MARXISM TODAY SERIES

EDITED BY PROFESSOR BENJAMIN FARRINGTON, M.A.

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DIALECTICAL MATERIALISM AND SCIENCE

MAURICE CORNFORTH

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By Maurice Cornforth

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NOTE

THIS BOOKLET is based on a report given to a conference of British Marxist scientists in London in June 1949. The original report has been amplified and corrected in the light of the discussion which there took place, and additional material has been added. What follows is to a great extent a collective effort. I am alone responsible for the form in which it here appears; and, in particular, for any mistakes that may be found in it; but it could not possibly have been written without the help of a number of comrades and it represents the summary of many discussions.

MAURICE CORNFORTH
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FOREWORD

THIS LITTLE ESSAY, so masterly in its grasp of its subject, so lucid and vigorous in expression, clears up one of the major problems of our time. When we Marxists have fully assimilated it we shall be so much the more fit to carry the burden of leadership which history must soon lay upon our shoulders.

No history of philosophy, no history of science, can be successfully written independently of the history of society, for the basic categories of science are in the last analysis determined by the structure of society. In a class-divided society no ruling class has ever pushed its thought to the point which would undermine its own position. Social categories thus penetrate the natural sciences, explaining an essential feature of their constitution and explaining also the causes of their distortion and decay.

From this it also follows that the development of science, not only in its applications but in the most intimate recesses of its theory, is a political question. To speak like Aristotle: science is by nature a political matter.

This is a burning question of our day, one that is in itself difficult to understand and where understanding is clouded by passion. For this reason one welcomes an essay combining topical urgency with the serenity of science. Short works written in this mood have before now exerted a powerful action on events. One cannot suppress the hope that this booklet may be found useful not only in our own country but beyond.

BENJAMIN FARRINGTON

DIALECTICAL MATERIALISM AND SCIENCE

I

THE CRISIS OF BOURGEOIS SCIENCE

MODERN SCIENCE is the creation of the bourgeoisie. It is one of the most typical products of bourgeois society. And it carries the mark of its bourgeois origin in its methods and in its ideas. It is the means for understanding and controlling the processes of nature and society created under the conditions of the development of capitalism.

To say this is at once to imply a method of criticism of science. It is to say that the science of the past and present is not pure science but the science of a class, and to be criticised as such.

But it is not to deny the achievements of science.

BASIC CONCEPTIONS

THE GREAT development of modern science took its origin in the sixteenth and seventeenth centuries. At the foundation of this development was (*a*) the radical criticism of the dogmas which had hardened in the middle ages and circumscribed the whole previous development of science. The great initial discoveries of the sciences, whether those of Copernicus, Galileo or Harvey, all proceeded from this basis, which was expressed philosophically in Bacon's first aphorism:

"Man, as the minister and interpreter of nature, does and understands as much as his observations on the order of nature —either with regard to things or the mind—permit him, and neither knows nor is capable of more."[1]

At the foundation was (*b*) the experimental method, which aims at discovering the laws governing particular classes of phenomena by means of controlled experiments and the use of perfected instruments and apparatus, particularly instruments and apparatus of measurement.

[1] Francis Bacon, *Novum Organum*, Bk. I, 1.

The experimental method was not the creation of modern science. On the contrary, it had been employed by the Greeks. But with modern science it was first used on a wide scale, intensively developed, applied in all spheres of investigation as the fundamental method of scientific investigation—replacing mere observation and speculation about the causes of observed facts.

And (*c*) there was rapidly built up a mechanistic conception of nature, as a system of bodies eternally, or since the creation of the world, going through the same cycle of movements according to fixed laws.

This mechanistic conception reached its zenith in the Newtonian mechanics. The application of the bourgeois conceptions of mechanism—and their power and fruitfulness—is likewise shown, for example, in Harvey's discovery, which overthrows the old Galenic ideas by regarding the heart as essentially a pump, which pumps the blood around the body.[1]

SUCCESSIVE DEVELOPMENT OF THE SCIENCES

WHAT, THEN, has been the character of the achievements of bourgeois science in the period of its rapid and flourishing development since the seventeenth century? These achievements can be summarised under three heads.

(*a*) There has been achieved what Engels called "the successive development of the separate branches of natural science"[2] —the evolution of the different sciences one from another, and

[1] Galen, who lived in the second century A.D., was physician to the Roman Emperor, Marcus Aurelius, and his ideas were revived in the late middle ages. He taught that blood was formed in the liver and flowed out from the liver and back again along the same channels by a sort of tidal ebb and flow. In the heart the blood was purified and mixed with air from the lungs, taking up "vital spirits" in the process. Harvey, who was physician to the English King Charles I, wrote in his *On the Movement of the Heart and Blood*, published in 1628: "I profess to learn and to teach anatomy, not from books, but from dissections; not from the positions of philosophers, but from the fabric of nature." He showed that the heart was a hollow muscle, whose contractions cause the blood to circulate in a constant direction, out by the arteries and back by the veins. His essential discovery was the demonstration of the *mechanism* of the circulation of the blood.

[2] Engels, *Dialectics of Nature*, p. 214.

their differentiation one from another as distinct "disciplines".

"Apart from mathematics, astronomy, and mechanics, which were already in existence", writes Engels, "physics becomes definitely separated from chemistry (Torricelli, Galileo . . .). Boyle put chemistry on a stable basis as a science. Harvey did the same for physiology. . . . Zoology and botany remain at first collecting sciences, until palæontology appeared on the scene—Cuvier—and shortly afterwards came the discovery of the cell and the development of organic chemistry. Therewith comparative morphology and physiology became possible. . . . Geology was founded at the end of the eighteenth century. . . ."[1]

In this process, which, as Engels says, must be "studied further in detail", the successes scored in one field of science create the possibility for the establishment of the scientific investigation of new fields. The whole process exhibits its own internal logic of development, which unfolds on the basis of the development of the productive forces of capitalist society, which at one and the same time present new problems for science to tackle and provide the technical means for tackling them.

This successive development and differentiation of the sciences, which proceeds right to our own day, and will continue, has, however, its negative side. This is shown in the tendency to the separation of the sciences and to overspecialisation, which continues to operate despite the establishment of intermediate sciences, such as physical-chemistry, biochemistry, etc., and which today results in "the unity of science" being posed as a major unsolved problem by bourgeois philosophy of science.

ACHIEVEMENTS OF ANALYSIS

(*b*) IN ALL the successive fields of science the major achievements have been achievements of *analysis*—the analysis of the phenomena of nature into their parts or elements. This essentially means the demonstration of how things work, in the sense of the demonstration of how the action of the parts produces the action of the whole.

[1] *ibid*, p. 215.

One of the greatest achievements of scientific analysis is the atomic theory, which regards all bodies as made up of atoms. On this basis it was demonstrated, for example, how chemical compounds are formed—as when atoms of oxygen and hydrogen combine in the proportions of one atom of oxygen to two of hydrogen to form water. Again, the basis of the solid, liquid, and gaseous states of matter was demonstrated: the differences between these states depend on nothing else but a change in the distances separating the atoms or molecules of the substance in question. Again, it was shown that heat is nothing but the movement of the atoms, which increases as the temperature rises, so that when a solid body is heated it becomes liquid, and then turns into a gas. Thus a flood of light is thrown on the properties of bodies, and on what happens to them under various conditions, by the discovery that bodies are made up of atoms.

Such analysis, achieved by scientific investigation, proves a powerful instrument for man's control over nature, in as much as knowledge of the parts and how they function gives power of control, and—as Engels pointed out when he described how "things in themselves" become "things for us"—power to make a thing for ourselves, "bringing it into being out of its conditions and using it for our own purposes into the bargain. . . ."[1]

TWO KINDS OF ANALYSIS

IT IS worth noting in this connection that there are at least two kinds of analysis practised by science.

(1) There is the kind of analysis which demonstrates how a process on a macroscopic scale is constituted out of processes on a microscopic scale. This is exemplified in the atomic theory in physics and chemistry, in the cell theory in biology, and also in Marx's economic analysis of commodity production. It is the kind of analysis which investigates the elementary processes which go to constitute a more complex process, and has resulted in some of the most outstanding and permanent discoveries and achievements of science.

[1] Engels, *Feuerbach*, p. 32.

Thus the atomic theory investigates the fundamental processes taking place in and determining the course of physical and chemical changes. The cell theory in biology shows how the growth of the organism is a process of the multiplication and differentiation of cells, and investigates in the cell the basic processes of metabolism. Again, Marx's *Capital* affords an example of the same kind of analysis in the sphere of economics. It was on the basis of an analysis which revealed the fundamental, elementary economic processes of the circulation of commodities in capitalist society that Marx was able to demonstrate the laws of motion of capitalist society.

(2) There is the kind of analysis which postulates that the production of a certain end-result is controlled by the action of various factors.

This kind of analysis occurs, of course, throughout the whole field of science, whenever it is asserted that a certain result depends upon the values of a number of variables—for instance, the dependence of the volume of a gas on the temperature and pressure, or where such factors as specific gravity, specific heat, valency, etc., etc., are sorted out. Again, this type of factor analysis is exemplified in biology, when factors of nature and nurture are distinguished as influences affecting the development of the organism; or in economics, when factors of supply and demand are distinguished as influencing prices.

In fruitful scientific work the two kinds of analysis are combined. However, in many departments of bourgeois science strong tendencies arise to separate the second kind of analysis —factor analysis—from the first—analysis of fundamental processes. For example, in his fundamental economic analysis Marx demonstrated the *law of value,* i.e.: "The magnitude of the value of any article is the amount of labour socially necessary, or the labour-time socially necessary, for its production."[1] Then he was able to analyse various factors which cause commodities to exchange at other than their values. But bourgeois economics altogether neglects the analysis of the fundamental processes of the circulation of commodities, and confines itself to attempted analysis of factors governing the production and

[1] Marx, *Capital,* Vol. I, ch. i, section 1.

exchange of commodities. Such analysis is superficial and leads to falsification of the phenomena investigated.

The same thing happens in bourgeois genetics. A number of factors are said to constitute the genotype of the organism, which combine with environmental factors in determining the fate of the particular organism. But this analysis is separated from any fundamental analysis of the processes of growth, of heredity, and of the interaction of organism and environment.

TENDENCY OF ANALYSIS TO BECOME METAPHYSICAL

THE ACHIEVEMENTS of scientific analysis in bourgeois science have their negative side, which is expressed in the tendency of analysis to become metaphysical. This tendency is bound up with the tendency in bourgeois science to conceive everything mechanistically and hence to conceive of analysis as the investigation of mechanism.

If one is presented with some mechanism—a watch, for example—and wants to know how it works, one must take it to pieces, find out what parts it is made of, how they fit together, and how they operate on one another: in this way one demonstrates how the watch works, its mechanism.

If the task of analysis is conceived of exclusively after this analogy or model, then its aim is to demonstrate how the phenomena of nature are made up out of a number of separate parts, and how the processes of nature result from the external or mechanical interactions of these parts one on another. In this way the conception of nature is dominated by the conception of the machine. This domination of the machine over the people who make it, who thereby fail to understand the nature of their own handiwork, has long been manifest in bourgeois science.

What is a machine? Marx showed that "all fully developed machinery consists of three essentially different parts, the motor mechanism, the transmitting mechanism, and finally the tool or working machine".[1] The machine is a man-made assemblage of parts, such that if a motive force is applied and they are set in motion, the operation of the machine produces certain results.

[1] Marx, *Capital*, Vol. I, ch. xv, section 1.

The parts are essentially separable. If no motive force is applied, if the motor is not set in motion, nothing happens. If the transmitting mechanism is disconnected from the tool, again nothing happens.

Hence if nature is conceived of after the model of the machine, then nature is conceived as made up of so many separable parts in interaction, whose motion always results from some impulse from outside.

