EPISTEMOLOGY IN TRADITIONAL PHILOSOPHY AND CONTEMPORARY PHILOSPHY OF SCIENCE

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An Introduction

(1)

The problem to which this dissertation is devoted can hardly be called new. It had already been posed in antiquity. However, in spite of the fact that attempts to solve it have given rise to a voluminous literature, one can say that the results achieved have not given a satisfactory answer to it. The problem has remained topical to the present day. Not only has interest in epistemology (theory or knowledge) not diminished in recent times but there has been a tendency, on the contrary, for it to mount, evoking lively discussions among both philosophers concerned with theory of knowledge and scientists concerned with the philosophy of science.

(2)

The dawn of natural philosophy, which is to say, of science, was marked, from the standpoint of epistemology, by a fascination with disparities between appearance and reality, disparities between what seemed, given one's beliefs and some observations, to be true, but what, given other beliefs and observations, seemed to be false. Early philosophers were moved to suspect that low things appearance may be the outcome of a deeper reality, hidden from view, and radically different from that apprehended in observation. Their reflections on the nature o substance, change, motion, and so forth, give rise to bold theories about the deeper reality and about why it was not immediately perceived. Thus, historically, the ancient Greek philosopher Democritus (460-370 B.C.), for instance, claimed that the reality underlying appearance consisted of nothing but atoms and void. The atoms, he hypothesized, hooked together in assorted ways, and differences in the shapes and collective organization, of the fundamental atoms. Human beings, like everything else in the universe, were at bottom just organized assemblies of atoms, although the organization was neither understood nor assumed simple. The human mind, as the organ of cognition, therefore, was conceived as being fundamentally material, and its remarkable capacities were the functions of the remarkable organization of matter.

That was one of the ancient forms of early epistemology. The other was that of Plato (429-347 **B**.C.). Plato thought that Reality was not to be found in the physical world (the world of sensibilia) at all but rather in the non-physical world of the intelligibilia: the non-physical objects of thought. Only by turning away from the sensible world and by contemplating the non-physical objects of intellection could true or real understanding be achieved. This means that interaction with the physical world might yield opinions or mere beliefs, but it could never yield knowledge of Reality. Pure contemplation was, therefore, the proper occupation of the Mind (the self, the soul), the non-physical substance capable of existence independent of the physical body.

(3)

Epistemology (Gnoseology) or the theory of knowledge is a department of philosophy concerned with the relation of the subject and the object in the process of the human cognitive activity, the possibility of the cognition of the world, the relation of knowledge to reality, the criteria of truth, and the authenticity of knowledge. In other words, epistemology studies the essence of the human cognitive attitude towards the world. Therefore, any epistemological approach inevitably proceeds from a definite solution of the Fundamental Problem of Philosophy: (the question of the relationship of the Consciousness to Being, of thought to matter – matter is examined, epistemologically, on two planes: what is primary mind or matter, and how is the knowledge of the surrounding world related to the world itself, or, to put it differently, does Consciousness correspond to Being; is it capable of truthfully reflecting the reality.

(4)

The problem of epistemology, as already stated, arose with philosophy itself. In Greek philosophy the analysis of the nature of knowledge began with Democritus and Plato. However, one can say that some kind of cognition began presumably as soon as human beings appeared on the Earth. Of the pre-historic method of cognition knowledge was vague and speculative. But we know a good deal about different methods that have been used in the remote history of mankind. We know, for instance, that the methods which now control science are of comparatively recent origin in both mathematics and natural sciences. We also know that different methods have been not only tried, but they have been tried out, that is, tested.

Earlier methods failed in some important respects. In consequence of this failure, some of them were modified as that more dependable results were secured. Speaking in general terms, earlier methods yielded conclusions that could not stand the strain put upon them by further investigation. It is not merely that conclusions were found to be inadequate or false but that they were found to be so because of the inadequate methods employed. Other methods of cognition were found to be such that persistence in them not only produced conclusions that stood the strain of further inquiry but that tended to be self-rectifying. They were methods that improved with and by use. In other words, the developing course of natural science presents us with an immanent criticism of the methods previously tried.

Chapter One
Epistemology in Traditional Philosophy

A: Preliminary Remarks
B: Rationalism versus Empiricism
C: Concluding Remarks

A: Preliminary Remarks:

Philosophy is the sole field of knowledge in which agreement among its leading spokesmen is the exception rather than the rule. In science the area of disagreement is a comparatively small part of the vast territory already mastered, in which peace and harmony seemingly reign, whoever studies science to some extent lacks choice; he assimilates the established scientific truths that will, of course, be refined, supplemented and sometimes revised and discarded. It is not so in philosophy, in which there is a host of doctrines each of which, as a rule, has not only historical justification but also a certain actual sense. In philosophy one has to choose, to sock oneself in a specific atmosphere of philosophical thinking, by nature polemical, so as to find one's point of view, refuting all others that are incompatible with it. There is not in our contemporary situation an authoritatively accepted body of doctrines called "philosophy" for which duly accredited spokesmen can pretend to speak. There are philosophies and philosophers, and they differ philosophically on just the issues with which they are called upon to deal. But a search of that kind presupposes the study of the whole variety of philosophical doctrines, a condition that is obviously not practical.

The history of science enables one to say that the existence of absolute antithesis is, epistemologically, excluded, at least within the context of the existing scientific knowledge at a particular period of time; new scientific truths do not always refute completely "old" ones. They make them more precise, concretize and supplement them, taking them into a system of more profound scientific notion. Theories whose correctness has been established experimentally for any field of physical phenomena are not always completely eliminated as something false when new, more general theories appear, but retain their significance for the former domain of phenomena, as a limiting form and partial case of the new theories.

B: Rationalism versus Empiricism:

(1)

Traditional or classical philosophy long ago single out two elements that make up cognition. They were the Rationalist and the Empiricist.

Plato's epistemology was a theory of recollection, according to which, one knew because the human soul turned away from the sense-perceived world and forgot its perishable earthly life so as, having concentrated, to immerse itself in itself and discover precisely in itself the knowledge that it was impossible to acquire in the world of things. He, therefore, called for a stopping of the ears and closing of the eyes; only by tearing loose from nature, did the soul get back to itself from the world of alienated existence. And then it was faced not with things, but with the ideas of things, the transcendent primary essence that it had contemplated before its fall, i.e. its incarnation in the human body.

