The Marxist, XXX 2, April–June 2014

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In Defence of Dialectical Materialism: A Response to T. Jayaraman

I

Why this essay?

This essay has been prompted by two articles of T. Jayaraman in the *Marxist*: "Scientific Realism for the Materialist" (XXIII 1, Jan-Mar 2007) and "Dialectics and Materialism" (XXIX-4 Oct-Dec 2013). My defence of dialectical materialism is in the face of the impressions created in these articles that (a) Marxist Philosophy needs the friendly help from Scientific realism to tackle certain problems in modern science, and especially in the area of quantum theory, and that (b) the categories of dialectics need to be drawn from a renewed study of Hegel so that dialectical laws are derived not from Science(in view of the unsolved issues particularly in the field of quantum theory), or nature, but from a study of concepts, a *la* Hegel, starting from some basic concepts and moving on to more and more complex concepts.

I hope to be able to answer some of the questions raised, and to show that the philosophy of dialectical materials stands on its own, and needs no outside support. My attempt will not be to go into the details of the proposed philosophy of scientific realism, but to merely show that the support of such a philosophy is not required by dialectical materialism. For this purpose we develop some of the basic ideas of dialectical materialism in the following section. We start from the non-duality of matter- mind and go on step by step to the laws of dialectics.

II

Consciousness is a Reflection of the Material World

In the Buldhana district of Maharashtra, some 80 miles from Malkapur railway station, is to be found the famous Lonar Crater. It is an impact crater which, unlike a volcanic crater, is formed when a meteor or a meteorite collides with the earth with a certain minimum speed. If a meteorite falls on to the ground with a speed not exceeding several hundred metres a second, it makes a hole not much larger than its own size. But when the speed is from two to four kilometers a second, both the meteorite and the ground it touches instantly turns into gas, and a huge crater is formed. The Lonar crater is one such. The Lonar crater was formed from such an impact which took place, according to the latest research figures, about 656,000 years ago. In such cases, the meteorite will reproduce several traces in the solid rock that is formed where it hit the earth. The trace left by the meteorite is its reflection resulting from its impact on the surface of the earth. This is an example of the *concept of reflection* which Lenin introduced as a way of understanding the evolution of matter into mind and consciousness.

In his seminal work *Materialism and Empiriocriticism*, written in 1908, Lenin attempts to give a materialist account of the development of matter in its evolution into consciousness. He identifies consciousness with a property of all matter, namely, the property of reflection. Lenin quotes from Pearson's work *The Grammar of Science*, where the latter breaks away from Berkeley's arguments and speaks of the relation of brain to thought: "From will and consciousness associated with material machinery we can infer nothing whatever as to will and consciousness without that machinery". While

quoting from Pearson again, Lenin inserts his own understanding about reflection within square brackets. "Consciousness has no meaning beyond nervous systems akin to our own; it is illogical to assert that all matter is conscious [*but it is logical to assert that all matter possesses a property which is essentially akin to sensation, the property of reflection*], still more that consciousness or will can exist outside matter". This represents a profound contribution from Lenin to dialectical materialist philosophy. Let us briefly trace the development from reflection to irritability to mental activity in the evolution of matter.

We begin by defining the property of reflection which is a basic property of all matter: when one material object acts on another, the latter changes in such a way as to reproduce certain characteristics of the former. This is one of the forms of interaction, about which dialectics speaks, for Engels says in *Dialectics of Nature* that "everything affects and is affected by every other thing". One important feature of this relation is that "an image cannot exist without the thing imaged, and the latter exists independently of that which it images".

Lenin asks the question: Did nature exist prior to man? He gives the obvious answer. "Natural science positively asserts that the earth once existed in such a state that no man or any other creature existed on it. Organic matter is a later phenomenon, the fruit of a long evolution. It follows that there was no sentient matter, no "complexes of sensations", no *self* that was supposedly "indissolubly" connected with the environment in accordance with Avenarius' doctrine. Matter is primary, and thought, consciousness, sensation are products of a very high development. Such is the materialist theory of knowledge, to which natural science instinctively subscribes."

Coming to evolution, we know that every living organism is characterized above all by metabolism, i.e., continued interchange of material with its surroundings. Another important characteristic is what is called "survivability", meaning the capacity of a living organism to react to external influences in a way which increases the chances of its survival. Lastly, all living organisms are capable of growth and reproduction. The capacity of living bodies to survive is closely linked to the property of reflection which all matter possesses.

Every variation in an organism must require that the capacity to survive is strengthened. The capacity of living organisms to react to the environment in a way which helps it to survive is called irritability. On being stimulated, the organism *reflects* those characteristics of the external phenomena which increase or decrease its chances of persisting in a living state, and transforms these *reflections* into internal processes (chemical or physical) to effect a response essential to self preservation. This quality of living organisms emerged in the process of natural selection. Those organisms lived and multiplied, which were built in such a way that their reactions to the environment provided for their preservation. All others died out.

In more highly organized animals, a special tissue develops whereby an organism's responses increasingly anticipate external phenomena. This is the *nervous* system. An anticipatory reflection effected through the nervous system is called *a reflex*. Reflections which appear, are transmitted, stored, processed and retrieved are called information. Information not only circulates within a living organism but is passed on from generation to generation, thus ensuring transmission of qualities by heredity. Heredity operates through molecules, of which the living cells consist.

There is no reason to suppose that in plants, viruses, and the simplest unicellular animals, reflection is accompanied by sensation or emotion. Only irritability is present, not even the most primitive form of mental activity such as sensation. Rudiments of mental activity are found in more highly organized, multi-celled animals. Most of these have a centralized nervous system which regulates their responses to stimuli and coordinates their movements. Reflection in living matter, which does not show mental activity, merely consists in the differentiation of stimuli as favourable or unfavourable.

Hundreds of millions of years of natural selection have resulted in reflections of the characteristics of what is going on in the external world (sensations) and motivations to attain favourable and avoid harmful objects. Both sensations and motivations are activities of a specific individual organism, and are classed as mental activity. These are subjective experiences. However, Lenin was quick to point out that

sensations exist, but there is no such things as “fictitious sensations, nobody’s sensations”, which stresses the fact that every sensation must be somebody’s sensation.