The outcome is a metaphysical scheme—an analysis of nature, which fails to regard nature as a complex of processes but sees it rather as a complex of separate and distinct things, each with its own fixed nature independent of everything else, and which fails to discover the real, inner driving forces of change.

From this there follows, too, a tendency towards mechanist "reduction" or "levelling down", in which it is attempted to reduce the unique qualities or forms of movement of the whole to the sum of the separate motions of the parts. That a process is constituted out of its parts does not mean that nothing exists but those parts and their separate movements. To say this is to turn science into metaphysics, and to assert that the world consists of certain "ultimate" elements, which are the "ultimate reality"—or which are, at all events, the limits of knowledge.

The metaphysical tendency of analysis shows itself in factor analysis when the factors which are distinguished are rigidly conceived each apart from the others, separate and independent. And sometimes this leads to postulating whole sets of separate and distinct entities corresponding to the factors which are distinguished. When a number of separate factors are distinguished as controlling a certain end-result, it is postulated that each separate factor must represent the operation of some separate thing.

This is the procedure in bourgeois genetics, for example. Corresponding to the various factors which are distinguished as constituting the genotype of the organism are postulated sets of material particles—the genes—which are said to be strung out along the chromosomes in the cell like beads on a string. For each separate factor there is postulated a separate entity.

The result of this procedure in the case of factor analysis is that the factors are postulated as something given and largely uncontrollable. This is exactly what has happened with genetics, with the genetic constitution of the organism, when first a number of separate hereditary factors are distinguished and then each factor is transformed into a fixed and separate thing. The result of such metaphysics is that, from being an instrument for the more effective understanding and control of natural processes, analysis becomes the very opposite. It becomes rather an expression of what men conceive to be the limitations of their action than an instrument for enlarging their powers of action.

EVOLUTION

(*c*) THE THIRD achievement to be noted is the advance of bourgeois science from the static conception of nature as the eternal repetition of the same kinds of processes, in which the same kinds of things keep on repeating the same kinds of movement, to the evolutionary conception.

Evolutionary ideas took possession of one field after another: for example, in the theories of the origin and development of the solar system, and likewise of the stars and of the galaxy; in geology, which traces the history of the evolution of the earth's crust; in another way in chemistry, with Mendeleyev's periodic scheme of the elements; in biology, with the theory of the evolution of organic species; and in various conceptions of the stage-by-stage evolution of human society.

It was in this connection that Engels noted the profound importance of three great discoveries of bourgeois science, namely: " the discovery of the cell as the unit from whose multiplication and differentiation the whole plant and animal body develops ", the discovery of the law of the transformation of energy, and the Darwinian theory.[1]

These discoveries, he pointed out, transformed the conception of the interconnection of natural processes and led to the recognition of nature as " an historical process of development ".

Engels likewise pointed out that the introduction of evolu-

[1] Engels, *Feuerbach,* p. 56.

tionary ideas was a further blow towards the emancipation of science from theology.

In the seventeenth and the first part of the eighteenth centuries, he points out, " science was still deeply enmeshed in theology. Everywhere it sought and found its ultimate resort in an impulse from outside that was not to be explained from nature itself. . . . Copernicus at the beginning of the period writes a letter renouncing theology; Newton closes the period with the postulate of a divine impulse ". But the evolutionary theories removed the necessity of explaining the world by a divine impulse from outside, by " explaining the world from the world itself ".[1]

The advance to evolutionary conceptions of nature was connected with the rise of industrial capitalism and the industrial bourgeoisie, which supplanted the earlier manufacturing and mercantile phase. It was the harbinger and concomitant of the industrial revolution. Society entered upon a period of exceptionally rapid change, which invaded the consciousness of both philosophers and scientists.

As Caudwell put it: " Now the bourgeois philosopher sees nature through rapidly changing economic categories, and hence sees changing nature. He sees the change in nature. . . . The interest of scientists is now directed to change in nature, and the Darwinian theory emerges, which is a theory of change in nature explained by the categories of the bourgeois society of the industrial revolution, with its *laisser-faire* policy."[2]

The conception of evolution was integrated with the liberal conception of progress characteristic of the industrial bourgeoisie. And it was a genuine discovery of science, representing most important insight into natural processes, for which the ground had been prepared by the materials amassed and the methods of investigation established by earlier science, but which supplanted earlier conceptions.

At the same time, evolutionary ideas were hampered by the limitations inherent in even the most progressive bourgeois outlook.

[1] Engels, *Dialectics of Nature,* p. 7.

[2] Caudwell, *The Crisis in Physics,* p. 52.

DIALECTICAL MATERIALISM— A SCIENTIFIC GENERALISATION

THE ACHIEVEMENTS of bourgeois science—the successes of scientific analysis in field after field of investigation, and the discovery that in every field nature is a process of historical development—prepared the ground and provided the materials for the great scientific generalisation embodied in dialectical materialism.

Thus Engels could already write in 1885: "The revolution which is being forced on theoretical natural science by the mere need to set in order the purely empirical discoveries, great masses of which are now being piled up, is of such a kind that it must bring the dialectical character of natural events more and more to the consciousness even of those empiricists who are most opposed to it. . . . Natural science has now advanced so far that it can no longer escape the dialectical synthesis. . . . Nature is the test of dialectics, and it must be said for modern natural science that it has furnished extremely rich and daily increasing materials for this test, and has thus proved that in the last analysis nature's process is dialectical and not metaphysical."[1]

It is precisely in the analysis of the processes of nature into their parts and elements, and in the discovery of the real interconnections of nature and of the laws of change and development, that there is demonstrated the dialectical character of nature's process. From this point of view the conceptions of materialist dialectics are the crowning generalisation of a whole epoch of scientific advance and the point of departure for new advances.

THE REVOLUTIONARY CHARACTER OF DIALECTICAL MATERIALISM

BUT IF the ideas of materialist dialectics are a generalisation the basis of which was prepared by the achievements of bourgeois science, that does not mean that the philosophy of dialectical materialism is simply a summary or record of those

[1] Engels, *Anti-Duhring*, pp. 18, 19, 20.

achievements. On the contrary, this generalisation was, as Zhdanov has pointed out, a genuine new discovery, of transforming, revolutionising significance for philosophy and for the sciences.[1]

The main thing is that dialectical materialism gives generalised philosophical expression to the outlook of a new class, the revolutionary proletariat. This outlook assimilates into itself the most advanced achievements of bourgeois science and bourgeois philosophy. But it is a new outlook, which transforms both science and philosophy. It discovers and brings out the underlying dialectical connections and the dialectical motion of the processes of nature and of history, thus introducing into the sciences what Engels called "the dialectical synthesis" and at the same time ridding them of the limiting, hampering conceptions of bourgeois thought and bourgeois methodology.

What are the new, revolutionary features of dialectical materialism?

(1) *It is the complete victory of the materialist outlook, establishing the principles of a complete and absolutely consistent materialist approach in all spheres of thought.*

"This means", said Engels, "that it was resolved to comprehend the real world—nature and history—just as it presents itself to every one who approaches it free from preconceived idealist fancies. It was decided relentlessly to sacrifice every idealist fancy which could not be brought into harmony with the facts conceived in their own and not in a fantastic connection. And materialism means nothing more than this."[2]

This materialism involves at one and the same time the criticism of both the idealist and the mechanist preconceptions which penetrate bourgeois thought in the sciences. The categories of materialist dialectics provide precisely the method to comprehend the processes of nature and history *as they really are*, free from the falsification introduced by idealist and mechanist ideas.

[1] A. A. Zhdanov, *On the History of Philosophy*—speech at conference of Soviet philosophers, June, 1947.

[2] Engels, *Feuerbach*, p. 53.

(2) *Dialectical materialism ends the philosophical systems of the past, in which it was attempted to erect a philosophy standing above the sciences, dictating its conclusions to the sciences, or claiming to produce a more true and complete account of the world and of human thought and activity than could be achieved by the sciences.*

In her book on science in the seventeenth century, Martha Ornstein calls the philosophers "the propagandists of science".[1] This is true, in the sense that what the bourgeois philosophers have done is to abstract the idealist and mechanist categories of interpretation used in bourgeois science in its various stages of development, and elaborate these into rigid systems, thus obtaining a generalised expression of the preconceptions of bourgeois science and hardening them into dogmas, into hard and fast systems claiming to be eternal truth. And at the same time the inventors of philosophical systems have claimed to go beyond the sciences: they have claimed to reveal the ultimate nature of the reality which science deals with and to reveal the nature of spiritual reality inaccessible to science—the nature of God and of the human soul.

In opposition to all philosophical systems, Engels wrote: "Modern materialism is essentially dialectical and no longer needs any philosophy standing above the sciences. As soon as each separate science is required to get clarity as to its position in the great totality of things and of our knowledge of things, a special science dealing with this totality is superfluous. What still independently survives of all former philosophy is the science of thought and its laws—formal logic and dialectics. Everything else is merged in the positive science of nature and history."[2]

(3) This means that *with dialectical materialism philosophy for the first time becomes scientific, in the sense of being firmly based on the sciences. And the philosophical generalisation which is based on the sciences is at the same time a guiding method for the sciences, an instrument for the further advance of science.*

[1] M. Ornstein, *The Scientific Societies of the 17th Century.*

[2] Engels, *Anti-Duhring*, p. 32.

"Marxist philosophy", said Zhdanov, "as distinguished from preceding philosophical systems, is not a science dominating the other sciences; rather is it an instrument of scientific investigation, a method, penetrating all natural and social sciences and enriching itself with their attainments in the course of their development."[1]

The ideas of dialectical materialism are generalised from the attainments of the sciences, and continually enriched as the sciences advance. And the point of this generalisation is that it is something that can be set to work. *Dialectical materialism is a guide to the grand strategy of future scientific advance, a weapon of criticism against mechanism and idealism in the sciences, and an instrument for the interpretation of scientific results and their integration in the materialist conception of nature and history.*

Bourgeois philosophy, which sets up systems above the sciences, by so doing robs the sciences of adequate philosophical guidance.

This was commented on by Caudwell, when he said of the theoretical outlook of bourgeois science: "That is not to say science has no theory; it is impossible to have any practice without a theory, but science's theory is the minimum theory possible, a theory which is empiricist and opportunist because it springs directly from practice. It is not a theory which has been evolved to meet the needs of a man's whole life in society, including his scientific speculation. It is a specialised theory designed only to meet the needs of a man as a scientist and not as a man with blood in his veins who must eat, labour, marry, and die. This limitation is pointed out with pride by modern scientists. It leaves room for God, they explain."[2]

Dialectical materialism, which ends philosophy standing above the sciences, provides the sciences with their philosophy, creates a philosophy which penetrates the sciences. This is its strength; and this is one of the things about it which those imbued with the traditions of bourgeois science can least stomach.

[1] Zhdanov, *On the History of Philosophy.*

[2] Caudwell, *Crisis in Physics*, p. 59.

FRUSTRATION OF SCIENCE

BUT THE achievements of bourgeois science, which prepared the basis for dialectical materialism, have at the same time had the effect of throwing bourgeois science into a condition of chronic, permanent crisis.

This was already perceived by Engels, when he said: "But the scientists who have learned to think dialectically are still few and far between, and hence the conflict between the discoveries made and the old traditional modes of thought is the explanation of the boundless confusion which now reigns in theoretical natural science and reduces both teachers and students, writers and readers, to despair."[1]

The crisis of bourgeois science may be studied under three aspects. It manifests itself in three principal ways.

(1) Firstly, there is the organisational side. Science has developed from the stage in which it was carried on by private individuals using home-made apparatus to the stage in which it is carried on in large institutions, involving the co-operation of whole research teams, with technicians and assistants, involving heavy finance, elaborate organisation, including publishing houses and journals, and complicated and expensive equipment.