Plato attributed a mystical sense to the ordinary notion of the human memory (everyone knows that it means to remember); during remembering, from Plato's standpoint, the soul mentally returned to its transcendent primary source.

Rationalism, in its most general form, is a teaching in the theory of knowledge (epistemology) according to which universality and necessity – the logical attribute of true knowledge, cannot be deduced from experience and its generalizations; they must be deduced only from the human mind itself; either from concepts innate in the mind (according to the theory of innate ideas assumed by Descartes) or from the acquired by the mind itself. (In this sense Rationalism is in opposition to Empiricism). Subsequently, Rationalism was an attempt in epistemology to account for the logical peculiarities of mathematical truths and "mathematical" natural sciences. Its main representatives in the 17th century, for instance, were Spinoza (1632-1677) and Leibniz (1646-1716) and in the 18th century, Kant (1774-1804), Fichte (1762-1814), Schelling (1775-1854) and Hegel (1770-1831).

(2)

Empiricism is a philosophical tendency in the theory of knowledge which holds that the human sense organs and the sensory experience are the only source of knowledge. It affirms that all knowledge is founded on experience and is obtained through experience.

The nature of the human knowledge, the principles governing the acquisition and accumulation of knowledge, its limitations, and its logic were the topics of inquiry for the classical Empiricism. The history of philosophy remembers especially John Locke (1632-1704) and David Hume (1711-1776) in the eighteenth century, and James Mill (1775-1835) and John Stuart Mill (1806-1873) in the nineteenth century. (To be sure they did not speak with one voice, but highly simplified, the central thesis of their approach was that there are two kinds of things that we can know about: the nature of the empirical world-matters of facts –, on one the one hand, and the relations between ideas-matter of logic – on the other hand).

Empiricism is originally connected with Sensationalism (Sensationism): a doctrine in epistemology which considers sensations as the sole source of knowledge.

Empiricism is, historically, associated with John Locke. In his major work *Essays Concerning Human Understanding* he developed the theory of knowledge from the standpoint of Empiricism. Rejecting the doctrine of innate ideas (concepts which, according to Rationalism, are primordially inherent in the human mind and are independent of experience; they include axioms in mathematics and logic).

Locke regards experience to be the sole source of all ideas. Through the ideas and sensations we apprehend in things either primary or secondary qualities. (By primary or objective properties Locke meant notions, impenetrability, solidarity, cohesion of particles, shape, volume, etc. Secondary or subjective qualities were colour, smell, taste, sound). Ideas, acquired through experience, are only the material of knowledge, not knowledge itself. To become knowledge the material of ideas must undergo the process of reasoning, which forms both sensation and reflection. Through this activity simple ideas are transformed into complex ones.

C: Concluding Remarks:

In traditional or classical philosophy, the main trends in epistemology are, as already briefly stated, Rationalism and Empiricism. The relation of the sensual and the rational aspects of understanding has been the main philosophical issues from the time of Plato. Philosophers have been investigating the difference between the mentally comprehended (nomenon) and what is comprehended by sensations (phenomenon), a difference they reduce to opposition. Classical (traditional) philosophy drew a more or less clear line between sensations and reason. But difficulties arose when explaining the connection between these two aspects of the human cognitive activity which led to the formation of the rival conceptions that found expression in centuries – long confrontation of Rationalism and Empiricism. Discussions developed, in particular, on the source of knowledge that every individual person and humankind as a whole disposed of by the course of knowledge, moreover, was understood that human cognitive capabilities that enabled the human being to obtain knowledge about the external world and themselves. On the other hand, it seemed natural that our knowledge of anything could not emerge on our head unless we had the power to sensually perceive a phenomenon about which we know something. How can it be claimed that we really know something if we have never seen this "something" anywhere? Have heard nothing about it? Have not perceive it? Have not experienced grief or joy from it? And so on? However, there is also the undoubted fact that our mind has facts about sensually unperceived objects. People have mentally employed fantastic images of, for instance, centaurs, goblins, local and universal gods, etc, from immemorial. Works of art and literature would be impossible without invented characters. Idealized objects that do not exist in reality and therefore cannot be sensually perceived as independent of our mind, were widely employed in science (for example, in mathematics) long before the appearance of modern science.

Sensory knowledge operates usually with visual images that arise as a result of direct or immediate observation. It is ultimately some sort of aggregate of the sense data (sensation: sensibilia): unique, concrete character on both the peculiarities of the concretely observed objects and those of the structure of the observing subject's sensory apparatus.

Rational knowledge, on the contrary, operates with concepts (universals) that have a general character. Operations with concepts follow definite rules that do not depend on the will of on e individual (individualism). It is mediated by a system of signs (language).

Chapter Two

Epistemology in Contemporary Philosophy of Science

A: Introductory Remarks
B: Epistemology from the Standpoint of Modern Physics: Relativity and Quantum Mechanics.
C: The Epistemological Aspect of Neurosciences: Neuropsychology and the Mind-body Problem

A: Introductory Remarks:

(1)

In order to grasp the epistemological aspect of contemporary philosophy of science one has to remember that science is dynamic, processual, and historical. What scientists do now will (perhaps) in the future become a child's play; the character, content, and meaning of science change.

Modern science is, epistemologically, a multi-dimensional phenomenon with numerous aspects. The cognitive complexes forming it are extremely polymorphous and belong to different levels. Modern science is a broad association of mathematical, natural, scientific, technical, and human branches of "disciplinary" and "inter-disciplinary" studies, highly specialized and complex sub-divisions functioning as discrete units of Rational (theoretical) and Empirical (applied) kinds of knowledge.

The sphere of non-science is wide and heterogeneous: (including the non-scientific forms of the process of cognition – traditional or classical epistemology).

(2)

The interrelation between that which science gives and that which it takes away may be clearly imagined with the aid of the following parable. A certain merchant, let us say, has one thousand coins which he assumes to be made of gold. One day a wanderer, the "legendry guest", experienced and generous, arrives at the home of the merchant. The wanderer is able, first, to distinguish authentic gold coins from counterfeit, and secondly, to produce artificial gold. Having looked over the merchant's wealth the wanderer informs him that of the thousand coins only five are in fact true gold, the remainder ones are counterfeit. Being not only experienced but also of a generous cast of mind the wanderer produces and presents as a gift to the merchant yet another five authentic gold coins (he is not capable of more).