With highly organized animals the significance of mental activity as a regulator of behavior increases. So does the importance of the brain, a special organ which controls uninherited forms of behavior. Even among the higher animals, the part played by the brain is not the same, but the brain plays a greater and greater part as the internal organization of the animal becomes more complex.

Labour, Language and Thought

In June 1876 Engels wrote the brilliant article *The Part Played by Labour in the Transition from Ape to Man.* He showed step by step how in the evolution of man from the anthropoid apes labour played an important role: “we have to say that labour created man himself”.

He takes us through the erect posture, which was a decisive step in the transition from ape to man. This freed the hand from locomotion for other tasks, which we begin to see even in the apes. “Before the first flint could be fashioned into a knife by human hands, a period of time probably elapsed in comparison with which the historical period known to us appears insignificant. But the first step had been taken, *the hand had become free*…” Engels goes on to explain that the hand is not only the organ of labour, it is also the product of labour.

From the development of the hand, and the gregariousness of man, the most social of all animals, Engels shows how the mastery of nature increased. The development of labour necessarily helped to bring the members of society closer together by increasing cases of mutual support and joint activity, and by making clear the advantage of this joint activity to each individual. In short, men in the making arrived at a point where they had something to say to each other. The origin of speech and language is explained from and in the process of labour. “First labour, after it and then with it speech- these were the two most essential stimuli under the influence of which the brain of the ape gradually changed into that of man”. The development of senses, along with this, hearing and sight, are then taken up by Engels. But let us leave this here.

Coming to a more modern text book, it is shown that to be able to fashion and use implements and kill large animals, primitive men had to act jointly and circulate information of ever greater variety and scope. Such information must be equally understandable to all. And, if it is of a multiple nature, then the signal (speech) conveying it must be such as to indicate not unique but diverse phenomena that possess, at the same time, such common characteristics as must produce a uniform response in every member of the community. The signal must be common to a class of things, as well as to all those involved in a common effort. Hence, the information conveyed by a signal is not a sensuous image, but a concept, a general idea; and the signal itself is a word by which the idea is expressed.

The concept of a tree, for example, contains no reference to its height etc. However, we cannot imagine a tree without a height. The word ‘tree’ denotes the class of all trees. This is why Lenin wrote: “Every word (speech) already *universalizes*”. He was referring to Feuerbach, who says that we come across a contradiction between the word which represents the universal and the thing which is a particular. Of course, alongside of this statement, Lenin also gave the other aspect of this observation: “The senses show reality; thought and word – the universal”.

There are experiments to show that concepts cannot be formed even by highest (Anthropoid) apes. Consider the following example:

“By imitating people, a chimpanzee learned to get bananas surrounded by burning candles. He turned on the tap, filled a mug full of water and extinguished the candles. He could also cross a pond using a raft and pole. Once, when he was brought to the pond, there was a raft with a pole at the bank, while in the middle of the pond, there was another raft with some bananas on it. All round the bananas were lighted candles, and beside them stood the familiar mug. The chimpanzee got on the first raft and reached the other raft. Picking up the mug, he got back to the bank, ran up to the tap, turned it on, filled the mug and

hurried back to the pond with it, intending to put out the candles with the tap water. He proved incapable of abstracting from the distinction between water running from the tap and water in the pond and form the image of water as such".

Even a five year old child , when it uses one word 'water' to describe that which runs from the tap, that which fills a pond and that which falls from the sky as rain, has the notion of water as such. The interesting experiment conducted on the chimpanzee showed that he proved to be incapable of abstracting from the distinction between water running from a tap and water in a pond.

With the concepts that were available to man, thanks to this capacity engendered by labour, he is able to go through a process of *reasoning*: if I bring one kind of stone to bear on another, I shall obtain an object with which, by using it in a certain way, I shall be able to kill a certain kind of game. Thus the development of thinking and reasoning in man is seen as an evolution of matter, without the admixture of any foreign element. Lenin's concept of the property of reflection, that is a property of all matter, is seen to evolve into the mental process of thinking and reasoning in man.

The connection between labour, language and thought has been briefly described here. We have also referred to Lenin's description of the 'word' as that which universalizes. The ultimate relation between the actual world and the world of thought has been described by Marx and Engels as a relation mediated by language, and they point to the difficulty faced by philosophers due to this very fact. In *The German Ideology* they say:

"One of the most difficult tasks confronting philosophers is to descend from the world of thought to the actual world. Language is the immediate actuality of thought. Just as philosophers have given **thought** an independent existence, so they were bound to make *language* into an independent realm. This is the secret of philosophical language, in which thoughts in the form of words have their own content. The problem of descending from the world of thoughts to the actual world is turned into the problem of descending from language to life."

How prophetical these words are, when we consider the development of *postmodernism* which reduces human history to a collection of narratives,(Please see below), and philosophies of socialism and classless societies into grand narratives in the postmodernist world of discourses!

Coming back to the development of consciousness from labour, language and thought, we come to the evolution of relationships like the subject-object relationship. Scientists have shown that in the case of animals, the animal's physical condition, mental experience, reactions and results, as well as the environment have an effect of the animal as an integral whole. The French philosopher and psychologist (in the field of social psychology) Henri Wallon showed by conducting a series of experiments that for an animal, the "subjective and objective factors form an indivisible unity". However man, in the process of labour, masters some connections of the external world, and some connections between his own and other workers' efforts. The ability to discriminate between the reflections of the environment and of oneself becomes important in the labour process. Man owes this capacity to detach himself from the environment to social relations that develop in the process of labour. The Subject and Object relationship therefore has its roots in this evolutionary process.

Matter and Mind

We have seen above how the mind, with its capacity for sensation and for reasoning arises ; namely, in the process of evolution from lifeless matter to living matter, through irritability, and the development of the nervous system, through social labour, language and the development of the human brain. However, this does not mean for a moment that the mind or consciousness is "less" real. Thus we have Lenin: "It is, of course, sheer nonsense to say that materialism ever maintained that consciousness is "less" real, or necessarily professed a "mechanical", and not an electromagnetic, or some other, immeasurably more complex, picture of the world of moving matter."