This has proceeded together with the growth of industrial capitalism into monopoly capitalism. And it has meant that as science has developed into a great social institution, so it has fallen more and more under the control of the great monopolies and of the imperialist state machine. Science has become subject to the dictates of the capitalist monopolies in their scramble for profits and drive to war.

This means that the very organisation of science under monopoly capitalism carries with it the disorganisation of science, the frustration of science, and its distortion into those directions demanded by the interests of the monopolies. Scientists as individuals become the servants of monopoly capitalism, have to work as the monopolies direct, and are subject to all the economic and political hazards of capitalism in its declining days.

It is only as the outcome of the struggle for socialism that

[1] Engels, *Anti-Duhring*, p. 29.

this frustration and distortion of science can be overcome. Socialism means the free, planned, and unfettered development of science in the service of the people.[1]

CRISIS OF IDEAS

(2) SECONDLY, THERE is the aspect of the internal, theoretical crisis of science—the crisis of scientific ideas. The essence of this crisis in all fields is precisely that stated by Engels—"the conflict between the discoveries made and the old traditional modes of thought".

The great achievements of bourgeois science, its penetrating analysis of nature, its discoveries of the interconnections of natural processes and of their laws of movement, have come into collision with its traditional modes of thought—its narrow mechanism and empiricism. The further theoretical development of science demands, as Engels put it, the dialectical synthesis. But this would be to carry theory far beyond the limits imposed on it by the bourgeois outlook. Hence the crisis of ideas in science.

Just as the development of the productive forces reaches a point where it can continue only by bursting through the fetters of the capitalist social relationships, so the development of the sciences, which in the last analysis reflects the development of the productive forces, reaches a point where it can continue only by bursting through the fetters of the ideas which reflect the capitalist social relationships.

The task of breaking these fetters belongs to the new, rising social force, the working class. In its struggle the working class gives rise to its political party, the Communist Party, armed with the theory of Marxism-Leninism. And the task of leadership in the sphere of the sciences, too, devolves upon this Party.

The entire tendency of the discoveries of the sciences is to reveal with growing comprehensiveness and clarity the dialectical laws of motion and interconnection in nature and human society, and thus to break through the traditional mechanistic materialism and narrow empiricism of the scientists

[1] See further, J. D. Bernal and M. Cornforth, *Science for Peace and Socialism.*

and to confirm the outlook of dialectical materialism. It is this which Lenin underlined in the case of physics, when he wrote: "Modern physics is in travail; it is giving birth to dialectical materialism."[1]

But this tendency does not suit the bourgeois outlook, and contradicts it. Hence arises a counter-tendency in bourgeois science. It turns back from its own achievements, gives up the vantage grounds which have been won and suffers a theoretical collapse.

This tendency has revealed itself in all fields of science. It revealed itself first, not in the natural sciences but in economics, where the class interests of the bourgeoisie were most nearly and most immediately affected. Classical English political economy established the scientific foundations of the analysis of commodity production and discovered the law of value. But it was left to Marx to follow up this achievement by the discovery of surplus value and the law of motion of capitalist society. As for bourgeois political economy, it collapsed into mere apologetics of capitalism and could not follow up its own initial achievement.

In sociology the same process was repeated after the publication of Morgan's *Ancient Society* in 1877. By his discovery of the gens, Morgan discovered the key to the scientific understanding of, as he expressed it, "the lines of human progress from savagery through barbarism to civilisation", the origin of the family, private property, and the state. This achievement was immediately recognised and followed up by Marx and Engels.[2] It could not be followed up by bourgeois sociology, which has suffered the same collapse as bourgeois economics.[3]

In biology the same process was repeated after Darwin. Bourgeois biologists have, for the most part, turned their backs upon the materialist teachings of Darwin concerning the evolu-

[1] Lenin, *Selected Works*, Vol. XI, p. 365.

[2] See Engels, *The Origin of the Family, Private Property and the State.*

[3] A brilliant vindication of Morgan's researches, following up Morgan's discoveries in the analysis of ancient society and exposing the bankruptcy of bourgeois "scholarship", is contained in George Thomson's Marxist work, *Studies in Ancient Greek Society.*

tion of living organisms and there emerged the trend known as "neo-Darwinism".

"Even when Darwin's teaching first made its appearance, it became clear at once that its scientific, materialist core, the theory of the evolution of living nature, was antagonistic to the idealism that reigned in biology", writes Lysenko. "Darwinism as presented by Darwin contradicted idealist philosophy, and this contradiction grew deeper with the development of the materialist teaching. Reactionary biologists have therefore done everything in their power to empty Darwinism of its materialist elements. The individual voices of progressive biologists . . . were drowned by the chorus of anti-Darwinists, the reactionary biologists the world over.

"In the post-Darwinian period the overwhelming majority of biologists—far from further developing Darwin's teaching—did all they could to debase Darwinism, to smother its scientific foundation. The most glaring manifestation of such debasement of Darwinism is to be found in the teachings of Weismann, Mendel and Morgan, the founders of modern reactionary genetics."[1]

It was left to Soviet biologists to reinstate and continue the achievements of Darwinism and to expose the theoretical collapse of bourgeois biology.

In physics, once again, the same process is being manifested. Unable to undertake the materialist theoretical generalisation of its own discoveries concerning the electron, the atomic nucleus, the quantum of action, bourgeois physics has collapsed into formalism, into various varieties of the theory that "matter has disappeared", and into idealist cosmological speculations.

All along the line bourgeois science suffers this same theoretical collapse. Its own discoveries contradict its own traditional modes of thought and it proves unable to carry them forward. Its practice collapses into empiricism and narrow specialisation. Its theory dissolves into fragments: it despairs of any general theory of science, of positive knowledge of

[1] Lysenko, *Address to Lenin Academy of Agricultural Sciences*, July 31, 1948. See *The Situation in Biological Science*, p. 14.

reality,[1] and takes refuge in *ad hoc* hypotheses, in formalism and idealist speculations.

As a result there is to be found no clarity of fundamental ideas in any department of science today, and it is rent with controversy in all spheres. Such is the real situation of bourgeois science. This situation is disguised only by the enormous output of particular, specialised studies, accumulating in an unmanageable number of specialised journals. But this very empiricism and specialisation is only one of the symptoms of the profound crisis of ideas. At the same time, the true situation in the sciences is hidden from laymen by the pontifical pronouncements of certain scientists in the popular press and over the radio, when they come forward in the character of experts, though it is often only a case of the blind leading the blind.

The way out of this crisis is by the application in science of the categories and methods of dialectical materialism. This, of course, is by no means an easy job. And it is worth pointing out that there is a revisionist way of seeking to apply dialectical materialism in science, as well as a Marxist way. The revisionist way is uncritically to accept the particular formulations being made by bourgeois science and to try to dress them up in a dialectical materialist terminology. The Marxist way is by the method of criticism and self-criticism.

TWO TRENDS IN SCIENCE

(3) THIRDLY, WITH the triumph of socialism in the Soviet Union, and with the division of the world into its socialist and capitalist sectors, the crisis of bourgeios science begins to assume the aspect of the conflict of two trends of science—of science in the capitalist world and of science in the socialist world. The trend of science subjugated to monopoly capitalism is opposed by the trend of science planned and organised in the service of the people. Bourgeois science is opposed by Soviet science, guided by the ideas and methods of dialectical materialism.

[1] Cf. Caudwell, *The Crisis in Physics*, p. 60.

II

MATERIALISM VERSUS IDEALISM

THE FUNDAMENTAL categories of the Marxist criticism of bourgeois science in its theoretical aspect are (*a*) the criticism of its idealism and (*b*) the criticism of its mechanism. At the roots of the dialectical materialist outlook are the twin conceptions of *materialism versus idealism*, and of *dialectics versus metaphysics*—mechanism being a form of metaphysics. Thus Stalin says of dialectical materialism:

"Its approach to the phenomena of nature, its method of studying and apprehending them, is dialectical, while its interpretation of the phenomena of nature, its conception of these phenomena, its theory, is materialistic."[1]

AGAINST IDEALISM AND MECHANISM

OUR CRITICISM has a double edge—against idealism and against mechanism.

This is expressed in the conception of the fight for Marxism as a fight on two fronts. This fight on two fronts has a perfectly clear meaning. It means that in expressing our Marxist point of view we must guard against two errors, fight against two deviations—a mechanist error and an idealist error.

The typical mechanist error is to forget dialectics and reduce Marxism to crude mechanistic materialism. The typical idealist error is to put forward the categories of dialectics as a kind of Hegelian scheme, forgetting that these categories are evolved from our study of and action in the material world and that "nature is the test of dialectics". Obviously both errors mean the substitution of bourgeois philosophy for Marxism—a revision of Marxism, a retreat from Marxism.

And so in fighting against, criticising, bourgeois philosophy and bourgeois ideology in the sciences, we are fighting against and criticising both its idealist and mechanist tendencies.

But this does not mean that there are two separate enemies, two disinct theories which we are criticising. On the contrary,

[1] *History of the Communist Party of the Soviet Union*, p. 105.

idealism and mechanism are like siamese twins: they are joined together in bourgeois theory, each is the complement of the other and reinforces the other.

This point was vividly expressed in an interjection during Zavadovsky's speech in the Soviet discussion on the situation in biology. Zavadovsky referred to the fight on two fronts; he admitted that Lysenko was criticising idealist tendencies in biology; and then he asked: "Where is the fighting front against mechanism?"

VOICE FROM THE AUDIENCE: "In the same place."

ZAVADOVSKY: "Now that is what I fail to understand, and I would like somebody to enlighten me on the point."[1]

Because of this, Zavadovsky tried to find a middle path in biology. Bourgeois genetics was idealist, but Lysenko was mechanist, and what was wanted was a middle path. What he failed to understand was that Lysenko's dialectical materialist criticism was directed against both the idealist and mechanist mistakes of bourgeois biology—that Lysenko was advancing *a materialist theory dialectical in its approach,* while the geneticists were defending *an idealist theory mechanistic or metaphysical in its approach.* That is why Lysenko's Marxist criticism was directed at one and the same time and in one and the same place against idealism and mechanism.

The difference between materialism and idealism—between the materialist and idealist interpretation or conception of the phenomena of nature—was defined by Engels in a classical passage:

"The great basic question of all philosophy, especially of modern philosophy, is that concerning the relation of thinking and being. . . . The answers which the philosophers gave to this question split them into two great camps. Those who asserted the primacy of spirit to nature and therefore in the last instance assumed world creation in some form or other comprised the camp of idealism. The others, who regarded nature as primary, belong to the various schools of materialism."[2]

[1] *Situation in Biological Science,* p. 345.

[2] Engels, *Feuerbach,* pp. 30, 31.

Elaborating this, Stalin said:

"Materialism holds that the world is by its very nature material, that the multifold phenomena of the world constitute different forms of matter in motion . . . that thought is a product of matter which in its development has reached a high degree of perfection, namely, of the brain, and the brain is the organ of thought, and that therefore one cannot separate thought from matter without committing a grave error."[1]

Marxists are uncompromising partisans of the materialist point of view against idealism. Thus Lenin said: "The genius of Marx and Engels consisted in the very fact that in the course of a long period, nearly half a century, they developed materialism, that they further advanced one fundamental trend in philosophy. . . ."[2]

The discovery of the materialist dialectical method by Marx and Engels meant the decisive victory of the materialist interpretation of the world over idealism, by transcending the mechanistic limitations of the materialism of the past.