Did the real wealth of the merchant increase? Undoubtedly. To be exact, it doubled. Previously, the merchant was in possession of only five authentic gold coins, now he has ten. But it is also certain that previously the merchant felt himself to be 100 times richer. The wanderer, who has twice rendered a good deed to the merchant (one when he informed him that his wealth was unreal, and the other time, when he increased the real holdings of the merchant by five gold coins), has also impoverished him, for the fictive wealth of the merchant has in his mind been completely real. It gave him a consciousness of his own strength and power, and tempted him to embark upon risky undertakings, to be persistent in his claims.

This means that the scale of the dispelled illusions always exceeds that of certainties, on the one hand, and that real possibilities are offered by science at a given moment, on the other hand. Moreover, the "wrecking operations" carried on by science against existing pre-scientific knowledge (classical epistemology, for instance) vary directly with the significance of the creative and constructive contribution made by science to the human conception of the surrounding world. "Science is not and will never be a closed book," remarked Einstein[١]. "Every important advance brings new questions. Every development reveals, in the long run, new and deeper difficulties." On the other hand, as Einstein also remarked. "Science is not just a collection of unrelated facts. It is a creation of the human mind with its freely invented ideas and concepts. Physical theories try to form a picture and to establish its connection with the wide of sense impressions. Thus the only justification for our mental structure is whether and in what way our theories form such a link."[٢]

It is of interest to note here that lack of scientific knowledge of any phenomenon always ends, historically, in despising or else unreasonably admiration. When primitive people have no scientific knowledge of the surrounding world they either passively submitted for it or else sought to control it "magically". (The main principle of "magic" is found whenever it is hoped to get certain results without the scientific control of the means employed; and also when it is supposed that means can exist and yet remain inert and inoperative).

[1]- Einstein, A. and Leopold Infeld. *The Evolution of Physics*. Simon and Schuster, New York,1942, p.308.
[2]- Ibid, p. 310.

(3)

The revolution in natural science at the turn of the century helped to change the notion about science itself, dispelling the idea that it was a hard – and – fast system of knowledge containing in the final form the answer to the fundamental problems of man and his surrounding world. That kind of science ceased to be the ideal of cognition. The radical transformation of the concepts: matter, space and time, motion, outer space and the microcosm, the basic processes of the vital activity and the development of the organic world led to the idea of science as being in a constant revolution. The essence of the revolution in science consists, not only in the demolition of hitherto established concepts, theories, principles, and laws affecting a particular area of scientific knowledge but also a revolution in the scientists' thinking, in their overall mode of perceiving the world they study. Hence, it follows that the scientific revolution takes place in the field of thinking, i.e. , in the sphere of theoretical ideas, generalizations and explanations, but not in the sphere of purely empirical discoveries and observations, which are merely the premise for a revolution in science but do not as yet cognize such a revolution. For instance, the empirical discovery of what came to be known as oxygen (its actual discovery in Nature) was not yet a revolution, and was fully interpretable from the position of phlogiston ideas. It was only after Lavoisier, on the basis of a correct theoretical interpretation of the discovery, demolished the phlogiston theory to its very foundations that a revolution took place in chemistry at the end of the 18^{th} century. In exactly the same way, the empirical discovery in physics since it could be reconciled with the idea that the atom was something constant and indestructible. It became a revolution only after Rutherford and Soddy, in the early 20^{th} century, brought forward an explanation of radioactivity as spontaneous atomic decay, as a transformation of elements. Again, the phenomenon of nuclear fission, which was observed in 1934-1938, could be and was explained as a simple consequence of the formation of transurania, which meant that it was in full accord with the previously existing ideas, without yet leading up to any particular revolution. It was only in 1939, when Hahn and Strassmann advanced a theoretical explanation of that phenomenon as fission of the nucleus, that a new stage of revolution began in the 20^{th} century physics.

Each of these discoveries was not only revolutionary in content but also brought about and embodied a revolution in philosophy of science since it demolished the entire system of previously held ideas, the entire mode of scientific thinking. In other words, there was a complete breakdown followed by a restructuring of the mode of perceiving and explaining the world studied by science. Therefore, we are here dealing with different instanced of revolution in science, all of them, epistemologically, being varieties of one and the same type of scientific revolution. In all these instances, the revolution in science consisted in a thorough demolition of a given mode or system of scientific philosophy.

Any revolution in science pursues two main objects and possesses two main functions which it sets about accomplishing sometimes simultaneously in their interaction, and sometimes consecutively. The first task of the revolution in science (its first function or first phase) is negative, destructive in character: there exists a necessity for the revolutionary overthrow, i.e., in a decisive fashion, down to its very foundations – of the entire system of the old concepts, theories, principles and laws; and simultaneously and principally, of the entire previously existing system of the scientific outlook. The second task of the revolution in science (its second function or phase) is fundamental and decisive, positive and creative in character: the need exists for the revolution, substantiation and establishment of a system of new concepts, theories, principles, and laws in science, and together with that and most important, a new scientific approach (outlook, philosophy).

(4)

Mathematics has by right won a leading place in the contemporary cognition of the natural world. It is now hard to find a field of knowledge where mathematical methods and research approaches are not used in one way or another. Mathematics has been spreading to ever new fields of knowledge, and intensively penetrating ever deeper into the "secret recesses" of natural sciences, helping them to solve problems which had once appeared to defy solution. It is safe to say that mathematics is now becoming one of the powerful instruments which help to integrate into a single whole the great range of knowledge in all its diversity.

Why is the expansion of mathematics in science so all-embracing? Why has mathematics become a most important instrument of its integration? Only a philosophical analysis of the problem will provide the answer. This is most clearly manifested in the philosophical view of mathematical logic and its relation to epistemology. This is highly important because mathematical logic, being logic in subject-matter and mathematics in method, exerts a tremendous influence on generalizing ideas, concepts, and the language of mathematics itself, and on the cognitive functions of the other sciences.

