IMPACT OF RELATIVITY THEORY AND QUANTUM MECHANICS ON PHILOSOPHY

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In present times, Science has become more and more contiguous to philosophy due to the advent of Relativity theory and Quantum Mechanics. Relativity has modified our concepts of mass, length, force, law of addition of velocities and simultaneity and has given a new interpretation of laws of conservation of energy and momentum. It has demonstrated the inner necessity of the idea of dialectical contradiction in theoretical development of the contents of physics. Quantum mechanics has continued what began with the theory of relativity. It rejects unlimited detailing of objects in space and of phenomena in time. The concept of energy, momentum and angular momentum have now to take into account the possibility of quantization and the limitations imposed by the uncertainty relations. It has shown that the basic laws of nature are statistical, and that the probabilistic form of causality is the fundamental form. It lays emphasis on relations of a qualitatively different dialectic types, like the relations of complementarity and relations of interference (1). In the article an attempt is made to show that these theories have called for a drastic revision of the seminal kernels of the traditional philosophy of science.

Space, Time and Measurements

Most of the earlier thinkers, since Aristotle, thought of 'space' as a continuous distribution of material and ethereal elements (2). The medievalist like Descartes and many others in the renaissance period, as well as physicists of the 19th century, were of the view that space is filled with an electromagnetic ether. Space as a void, existing in its own right, absolute and independent of the things contained, is an idea which originated with the Atomists. It became the major concept of the Newtonian universe. But it blossomed into the space-time continuum with the establishment of relativity theory (3).

The time that we experience as human beings, the *"time that devour all things"* according to Ovid (2), is not quite the same as that used in science. The latter has been changed by relativity theory into a continuous one dimensional space. The physical time of space-time is an abstract refinement of the colloquial time used in every day affairs.

The special theory of relativity, put forward by Albert Einstein in 1905, required (3) that we abandon the belief that intervals of time and space are the same for every body. Space by itself and time by itself are peculiar to each observer, and only space-time is the public thing that we all share in common. From the point of view of relativity theory (1), it is not time itself that is measured by the clocks, but the time aspect of an *'interval'*; it is not the distance itself that is measured by a ruler but the spatial aspect of an *'interval'*. The relativity theory (4) has shown that nature offers no absolute standards of comparison and space is simply the order of relation of things among themselves. The motion of bodies can be described only with respect to each other and for space there are no directions and no boundaries. It has further discarded the concept of absolute time and has shown that just as space is simply a possible order of material objects, so time is simply a possible order of happenings.

Relativity tells us that there are no such things as fixed interval of time independent of the system to which it is referred. There is indeed no such thing as simultaneity; there is no such thing as "now" independent of a system of reference.

Mechanics and Relativity

In order to describe the mechanics of the physical universe, three quantities are required : time, distance and mass. Now an important deduction from relativity is the principle of equivalence of energy and mass (4). Prior to relativity, the universe was pictured as a vessel containing two distinct elements : matter and energy-the former inert, tangible and characterized by a property called mass and the latter active, invisible and without mass. The relativity theory has shown that mass and energy are equivalent; the property called mass is simply concentrated energy. In other words matter is energy and energy is matter and the distinction is simply of temporary state. General relativity goes one step farther: the distinction between inertia and gravitation has disappeared. The gravitational action between two bodies follows from the same equations, and is the same thing, as the inertia of one body. A body under gravitational effect describes a geodesic in 4-D continuum, as it describes a straight line in the absolute space of Newton under the influence of inertia alone. A related conclusion is that the geometry of space-time (3) is not the same as that of a piece of paper and the 'shortest distance' between two events is generally not a straight line.

A remarkable fact is that while Newton's Laws of motion have been altered by relativity theory (3), the direct connection between the symmetry of space and the conservation of momentum has been unaffected or even strengthened by this modern theory. All the three conservation laws of energy, momentum and angular momentum are now understood in terms of the symmetry of space-time and indeed the relativity theory has shown that these three laws are all part of a single general law in the four-dimensional world.

Absolute Concepts in Relativity Theor

The relativity theory has given birth to several 'absolute' concepts (5, 6). The speed of light is absolute, the pattern of curved space near a massive object is absolute, the rest energy of an object is absolute, and all the laws of physics are absolute, not in the sense of being unalterable by the progress of research but in the sense that they are consistent throughout the universe.

Wave-Particle Duality

Quantum machanics has continued what began with the advent of theory of relativity. A transition from macro-phenomena to micro-phenomena presupposes rejection of the basic ideas of classical physics (7-8).

In the world of macro-phenomena, the corpuscular and wave motions are clearly distinguished. These usual concepts, however, cannot be transferred to the world of micro-particles, whose motion is characterized simultaneously by wave and corpuscular properties. This wave-particle duality comes as a new concept of physics and philosophy. The advent of quantum mechanics rejects the trajectory concept of a 'path' and introduces the existence of wave properties in micro-particles.

Determinism And Uncertainty Principle

Determinism (9), the Philosophical doctrine that the universe is a vast machine operating on a strictly causal basis, with its future determined in detail by its present state, is rooted in the Newtonian model of mechanics. The uncertainty principle due to Heisenberg proclaims the impossibility of simultaneous determination of the position and momentum of a particle with an arbitrary degree of accuracy. The principle comes out as a consequence of wave-particle duality, but the significant fact is that in this form it says that physics is no longer pledged to a scheme of determinisic law (10). The mechanical determinism of classical mechanics has been relegated to be an article of faith. While macroscopic phenomena justify that faith. we just cannot extend it to microscopic levels —the experimental evidence is otherwise.