The definition of matter was given by Lenin by first saying that, while in the question of the priority of matter to mind there can be no doubt that matter comes first and mind arises out of matter, yet, " The difference of the ideal from the material is also not unconditional, uberschwenglich (inordinate)".(Lenin Vol 38 p 114). He defines matter by asking a simple question: "We ask, is a man given objective reality when he sees something red or feels something hard, etc., or not? This hoary philosophical query is confused by Mach…. If you hold that it is given, a philosophical concept is needed for this objective reality, and this concept has been worked out long, long ago. This concept is *matter*. *Matter is a philosophical category denoting the objective reality which is given to man by his sensations, and which is copied, photographed and reflected by our sensations, while existing independently of them*." (Lenin, *Materialism and Emperiocriticism***,** p. 114).

A careful examination of Lenin's definition of matter shows that there are two parts in it. The first part of the definition deals with objective reality. Objective reality is everything that has existed in the real world, that exists and of necessity will exist in future. It is the entire universe in its mutual transitions and transformations which exist independently of consciousness.

The second part of the definition gives a clear-cut answer to a basic question of philosophy with regard to the relationship between matter and consciousness. The definition asserts that the world is cognizable, that it is knowable.

Indeed, dialectical materialism holds that the world is cognizable. It differs from all other epistemological positions by insisting that the yardstick of knowledge is social practice. The cognitive act includes (1) the object of cognition, (2) experimentation or man's action on the object with the aid of instruments, tools, etc., and (3) knowledge as a reflection of the object's qualities and distinctive properties discovered during experimentation. Earlier philosophical systems described the cognitive act as a two-fold relation, of the object concerned and knowledge. These systems lacked a yard-stick by which their positions could be verified. Dialectical materialism approached the problem from an entirely different standpoint, shifting the emphasis to the material basis and objective yardstick of knowledge.

Marxist materialism does not accept the position of various other philosophical systems which deny the possibility of knowing the world and its laws, or those systems which hold that there are "things in themselves" that can never be known to science. The position of dialectical materialism can be judged from the following words of Engels (in Ludwig Feuerbach):

"The most telling refutation of this as of all other philosophical fancies is practice, viz., experiment and industry. If we are able to prove the correctness of our conception of a natural process by making it ourselves, bringing it into being out of its conditions and using it for our own purposes into the bargain, then there is an end of the Kantian incomprehensible 'thing in itself'".

Categories of dialectical materialism

Philosophy is concerned with the following ultimate concepts: matter and mind, motion and rest, general and particular, substance and phenomena, quality and quantity, cause and effect, necessity and chance, possibility and reality, content and form, structure and function, and so on. These ultimate concepts are called categories. Lenin remarks in his conspectus of Hegel's Science of Logic:

"How is this to be understood? Man is confronted with a web of natural phenomena. Instinctive man, the savage does not distinguish himself from nature. Conscious man does distinguish, categories are stages of distinguishing, i.e., of cognizing the world, focal points in the web, which assist in cognizing and mastering it." Thus categories are taken out of nature. They are not spun out of one's head, or given *a priori* to man as the philosopher Kant had stated.

Similar is the case of the process of reasoning and the forms of logic. These also arise from man's evolution over thousands of years and his social practice. Lenin states in the same book: "man's practice, repeating itself a thousand million times, becomes consolidated in man's consciousness by figures of

logic. Precisely (and only) on account of this thousand-million-fold repetition, these figures have the stability of a prejudice, an axiomatic character."

Further, in connection with the cause-effect relationship, Lenin refers to Engels to illustrate how the laws of thought correspond with the laws of nature. We have the following in Materialism and Empiriocriticism: "If we find that the laws of thought correspond with the laws of nature, says Engels, this becomes quite conceivable when we take into account that reason and consciousness are "products of the human brain and that man himself is a product of nature." Of course, "the products of the human brain, being in the last analysis also products of nature, do not contradict the rest of nature's interconnections" (Engels: Anti-Duhring).

The Laws of Dialectical Materialism

Keeping in mind the main task before us, namely of showing how dialectical materialism on its own is able to deal with the developments of science, and need no support from any philosophy like the philosophy of scientific realism, we skip any detailed exposition of the laws of dialectical materialism, but merely mention them. The main laws enunciated by Engels are: The law of transition of Quantity into Quality, The law of Negation of the Negation, and The law of Unity and Conflict of Opposites. In his Plan Outline of the book *Dialectics of Nature*, Engels gives the following telegraphic description:

Dialectics as the science of universal inter-connection. Main laws: transformation of quantity and quality- mutual penetration of polar opposites and transformation into each other when carried to extremes – the development through contradiction or negation of the negation- spiral form of development.

Keeping in mind Com EMS Namboodiripad's advice that dialectics is a developing science, we should not forget to add that several additions have been made to this list. For example, Lenin emphasized that the law of unity and conflict of opposites is the defining law of dialectics. "In brief, dialectics can be defined as the doctrine of the unity of opposites. This embodies the essence of dialectics."

Indeed, both the law of transition from quantity to quality and that of the negation of the negation may be regarded as particular instances of the law of unity and conflict of opposites, which reveals the source of all development. Lenin added to this list the law of reflection as an essential property of all matter. Trying to defend Feuerbach about his limitations, Engels had pointed out that the sciences themselves had not developed sufficiently when Feuerbach was writing, and then listed three important discoveries in the field of science that had suggested the laws of dialectics to Marx and himself. Taking this argument a step further, we may add that Lenin was able to understand and grasp the great discoveries of science in the first decade of the twentieth century, including the work of Einstein, and was therefore able to contribute a new law of dialectics when he said:

"The 'essence' of things, or 'substance', is *also* relative; it expresses only the degree of profundity of man's knowledge of objects: and while yesterday the profundity of this knowledge did not go beyond the atom, and today does not go beyond the electron and ether, dialectical materialism insists on the temporary, relative, approximate character of all these *milestones* in the knowledge of nature gained by the progressing science of man. The electron is as *inexhaustible* as the atom, nature is infinite but it infinitely exists. And it is this sole categorical, this sole unconditional recognition of nature's *existence* outside the mind and perception of man that distinguishes dialectical materialism from relativist agnosticism and idealism." (Materialism and Empiriocriticism p 243).

In this series of additions, we may add the simple but authentic exposition of dialectical materialism in the book *A Short History of the CPSU (Bolshevik),* the contributions of Mao Zedong in his book *On Contradiction*, as well as the critical comments on contradictions, antagonistic and non-antagonistic, made by the Indian Marxist M.Basavapunniah.