MECHANICAL MATERIALISM IN THE FIGHT AGAINST IDEALISM

THE FACT that Marx criticised mechanical materialism should not blind us to the tremendous progressive role which it played in the fight against idealism. Referring to this, Lenin said:

"Throughout the modern history of Europe, and especially at the end of the eighteenth century in France, which was the scene of a decisive battle against every kind of medieval rubbish, against feudalism in institutions and ideas, materialism proved to be the only philosophy which was consistent, true to all the teachings of natural science and hostile to superstition, cant, and so forth. The enemies of democracy therefore tried in every way to refute, undermine, and defame materialism, and advocated various forms of philosophical idealism, which always, in one way or another, amounts to an advocacy or support of religion."[3]

[1] *History of the Communist Party of the Soviet Union,* pp. 111-112.

[2] Lenin, *Selected Works,* Vol. XI, p. 386.

[3] *ibid,* p. 4.

Inherent in idealism is always a *dualistic* outlook, a separation of the world into two realms of matter and spirit, which is itself but a continuation in philosophy of the dualism inherent in all religion and which has its origin in the division of society into classes. *The mechanical materialists waged a progressive fight against idealism and clericalism by trying to extend to the realm of mind and society the same mechanistic conceptions which were used in the scientific investigation of nature; they sought to include man and all his spiritual activities in the mechanistic system of the natural world.*

It is not at all true to say, as has sometimes been suggested, that mechanical materialism sought to exclude mind from the material universe; on the contrary, it sought to *include* it—this was the very essence of its materialism.

However, mechanical materialism tended to see man only as the product of his environment, and not to understand how man changes his environment and in that process changes himself. It saw consciousness only as reaction to environment, not as human activity.

Marx laid his finger on this weakness of mechanistic materialism in his *Theses on Feuerbach.* Thus: "The chief defect of all hitherto existing materialism . . . is that the object, reality, sensuousness is conceived only in the form of the *object* or contemplation, but not as *human sensuous activity, practice,* not subjectively."[1]

The materialists, conceiving of the sensible world as a system of bodies in interaction, conceived of our perceptions and ideas simply as the image produced in our consciousness when those bodies impinge on our sense organs. They did not appreciate that our perceptions and ideas, our consciousness, our knowledge of the world, is not simply a product of the action of external things on us, but is produced by us in the process of our acting on external things—that we gain our knowledge of the world, not just by receiving impressions of objects and contemplating the world, but by changing the world.

"Thus it happened", Marx continued, "that the *active* side,

[1] Marx, *Theses on Feuerbach,* I.

in opposition to materialism, was developed by idealism—but only abstractly. . . ."[1]

It was the achievement of classical German idealism, from Kant to Hegel, to have realised that consciousness does not consist in a passive reception and combination of impressions and ideas, but is an activity. But, as Marx said, they conceived of this "active side . . . only abstractly". They conceived of it as an activity of "pure thinking": they separated thinking from the material world, transformed it, as Marx said elsewhere, into "an independent subject",[2] and then made out that it was actually thinking which created and governed the world. They did not appreciate that thinking is the activity of concrete human beings.

Developing his standpoint in opposition to idealism, and criticising mechanistic materialism, Marx continued: "The question whether objective truth can be attributed to human thinking is not a question of theory but is a practical question. In practice man must prove the truth, i.e. the reality and power, the 'this sidedness' of his thinking. The dispute over the reality or non-reality of thinking which is isolated from practice is a purely scholastic question."[3]

And he concluded: "The materialist doctrine that men are products of circumstances and that, therefore, changed men are products of other circumstances and changed upbringing, forgets that circumstances are changed precisely by men and that the educator must himself be educated. . . ."[4]

In this way Marx diagnosed and corrected the defect which mechanistic materialism manifested in its progressive struggle against idealism.

The starting point of the mechanical materialist philosophy was in the static view of nature typical of the mechanistic science of the seventeenth and eighteenth centuries. It is sometimes said that, just as mechanistic materialism saw man and his consciousness only as the product of circumstances and did

[1] *ibid.*

[2] Marx, *Capital,* Preface to second edition.

[3] Marx, *Theses on Feuerbach,* II.

[4] *ibid,* III.

not appreciate how circumstances are changed by men, so also the whole idea of evolutionary process was alien to mechanistic materialism and was contributed solely from the side of idealism.

This, however, is not the case.

The idealist, Hegel, made the conception of a stage-by-stage evolutionary development the central theme of his philosophy. But he conceived of this evolution as belonging solely to the realm of spirit.

"The changes that take place in nature, how infinitely manifold soever they may be", wrote Hegel, "exhibit only a perpetually repeating cycle; in nature there happens 'nothing new under the sun' . . . only in those changes which take place in the region of Spirit does anything new arise. This peculiarity in the world of mind has indicated in the case of man an altogether different destiny from that of merely natural objects—in which we find always one and the same stable character, to which all change reverts; namely, a real capacity for change, and that for the better—an impulse of perfectibility."[1]

The great and undoubted achievement of Hegel should not blind us to the radically *dualistic* character of his idealist system, which affirmed the evolution of *spirit* only to deny the evolution of *nature;* nor distract attention from the achievements of the materialists, who were pioneers in the evolutionary conception of nature and society. For the whole idea of evolution is in essence a materialist idea, whatever idealist gloss may be put on it.

Thus, for example, the mechanical materialist Condorcet advanced the conception of the progressive development of human society, from savagery through definite stages to the reign of "liberty, equality, and fraternity", and he endeavoured to correlate these stages with corresponding advances of productive technique. Diderot, who based his ideas on the inseparability of matter and motion, was almost a dialectical materialist. And the highest achievement of French mechanistic materialism was the evolutionary theory of Lamarck. Lamarck

[1] Hegel, *Philosophy of History,* translated by J. Sibree, p. 54.

based his theory on the materialist conception of the living organism as the product of its environment, with its corollary of the inheritance of acquired characters.

Thus the philosophy of mechanistic materialism led to the conclusion that the world and everything in it was in continual process of change and development, and that this process proceeded by laws that could be discovered by science and formulated with strict scientific accuracy. Yet this conclusion was in contradiction to their conception of the universe as a mechanical system. They could recognise a development, but the mechanistic categories which were their tools of thinking would not suffice to explain it.

The mechanical materialists, for all their weaknesses, carried the materialist fight against idealism a long way. *Marx, by enriching materialism with the ideas and methods of dialectics, established the basis of an absolutely complete and consistent materialist outlook, in opposition to idealism. By introducing the dialectical method into materialism, Marx showed how to carry the materialist fight against idealism to complete victory and how to destroy and demolish idealism root and branch.*

THREE TYPES OF IDEALISM

THERE CAN be distinguished three typical forms of modern idealism.

(*a*) There is idealism of the *objective* type—old-fashioned, classical idealism. It does not deny that the material world exists or that we can gain extensive knowledge of the material world; but it says that its existence is secondary and derivative, and that behind it is the ultimate reality, which is spiritual. Such doctrines vary from the simple theological view that God created the world, through Leibnitz's theory that matter is only the outward manifestation of the activity of spiritual monads, to Hegel's view that the world is the embodiment of the Absolute Idea, or Whitehead's that real processes consist in the ingression of Eternal Objects into space and time.

(*b*) There is *subjective* idealism, which says that the material world does not exist, and that nothing exists but our own sensations, perceptions, and ideas. For subjective idealism a table,

for instance, is neither a material object nor a collection of monads, nor a materialisation of the idea of table: it is a collection of sensations in my mind.

(*c*) Closely related to subjective idealism are *relativist* types of idealism. Such idealism does not deny the existence of external reality, but says that it is unknowable. Our knowledge it says, is strictly relative: we know how things appear to us, but not what they are in themselves.

Stalin describes this idealism as follows: that it "denies the possibility of knowing the world and its laws . . . does not believe in the authenticity of our knowledge, does not recognise objective truth, and holds that the world is full of things-in-themselves which can never be known to science. . . ."[1]

A good example of such relativist idealism is Russell's latest book on *Human Knowledge, its Scope and Limits*. He used to say that the physical world was "a logical construction" made up of sensations. Now he does not even say that. He says: "Physical events are known only as regards their space-time structure. The qualities that compose such events are unknown —so completely unknown that we cannot say either that they are, or that they are not, different from the qualities that we know as belonging to mental events."[2]

It is important to distinguish these forms of idealism, and in particular to grasp the distinction between objective idealism on the one hand, and subjectivism and relativism on the other hand. For *the most typical form of contemporary idealism is relativism and subjectivism: this is the typical ideology of capitalism in decay.*

And it follows that in contrast to such forms of idealism, certain systems of objective idealism may even in some respects stand out as progressive trends in bourgeois philosophy—making a stand for the objectivity of scientific knowledge against the prevailing subjectivism. Thus Whitehead, for instance, was undoubtedly in some respects a progressive thinker. He was an idealist who still maintained the objective existence and knowability of the material world. And it was because Hegel

[1] *History of the Communist Party of the Soviet Union*, p. 113.

[2] Russell, *Human Knowledge*, p. 247.

was an objective idealist, who consistently fought against subjectivism and relativism in all its forms, that he was able to make the vast contribution which he did make to the progress of philosophy, and could formulate, although in an idealist way, the principles of dialectics which were afterwards, as Engels put it, stood on their feet by Marx.

THE DOCTRINE OF LIMITATION

THE VERY essence of the doctrines of subjectivism and relativism is the doctrine of the limitations of human knowledge and the corresponding limitations of human practice. This is becoming expressed in the very titles of recent books—Russell: *Human Knowledge, its Scope and Limits*; Chwistek: *The Limits of Science*.

"The most we can do," says Professor Ayer, "is to elaborate a technique for predicting the course of our sensory experience." We can describe the order of our sensations, not the laws of motion of objective processes. All physics can do, says Bridgman, is to speak about our own physical operations and their outcome. Everywhere what is expressed is a doctrine of limitations. "There is an absolute limit to the fineness of our powers of observation," says Dirac. Reichenbach speaks of an inherent "anomaly" in any description of the physical world, so that it is absolutely impossible to give any account of the world free from "anomalies".[1]

The same doctrine of limits turns up everywhere—in views about the limits of the possibilities of raising crop yields, in views about the ineradicable primitive instincts of mankind which baffle every social reformer; and just the same views are expressed in the financial policy of the British Government.

The fact is that capitalism has reached its limits, and this is what is being expressed in the pervading subjectivist and relativist philosophy, which penetrates every sphere of thought and activity. This philosophy is the typical ideological expres-

[1] See A. J. Ayer: *Foundations of Empirical Knowledge*; P. W. Bridgman: *The Logic of Modern Physics;* P. A. M. Dirac: *Quantum Mechanics;* H. Reichenbach: *Philosophical Foundations of Quantum Mechanics.*

sion of the general crisis of capitalism. It expresses the state of the capitalist world as it appears to the denizens of that world just as faithfully as the liberal philosophy of the mid-nineteenth century expressed the rising phase of industrial capitalism, or as, much earlier, the philosophy of Aquinas (with its hierarchy of being, with God at the top, a hierarchy of angels, then man, and then matter at the bottom) expressed the state of the feudal system in the thirteenth century.

POSITIVISM

THE MOST characteristic expression of subjectivism and relativism in relation to the sciences is the positivist theory of knowledge. This theory has received many expressions, but its essence is to say that our knowledge of the world, which starts from our sensations and sense-impressions, can never extend to anything beyond those sense-impressions, and that the job of science is simply to correlate observational data. Thus Eddington said that the data of physics consisted in "pointer-readings and similar indications"; the physicist could never say what lay behind those observations; all he could do, or needed to do, was to state their correlations. The real world could never be known to science, but we might get some hints about it from theology.[1]

Positivism has very definite views about *causality*. These were expressed by John Dewey, when he said that causality was a logical not an ontological category. Causality is a useful word to use when correlating observations, but there is no real, objective causal connection.[2]

The positivist outlook is not a philosophy superimposed on modern science, which can be easily flung off; but it has very deep roots in bourgeois science in the past and deeply penetrates the conceptions of bourgeois science today.