Mathematics is able to structure its concepts not only by abstracting itself from the properties of real things, but also through further abstraction from its own concepts. This type of abstraction (abstraction of identification) makes it possible to carry on mathematical research in breadth and depth and to make discoveries in isolation from experiment and practice. For example, electromagnetic waves were initially "deduced" from electro-magnetic field equations, while theoretical mechanics was established through the interpretation of a small number of axioms. Because of this, mathematics can "ignore" and frequently does "ignore" empirical proof, even if this appears to refute its conclusions. Because of the great precision of its proof, mathematics now and again throws a different light on well-known phenomena, things their properties and relations, in defiance of the empirical common sense. What is more, because of this, it is able to describe existing but still unknown phenomena and things or, non existent ones the probability of whose existence cannot be ruled out in the future.

Philosophy had truly investigated many of the functions of mathematics, providing powerful stimuli for their development. Thus, philosophy has helped mathematics to make theoretico-cognitive function scrupulously complete and mobile, while the discovery of the organic interconnection between quantity-quality has turned the ordinary function of computation into a powerful instrument for the cognition of the inner nature, the substance of material things and phenomena.

Physics is known to have been most vigorously subjected to mathematics. The start of this process was made at the end of the 17^{th} and the beginning of the 18^{th} century, when Newton wrote his classical works. Since then the mathematization of physics has gone forward unabated. Physics has benefited and continues to derive much benefit from its intercourse with mathematics. The language of mathematics helped it to formulate many scientific laws as a basis for predicting the course of events in nature (equations of celestial mechanics, for instance, make it possible to anticipate the behavior of celestial bodies), to determine new and unknown phenomena (the discovery of Neptune, the prediction of the existence of antiparticles, etc), and to carry out stringent verification and sorting out of a large number of hypotheses.

(5)

The theory of relativity and quantum mechanics that become the cornerstones of modern, or non-classical, physics, were arrived at by the royal road of the development of physical science in the 20th century. These are the fundamental theories of science. They are not reducible to the concepts and principles of the theory of previously existing classical physics, although they are linked with the latter. This was first clearly expressed in the language of Einstein's theory of relativity (we mean the spatial and general relativity theories completed some time in the late 1910s) and, somewhat later, in the concepts and principles of quantum mechanics (completed in the late 1920s) largely founded by Neils Bohr.

The scientific revolution that yielded the non-classical physics is radically different in its complexion and cognitive results from the revolution that produced the classical, fundamentally, mechanist physics. For modern physics, it is essential not merely to find the laws of phenomena in certain material system or area of interconnections: it is extremely important to find the laws of transition from laws governing a certain set of phenomena to the more profound and general laws of a new and more extensive set of phenomena (and that task arises in some form of other at a certain stage in the development of physics).

In creating the relativity theory, Einstein laid the basis for a new concept of the foundations of physics, quite different from the time of Newton and up to the last century. It was the relativity theory that had seemed so self-obvious before Einstein. The very emergence of this theory at the borderline between the classical mechanics and classical electrodynamics, which resulted from Einstein's solution of the contradictions between them, is a magnificent of the creativity of the human mind.

"We have two realities: matter and field. From the relativity theory we know that matter represents vast scores of energy and that energy represents matter. We cannot, in this way, distinguish qualitatively between matter and field, since the distinction between mass and energy is not a qualitative one. By far the greater part of energy is concentrated in matter, but the field surrounding the particle also represents energy, though in an incomparably small quantity. We could therefore say: matter is where the concentration of energy is great, field is where the concentration of energy is small. But if this is the case, than the difference between matter and field is a quantitative rather than a qualitative one. There is no sense in regarding matter and field as two qualities quite different from each other. There would be no place, in our new physics, for both field and matter, field being the only reality. The theory of relativity stresses the importance of the field concept in physics"[١].

"A new concept in physics, the most important invention since Newton's time: the field. It needed great scientific imagination to realize that it is not the charges nor the particles but the field in the space between the charges and the particles which is essential for the description of the physical phenomena"[٢].

[1]- Ibid, pp. 258-260.
[2] - Ibid, p.259.

The word "relativity" is used as a scarecrow to frighten away philosophers from critical assault upon "absolution". Dependence upon space-time connections now marks all the victories won by scientific inquiry. It is silly to suppose they terminate in mere particulars. On the contrary, they constantly move toward the general, provided only the generalizations have to do with wider connections, so as not to swim in wordy vacuity. And so it is with epistemology. No span of connections in space-time is too wide or too long provided they are relevant to judgment of the human thought. Not "relativity" but absolutism isolates and confines.

(6)

Quantum mechanics is based on the interpretation of matter in motion as both connected substance and field simultaneously possessing both corpuscular (discrete) and wave (continuum) properties. In quantum mechanics, the corpuscular and wave concept lose their "classical" independence. In accordance with the idea of the dual corpuscular-wave nature of the micro-objects, matter, that is substance and field, is not as ensemble of particles or waves in the sense of the classical physics, neither is it a combination of corpuscular and wave properties in some mechanical model. This conception accords with the fact that the motion of the micro-objects can in some cases be interpreted as the motion of the "classical" properties or propagation of the "classical" waves only as an approximation. There is a single experiment where the properties of micro-objects would be manifested precisely as the properties of a particle of those of wave studied by the classical physics. Only in the limiting cases do micro-objects behave as particles under some physical condition and as waves under others.

(7)

It is difficult to put into words the feeling in the presence of something titanic which envelopes one analyzing one of the most outstanding intellectual battles in the history of scientific knowledge – the Einstein-Bohr controversy on the problems of quantum mechanics. There have been scientific debates before and after it, but no one of them had the same far-reaching consequences and attracted such general attention.