Marx and Engels were scientists working with an open mind. Descartes is often portrayed as a dualist philosopher, and so having nothing to do with materialism. But in the *Holy Family* Marx and Engels

write: “We shall merely say the following: *Descartes* in his *physics* endowed *matter* with self-creative power and conceived *mechanical* motion as the manifestation of its life. He completely separated his *physics* from his *metaphysics. Within* his physics, *matter* is the sole *substance*, the sole basis of being and of knowledge.” Here was deposited the seed of dialectics, the refutation of dualism, and the endowing of matter with the capacity of evolving consciousness and *knowledge.*

The joint contribution of Marx and Engels to the development of dialectics, as well as the fact that dialectics cannot be separated from matter has to be emphasised. We cannot separate dialectics from materialism. There can be no question of merely asserting a certain mechanical unity of dialectics and materialism.

This scientific openness of the founders of the science of dialectical materialism needs to be stressed because there is a new discipline today of the philological study of Marx and Engels, which takes the job of comparing different works of these writers and finds contradictory positions in their formulations on important questions. This exercise completely ignores the fact that dialectics is an evolving science, and to the final works of Marx and Engels are added the creative contributions of Lenin and others.

III

Philosophy of Scientific Realism and Quantum Theory

In both his articles, “Scientific Realism for the Contemporary Materialist” (2007) and “Dialectics and Materialism” (2013), T. Jayaraman refers to the Quantum Theory apparently as one of the reasons for his ventures into (a) the philosophy of scientific realism and (b) the attempt to understand materialism from the perspective of dialectics. We propose in this article to deal with the question of quantum mechanics in some detail. But first let us see how scientific realism is to be seen.

Scientific realism is presented as a philosophy which would assist dialectical materialism in “elaborating a Marxist view of science”. The growth of realist trends in academic philosophy could make a positive contribution to advance the insight available in Marxist classics such as Lenin’s Materialism and Empirio-Criticism. It is claimed that realist philosophy of science has been in vigorous health and has provided a consistent, sophisticated and sound response to the new challenges posed by idealism and positivism. “These advances constitute a valuable resource for the further evolution of a Marxist perspective on science.”

“Scientific realism, broadly speaking, accepts the existence of objective reality as a fundamental premise. This objective reality exists independent of our theories and descriptions, and beliefs and thoughts concerning the same. These theories and descriptions acquire the status of truths or falsehoods depending on how they stand with respect to that objective reality,…Among this limitless set of truths, there are some that we know now, some that we don’t know now and will find out later and some *that may lie beyond the furtherest reach of our knowledge seeking powers…”*.(Emphasis added).

This is similar to Karl Popper’s definition: “The central issue here is realism. That is to say, reality of the physical world we live in: the fact that this world exists independently of ourselves; that it existed before life existed, according to our best hypothesis and will continue to exist, for all we know, long after we have all been swept away”*.(Quantum mechanics and in the schism physics).*

How does scientific realism differ from dialectical materialism? T.Jayaraman explains: “Avoiding technical definitions we shall take the philosophical position of materialism to imply, among other things, primacy of matter over mind, with the mind possibly being regarded as an emergent phenomenon. Thus materialism implies a definite position that eschews a dualism of mind and matter. It also more particularly, especially for Marxists, implies that the social superstructure, depends ‘in the last analysis’ on a material base. *Scientific realists need not be committed to these positions.”*

“One of the major features of many forms of contemporary scientific realism is the realization that a consistently realist view requires also a realist view of causation and explanation. The realist answer to

the basic question of what is the meaning of cause and effect denies that causation is to be viewed (in the fashion attributed to Hume) as regularities that are perceived in Nature. In this view, cause and effect are simply the ordering of events in time, the constant conjunction of events, and there is nothing more to causation than this ordering. However in the realist view, cause and effect are processes that are caused by some mechanisms or properties that are inherent in the particular nature of things. This view, referred to as the idea of causal powers, or causal dispositions provides the basis for a realist appreciation of the role of laws in nature. Such laws, in the realist view, are just the inherent 'generative mechanisms' or 'causal powers' that are characteristic of matter in various forms."

It may be pointed out here that scientific realism eschews any attempt to search for inner contradictory tendencies while trying to understand movement and development. The central law and category of dialectics, namely, the category of contradiction, is given a go-by in scientific realism, while trying to use the "causal powers". Lenin had pointed out: "The splitting of a single whole and the cognition of its contradictory parts… is the essence (one of the essentials, one of the principal, if not the principal characteristics or features) of dialectics". This rejection of the essence of dialectics is the basic weakness of scientific realism, which is manifested in its inability to deal objectively with quantum phenomena or distinguish between alternative theories of the quantum.

Jayaraman admits that earlier forms of realism had implicitly allowed key aspects of their philosophical positions to be founded on positivist or Humean views on issues such as causation, explanation, the nature of scientific laws and the semantic structure of scientific theories. He also admits that there are several directions from which attacks have come on this philosophy. It is well known that these challenges include the Empiricist Challenge, the Neo-Kantian Challenge, and the Postmodern Challenge. Jayaraman makes a study of the various attacks and presents arguments in support of the philosophy of scientific realism.

It is not the attempt of this paper to enter into this field. What we wish to point out is that, in spite of this courageous defence, the philosophy of scientific realism is not able to tackle the very problems of science, namely in the field of quantum theory, for which dialectical materialism was supposed to take its help. He openly admits of the "problems of arriving at a satisfactorily realist understanding of quantum mechanics", which are "cited in defence of anti-realist attitudes". He ends the section on Quantum Mechanics with the following statement: "It would certainly benefit the scientific realist view when the outstanding problems with the interpretation of quantum mechanics are resolved and our understanding attains a far more definitive state than the one which obtains today".

IV

Dialectics, Relativity and Quantum

I wish to humbly submit that for the past forty years, ever since 1972, I have been working on these problems of dialectical materialism and the sciences. My doctoral thesis was on dialectics and modern science with special reference to the theories of relativity and quantum mechanics. The main findings have been published in the book *Dialectics, Relativity and Quantum* (DRQ) (NBA,Kolkata,1998). I shall draw from these to answer the questions of the relevance of dialectical materialism, and its sufficiency in dealing with the problems of science.