1. The positivist outlook is bred out of the empiricism and specialisation characteristic of the natural sciences. It is but the philosophical expression of the attitude of the scientist who con-

[1] Eddington, *The Nature of the Physical World,* Chap. 12.

[2] Dewey, *Logic,* p. 459.

ceives his job to be to work at some particular problem, to take observations bearing on that problem and then to generalise the results of those observation. Indeed, it is sedulously taught that the "scientific attitude" consists in simply reporting observations and correlating them, while avoiding any comment on them, any interpretation. This is known as scientific "objectivity" and "impartiality", and positivism is the philosophical expression of this type of "scientific attitude".

2. By the very way it expresses the narrow specialisation of science, the positivist outlook deprives science of any tendency to militant materialism. If science is only correlating observations and not discovering the laws of motion of the real, objective world, then science leaves plenty of room over for religion or for any species of obscurantist teaching which is current in the capitalist world.

3. Recently the positivist outlook has assumed particular prominence in physics. It is expressed in the formalism characteristic of physical theory; that is, in the conception that the job of physics is to produce formulae which correlate observations and predict the results of particular operations, or rather the probabilities of those results. Thus Carnap states that there is no need to "understand" the formulae of physics in any other sense than this, no need to give the terms of those formulae "any explicit interpretation" as referring to objective physical processes.[1] And Dirac says we "cannot form a mental picture" of real physical processes "without introducing irrelevancies", and "it is quite unnecessary that any satisfying description of the whole course of the phenomena should be given."[2]

This formalism is closely connected with the breakdown of the classical mechanistic ideas in physics. The mechanistic picture of the physical world has broken down; positivists quite correctly say that the old metaphysics must be rejected, but from this conclude that what must be rejected is all and any attempts to picture the real physical world.

[1] Carnap, *Foundations of Logic and Mathematics.*

[2] Dirac, *Quantum Mechanics.*

THE FIGHT against this type of subjectivism and relativism in the sciences, which stultifies the theoretical development of science and is an expression of the deep crisis of bourgeois science, demands that we adopt an uncompromising advocacy of materialism. And it demands that we really master the method of materialist dialectics.

In his *Materialism and Empirio-Criticism,* Lenin brought out the principles of the materialist theory of knowledge, as a fighting weapon in the sciences.

1. *For the materialist theory of knowledge, our knowledge is based on social practice and tested in social practice. Knowledge is generated and tested in the activity of changing the world. And so the object of knowledge is objective reality, and we learn more of the truth concerning the world as we are able more fully to master and control the objective processes in the world.*

The positivist theory of knowledge, on the other hand, expresses first of all a situation in which practice is limited, empirical and specialised. And the positivist, and the scientist whose theory is tinged with positivism, sees scientific knowledge also in a limited, specialised way. He sees the basis of knowledge in the particular operations of the scientists and in the observations to which they have led, and for him theory is an account of those operations and observations, and not a grasp of the objective world. He sets the one against the other.

2. *For the materialist theory of knowledge, knowledge must always be limited, just as the power of action must always be limited—the limitation corresponding to the stage of social development and, in particular, to the techniques available at any stage.*

But for the materialist theory of knowledge, such limitations are never absolute: knowledge and practice is always limited, but the task is always to get over those limitations.

Thus, for example, the power and knowledge available from the technique of microscopy was limited by the wave length of light, and this was a limitation inherent in the ordinary microscope. But it was not an absolute limitation, and it was

overcome by the invention of the electron microscope.[1]

The modern idealists, on the other hand, are always propounding theories to make limitations absolute.

Thus modern physics has come up against the fact of the interference of the investigator in the processes he is investigating. If we seek to determine by observation the position or momentum of an electron, then the very act of observation causes a disturbance of the position or momentum of the electron of an order of magnitude which cannot be neglected. So modern physics has had to recognise and formulate the truth that we know nature by changing it. This is an important advance in scientific theory.

But this principle is formulated as a "principle of uncertainty". If we seek to determine the position of an electron, then the observation creates a disturbance which renders the momentum of that electron uncertain; and if we seek to determine the momentum, then the disturbance renders the position uncertain. Hence there is an inherent and inescapable uncertainty about the motions of electrons. In this way the very discovery of the interference of the investigator in the processes he is investigating is formulated as an absolute limitation to the possibilities of knowledge of physical processes.

This "principle of uncertainty" is formulated by one school of physicists in another way. They adopt the view which was expressed by Eddington when he wrote: "Something unknown is doing we don't know what—that is what our theory amounts

[1] When a beam of light is employed to observe objects, the fineness of the power of observation is limited by the wave length of light. By employing a beam of electrons in the electron microsope, the fineness of observation is greatly increased, since the wave length associated with the electron beam is much less than that of light. Hence we can see much smaller objects.

The positivist Mach used to say that objects on the molecular level must always and necessarily remain on a purely hypothetical plane, because we can never possibly see them. Today it is possible to examine a crystal structure with an electron microscope and to see quite clearly the orderly arrangement of the separate molecules in the crystal. Mach was quite wrong. It is possible, too, in a Wilson chamber, to see—not, it is true, electrons, protons, and other constituents of the atom themselves, but the traces left by their passage.

to."[1] According to this school, the properties of material processes are expressed in wave equations. They deny the material existence of particles and say that particles are "wave packets". But the waves are not propagated through any known material medium—they are simply waves—"waves of nothing in nothing."[2] The wave equations are regarded, then, simply as a mathematical formalism, which offers no comprehensible picture of any physical reality, but is useful in so far as it enables the investigator to predict the probability of observations. The "principle of uncertainty" then takes the form that the equations of physics do not allow the quantities known as the position and momentum of the unknown "something" which we call "an electron" to be simultaneously specified except within certain limits of uncertainty. If the one quantity is determined, then there is an indeterminacy about the other.

The materialist criticism of the views associated with the "principle of uncertainty" does not seek to deny the truth which these views express, i.e., the recognition of the effects of the interference of the investigator in the processes he is investigating. It must be directed against the idealist way in which these views have expressed and distorted that truth. This idealism consists in transforming the particular limitations of a particular physical technique into absolute limitations of all possible physical knowledge; and in transforming physical theory into a formalism, which attempts to predict the probability of observations resulting from a particular set of physical operations, while at the same time teaching that physical reality is unknowable.

3. *For the materialist theory of knowledge, truth is always relative, in the sense that it is limited and conditioned by the particular nature of the technique whereby we have arrived at it. We can only express the truth about things in terms of our own experience of them and of the operations whereby we have come to know about them.*

But at the same time, truth is absolute, or objective, in the sense that it relates to the objective, material world; and that

[1] Eddington, *The Nature of the Physical World*, p. 291.

[2] cp. P. Freedman, *The Principles of Scientific Research*, p. 60.

we are able to arrive at a more and more adequate expression of the real properties and laws of motion of objective things and processes.

For the subjectivist and relativist, on the other hand, truth is solely, exclusively relative—it relates exclusively to our own observations and operations, not to the objective world, the nature of which is inexpressible.

"Every ideology is historically conditioned," writes Lenin, "but it is unconditionally true that to every scientific ideology there corresponds an objective, absolute nature. You will say that this distinction between relative and absolute truth is indefinite. And I shall reply: yes, it is sufficiently indefinite to prevent science from becoming a dogma in the bad sense of the term, from becoming something dead, frozen, ossified; but it is at the same time sufficiently definite to enable us to dissociate ourselves in the most emphatic and irrevocable manner from fideism and agnosticism, from philosophical idealism and the sophistry of the followers of Hume and Kant. . . ."[1]

[1] Lenin, *Selected Works*, Vol. XI, p. 198.

III

DIALECTICS VERSUS METAPHYSICS

WE APPROACH the problems of science, and of the criticism of bourgeois science, armed with the weapons of materialism and the materialist theory of knowledge—and armed with the method of materialist dialectics.

Engels opposed dialectics to metaphysics. Metaphysics is that way of thinking which tries to sum up the nature of the world, or of any particular part of the world which is being investigated, under some formula of the sort which says that there exist certain definite things, each with its own fixed nature and properties, marked off and distinct from one another, and co-existing and interacting in some fixed framework of relationships.

This metaphysical way of thinking, he says, "had a good deal of historical justification in its day. It was necessary first to examine *things* before it was possible to examine *processes*. One had first to know what a particular thing was before one could observe the changes going on in connection with it."[1]

But this way of thinking has to be overcome; and the need to overcome it and the way to do so is demonstrated in the very advance of the sciences themselves.

Dialectics, says Engels, comprehends the world "not as a complex of ready-made things but as a complex of processes".[2]

"The revolution which is being forced upon theoretical natural science," he wrote, ". . . is of such a kind that it must bring the dialectical character of natural events more and more to the consciousness even of those empiricists who are most opposed to it. . . . The old rigid antitheses, the sharp, impassable dividing lines are more and more disappearing. . . . The recognition that these antitheses and distinctions are in fact to be found in nature, but only with relative validity, and that on the other hand their imagined rigidity and absoluteness have been introduced into nature only by our minds—this recognition is the kernel of the dialectical conception of nature."[1]

[1] Engels, *Feuerbach*, p. 55 (my italics, M. C.).

[2] *ibid*, p. 54.

The method of dialectics is the method of investigating and understanding the processes of nature, and the development of nature, as they really exist—"in harmony," as Engels said, "with the facts conceived in their own and not in a fantastic connection". This is the meaning of the principles of dialectics as formulated, for example, by Stalin, in the chapter on dialectics in the *History of the Communist Party of the Soviet Union*.[2]

MECHANISM AS A FORM OF METAPHYSICS

THE TYPICAL form which the metaphysical approach takes in bourgeois science is that of mechanism.

Now some confusion exists among bourgeois scientists and philosophers as to what is meant by "mechanism". For instance, in a "glossary of terms" given at the end of a recent book on philosophy there occurs the following definition: "Mechanism is the theory that all phenomena can be reduced to the laws of

[1] Engels, *Anti-Duhring*, pp. 17-19.

[2] See *History of C.P.S.U.*, p. 106 ff. Also Stalin, *Dialectical and Historical Materialism*.

Stalin formulates four principles of the dialectical method:

1. Things must be investigated, not each by itself, in isolation from other things, but in their inseparable connection with surrounding phenomena, as conditioned by surrounding phenomena; and 2. in their movement and change, their development, their coming into being and going out of being. 3. Development must be understood, not as a simple process of growth, but as a process in which quantitative changes become transformed into qualitative changes; and 4. not as a harmonious unfolding of phenomena, but as a disclosure of the contradictions inherent in things and phenomena, as a struggle of opposing tendencies which operate on the basis of these contradictions.

Those who take it upon themselves to examine and criticise the dialectical materialist method commonly overlook Stalin's classical formulation of the principles of this method, which is the summary of many years experience of Marxists in the application of dialectics. As a result, they involve themselves and their readers in misunderstandings. This is the case, for instance, with Hudson and Richens' examination of the dialectical materialist method in *The New Genetics In the Soviet Union* (p. 52 ff), and with Paul Freedman's examination of it in *The Principles of Scientific Research* (p. 63 ff).

matter in motion."[1] If that is so, then mechanism is the same as materialism (which, needless to say, this author does not define in his glossary); for materialism holds that everything that exists is an exemplification of the laws of matter in motion. But on the contrary, mechanism is a particular, restrictive, metaphysical view about matter and its laws. The mechanist conceives the motion of matter exclusively as mechanical motion.

From the point of view of the mechanist, mechanical motion is the sole possible motion of matter. Hence when he finds material processes, forms of the movement of matter, which do not answer to the mechanist postulates, he comes to the conclusion that the whole idea of matter has broken down—that either matter has disappeared, as some physicists now say, or that some non-material principle sometimes gets into matter and interferes with it, as the vitalists say in biology. This is just what has happened in bourgeois science. But it only happens because the mechanist conception of the movement of matter is not an adequate conception, and the scientists have lacked the dialectical conception of the forms of movement of matter.