How one to explain the special place which this debate occupies among other scientific debates? One reason certainly was that its subject was quantum theory, one of the most revolutionary physical theories in the entire history of knowledge. But this is not the only point. As a rule, discussions of the truth of theories ended when one of the theories was confirmed better than others and were immediately relegated to history. The Einstein-Bohr controversy, however, touched on the deepest aspects of the scientific cognition of the world and its basic principles. The scope and significance of this controversy are determined by the choice of the ways of development of scientific cognition implied in the controversy. The debate ranged over a number of interconnected problems: the general principles from which a concrete type of physical laws may be deduced as against obtaining these laws by generalization of experimental data; clarity and distinctness of knowledge as against its contractoriness; continuity of processes and discreteness of the world; universal causality and chance. All these problems are most intimately connected with a scientist's general world outlook, with epistemology. That is why the Einstein-Bohr controversy has not only special scientific but, in the first place, general philosophical content. The Einstein-Bohr controversy is thus not so much a conflict of the personal world-view of two most outstanding scientists of our times as a conflict of two fundamental conceptions each of which possesses certain inner integral quality and goes back to the traditions of the previous development of science.

(8)

Science is the most effective way enabling mankind to understand and benefit from nature. The scientific approach to problems is applied to questions ranging from the fundamental constitution of matter to the nature of the human being. Philosophy of science is multidisciplinary – including philosophers, historians, sociologists of science, and scientists themselves – and attempts to explicate the nature of science. Its goal to grasp and make explicit the process of scientific inquiry, perhaps – thereby improving the way science works, and helping its application to younger fields such as psychology.

Historically, Newton and Descartes, for instance, as practicing scientists wrote treatises on method, but it was not until after the scientific revolution at the present century and the success of science as an institution that a real need for a philosophy of science arose. In the nineteenth century, a philosophical movement called positivism arose, being itself squarely on a Newtonian concept of science, and seeking to extend the scientific method to social sciences. In the twentieth century, philosophy of science was started as a formal discipline by the Vienna circle of logical positivists. Their picture of science was a formal version of most people's picture of science. The scientist is a disinterested investigator whose extensive observations ultimately produce powerful mathematical-theories that slowly improve with each scientific generation. From their description of science, the positivist proposed prescriptions of what science should be like, and they were quite influential in philosophy and psychology. However, their explanation of science has proved inadequate.

(9)

Einstein, for instance, always had a great liking for philosophy in general and, of course, for the philosophy of modern science in particular. "The critical thinking of the physicist cannot possibly be restricted to the examination of the concepts of his own specific field", wrote Einstein in his *ideas and Opinions*[١]. On many occasions he emphasized that modern physicist cannot cope with its problems without philosophical knowledge. "The present difficulties of his science force the physicist to come to grips with the philosophical problems to a greater degree than was the case with the earlier generations"[٢].

Apart from other problems, Einstein was interested in epistemological ones like the following: "What knowledge in pure thought is able to supply independently of sense perception? Is there any such knowledge? If not, what precisely is the relation between our knowledge and raw-material furnished by sense-impression?"[٣]

[1] - Einstein, A. *Ideas and Opinions.* Crown Publishers, New York. 1954, p. 290.
[2] - Einstein, A. Remarks on Bertrand Russell's Theory of Knowledge. In: P.A. Schilpp, editor, *The Philosophy of Bertrand Russell.* Northwestern, University, Evanston and Chicago. 1944, p.279.
[3] - Ibid.

It is important to note here that the transition from the classical (Newtonian) to modern physics and, much earlier, from the "natural philosophy" of antiquity and the Middle Ages to the classical physics, were scientific revolutions closely linked in contemporary philosophy of science. A revolution in physics (with reference to the natural science as a whole) is a transformation of its theoretical content which breaks up its established, that is an essemble of its principles and fundamental concepts, along with the customary methods of cognition and style of thinking, and establishes new foundations, new methods of cognition and a new style of thought.

Unlike antique and medieval philosophy, the philosophical cognition and the natural science of modern times rejected the idea of the immutable philosophical and scientific values rooted in common sense. Physics has become an experimental science; sense perception is combined in it with theoretical thinking.

The discovery and use of scientific reasoning by Galileo was one of the most important achievements in the history of human thought, and marks the real beginning of modern physics. This discovery taught us that intuitive conclusions based on immediate observation are not always to be trusted, for they sometimes lead to the wrong clews.

At the present time, on the other hand, abstract methods and the closely related "mathematization" of science become common. Experimental data are no longer characterized as common-sense notions but are rather interpreted by scientific theory featuring concepts that are remote from sensual governess both in their content and mutual relations. The apparatus and experimental tools without which profound knowledge of nature in the classical physics would be impossible enabling scientists to see atom in thought (with this regard, modern physics furnishes a wealth of data on elementary particles).

A critical analysis of the philosophy of operationism is of great importance for a deeper understanding of contemporary philosophy of science from the standpoint of Einstein and in the first place of his conception of the method of scientific cognition.

Operationism was worked out by Bridgman (1982-1961), an outstanding American scientist, specialist in high-pressure physics, awarded the Nobel Prize for studies in this field. Bridgman undertook an attempt to critically revise, from the position of operationism, the content of modern physics (in particular of Einstein's relativity theory) and its philosophical implications. (In 1949, Einstein and Bridgman were engaged in a controversy reflected in two articles published in the book: *Albert Einstein: Philosopher – Scientist*).[1]

The main epistemological problem tackled by operationalism is the definition of the content of physical concepts. Physics differs from mathematics in that the magnitudes of the equations of the physical theory are liked with the results of observations and experiments. Physics requires an empirical interpretation of its formalism. It is usually assumed that corresponding the physical concepts are the properties of the real physical objects established by the physical experiments. It is these properties that determine the content of the physical concepts.

Bridgman believes the solution outlined here to be unsatisfactory. In his view, the content of the physical concepts is not determined by the properties of things but rather by operations performed on these concepts.

Speaking in general terms, operationalism was directed, epistemologically, against the contemplative interpretation of the physical knowledge which underestimated the

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[1] -Einstein, A. Remarks Concerning the Essays Brought Together in this Cooperative Volume. In: Schilpp, P.A., editor, *Albert Einstein: Philosopher – Scientist*, Evanston, Illinois, 1949, pp. 333-335, 663-788.

role of measurements. However, operationalism itself did not yield a correct evaluation of the role of measurements in modern physics. In other words, the operationalist epistemological approach displays features not only of subjectivism but of empiricism as well. Rigid limitations imposed on the physical concepts used follow from it. If we are not in a position to indicate the operations in which a concepts is to be used the latter is empty, from the operationist viewpoint, and has to be excluded from physics. The consequences of applying this approach to the relativity theory are not hard to imagine. This theory, with its abstract mathematical formalism, contradicts the operationlist ideal of scientific knowledge, for many of its concepts are not directly connected with the physical operations.

