientism and irrationalism, which have the purpose of "closing up" man's consciousness within the dead-ends of the bourgeois world outlook.

Both the abstract humanistic and the pragmatic and technicist conceptions of cosmonautics propounded by bourgeois ideologists are, quite naturally, unacceptable in principle, because they are an actual reflection of the discrepancy between present-day capitalist relations and the level of the productive forces which mankind has attained in the space age. The present stage in scientific and technological progress and the rapid advance of the scientific and technological revolution require the elimination of antagonistic social relations and transition on a global scale to a society without private ownership of the means of production, the land or outer space. Neither space, nor cosmonautics fit into the framework of the antagonistic social system, visually indicating the need for the socialisation of mankind on communist principles.

The dilemma of the conceptions of "technicism" and "pseudohumanism" in the ideological comprehension of the space age illustrates the growing collision between the requirements of social progress and the impossibility of their full and comprehensive realisation under social forms which are doomed to disappear. Rejecting the artificial

dilemma of the bourgeois world outlook, the Marxist-Leninist approach to the problems of cosmonautics start from the assumption that cosmonautics and the use of its achievements are necessary for the benefit of man and of society as a whole, because this is a realisation in cosmic terms of the principle proclaimed in the Programme of the CPSU, which says: "Everything for the sake of man, for the benefit of man."

Space research and space technology most visually demonstrate the idea that the efficient use of scientific and technical achievements for the benefit of man is possible only under socialism and communism, a classless society which helps organically to blend the fruits of science and technology with the advantages of the progressive social system. The truly humanistic uses of cosmonautics throughout the world require deep-going social transformations which go beyond the framework of capitalism. Only a society guided by the ideals of communism can place the exploration of the Universe at the service of man and mankind as a whole.

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India	People's Publishing House (P) Ltd., Rani Jhansi Road, NEW DELHI-55; Magazine Centre, F-82, 1st Floor, Ghaffar Market, Karol Bagh, NEW DELHI-5; People's Literary Centre, 9895, Nawab-Ganj., Pulbangash, DELHI-6; Lok Vangmaya Griha,Khetwadi Main Road, BOMBAY-4; People's Book House, Piramshah Manzil, Relief Road, AHMEDABAD; Vijay Stores, Commissariat Bldg. 1st floor, 231, D.N.Road, BOMBAY-1 Navakarnataka Publications (P) Ltd., Sarpabhushana Mutt Compound, Kempegowda Circle, BANGALORE-9; Magazine Centre, 2nd Floor, Ganapathi Bldgs, B.V.K. Iuengar Road, BANGALORE-53; People's Book House, Opp.Patna College,Asok Raj Path, PATNA-4; Manisha Granthalaya (P) Ltd., 4/3B, Bankim Chatterjee Street, CALCUTTA-12; National Book Agency (P) Ltd., 12, Bankim Chatterjee Street,CALCUTTA-12; Bingsha Shatabdi, 22/A, Arabinda Sarani, CALCUTTA-5; Visalaandhra Publishing House, Eluru Road, VIJAYAWADA-2; New Century Book House (P) Ltd., 6 Nallathambi Chetty Street MADRAS-2; Prabhath Book House, Head Office Prabhath Bldg. TRIVANDRUM-24; Vijay Stores, 62, Kalyan Bhuvan, AHMEDABAD-1; Vijay Stores, Station Road, ANAND (W.Rly); Vijay Stores, Rajni, 1st Floor,