We may recognise mechanism in its purest and simplest form, as a metaphysical view of matter, in the conception that matter consists of discrete particles, distributed in space and interacting in time. The mechanist assumption is that each particle has certain definite properties, such as its position, mass, velocity, and so on; that the particles interact according to certain definite and eternal laws; that the motion of a particle never changes except as a result of the action of some outside force; that everything that happens can be reduced to this type of interaction, i.e. to the mechanical interaction of particles; and that all the changing qualities which we recognise in matter are nothing but the appearances of the basic mechanical motion of matter.

The essence of mechanism is not that it reduces all phenomena to the laws of motion of matter, but that it reduces all the motion of matter to mechanical motion, i.e., to the simple change in place of particles as a result of the action of external forces upon them.

[1] H. Hawton, *Philosophy for Pleasure*, p. 204.

DETERMINISTIC AND STATISTICAL REGULARITIES

THE CONCEPTION of mechanism was historically associated with that of determinism, and the mechanist conception of matter gave rise to its own peculiar conception of determinism. This determinism postulates that the properties of particles and the laws governing their interaction are such that, given the complete state of the material world at any instant of time, everything else that happens afterwards is thereby uniquely determined.

But the conception of determinism then itself gives rise to the conception of probability and of statistical regularities in the aggregate motions of matter. For in general, examining the motion of a material system involving the interaction of a very large number of particles, we do not know enough about it to say exactly what is the state of each particle, and therefore of the whole system, at any instant, and exactly what is going to happen next to each particle. But we can, on the other hand, formulate statistical regularities expressing the probabilities of what will happen in such a system. For example, in tossing coins, we do not know enough to say how the coin will fall in each instance, but we can express the probability of its falling "heads" over a large number of instances.

Thus the mechanist conception gives rise to the twin ideas of deterministic and statistical regularities in nature.

From this it is a simple step to the rejection of determinism. It used to be supposed that the deterministic regularities were the *ultimate* regularities, which everything obeyed: and that statistical regularities were *derivative*—that *individuals* obeyed deterministic laws and *aggregates* statistical laws. But there is no need for the mechanist to make this postulate. Mechanism can well dispense with it, and has dispensed with it. From saying that the individuals obey deterministic laws but we cannot know enough about them to demonstrate that they do, mechanism can pass to saying that *the ultimate regularities are statistical* and that *there is an absolute randomness in the motion of individuals.*

This simply means that the mechanist transfers the uncertainty in his own mind into nature, and makes that uncertainty objective. In the mechanist metaphysics, the con-

ception of statistical regularity is first deduced from that of deterministic regularity, and then leads to the negation of determinism. Such is the development of the mechanist metaphysics of science.

It is sometimes supposed that this rejection of determinism is the rejection of mechanism. This is not so. Science continues to be mechanistic even when it rejects the postulate of determinism and substitutes for it that of an ultimate statistical regularity. The argument as to whether the motion of matter "ultimately" obeys deterministic or statistical regularities is a metaphysical argument between two equally mechanist conceptions of the movement of matter.

The dialectical materialist seeks to formulate the internal dialectic of the motion of matter, the movement of contradictions issuing in the transformation of quantitative into qualitative changes. For dialectics, both deterministic and statistical regularities are useful conceptions of science—but not if either of them is made into a metaphysical ultimate. Materialist dialectics reinstates the conception of determinism—but not in its old, metaphysical, mechanist form. For dialectical materialism everything that happens is determined—not by the initial position and velocity of each separate material particle in some hypothetical antecedent state of the universe—but in the course of the struggle of opposing tendencies which operate on the basis of the contradictions contained in all things and phenomena of nature.

CRITICISM OF MECHANISM

WHAT ARE the basic features of our criticism of mechanism? (*a*) Firstly, in opposition to the mechanist conception of the reduction of all forms of movement of matter to a single, ultimate mechanical form of movement, there is the conception of the range of forms of movement of matter, from simple change of place to the movement of consciousness—the transformation of one form of movement into another and the derivation of one form of movement from another—bringing with it the emergence of new qualities of matter in motion, which are the expression of differences in the form of motion.

(*b*) Secondly, in opposition to the metaphysical, mechanist conception of the world as a complex of "ready-made things", each with its own fixed properties, there is the conception of the world as a complex of processes, in which things arise, have their existence, and pass away.

And this involves the conception of the inexhaustibility of the properties of matter. In Lenin's words: "The 'essence' of things, or 'substance' . . . expresses only the degree of profundity of man's knowledge of objects; and while yesterday the profundity of this knowledge did not go beyond the atom, and today does not go beyond the electron and ether, dialectical materialism insists on the temporary, relative, approximate character of all these milestones in the knowledge of nature gained by the progressing science of man. The electron is as inexhaustible as the atom, nature is infinite. . . ."[1]

(*c*) Thirdly, in opposition to the mechanist conception of particles in interaction in space and time, which only move or change their motion in response to some external force, there is the conception of the self-movement of matter, of the inseparability of matter and motion, of motion as the mode of existence of matter—the refusal to make a metaphysical separation of matter from motion, or of space and time from matter in motion.

The discoveries of modern science in their entirety bear out and vindicate this criticism of mechanism. The crisis of bourgeois science is the expression of its failure to rid itself of mechanist conceptions and to advance to the conceptions of dialectics.

And as a result, mechanism in science becomes the companion of idealism in science. The failure of bourgeois science to rid itself of its own mechanist preconceptions and to achieve the dialectical synthesis is at the same time its collapse into idealism.

The inseparable companionship which has come into existence between idealism and mechanism has two aspects.

On the one hand, when those who can conceive of no other form of motion of matter than mechanical motion find that

[1] Lenin, *Selected Works*, Vol. XI, p. 318.

the classical mechanist explanations break down in the face of scientific discoveries, they conclude that material processes are inexplicable, that, as Eddington put it, " something unknown is doing we don't known what ".

On the other hand, those who are concerned to combat materialism and to spin out idealistic theories, make use of mechanist conceptions to give a " scientific " appearance to their idealist fantasies.

There remains, of course, a large body of research workers who continue to cling to the traditional mechanist materialist conceptions of science and who, because of the manifest defects of these conceptions, either continue to wage a losing battle against idealism, or else take refuge in specialised, empirical studies and are content to let questions of theory look after themselves.

The way in which mechanist conceptions are worked into idealist theory in order to give it an appearance of " science " is well illustrated in Toynbee's *Studies in History*. Toynbee's conception of history is completely idealist: he regards the movement of history as due to a " creative minority ", endowed with special spiritual gifts. But to explain the course of history he then has recourse to the mechanist conception of " challenge and response ". Men face a series of " challenges " to which a " response " must always be made. Civilisation progresses in so far as the creative minority manages to make the right response; but when their creative impulse wears out and they are dragged back by the inert majority, the uncomprehending masses, then civilisation collapses. Toynbee further has recourse to a mechanistic conception of probability to justify the view that every civilisation must inevitably collapse. Whenever there is a challenge there is always a chance that a wrong response will be made; and as challenges multiply themselves the probability of a wrong response, and therefore of the disintegration of civilisation, becomes overwhelmingly great. Thus Toynbee uses mechanist conceptions to give colour to an idealist theory of history—and moreover to an utterly reactionary theory of history, which presents the masses as a purely negative factor

in the struggle for progress and that struggle itself as a hopeless fight against overwhelming odds.[1]

DIALECTICAL CONTRADICTION, BASIC CONCEPTION OF MATERIALIST DIALECTICS

LENIN WROTE that " in its proper meaning, dialectics is the study of the contradiction within the very essence of things ".[2] And further, in his notes *On Dialectics*:

" Development is the struggle of opposites. The two basic conceptions of development are: development as decrease or increase, as repetition, and development as unity of opposites. In the first conception of motion, its *driving force* remains in the shade. In the second conception it is to the knowledge of the *source* of self-movement that attention is chiefly directed. The first conception is lifeless. The second is vital. The second alone furnishes the key to the self-movement of everything in existence; it alone furnishes the key to the leaps, to the breaks in continuity, to the transformation into the opposite, to the destruction of the old and the emergence of the new. The unity (coincidence, identity, resultant) of opposites is conditional, temporary, transitory, relative. The struggle of mutually exclusive opposites is absolute, just as development and motion are absolute."[3]

The conception of dialectical contradiction, as " the key to the self-movement of everything in existence ", is the basic conception of the dialectical method.

CONTRADICTION AND INTERACTION

THE DIALECTICAL conception of " the contradiction within the very essence of things " must not be confused with the mechanist conception of interaction. The mechanical interaction between bodies moving in different directions, which bump up against

[1] I have not mentioned Toynbee's so-called " empirical method " of studying history, which consists, not of investigating the actual movement of history, but of making a series of arbitrary postulates and then ransacking the records of all countries and of all periods to find examples which appear to illustrate those postulates.

[2] Lenin, *Philosophical Notebooks,* quoted in *History of C.P.S.U.*, p. 109.

[3] Lenin, *Selected Works,* Vol. XI, p. 82.

one another—or between forces acting in different directions, their opposition producing a resultant force—is not the same as dialectical contradiction.

This is not to say that mechanical interaction is not a fact. Of course it is. But it is not the key to the self-movement of matter, and the self-movement of matter cannot be reduced to mechanical interaction. Mechanical interaction takes place within the system of contradictions characteristic of the processes which are being investigated; and the course of those processes, the self-movement of matter, takes place through the struggle of opposite tendencies, including forms of mechanical interaction, which operate on the basis of those contradictions.

Sometimes, however, the mechanist conception of interaction is dressed up in a " dialectical " language, so that mechanism is substituted for dialectics, and dialectics is reduced to vulgar mechanism.

Thus Bukharin used to give as the best example of dialectical contradiction, the parallelogram of forces—the action of force *A* and force *B* produces a resultant, *C*.

This same reduction of dialectics to mechanics leads to the view that the " dialectical conflict " of opposite tendencies must result in the establishment of some state of equilibrium between them and in some resultant in which the conflict of opposites is reconciled and overcome. Thus that dubious authority on dialectics, Dr. Julian Huxley, who is incapable of thinking in any but a mechanist way, states that " one element in orthodox Marxism " is " the principle that advance is effected through the reconciliation of opposites, by the reconciliation of thesis and antithesis in a higher synthesis."[1] Actually, Marxism holds that, as Lenin puts it, " the unity, coincidence, identity, resultant of opposites is conditional, temporary, transitory, relative. The struggle of mutually exclusive opposites is absolute, just as development and motion are absolute ".

Again, dialectical materialism is sometimes presented as if it were nothing but a commonplace theory of the interaction

[1] J. Huxley, " Soviet Genetics, the Real Issue," in *Nature*, Vol. 163, No. 4156, June 25, 1949, p. 978. Dr. Huxley is shocked that Soviet geneticists appear to have " abandoned " this " principle ".

of mind and body. The mechanical materialists, we are informed by those who hold by this sort of " dialectics ", taught that matter acts on mind, the idealist taught that mind is independent of matter and acts on matter, but dialectical materialism says that they interact. At that rate one of our leading " dialectical materialists " is Professor William McDougal.

Again, it is said that bourgeois genetics is highly dialectical, because it teaches that the form of the body is the result of the interaction of genes and soma.

But none of this departs from the standpoint of mechanism. To talk like this is not to use the dialectical method, but is to dress up mechanistic science in a " dialectical " terminology. Anyone can find " dialectical contradictions " like this with a minimum of effort, but they do not help much to understand the self-movement of matter, the driving force, as Lenin said, of development. The self-movement of matter cannot be reduced to mechanical interaction, even if that interaction is called " the struggle of opposites ".