Einstein believes that the hypothetical-deductive scheme of cognition to be the most adequate procedure for the purpose of physics in the field of epistemology. According to this scheme, theoretical principles are formulated first and then empirical consequences are drawn from them in a deductive manner, the basic theoretical principles being "free inventions" of the scientist's creative imagination. However, Einstein does not interpret the terms "free inventions" in the sense of subjective arbitrariness of the formulation of the theoretical principles. He explains that freedom in this case has a specific meaning. "The liberty of choice, however, is of special kind," wrote Einstein.[1] " It is not in any way similar to the liberty of the writer of fiction. Rather, it is similar to that of a man engaged in solving a well-designed word puzzle. He may, it is true, propose any word as the solution; but, there is only one word which really solves the puzzle in all its parts." This means that "freedom" is interpreted by Einstein mostly in the sense of anti-inductivism, as the possibility of formulating, on the purely logical grounds, theoretical principles that do not directly follow from experience. That was the kind of freedom that was manifested in the emergence of the general relativity theory.

Nevertheless, the hypothetical-deductive method in the Einstein version is unacceptable for operationalism. This method assumes the possibility of global empirical substantiation of the physical theory as a whole. According to Bridgman, however, that task consists in empirical verification of the logical elements of the theory – the concepts and the principles considered separately. Only this kind of epistemological analysis, Bridgman believes, can bring out the meaningfulness and the empirical substantiation of the physical theory. This means that Bridgman's desire for determining the epistemological destiny of each proposition of the physical theory by separate empirical verification and that abstract theoretical constructs that are not directly linked with experience are untenable. Following the logic of operationalism, these theoretical constructs would have to be completely excluded from the physical theory.

A clear manifestation of Bridgman epistemological empiricism is his negative attitude to the "idealized experiments." These experiments introduce, in his view, speculative elements in the solution of the problems of the observables, which is unacceptable in physics. "Idealized experiments" must therefore be banished from physics and replaced by the real, actually performed experiments, and the problem of the observables must be reformulated to satisfy the conditions of the latter. It is important to point out here that Bridgman connects the "idealized experiments" with the work of Einstein, mostly with his general theory of relativity. Indeed, Einstein widely used the method of the "idealized experiments" in the formulation of the general relativity theory, but this method is not characteristic of Einstein only. Its

[1] -Einstein, A. *ideas and Opinions*. Crown Publishers, New York. 1954, pp. 294-295.

employment goes back to the beginning of physics as a science. Even the first law of mechanics, the law of inertia, could not have been established without idealized experiments. At present, idealized experiments are employed not only in relative physics but also in quantum mechanics and elementary particles physics. It is hard to imagine the development of the physical cognition without them. It is highly important to mention here that the "idealized experiments" in themselves do not introduce a speculative element in the solution of the problem of the observable. On the contrary, they permit a more rigorous solution of that problem. It is on the basis of these idealized experiments that the concept of the observability in principle is introduced. In physics, an object is recognized as observable if it is measurable. Observability is thus identical with measurability. In many cases, however, what is important is not the actual measurability but the possibility of the measurement in principle. That means that we can ignore the technical difficulties of the procedure of measurement due to the imperfection of the instruments and the influence of other phenomena on the measured magnitude. This kind of abstraction is realized in the transition from a real to an idealized experiment is called observable in principle. Idealized experiments also make more precise the concept of the objects unobservable in principle, which must be excluded from theory. The objects unobservable in principle are divided into two classes: abstract theoretical constructs that have significance within science, and empirical objects. Theory forbids only those objects which are ascribed epistemological empirical status, not all objects unobservable in principle. Now, what are the objects of the former type? These are apparently objects that cannot be registered even in an idealized experiment, let alone an actual one. The impossibility of discovering them is due to the physical laws than technical difficulties. Idealized experiments thus permit an abstraction from all the technical details that interfere with the elucidation of the observability or non-observability of the empirical objects in principles and with the formulation of the following clear-cut criterion of the unobservability in principle: the admission of the reality of objects unobservable in principle contradicts the established physical principles and laws.

The solution of the problem of the observables in relativity theory both spatial and general does not make this theory a speculative scheme. On the contrary, relativistic physics, as distinct from the classical physics, offered a rigorous empirical definition of spatio-temporal concepts. Thus the spatial relativity theory revealed the physical meaning of the concept of simultaneity of events occurring in different places, which was believed to be intuitively clear in the classical physics and perceived in a purey subjective fashion. The general relativity theory implemented the transition from the abstract geometry to the physical geometry. Besides, the Einsteinian conception of the observables permitted to fundamentally exclude from physics the unobservable objects.

It would appear that Bridgman's empiricist principle would lead to a more "realistic" interpretation of physics as a natural science. In accordance with these principles, physics was to be freed from abstract theoretical constructions, generalizations which go beyond the framework of experience, as well as any ideas which have no direct empirical substantiation. All of this would have certainly narrowed down physics, reducing it to the status of mere phenomenological description, a kind of catalogue of facts. To make up for that, physics would retain absolutely "reliable" truths offering objective conceptions of the physical world. This type of revision of physics from the empiricist position is, generally speaking, logically permissible. But Bridgman's empiricism does not contribute to a greater objective value of the physical knowledge but, on the contrary, introduces elements of subjectivism in their interpretation.