	Bhupendra Road, RAJKOT-1; Punjab Book Centre S.C.O.1038, Sector 22-13, CHANDIGARH-22.
Iraq	State Advertising Bureau, Ministry of Information, Al-Numan Building, Al-Jamhoria Street, BAGHDAD.
Jamaica	Independent Book Stores, 2, Wildman Street, KINGSTON W.1.
Japan	Nauka Ltd., 30-19, Minami-Ikebukuro, 2-chome, Toshima-ku, TOKYO; Nisso Tosho Ltd., c/o Masumoto Bldg., 1-5-16, Suido. Bunkyo-ku, TOKYO; Kaigai Publications Ltd., P.O.Box 5020, TOKYO International, TOKYO 100-31; Far Eastern Book-Sellers, Kanda, P.O.B.72; TOKYO.
Jordan	Jordan Distribution Agency, P.O. Box 375, AMMAN.
Kuwait	Farajalla Press Agency, P.O.Box 4541, KUWAIT, Arabian Gulf.
Nepal	Baje Ko Pasal, Bank Road, Biratnagar, P.O.1, BIRATNAGAR; International Book House, 11/20, Kamalakshi, Post Box 32, KATHMANDU.
New Zealand	Progressive Book Society Ltd.,21, Elliott Str, AUCKLAND I.; Technical Books, Ltd., 262, Lambton Quay, WELLINGTON; New Zealand Tribune,P. O.Box 19-114, AUCKLAND; International Books Liberation Bookshop, 123 Willis Str., WELLINGTON.
Pakistan	Classic, Shahrah-E-Quaid-E-Azam (The Mall), LAHORE-3; Paradise Subscription Agency, Fatima Jinnah

	Road, KARACHI-4; Standard Publishing House, Marina Hotel, Bonus Road, KARACHI-4.
P.D.R.Y.	The 14th October Printing Publication, Distribution and Advertising Corporation, P.O.Box 4227, ADEN.
Singapore	Book Associated International Shop 117, Show Center, SINGAPORE 9.
Somalia	Samater's, P.O.Box 936, MOGADISCIO.
Sri Lanka	People's Publishing House, 124, Kumaran Ratnam Road, COLOMBO-2; Ananda Bookshop, 148, Galle Road, Wellawatta, COLOMBO 6.
Sudan	Sudanese Intercontinental Marketing Co., P.O.Box 1331, KHARTOUM.
Sweden	Wennergren-Williams AB, Fack, S-104 25 STOCKHOLM 30; A.B.C.E.Fritzes Kungl. Hovbokhandel, Fredsgatan 2, STOCKHOLM, 16; Nordiska Bokhandeln AB., Subscription Department, Fack, S-101 10 STOCKHOLM 1; Förlags Ab Arbetarkultur Kungsgatan, 84, 112 27 STOCKHOLM; Gumperts Bokhandel AB, Södra Hamnngatan 35, GÖTEBORG; Almqvist & Wiksell, 26, Gamla Brogatan, Box 62 S-101 20 STOCKHOLM; Gleerupska Universitetsbokhandel, LUND; Forbundet Sverige-Sovjetunionen, Kaarinavägen 20, 1 tr. 116 45 STOCKHOLM.
Syria	Dar Dimachq, Editeurs-Distributeurs, Adib Tounbakji, Share Port Said, DAMAS; Dar-Al-Fajr Etition et

	Distribution, Rue Al-Kouatly, En Face du Cercle des Oficiers, ALEP; Al-Zahra New Bookshop, P.O.Box 2858, DAMAS.
Tanzania	Tanganyika Standard (newspapers) Ltd., P.O.Box 9033, DAR ES SALAAM.
United Kingdom	Central Books Ltd., 37, Grays Inn Road, LONDON W.C.1; Collet's Holdings, Ltd., Denington Estate, WELLINGBOROUGH Northants.
USA	Four Continent Book Corporation, 149 Fifth Ave., NEW YORK, N.Y.10010; Imported Publications Inc., 320 West Ohio Street, CHICAGO, Illinois 60610; Stechert-Macmillan, Inc., 7250 Westfield Ave., PENNSAUKEN, N.J. 08110; EBSCO Subscription Services, 17-19 Washington Avenue, TENAFLY, New Jersey 07670; Victor Kamkin, Inc. 12224 Park Lawn Drive, ROCKVILLE, Md.20851; Znanie Book Store, 5237 Geary Boulevard, SAN FRANCISCO, Ca. 94118.

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