DIALECTICAL CONTRADICTION ILLUSTRATED BY THE BASIC CONTRADICTION OF CAPITALISM

IF WE want to find the true meaning of dialectical contradiction, we shall find it exemplified in the materialist conception of history. Marx and Engels scientifically analysed the genesis and nature of the basic contradiction of capitalism and the movement of capitalist society on the basis of this contradiction. They demonstrated as the basic contradiction of capitalism, the contradiction between the socialisation of production, on the one hand, and, on the other hand, the private ownership of the means of production and private appropriation of the product.

With the development of capitalism, writes Engels, " the means of production, and production itself, had become in essence socialised ".[1] In place of individual producers, each turning out his own individual product, numbers of producers were brought together in great enterprises. Within the four

[1] Engels, *Anti-Duhring*, p. 304. See also *Socialism, Utopian and Scientific*, Chap. III.

walls of the factory, production was co-operative, social, planned. But socialised production was still " subjected to a form of appropriation which presupposed the private production of individuals, under which, therefore, every one owns his own product and brings it to market. The mode of production is subjected to this form of appropriation, although it abolishes the conditions upon which the latter rests ".[1]

Thus in pre-capitalist society, the individual producer owned his own means of production and appropriated the product. This private ownership of the means of production and private appropriation of the product was, however, carried over into the new stage when production had become socialised, and took the form of capitalist ownership and capitalist appropriation. Socialised production had abolished the conditions upon which private ownership of means of production and private appropriation rested, but this private ownership and private appropriation still continued to exist in a changed form. A contradiction was generated between socialised production, on the one hand, and private ownership of the means of production and private appropriation on the other hand.

This is the basic contradiction of capitalism, and says Engels, it " contains the germ of the whole of the social antagonisms of today. . . . The contradiction beteen socialised production and capitalist appropriation manifests itself as the antagonism of proletariat and bourgeoisie."[2]

Thus the form of the class struggle, and the entire movement of capitalist society, is generated by the fundamental contradiction of capitalism, and takes place and operates on the basis of this contradiction. This is an example of seeing " the contradiction in the very essence of things " and of understanding the contradiction as the driving force of development and the source of self-movement.

In the light of this we can begin to understand the profound meaning of Stalin's statement of the dialectical principle of contradiction, and the difference between the conceptions of dialectical contradiction and mechanical interaction.

[1] *ibid.*

[2] *ibid,* p. 305.

" Dialectics ", says Stalin, " holds that internal contradictions are inherent in all things and phenomena of nature, for they all have their positive and negative sides, a past and a future, something dying away and something developing."[1]

In the case of the development of capitalism, *the past* manifests itself as the continuation in new conditions of the private ownership of the means of production and private appropriation of the product, while *the future* manifests itself as the socialisation of production. Again, *that which is dying away* is the capitalist system of ownership and appropriation, while *that which is developing* is socialised production, which demands the expropriation of the capitalists and the establishment of socialist ownership of the means of production.

Further, it is the working out of this contradiction which provides the key to understanding the development of society. Bourgeois theorists can very well appreciate, for example, the existence of classes and the fact that classes come into conflict over various issues; they can recognise the *interaction* of classes and the class struggle. What they cannot recognise is that the class struggle proceeds on the basis of the fundamental *contradiction* of capitalism, the consequence of which is that it can issue only in the expropriation of the capitalists through the dictatorship of the proletariat.[2]

THE DISCOVERY OF CONTRADICTIONS: MICHURINIST BIOLOGY

THE disclosure of contradictions is always *a discovery,* the outcome of profound theoretical analysis operating on the material of experience, practice, experiment.

The basic dialectical contradictions " in the very essence of things " are not disclosed simply by seeking for *examples* in

[1] *History of C.P.S.U.,* p. 109.

[2] Thus Lenin wrote in *State and Revolution*: " It is often said and written that the core of Marx's theory is the class struggle; but it is not true. . . . The theory of the class struggle was *not* created by Marx, but by the bourgeoisie *before* Marx, and generally speaking it is *acceptable* to the bourgeoisie. . . . A Marxist is one who *extends* the acceptance of the class struggle to the acceptance of the *dictatorship of the proletariat.*" (Lenin: *Selected Works,* Vol. VII, p. 33.)

current scientific literature of "the conflict of opposite tendencies", but by a theoretical analysis, based on the materials of scientific investigation and tested in practice, which penetrates to and *discovers* the essence of the contradiction underlying the phenomena investigated. If the job of the dialectician were merely to look for *examples* of dialectics in science, then the methods of dialectics would be of little practical use to the scientist. But in fact dialectics is a *method penetrating the sciences, which shows the way to carry forward the advance of science to new achievements.*

This is again exemplified in the profoundly materialist-dialectical conceptions of Michurinist biology in the Soviet Union. The victory of the Michurinist trend in the biological controversy in the U.S.S.R. was, indeed, a victory for socialist science and for the Soviet people. And like all the successes of the Soviet Union, it is a success for the socialist movement and for the common people everywhere in the world, even if some do not like such successes.

In opposition to the mechanist conception of the growth of the organic body as the result of the interaction of genes and soma, Lysenko has disclosed the contradiction inherent in biological phenomena, namely, the dialectical contradiction between the heredity of the organism—which he defines as "the property of a living body to require definite conditions for its life and development and to respond in a definite way to various conditions",[1] and which is "inherent. . . in any particle of the living body"[2]—and the changing conditions of life.

Heredity, says Lysenko, "is the effect of the concentration of the action of environmental conditions assimilated by the organism in a series of preceding generations".[3] Hence "when an organism finds in its environment the conditions suitable to its heredity, its development proceeds in the same way as it proceeded in previous generations. When, however, organisms do not find the conditions they require and are forced to

[1] *The Situation in Biological Science,* p. 35.

[2] *ibid,* p. 606.

[3] *ibid,* p. 41.

assimilate environmental conditions which, to some extent, do not accord with their nature, then the organisms or sections of their bodies become more or less different from the preceding generation. If the altered section of the body is the starting point for the new generation, the latter will, to some extent or other, differ from the preceding generation in its requirements and nature."[1]

Hence at the basis of the whole development of organic life lies the dialectical contradiction between the nature of an organism—its heredity, representing its past—and the conditions of its life and development.

Here, then, is the discovery, the disclosure, of the contradiction on the basis of which operate all those factors which determine the actual fate and growth of the organism. This conception gives the key to the understanding of heredity and its variability, and at the same time opens the way to tremendous advances in practice, in men's control over nature—so that we do not need to wait for favours from nature, but learn better how to wrest them from her.

The discovery of Soviet Michurinist biology has a considerable bearing on the perennial controversy in bourgeois biology between mechanism and vitalism. It is the very limitations of bourgeois biology which generate this controversy, and it moves within the horns of a dilemma of its own creating. Bernard Shaw recently expressed the opinion that Lysenko was a vitalist. Zavadovsky said he was a mechanist. Actually the antithesis that theory must be either vitalist or mechanist only arises within biology when it has failed to grasp the dialectic of its own subject matter. Michurinism is neither vitalism nor mechanism in biology, it is dialectical materialism.

In its account of evolution, moreover, bourgeois biology has been faced with the dilemma, that either it must suppose that evolution is the result of the operation of chance occurrences, of a statistical frequency of random mutations upon which natural selection operates—in which case the action of the environment is represented as purely negative and destructive,

[1] *ibid,* p. 35.

killing off the unfit and leaving the others to survive and hand on their characters to their offspring—or else that some "purpose" is operating, a "life force" or an "entelechy".

This dilemma arises because the real dialectical unity of the organism and its environment is not understood. Michurin biology, which begins to disclose the dialectic of organic development, has no recourse to either of these suppositions.

It is aptly called "creative Darwinism", because it brings out the positive, creative aspect of the dialectical relations between organism and environment, and because it shows how we can creatively make use of this for changing the nature of plants and animals. It shows how changes in the conditions of life lead to changes in the "type of development of organisms", and so to changes in their heredity, in their "nature";[1] and consequently how "by regulating external conditions, the conditions of life of . . . organisms, we can change varieties in a definite direction and create varieties with desirable heredity".[2] Thus "Darwinism has not only been purified of its deficiences and errors and raised to a higher level, but has undergone a considerable change in a number of its principles. From a science which primarily *explains* the past history of the organic world, it is becoming a creative, *effective means* of systematically mastering living nature, making it serve practical requirements".[3]

Lysenko, incidentally, has been accused of "Lamarckism". True, Lysenko agrees with Lamarck that adaptive changes in the organism are not merely random occurrences, and he agrees with Lamarck—and Darwin—that "acquired characters" are inherited. But Lysenko has advanced far beyond Lamarck in studying the dialectical relation of organism and environment as the basis of which the organism is forced to undergo adaptive changes; and he has likewise corrected the simple Lamarckian conception that all acquired characters are heritable by the study of the conditions under which acquired characters can become heritable.

[1] *ibid,* p. 37.

[2] *ibid,* p. 41.

[3] *ibid,* p. 47.

"The extent of the hereditary transmission of alterations", writes Lysenko, "depends on the extent to which the substances of the altered section of the body join in the general process which leads to the formation of reproductive sex or vegetative cells."[1] To the extent that this condition is fulfilled, alterations consequent on organisms being "forced to assimilate environmental conditions which, to some degree or other, do not accord with their nature", are reproduced in the next generation and result in the formation of a changed heredity.

In this way Michurinist biology finds the basis for a materialist account of the occurrence of adaptive changes in the nature of organisms, on which natural selection operates, which involves neither the conception of a "life force", "purpose", or "entelechy", nor the conception of evolution having its basis in the chance ocurrence of mutations. And from this materialist conception it follows that we ourselves can learn to change the nature of organisms in desirable directions, by causing them to assimilate at definite stages of their development environmental conditions which force them to change in the directions we desire. Indeed, it was from the determined effort, in the Soviet Union, to change living nature, that there was gained the more profound understanding of the dialectical laws of the development of living nature which is contained in Michurin biology.

The Michurinist position contains a fundamental criticism of the idealism and mechanism in bourgeois biology; and this criticism involves the disclosure of the idealism contained in the mechanism of genetics.

"Morgan-Mendelism", said Lysenko, "endows the postulated mythical hereditary substance with an indefinite variation property. Mutations, i.e. changes of the hereditary substance, are supposed to have no definite tendency. . . . The Morgan-Mendelists, who proclaim that hereditary alterations or mutations, as they are called, are indefinite, presume that such alterations cannot as a matter of principle be predicted. We have here a peculiar conception of unknowability; its name is idealism in biology."[2]

[1] *ibid,* p. 38.

[2] *ibid,* p. 26.

In bourgeois genetics, idealism, which expresses itself through the medium of mechanistic conceptions, takes its most typical modern form as a doctrine of limitation and unknowability.

DIALECTICS AND PHYSICS

IN THE case of physics. it cannot be said that a dialectical materialist trend in physics has yet clearly emerged in opposition to the mechanism and formalism of bourgeois physics. Such a trend will emerge, not simply from the criticism of existing physical theory and the interpretation of existing experimental data, but as a new discovery in physics, arising from the pressing forward of physical research with the aim of mastering the forces of nature in the service of mankind.

Commenting on the existing state of bourgeois theory in physics, Lenin wrote: "The physical idealism of today merely means that one school of natural scientists in one branch of natural science has slid into a reactionary philosophy, being unable to rise directly from metaphysical materialism to dialectical materialism. . . . Modern physics is in travail; it is giving birth to dialectical materialism. The process of childbirth 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."[1]

Dirac, uncomfortably aware of the unsatisfactory character of the "dead products" of bourgeoise physical theory, writes that "it is quite unnecessary that any satisfying description of the whole course of the phenomena should be given."[2] What does he mean by a "satisfying description"? It is quite evident that he means a description in classical mechanist terms, which assigns the ultimate components of the physical world and then accounts for physical phenomena in terms of the mechanical interactions of these components. But classical mechanics has broken down. Therefore Dirac and other physicists conclude that "we cannot form a mental picture" of the real physical world "without introducing irrelevancies".[3] They despair of

[1] Lenin, *Selected Works*, Vol. XI, p. 365.