Two circumstances condition Bridgman's subjectivist interpretation of the physical science. The first is the operationalist interpretation of the content of the physical concepts. As we have already pointed out, Bridgman opposed the epistemological theory of concepts, according to which the latter have referents in the objective world, the content of concepts is determined by our operations on them rather than by the properties of things in the objective world. Concepts in this case diverse from objects and are closed in themselves. On the whole, one can understand Bridgman motive for emphasizing the role of the operational elements in the formation of the content of concepts. He opposes the naïve contemplative interpretation of the relation of the physical knowledge to its objects. That is clear from the following argument, for instance. "Property" is an invented concepts, defined itself by the property that things have properties in and of themselves, independent of what we do or think. But it is always dangerous to define concepts by their properties, and in this case we have obviously attempted the impossible, for we have neglected to remember that 'property' must find its meaning in operations."[١]

This passage combines Bridgman's dislike for naïve contemplative interpretation of the physical concepts and his subjectivism. We certainly cannot say anything about the properties of the physical world outside of the operations, their actual measurement and theoretical description. These operations impose an imprint in the content of concepts. Bridgman is quite right in this respect. Moreover, he should be given credit for drawing the attention of physicists to the role of the operational elements in the formation of the content of concepts. It would be a mistake to assert, however, that the properties of things are created by operations. The experimenter's instrumental operations do not create the properties of the physical objects, they only facilitate their manifestation.

Second, Bridgman's subjunctivism is also manifested in his constant stress on the individual element in the scientific activity, in rejecting the general validity and social character of science. "There is no escaping the fact that it is I who have the experiences that I am trying to coordinate into a physical theory, and that I must be the ultimate centre of any account which I can give… It seems to me that to attempt to minimize this fact constitutes an almost willful refusal to accept the obvious structure of experience."[٢]

In developing his conception of the individual quality of the scientific activity, Bridgman comes to reject the fact that science studies objective laws which have general validity for researchers. He criticizes the standpoint of Einstein, who postulated the existence of general physical laws expressible in convenient forms outside the human mind.

Summing up: The value of science lies in providing objective knowledge of the world that is not reducible to the personal viewpoint, to the individual scientist. The fact that Einstein emphasized this point shows the strength of his epistemological position rather than its weakness. Einstein believed that physical objects could be cognized more or less "speculatively", through the construction of a corresponding mathematical model whose correctness could only be proved after the fact, by the verification of the empirical consequences which follow from the theoretical description.

[1] -Bridgman, P.W. *The Nature of Physical Theory*. Princeton University Press. 1936, p.43.
[2] - Ibid, p.83.

Einstein views of the essence of the physical cognition and of the methods of the empirical substantiation of the physical theories are undoubtedly superior to Bridgman's operationalism.

C: The Epistemological Aspect of Neurosciences: Neuropsychology and the Mind-Body Problem.

(1)

The older dualism in epistemology between sensation and idea is repeated in the dualism between the empirical and the rational. It is, historically based on the dualism of the mind and the body. It seems safe to say that one does not know of anything disastrously affected by the tradition of the separation and isolation as is this particular theme of mind-body. The dualism in question is so deep-seated that it has affected even our language. We have no word by which to name mind-body in a unified wholeness of operation. For if we said "human life" few would recognize that it is precisely the unity of mind and body in action to which we were referring. Consequently, when we discuss the matter, when we talk of the relations of mind and body and endeavor to establish their unity in human conduct, we still speak of mind and body and thus unconsciously perpetuate the very division we are striving to deny.

(2)

Sherrington's classic work *The Integrative Action of the Nervous System* marks an epoch in the development of science. What is it which the action of the nervous system integrates? Clearly not its own self, but the behavior of the entire organism of which it is a part.

To satisfy the condition of neurology and psychology the term neuropshchology was coined in 1950s. it is scarcely necessary at the present time to convince psychologists and philosophers that the brain is the organ of the psychological processes (sensations, perception, conception) and the agent that integrates the rational and the empirical aspects of the human cognition. This means that all psychological phenomena must be studied in conjunction with the neurophysiological processes. But what does it mean to study them in conjunction? From the standpoint of neuropsychology, the neurophysiological processes are the "performing" mechanism of the psychological functions taking place in the human brain. Consequently, there is no mind-body dualism as well as no opposition between the two aspects of cognition – the rational and empirical in epistemology.

Whereas the empiricists in their epistemological approach unjustifiably exaggerate the role of the sensory reflection of reality, the representatives of older school of philosophic thought known as rationalism one-sidedly exaggerate and absolutes the role of "reason in cognition. In other words, in opposition to the sensory cognition of the empiricists the rationalists advanced" the "supersensory" intellectual contemplation. Both ignore the organic unity of the three fundamental elements (factors) in epistemology; sensations, perceptions and theoretical cognition. It is only a proper allowance for all three factors of cognition in their interaction and interconnection that permits one to completely overcome the one-sidedness of empiricism and rationalism in epistemology which, on the on hand, divorce thought and sensations and, on the other, is not capable of yielding an exhaustive criterion of the essence of epistemology.

By the empirical we mean a level of knowledge whose content is basically obtained from experience. At this level of knowledge the object of cognition is reflected in those of its properties and relationships that are accessible to sensory contemplation. Rational or theoretical cognition is, on the other hand, on a different level. At the rational level the object is reflected in its connections and laws. However, the two different levels are closely interconnected. This means that the development of knowledge presupposes constant interaction of the empirical and the rational aspects of epistemology, the interaction of experiment and theory. Thus, absolutisation of either is disastrous to the development of scientific epistemology.

Chapter Three

Closing Considerations

(1)

There is no doubt about the epistemological significance of the theoretical analysis of the history of philosophy. For philosophy is almost the sole field of knowledge in which agreement among its leading spokesmen is the exception rather than the rule; in the natural sciences usually called exact or special, the area of disagreement is a comparatively small part of the vast which peace and harmony seemingly reign. Whoever studies any of these sciences to some extent lacks choice: he assimilates existingly established scientific truths that will, of course, be refined, supplemented, and in part even revised, but hardly refuted. It is not so in philosophy, in which there is a host of doctrines, trends, and directions each of which, as a rule, has not only a historical justification but also a certain actual sense. In philosophy one has to choose, to soak oneself in a specific atmosphere of philosophical thinking, by nature polemical, so as to find one's point of view, refuting all others that are incompatible with it. But a search of that kind presupposes study of the whole variety of philosophical doctrines, a condition that is obviously not practical.

In concrete socio-historical conditions this situation has, of course, a certain obligatory character. He who also studies philosophy (or beginning to) is not, certainly, like the person browsing in second-hand bookshop looking for something suitable for himself. The moment of choice is inseparable from the purposive activity by which any science is mastered. Since the history of philosophy investigates the real gains of philosophy, this choice becomes an intellectual conviction and wise decision.