As Engels said, Nature is the proof of dialectics, and it must be said for modern science that it has furnished this proof with very rich materials increasing daily. This is precisely what my thesis shows after examining the following five theories of modern science: the special theory of relativity, the general theory of relativity (Einstein's gravitational theory), the relativistic theory of gravitation, the so-called standard quantum theory with its Copenhagen interpretation (CIQM), and the stochastic interpretation of quantum theory (SIQM developed by Bohm, Vigier et al).

The conclusion of my thesis is that three of the above mentioned scientific theories, namely, the special theory of relativity, the relativistic theory of gravitation and the stochastic interpretation of quantum theory, after detailed analysis, are found to support the various propositions of dialectical materialism, the most important being those regarding matter and motion, space, time, transformation of quantity and quality, and the law of unity and conflict (struggle) of opposites in all processes of nature. In the sequel we examine some of these issues.

The remaining two theories, general relativity and the CIQM, suffer from some very serious problems of a technical as well as philosophical nature. Yet in the areas where these two theories have been tested and confirmed, they also fully confirm the propositions of dialectical materialism.

Relativity throws light on Hume's definition of causation

One of the severest blows suffered by the reduction of causation to uniform succession came from relativity physics. Relativity showed that if two events A and B are viewed as simultaneous by one set of observers, then for another set of observers, it may appear that A occurred before B, and for yet another set of observers it may appear that B occurred before A. Thus temporal order is not an absolute. This situation was misused by some writers like Bertrand Russell to say that all relations of cause effect are relative. Further, the progress of history from the past to the future has no meaning!

In fact, what relativity showed was that for those events A and B, where one is causally related to the other, these two events do not alter their temporal order. The temporal order of causally connected events is absolute for all observers. It is precisely those pairs of events, which are not so connected, where time reversal is possible. Thus relativity gives a material definition of temporal priority. Priority in time is defined on the basis of causal chains, and it is not temporal priority that is the basis for defining causality. A time theory of causation is thereby reversed, and a causal theory of time is established. This is the end of Hume's definition of causation.

Every event in some manner or other affects other events. In general, effect is motion of matter connecting one event with others through a series of intermediate events. Using this relation as the foundation, A.D.Alexandrov defined space and time. This is a confirmation of the dialectical materialist position on space and time. The category of cause-effect thus gets a foundation through science. It may also be stated here that Alexandrov's definition furthers the investigation of problems of science, and that such conceptions as 'causal pathologies' posed by some relativity theorists are shown to be without basis (See DRQ).

Relativity theory confirms the position of dialectical materialism regarding the relation between space and time on the one hand and matter in motion on the other. It confirms that space and time depend on matter in motion. While Einstein's special theory of relativity confirms that space and time are derived from the causal relationships between events, the general theory of relativity goes further and shows that these relationships themselves are dependent on the motion of matter. Thus space and time are not given a priori as Kant assumed, but are derived from matter in motion (Please see DRQ).

Quantum Mechanics and Dialectics

Jayaraman devotes an entire section in his first essay to quantum mechanics, *Scientific Realism and Quantum Mechanics*, and in his second essay he has a section which states *Why the categories of science alone will not do.* He says: "Especially in the era of quantum physics, there is ever-present confusion over the relation between essence and appearance in the realm of quantum phenomena. Is the probabilistic nature of phenomena such as radioactivity, which is a consequence of the probabilistic nature of quantum phenomena, merely the appearance of a determinist essence?"

He points out in his first essay: "Quantum mechanics posed a number of problems to the existing views of physicists….One of the key issues was to understand the ontological meaning of statements such

as wave particle duality. Another was whether the inability to determine the exact trajectory of quantum particles while at the same time keeping exact account of their momentum, constituted a mere surrender of determinism or was a failure of realism, whatever that meant…. While acceptable solutions to these issues have been found, they have left behind a fundamental residue of contradictions, primarily in the failure of the local nature of causality. To put it differently, there exists a contradiction between quantum mechanics and the notion of locality following from the special theory of relativity, while maintaining the probabilistic aspect of the quantum theory."

As stated earlier, Jayaraman is not able to deal with these questions with the help of scientific realism, but says that '**it would benefit the scientific realist view** when the outstanding problems with the interpretation of quantum mechanics are resolved and our understanding attains a far more definite state than the one which obtains today'. Unfortunately, Jayaraman does not do justice to the state of quantum mechanics which obtains today. This is what I have tried to explain in two of my books: DRQ, and *Frederick Engels and Modern Science* (FEMS) (Navakarnataka,Bangalore,2005).

Necessity and Chance

In two of the above references Jayaraman refers to the "probabilistic aspect of quantum theory" and the "probabilistic nature of quantum phenomena". This appears to be a long held and firm view of the author, for we find in an article written by him in 1975 (Social Scientist No 35) the following statement: "The probability interpretation of psi marks a sharp break with the mechanistic determinism of classical physics and is a concrete expression of the statistical nature of quantum phenomena…. This must also be considered a part of the rational core of quantum theory".

This is very similar to the view of Hans Reichenbach (*Rise of Scientific Philosophy*): "The issue is whether causality is an ultimate principle or merely a substitute for statistical regularity, applicable to the macroscopic domain but inadmissible for the realms of atoms…. From the investigations of modern quantum mechanics we know that the individual atomic occurrences do not lend themselves to causal interpretation and are merely controlled by probability laws …. the idea of a strict causality is to be abandoned, and the laws of probability take over the place once occupied by the law of causality".

We shall not go into the technicalities of quantum mechanics, but shall merely state that in the twenties of the last century, under the heavy influence of positivism, quantum theory was presented with an idealist interpretation, known as the Copenhagen Interpretation of Quantum Mechanics (CIQM). Reichenbach is referring to this version of quantum mechanics. During the same famous Solvay Congress of physicists held in 1927, where the CIQM was accepted, there was another version of quantum mechanics presented by de Broglie. But under the strong positivist current of that time, his version was laughed out of court. The CIQM became the standard quantum theory.

There is a long history of debates on the fundamental assumptions. There were several attempts to come out of the Copenhagen approach by finding a causal quantum theory. But all these were discouraged. The attempts to obtain a more complete quantum theory with the help of variables which were hidden at the moment received a severe set back with the announcement in 1932 of a theorem by von Neumann. He argued : "It should be noted that we need not go any further into the mechanism of the hidden parameters since we know that the established results of quantum mechanics can never be derived with their help." The net result was that until 1950s the CIQM was the only quantum theory in physics.