[2] Dirac, *Quantum Mechanics*, p. 7.

[3] *ibid*, p. vi.

producing any physical theory, and take refuge in a formalism, the aim of which is merely to work out mathematical formulae which will enable them to predict the probabilities of observations. But this does not stop other physicists, and even the formalists themselves on occasion, continuing to seek for the ultimate components of the physical world and arguing whether these components are waves or particles or a mixture of both.

For dialectical materialism, the task of physical theory cannot be to write down the ultimate, irreducible physical components of the universe. Nor is it to work out a mathematical formalism which leaves the nature of the physical world shrouded in mystery. *For dialectical materialism the task of physical theory is to disclose and work out the basic contradictions underlying physical processes, and to show how the various factors which determine the course of physical processes operate on the basis of these contradictions. And this task cannot be achieved simply by philosophical discussion about physics, but only in the course of actual physical research.*

Here it may be noted that there are "dialecticians" who already rejoice in the fact that physical theory has involved itself in "contradictions". Physical theory teaches that an electron, for example, is a particle, and it also teaches that an electron is not a particle but a system of waves. Some physicists say that a particle is really a wave-packet, others say that a wave is merely the expression of the aggregate motion of many particles. The whole theory is a muddle, a contradiction.

But "dialecticians" then come forward and say that all is just as it should be: an electron is a particle, and it is also not a particle but a wave—there is the "dialectical contradiction" in physics.

If this were a dialectical contradiction, then one would only have to make self-contradictory statements to be a dialectician. This is a simple logical contradiction between contradictory propositions, of the sort that was analysed more than two thousand years ago by Aristotle. Aristotle taught that if a theory contains logical contradictions then that theory cannot be accepted; and dialectical materialists agree with him. The contradictions in bourgeois physical theory are symptoms of the

profound crisis of that theory, not signs that it is becoming "dialectical".

The task of dialectics is not to accept the contradictory proposition that an electron is both a wave and a particle. Its task is to disclose the real dialectical contradiction in physical processes—the objective contradiction in the physical world, not a formal contradiction between propositions—and to show how the wave-like and particle-like properties manifested by electrons come into being on the basis of that real contradiction. This has not been done, but remains to be done. It is a question of physical research.

So far as bourgeois physical theory is concerned, some of its main difficulties centre around the theory of the atomic nucleus. The atomic nucleus constitutes, as it were, the central knot of contradictions of the physical world, just as the simple commodity constituted the central knot of contradictions in the sphere of economics. Bourgeois theory in physics is no more capable of understanding the nature of the atomic nucleus than bourgeois theory in economics was capable of understanding the nature of commodities.

LEVELS OF ORGANISATION OF MATTER

Among the most important of the applications of the conceptions of dialectics is that to the problem of the so-called levels of organisation of matter. The conception of levels is a conception of process, of development—of a historical chain of development from physical processes to chemical, from chemistry to living organisms, from life to consciousness and to the development of human society. Each level is the subject matter of a separate science, and exhibits its own typical objects and laws, which emerge with the emergence of that level and are investigated with the help of the methods and concepts of the appropriate science.

It is a concept of bourgeois science, which has been generated out of the development of bourgeois science and has been exhaustively treated by bourgeois philosophy. Needham, for instance, has stressed the role played by the concept of levels

in the philosophy of Herbert Spencer.[1] Again, the same concept looms large in the recent theories about "the unity of science" of the logical positivists.[2]

So we must not think that the existence of levels of organisation of matter is a discovery of dialectical materialism, nor that simply to recognise and talk about the levels of organisation of matter is to be a dialectical materialist.

The levels of organisation of matter present an insoluble problem to bourgeois science and bourgeois philosophy. And as usually happens, the bourgeois thinkers and investigators are torn between two alternative and opposite bourgeois approaches.

On the one hand are the mechanists, who pose the task of so-called "levelling down": they maintain that everything that happens can be reduced to happenings on the lower level, which implies that there is a bottom level—the level of physics—to which everything can be reduced, so that there is really nothing in the world except the types of processes studied by physics. This was expressed by the logical positivists, who said that all the statements of all the sciences could ideally be translated into "the language of physics".

On the other hand are the "emergent evolutionists" and the "holists", who say that each level presents something absolutely new, which is *inexplicable* in terms of the lower level.

What is first of all important is that in arguing against the one view we should not embrace the other. We do not, for example, fight the mechanists as comrades-in-arms of Field Marshal Smuts. Smuts says that an "organised whole" has some superior sort of being of its own, higher than that of its parts. The utterly reactionary character of this view is shown by the fact, amongst others, that it is used to justify the theory that the State has a mystical being of its own, above and beyond the individual—that the State is an "organic whole", with a life and even a consciousness of its own, to which the individuals are subordinated. This is a very useful theory for fascists.

[1] J. Needham, *Time, the Refreshing River*, p. 233 ff.

[2] See Carnap, *Logical Foundations of the Unity of Science.*

The problem of levels has not yet been exhaustively treated in all its aspects by dialectical materialists; and, indeed, such a treatment is bound up with the further development of the various sciences themselves.

Of fundamental importance is it to realise that a new level is not something which mysteriously appears when a new sort of " organised whole ", with new qualities as a whole, is formed out of the aggregation of objects belonging to a lower level. According to some of those who talk about levels, objects can come together and interact as a " mere aggregate "; but on the other hand, to the mere aggregation of objects there may be added something extra—and how it is added appears inexplicable—namely, special " organising relations ", as a result of which an aggregation of objects becomes an organised whole.

Thus Needham, for example, writes of the special " organising relations " which it is the business of biology to study. He poses the task of studying the causal sequence whereby the higher organisation of the fully-formed organism arises from the lower organisation of the zygote—and, presumably, whereby the higher organisation of living matter arises from the lower organisation of non-living matter: but he appears to hold out few hopes of solving this task.[1]

This view of organisation—of special, higher-level organised wholes, arising from the appearance of special organising relations which impose themselves upon objects—rests upon the tacit acceptance of a mechanist view of matter. The material world is thought to consist of discrete objects in interaction: special organising relations controlling that interaction are then introduced to account for the so-called levels of organisation which emerge in the course of the historical development of matter. As so often happens, mechanist and idealist views here go hand in hand: mechanism gives rise to idealism, idealism makes use of mechanism.

But new levels primarily mean—not the organisation of the basic particles of matter into new " organised wholes "—but *new forms of movement of matter, which manifest themselves*

[1] Needham, *Biochemistry and Morphogenesis.*

in new qualities, new kinds of objects and new potentialities of movement. If, indeed, we talked about the ascending scale of the movement of matter rather than about the ascending scale of " levels ", such a terminology might be less confusing.

And this postulates that *the transition to the new form of movement can be demonstrated as arising from the previous form of movement.* We can find an example of such a demonstration in that sphere where the dialectical materialist method has been most consistently applied, namely, the materialist conception of history.

For Marxism, human society and its laws of development is an emergent. But Marxism does not regard the emergence of human society, with the new laws of development, new objects, new qualities which it involves, as in any way inexplicable. On the contrary, it seeks to demonstrate how human society came into being, and how its laws of development came into being and began to operate, when ape-like creatures began to stand upright, evolved human hands and brains, and began to co-operate in the use of tools. There is nothing in this transition which is in principle mysterious from the point of view of biology. But it constitutes the transition from ape to man and the emergence of human society.

And man henceforward can no longer be studied purely from the standpoint of biology. The movement of human society does not consist of anything but the activities of the individual men and women who belong to it. But it is a new form of movement, exhibiting new laws of motion and new qualities. And the individuals taking part in this movement become not simply human animals, a particular species which can be studied biologically, but social beings, with attributes of a special kind which transcend the field of biology—masters and slaves, capitalists and workers, and so on. Moreover, at a certain stage the products of human labour acquire special attributes and become commodities; and natural objects, like bits of metal and pieces of paper, become money and means of exchange and credit. All this is perfectly explicable. We can follow stage by stage the process whereby it all happened.

Moreover, when the higher form of movement is generated, it is built out of the lower forms, as it were, and contains them within itself; the objects which are drawn into the new movement acquire thereby new properties but retain their characteristics as participants in the lower movement; the higher form of movement contains the lower within itself and contradicts it, so that we may speak of a dialectical interpenetration and struggle of levels or of forms of movement of matter.

For example, the growth of the shell of a mollusc or the skeleton of a mammal, in the course of which the form of the shell or skeleton arises, depends on the mechanical properties of shell and bone. The mechanical, physical, and chemical properties of matter manifest themselves throughout the entire movement of living matter.[1] And the understanding of this is essential for the understanding of the higher form of movement as a whole. Medicine could not get far in the understanding and treatment of the processes of digestion, for example, if it did not investigate the chemistry of the process; at the same time, it needs to investigate such a process as digestion, not exclusively as a chemical process, but as a part of the new movement characteristic of the living organism.[2]

In general, *the more completely we can demonstrate how the higher form of movement was generated out of the lower forms of movement, how it contains those forms within itself but at the same time manifests new qualities and laws of motion, the more complete is our scientific understanding of the higher form of movement, and the greater is our power to control and regulate that movement in ways which we desire.*

A statement by Academician Perov, in the recent Soviet biological discussion, has a bearing on the problem of the dialectical understanding of "levels". He said:

"Science is already able to control life, can control living and dead protein. But science cannot yet say definitely what

[1] Cp. D'Arcy Thompson, *Growth and Form.*

[2] This was a fundamental feature of Pavlov's work on digestion, for example, in which Pavlov revealed the fact that he was anything but a mechanist, although he is often treated as one by vulgarisers of his work.

protein is, or what life is, as to the derivation of it. Why? Engels in his day put it excellently when he said that 'in order to gain an exhaustive knowledge of what life is, we should have to go through all the forms in which it appears, from the lowest up to the highest.' Consequently, in order to understand and learn what protein is, it is also necessary to go through all the forms of manifestation, from the lowest to the highest. And for this we need experiment, experiment, and again experiment."[1]

This statement expresses confidence in *the possibility of scientific understanding of the nature of the phenomena at every level by the disclosure of the dialectical movement characteristic of every stage, and by the derivation of the higher form of movement from the lower.*

The "problem of levels" is to be solved, and is only to be solved, by demonstrating, at each "level", how the new form of movement comes into being and what are its properties.

SCIENCE IN THE STRUGGLE FOR SOCIALISM

IN CONCLUSION, dialectical materialism is a world view and a method, which has its basis in the discoveries of the sciences, and which generalises and carries forward the discoveries of the sciences in the light of the new, creative ideology which expresses the experience and aims of the working-class struggle. This world view and method, which needs to be continually enriched and extended with the advance of the sciences, is a powerful weapon of science—a weapon of criticism, a method leading to new and profound discoveries, and a guide to the grand strategy of the planned advance of science in the service of the people.

In the capitalist world, the scientists are captives of monopoly capitalism—in their work, in so far as it is dictated and directed by the interests of the monopolies; and in their outlook, which is bounded by bourgeois mechanism and idealism, and which is content with the reduction of science to an aggregate of specialised studies.

The task of mastering and using materialist dialectics in

[1] *Situation in Biological Science,* p. 149. The quotation from Engels is from *Anti-Duhring,* p. 96.

science is a part of the class struggle. It is a front of the people's struggle against monopoly capitalism and for peace and socialism. In exposing the limitations and distortions, practical and theoretical, which science suffers under capitalist conditions, Marxists call upon scientists to join in this struggle, in order to build the new, socialist science which will carry forward the achievements of the past to new heights in the service of the people.

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