The course of history of philosophy, often likened to a comedy of errors, wandering in a labyrinth, and anarchy of systems, forms one of the most important dimensions of the cultural progress of mankind. The quest for a correct outlook on the world and the tragic delusions and misconceptions, and divergences of philosophical doctrines, and their polarization into mutually exclusive trends, the intellectual battle of the trends, which is sometimes perceived as a permanent philosophical scandal, are not just the searches, torments, and delusions of individual philosophers, but are the spiritual drama of all humanity, and he who pictures it as a force seemingly interprets the tragic solely as an isolated phenomenon.

The antinomies into which philosophy falls, the crises that rock it, the retreats and withdrawals, the following of a beaten path, including that the errors already committed in the past, the rejection of scientific discoveries for the sake of long-refuted fallacies, especially in epistemology, persistently taken for truth – do these just characterize philosophy? Philosophy is the spiritual image a mankind and its positive achievements and mishaps constitute the most vital content of the cultural biography of mankind.

The specific feature of philosophy is the theoretical comprehension of the universal human experience and the whole aggregate of knowledge so as to create and integral conception of the universe. The difficulties on the way of the philosophical comprehension of reality are constantly increasing because the treasury of the human experience and knowledge is being constantly enriched. The theoretical results of the philosophical exploration are quite modest, in particular when compared with those of natural sciences. The fight between philosophical doctrines that throws doubt on the possibility of getting agreement even on elementary matters evokes skeptical attitude among non-philosopher specialists to a discipline so unlike the others whose fruitful results are generally recognized. But philosophy, though it does not promise very much and yields even less (as it seems to some), possesses amazing attractive force, as even philosophizing dilettantes cannot help recognizing who suggest to establish it as practically useless; philosophy teaches how to think theoretically. In fact, in order to think about a separate subject, certain general notions are needed. The greater the aggregate of subjects the more general still the notions needed to understand it.

Philosophical (abstract) thought is an obligatory intellectual condition of theoretical knowledge. Without abstraction there is no thinking, of course, even at the empirical level. Theoretical thinking means to pass from concrete facts to abstract mental images. Since abstraction is, epistemologically, interconnected with generalization, there can also be no knowledge or understanding without generalization; it is through generalization that the human being, epistemologically, forms general concepts and general judgments, formulates norms, bonds and limitations, problems, conceptions, and theories. It is important to note here that the generalizing activity of human thought lies at the basis of speech activity and is closely linked with practice, in which the general rather than "individual, unique" epistemological problems are usually solved. By creating broader and broader generalization mankind gets the chance to disclose the inner interconnections between various laws already discovered by natural science. By creating general scientific theories we get the chance to explain the nature of facts that did not find scientific explanation within the initial narrow theory. Consequently, generalized-theories make it possible, from the standpoint of epistemology, to "concretize" previous initial theories. It became clear, for example, in the light of the theory of relativity, that the laws of classical mechanics were not of universal significance.

(2)

As is known, epistemologically, the first explicit formulation of the problem of the rational (the ideal) is credited to Plato. The problem posed in the philosophical system of the great ancient thinker, pivoted on the antithesis of the general determinations of being. The spiritual and the empirical (material), the eternal and the transient, one and many, the absolute and the relative, essence and appearance, chance and necessity, the actual and the proper, the mind and the body, the rational and the empirical, the perfect and the non-perfect, etc – these are the opposites, which make up the epistemological framework of philosophical thought, constitute the inner source of its development.

Plato gave a consistent solution to the basic question of philosophy from the viewpoint of Objective Idealism and unified accordingly all principal determinations of being on the basis of the epistemological category of the ideal (the rational). The eternal, the one, the absolute, the necessary, the universal, the perfect and the creative are posited in his conception exclusively as the rational (the ideal), in contrast with the empirical (the material) which is only the sphere of the transient, the individual, the accidental, etc. hence, the "universalism" of Plato who treats with contempt the sensuous, the empirical, the individual as patently inferior and not genuine. The ideal or the rational, in Plato's epistemology, is a common property of the World of Ideas.

(3)

The seminal insight of Logical Empiricism (the philosophical movement established by some scientists and philosophers of science in Vienna after the turn of the century) is that it is possible, epistemologically, to describe the systematicity of the human knowledge in the set of scientific beliefs by means of modern formal logic. By widening the concept of "science" to include all knowledge, the logical empiricists developed a new hypothesis about the structure and system of knowledge in general. The deliverances of the human sense organs were regarded as observations and yielding observation sentences, the sheer sensory features of the process of observation (referred to a "sense-data). It was argued that observation sentences provide the foundational certitude for science and epistemology (knowledge generally).

That is the position of Carnap in his early work (and also of Bertrand Russell) in his *Human Knowledge: Its Scope and Limitation.* Other logical empiricists, such as Neurath and Carnap in his later work, look as the foundation physicalistic sentence that qualitatively described space-time points in the language of modern physics.

A previously motivation of the logical empiricists was to characterize the fundamental difference between science, which would provide truths about the nature of the universe, and the unconstrained speculation, metaphysical posing, and assorted much that was frequently dished out in fancy language as Philosophical Wisdom. (Modern Logic and analysis of language using modern logic provided the means for characterizing the justificatory credentials of genuine scientific propositions. As we have seen, logical empiricism included an account of the nature of explanation of meaning as the epistemological foundations of the human knowledge. Mathematical logic provides the underlying principle of the unity of all sciences).

(4)

The results of scientific research very often force a change in the philosophical view of the problems which extend far beyond the restricted domain of science itself. This means that philosophical generalizations must be founded on scientific results. Once formed and widely accepted they very often influence the further development of thought by indicating one of the many possible lines of procedure. Successful revolts against accepted view results in unexpected and completely different development, becoming a source of new philosophical aspects. During the second half of the 19th

century, for instance, new ideas were introduced to science; they opened the way to a new philosophical view. "It was realized that something of great importance had happened in physics."[1] "A new reality was created … slowly and by a struggle the field concept established for itself a leading place in physics … The electromagnetic field is, for the modern physicist, as real as the chair on which he sits."

[1] -Einstein, A., Leopold Infeld. *The Evolution of Physics.* Simon and Schuster, New York. 1942, p.158.

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