Then a Marxist physicist David Bohm came up with a rebuttal to the above theorem of von Neumann. He argued on the basis of the dialectical principle that nature is infinite in depth: below every level of causal law are contingency fluctuations(given by probability), and below every level of statistical (stochastic-probability) law there are deeper causal laws operating. In 1952 Bohm published two important papers in the prestigious Physics Review (Vol 85) presenting a consistent quantum theory of 'hidden variables'. It was a version similar to the original de Broglie theory. This development of a theory, in which behind probability laws there are deeper laws at a sub-quantum level, has gone through a

long and tortuous history, and now this theory, which a causal stochastic quantum theory, has found a very strong confirmation in terms of experimental results. ThIs is termed as the Stochastic Interpretation of Quantum Mechanics (SIQM). As the name indicates,in this theory causal processes are intimately linked up with stochastic processes (probability laws).

Here we shall give brief accounts of the topics raised by Jayaraman, namely, radioactivity, the wave particle duality, and the 'many worlds' approach which, according to Jayaraman, is the "counterview that has gained the most adherents".

We shall also mention the so called delayed choice experiment of Wheeler which leads to the conclusion in the CIQM that the past does not exist independently of what we do in the present, "the past is undefined, and undefinable without observation". This surely makes way for the postmodernists like Lyotard, about whom Jayaraman speaks, to argue that history is a matter of language, discourse, or "narrative". It has therefore become the job of Marxists, exclusively, to fight in defence of history.

V

CIQM and SIQM

Quantum theory as it evolved in the beginning of the twentieth century consisted of three revolutionary steps. The first revolutionary step was taken by Planck and Einstein who postulated that energy is transmitted in a discontinuous fashion. This was a sharp break from the established ideas of continuity in classical physics. This was brilliantly confirmed in the study of the photoelectric effect. The second revolutionary step was taken by de Broglie with the hypothesis of the wave nature of particles, namely, the assumption that with every moving particle is associated a wave motion. The wave particle duality which he introduced was a great step forward. The third revolutionary step is the probability interpretation of some of the laws of quantum theory, and the recognition that along with necessary laws, there are in physics, statistical regularities governed by probability laws. At the level of quantum processes the operation of *probability laws* reveals a new form of law which goes beyond the usually recognized *causal laws*.

Under the influence of positivist philosophy it was suggested that materialist philosophy was undermined since quantum theory denied the operation of causal laws at the level of atoms etc. The motion of an elementary particle was described in terms of the wave equation called the Schrodinger equation, which described how a certain variable psi behaved with respect to space and time. The relation of psi to the particle in question was that the square of the modulus gave the probability of finding the particle in a given region. We have used the mathematical term 'modulus' because the variable psi is a complex variable. Schrodinger equation is an equation in which both sides are in complex numbers.

In this scheme we cannot speak of the motion of a single particle or of its trajectory. What we can do is to find out the probabilities in which a swarm of particles would be distributed.

We have explained in *DRQ* and *FEMS* the problems related to this approach of describing the motion of particles, including what is called the sudden collapse of the wave function when we actually observe a particle. It is enough to state that a whole lot of subjective formulations accompany the Copenhagen Interpretation of Quantum Mechanics. The question of the 'splitting universes', referred to by Jayaraman, is a supposed objective solution to this drama of the wave function subjectively collapsing when an observer makes an observation. In order to avoid the subjectivist conclusions of a wave collapsing whenever there is an observation, Hugh Everett and others proposed that there were many worlds, and the universe was constantly splitting into a stupendous number of branches, each branch with its own observers.

Suppose in a laboratory L a physicist P performs a quantum mechanical experiment in which there are two possible outcomes A and B. On performing the observation it is noted that the outcome is A and

not B. The original interpretation of the CIQM is that the probability function (wave) collapses to give the outcome A.

Instead of the wave collapse, the model used by Everett is of multiple universes. The explanation given in this case is that both outcomes A and B, being possible, actually do take place, but in two different universes, say U and U'. "This universe is constantly splitting into a stupendous number of branches, all resulting from measurement like interactions between its myriads of components." Such is the fantastic conclusion that the CIQM leads us.

It is to be noted that Jayaraman only states that this is view has gained the most number of adherents, and he is not able to reject this outright on the basis of scientific realism.

SIQM

The alternative theory to the CIQM is the stochastic interpretation of quantum mechanics. The SIQM starts from the Schrodinger equation itself, and noting that it is an equation in the field of complex numbers, works out the real and imaginary parts separately. It is shown that the two real equations resulting from the complex equation are both equations from classical physics, namely, (i) an equation of continuity and (ii) the so called Hamilton-Jacobi equation with a new interpretation (namely that, in the addition to the usual dynamical potentials there is an extra potential, called the quantum potential, Q).

This new quantum potential Q is closely connected with the modulus of the complex variable psi of Schrodinger. It may therefore be stated here that this quantum potential is as material as the variable psi, from which it is obtained. So it is not a 'hidden variable', and any attempt to describe the SIQM as a theory of hidden variables will be misleading.

In the SIQM, which is a causal stochastic quantum theory, every particle has associated with it an objectively real field given by the quantity psi. Psi is itself a real field and not just a mathematical symbol. The particle itself has a well defined position as well as a trajectory. It is acted not only by the classical potential but the additional quantum potential, which is in a state of rapid random and chaotic fluctuation, arising from levels that are deeper than the quantum level. The mean field psi obeys the Schrodinger equation.

It should be emphatically stated that the SIQM avoids all the subjective conclusions of the CIQM, such as the subjective collapse of the wave function, or the splitting up of the universe whenever an observation is made. The SIQM gives a materialist explanation of all quantum phenomena dealt with above

Radioactivity

In radioactivity we have the process of change of an atomic nucleus into another nucleus. Thus an atom of radium changes (decays) into another kind of atom when it gives out an alpha particle. Suppose we consider two particular atoms X and Y of a given sample of radium. We find that atom X has decayed, but atom Y has not decayed. Are we entitled to ask the question: Why has atom X decayed and not atom Y? In the CIQM such a question is not allowed. What CIQM would allow and answer is this: Of a given collection of N atoms of a certain kind, what proportion will decay in the next one hour? This is what Reichenbach meant by saying that the laws of probability take over the place once occupied by the laws of causality.