The *'uncertainty'* arises from the basic philosophy. now accepted, that it is meaningless to specify the measurement of a physical quantity without reference to the interaction with the measuring device. In order to be *'seen'* by an observer the observed body must interact with the observer, which could be a photon. The effect may be negligible on the macro scale, but in the case of microparticles it is not so Thus, in quantum mechanics the investigator and the object of investigation cannot, in principle, be isolated from one another.

Chance and Necessity

Laplacian determinism (10) excludes the element of chance from the behaviour of an isolated object; necessity completely dominates. But in quantum mechanics elements of necessity as well as chance are present. An excited atom spontaneously returns to the ground state without any external influence. But such a return is a random act; in other words, an element of chance is present in such a transition. Necessity is still manifested in the conservation laws which govern the processes There are other manifestations of this. As one example, the decay of an elementary particle is characterized by a set of possibilities according to the conservation laws, but out of these only one is realised. The process of resolving the contradictions between the possible and the actual thus becomes important. It is in the measuring process that the dialectical contradiction between the possible and the actual is resolved. In effect, the superposition of probabilities is destroyed and is replaced by one of the alternatives realised.

Concept of Causality

According to the empiricists, the idea of causality involves nothing more than the idea and expectation that one event will always be followed by another, (The talk of a link between the cause and the effect is a secondary matter). But in quantum mechanics the principle of causality refers to the relative possibilities of the realisation of different events; the crucial point is that no order of occurrence is predictable. That is the new philosophical element, otherwise it is a generalization of the principle of classical determinism.

Principle of Complementarity

The dialectical nature of quantum mechanics is reflected in the principle of complementarity put forth by Bohr. It states that in any experiment with microparticles the observer gets information not about the "properties of the particles themselves" but about the properties of the particles associated with some particular situation including (among other things) the measuring instruments. The information about the object obtained under different conditions cannot be added, accumulated or combined into a single picture; it reflects various sides (complementing one another) of a single reality, to wit, the object under investigation. The principle of complementarity finds a direct expression, in particular, in the idea of wave-particle duality and in the uncertainty relations.

Physical Reality

At the dawn of the 20th century, physical reality was conceived to be represented by continuous fields, which were subject to the partial differential equations. The special and general theories of relativity continued the independent introduction of material points and use of total differential equations. Quantum mechanics differs fundamentally from the above scheme. The quantities which figure in its laws make no claim to describe physical reality itself, but only the probabilities of the occurrence of a physical reality that we have in view.

Dielectics in Relativity Theory and Quantum Mechanics

It is true that dialectical nature is inherent in every physical science. But relativity theory and quantum mechanics have convincingly shown that a higher level of knowledge of the laws of nature is inevitably linked with a deeper and more serious knowledge and application of the methods of materialistic dialectics. The rise of the theory of relativity itself cannot be understood without and independently of idea of dialectical contradiction (1).

Recognition of the unity of the opposing corpuscular and wave concepts of matter is the necessary element of quantum mechanics. Quantum mechanics lays emphasis on the relation of qualitatively different dialectical types, like the relations of complementarity and relations of interference. In quantum mechanics the dialectical categories of necessity and chance, possibility and actuality are applied not only to the ensembles of objects but also to an individual microparticle. Thus, quantum mechanics has clearly demonstrated the dialectical struggle between form and content. It has shown that no content can be grasped without a formal frame and that any form, however useful it has hitherto proved, may be found to be too narrow to comprehend new experience.

Appearance and Reality

The doctrine of materialism (6) asserted that space, time and the material world comprised the whole of reality. The relativity theory and quantum mechanics have shown very clearly that all earlier systems of physics fell into the error of identifying appearance with reality. The reality, as we now know, is that no sharp boundaries exist between events and objects. We must probe into the deeper substratum of reality before we can understand the world of appearance, even as regards predicting the results of an experiment.

Concept of unobservables

The classical theories of physics deal directly with quantities which are measurable, usually called observables. The relativity theory contains certain quantities which are not themselves observable. Space itself may be regarded as an unobservable. Packets of curved space-tidal ripples —gravity waves and gravitons are other unobservable concepts. The equations of quantum mechanics also contain certain quantities which are not themselves observables. From these quantities (unobservables) the observables are derived. The wave function is one of the unobservable quantities. Thus it has become increasingly evident in recent times that nature works on a different plan. Her fundamental laws do not govern the world as it appears in our mental picture in any direct way, but instead they control a substratum of which we cannot form a mental picture without introducting irrelevancies (7).

Conclusion

The relativity theory and quantum mechanics emerged and developed as a result and expression of our penetration into the sphere of the most refined electromaganetic phenomena, into the atomic and subatomic world and into the field of immense cosmic phenomena. Acceptance of the idea of an internally necessary connection between several isolated concepts is a characteristic of these theories. As a consequence, a large scale revision of physical concepts, especially of physics and philosophy has taken place. In essence, the concepts of space and time are unified so also those of mass and energy, and of waves and particles. The scope of conservation laws has been expanded with universal applicability, and new universal constants—like speed of light and Planck's constant—have been defined as governing the laws of nature Though, these theories are purely physical, yet these have a very wholesome influence on metaphysical theories.

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