In the SIQM, a perfectly intelligible answer is given to this question of the decay of atom X in terms of the quantum potential. This is done by considering and analyzing the penetration of a latent alpha particle within the radium atom X by a barrier formed by the quantum potential of the atom. This problem has been studied in detail by Dewdney and Hiley. (See DRQ)

In this context we can examine Jayaraman's question. "More problematically, we are left with a variety of contradictions that confuse us. … Is the probabilistic nature of phenomena such as

radioactivity, which is a consequence of the probabilistic nature of quantum phenomena, merely the appearance of a deterministic essence?" The answer is related to the dialectical opposites of appearance and essence, as well as the relation between necessity and chance.

Lenin's contribution to dialectics of the infinite depth of nature as spelled out earlier, "… the electron is as inexhaustible as the atom, nature is infinite, but it infinitely exists…" indicates that there are no final stages of essence. Below what is seen as the essence, are deeper laws and determinations which determine this particular essence. Also below what is a probability law can be discerned deeper determinations which could be causal. In the particular case of the radium atom which decays, we see the operation of the quantum potential, which is itself undergoing rapid random (stochastic) fluctuations. As Engels had said, "…the accidental is necessary, and the necessary is also accidental." But the more important instruction from Engels is against what he called the rigidity engendered by our categories of thought. In Anti-Duhring he says: "It is however precisely the polar antagonisms put forward as irreconcilable and insoluble, forcibly fixed lines of demarcation and class distinctions, which have given modern theoretical natural science its restricted metaphysical character."

The Wave-Particle Duality

Waves and particles signify two different ways of transporting energy from one point to another: a floating piece of cork can be made to move either by throwing stones at it or by producing waves in the water which will travel to the cork. Typical properties of particles are mass, position, velocity, momentum, trajectory, and energy, whereas for waves we have the properties of frequency (number of oscillations per second), wave length, amplitude, speed of propagation and energy.

The quantum theory, as presented by Planck, Einstein, de Broglie and Bohr, showed that particles behaved like waves, in producing interference fringes, and waves behaved like particles, in knocking off electrons to produce the photoelectric effect. It was understood that with every particle and its motion in space was associated a wave.

Things changed when Heisenberg tried to study the manner in which the trajectory (positions at different times) for a particle is observed. He demonstrated that there was a peculiar difficulty that crops up. If we try to measure the position of an elementary particle with great accuracy, then its velocity or momentum gets affected in a random way, because of the impact of the light waves by which we are observing the particle. If we use less intense light, so that the disturbance is minimized, then the image gets blurred because of the longer wave lengths of the new light that is used. There is a margin of error in the position. There is also a margin of error in the measurement of the momentum if this is done. The two margins of error are reciprocally related: if we try to reduce one error, the other error gets larger. This result about measurements is called the Heisenberg principle of indeterminacy. (Pl see DRQ).

Now Marxism recognizes that to observe a thing is to interact with it and to change it. However, the dominating philosophy in the West was not Marxism but positivism. It was suggested by Neils Bohr (from Copenhagen, Denmark) that all attempts to speak of the position or trajectory of a particle should be given up. We can determine that a particle has passed a certain point by means of special experiments (say, the Geiger counter), or we can determine its wave nature by another kind of experiment (interference experiments).One or the other, the electron is a particle or a wave, not both. Bohr formulated the famous Complementarity Principle. According to this principle, the wave and particle aspects are mutually exclusive, and only that which is being measured is capable of existence at that moment. This is the subjectivist version of quantum theory as prepared and accepted by the majority of Western scientists. This movement was led by Bohr, and it is called the Copenhagen interpretation of quantum mechanics (CIQM).

In the SIQM, however, both particle and wave aspects are present throughout in the motion of a particle or a wave. A particle such as an electron does not cease to have its wave properties or particulate

properties at any moment. These are two opposite aspects which co-exist, and form the wave particle duality of the motion of the particle, irrespective of the act of measurement.

Why are waves the opposite of particles?

By saying that waves and particles are two ways of transporting energy and momentum we cannot show that these are opposites of each other. If messages are received on some occasions through the postman, and at other times through a homing pigeon, that does not make the postman into the opposite of the homing pigeon.

The most obvious feature of a particle is its localizability. In classical physics a particle is defined, like a point in geometry, as that which has no parts but has position at a given instant. We may say that a particle is localizability incarnate.

On the other hand, a wave is characterized by its non-localizability. In classical physics a wave consists of simultaneous non-local correlations in a field. This is the essence of a wave front. The events in a wave front are having what is called '**space-like'** separation. A wave is therefore non-localizability incarnate.

In the SIQM, particle and wave aspects are joined together, and therefore the motion of a micro-object expresses both aspects of localizability and non-localizability, respectively, through the particle and its quantum potential. Localizability and non-localizability are polar opposites of each other which get united in the motion of the particle. Recent experiments conducted by A. Aspect and others, based on the work of J.S. Bell, have confirmed that non-local connections do occur in relation to the motion of particles.

The ancient philosopher Zeno of Elea, who may be regarded as the first dialectician of history, had pointed out that motion contains a contradiction. He argued that an arrow X which is in flight is at a point A and is not at the point A simultaneously. Of course, he used this argument to show that motion is a fallacy. But credit should be given to him that he had pointed to this contradiction which is present in motion.

Engels states: "Motion itself is a contradiction: even simple mechanical change of position can only come about through a body being at one and the same moment of time both in one place and in another place, being in one and the same place and also not in it. And the continuous origination and simultaneous solution of this contradiction is precisely what motion is."

The causal stochastic quantum theory (SIQM) illustrates that the motion of micro-objects brilliantly confirms this position of dialectical materialism.

It may be pointed out that A.S. Boglomolov deals with the logical solution of the above dialectical contradiction as follows. He shows that the way to synthesize the two statements: the body X is at the place A and the body X is not at the place A, is through an integral act of thought which can be expressed as follows. "If body X is located in place A and is not located in place A, then body X is moving".

Can the Past be changed? Is History just narrative?

We have considered the issues raised by Jayaraman, namely, the question of the many universes, radioactivity and wave particle duality. We now take up another question, which relates to the objectivity of past events. Quantum mechanics is the favourite hunting ground for all subjectivist idealists and for the postmodernists, who are busy arguing that history is merely a matter of narration and discourse. Lyotard, whom Jayaraman mentions in his first paper, belongs to this group. Polkinghorne says in his book *The Quantum World*: "It is a curiously unreal state of affairs that none of us lives in outside the study. As Feynmann has said we are asked to believe that the historian who makes a statement about Napoleon simply means that there are books in the libraries which make statements similar to his own. There is no past; there are only sources."

We now consider the famous experiment of J.A.Wheeler called the 'Delayed Choice Experiment', which relates to the objectivity of past events. The question that is asked by Wheeler is: Does the past exist in a unique way that does not depend on what happens in the present? Wheeler discusses this in his long paper entitled: The Past and the Delayed Choice Double Slit Experiment.

As has been explained, in the CIQM, according to the complementarity principle, for a given particle (like a photon, which is a quantum packet of energy) it is either observed exclusively as a particle or as a wave depending on the experimental set up by which we are observing it. If we use the instrument of a photo-detector we observe a particle, and if we use the apparatus of the double slit experiment for interference we observe a wave manifestation. Depending on the observation, we can conclude that the photon existed as a particle or as a wave prior to the observation.

Wheeler set up the instrumentation in such a way that both particle aspect and wave aspect of the photon could be observed alternately merely by switching from one mode to another. (Please see DRQ for details). The photon is made to enter the set-up from a source S in such a way that there is only one photon at a time in the path. There is the double slit interference arrangement of two paths, as well as the photo detectors placed in the path. The main idea is to decide on whether to check for particle or wave aspect by switching the mode **after** the photon has left the source S. If the photon is to leave the source at time t, then the choice is made after this time t, but before the observation takes place. This is why it is called the *delayed* choice experiment.

Wheeler discusses seven thought experiments. On the basis of this he comes to the conclusion that the past does not exist independently of what we choose to do in the present. If we choose to check its particle nature, then that makes the photon *to be a particle* at time t when it leaves the source S but *before* the decision to check was made. This is the logical conclusion of the complementarity principle of the CIQM. The only interpretation of the delayed choice experiment in the CIQM is that what happens in the past is decided by what we do in the present. This is what is called retroaction.

After setting out the arguments Wheeler asks the question: "Does this result mean that present choice influences past dynamics, in contravention of every formulation of causality?" To avoid this absurdity he says: "… the lesson that presents itself rather is this, that the past has no existence except as it is recorded in the present. It has no sense to speak of what the quantum of electromagnetic energy (photon) was doing except as it is observed or calculable from what is observed. More generally, we would seem forced to say that no phenomenon is a phenomenon until – by observation or by some combination of theory and observation- it is an observed phenomenon."

Such is the strange and subjective conclusion reached as a direct result of using the CIQM, that is, the so called 'standard quantum theory'. The CIQM leads to a rejection of the objectivity of the past as also to the denial of the reality of micro-phenomena. This is from where the postmodernists take off to say that the past is not objective, and that history is merely a matter of social construction from the narratives that we have.

It may be stated here that the causal stochastic quantum theory (SIQM) gives a direct explanation of the delayed choice experiment without in any way denying either the reality of microphenomena or the objectivity of the past. This has been done by Bohm, Dewdney and Hiley in *Nature* Vol 315, 23rd May 1985.

They have shown that, using the quantum potential approach, it is possible to give a simple and intelligible account of a typical delayed choice experiment. Since the particle and the wave (quantum potential) exist together, in the double slit experiment, the particle passes through one of the slits while the wave passes through both slits. It is shown that it is not necessary to suppose that the behaviour we ascribe to a system in the past is affected by what we do to it later.

VI

Dialectical materialism stands on its own

We are here dealing with two theories, the CIQM and the SIQM. The philosophy of scientific realism is unable to make a choice between these two theories. Dialectical materialism , on the other hand, played an active role in the formulation of the SIQM after a thorough critical examination of the CIQM.

The need to describe quantum phenomena in terms of probability did not militate against the assumption of the basic lawfulness of nature. What was not acceptable to sections of physicists like Einstein, Schrodinger and de Broglie, however, was the complementarity principle which insisted that processes at the quantum level are essentially unanalysable. Although Louis de Broglie had presented a causal quantum theory, this theory was criticized sharply and he abandoned it at that point of time.

Around 1950 a systematic tendency to criticize the CIQM began to develop. The most thoroughgoing criticism came from the physicists Blokhinshev and Terletzky in 1951. Then in 1952 David Bohm found a simple causal explanation of the quantum theory, which in fact had been earlier proposed by de Broglie. He published a series of papers independently, and along with Vigier and also with Hiley. At this stage, de Broglie, encouraged by the work of Bohm, returned to the original proposals that he had put forward at the Solvay Congress in 1927, and in collaboration with Vigier further amplified his theory.

The theory in its original form, though logically consistent, contained many aspects which seemed unsatisfactory. This work has been carried forward and developed into the quantum mechanics known as the causal stochastic theory (SIQM). In the entire process, the philosophy of dialectical materialism has helped in the critical steps and in guiding work into a materialist direction.

To describe David Bohm as a realist would be an injustice to him. Bohm was a communist, and he suffered heavily in the USA under the McCarthyist regime. He was not even allowed to use his own research work, or his doctoral thesis, as these had been classified as sensitive. There was an inquiry set up against him for ‘Un-American activites, and he was suspended from Princeton where he was working as Einstein’s assistant. He was later removed from Princeton, in spite of Einstein’s intervention. He had to travel to Brazil to take up a job in the University of Sao Paulo, and then to the UK where he joined Birbeck College. His book *Causality and Chance in Modern Physics* shows how deeply he had imbibed the philosophy of dialectical materialism.

It is not a mere coincidence that David Bohm and Jean Pierre Vigier, who initiated and developed SIQM were Marxists, even as V.A.Fock and A.D.Alexandrov, who tried to rescue the general theory of relativity from subjective deviations, were Marxists. The upshot is that dialectical materialism stands on its own, and does not need the support of the philosophy of scientific realism. Its propositions are being daily confirmed by the developments in science, notwithstanding the confusing twists and turns that ‘the quotidian developments’ in science may seem to be taking to a passing observer.