THE GREAT IDEAS ONLINE

June ’20 *Philosophy is Everybody’s Business* № 1046

INTELLECT: MIND OVER MATTER

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REALITY IN RELATION TO QUANTUM MECHANICS

In Chapter 8 (TGIO1043) I promised to return to the apparent conflict between twentieth century quantum mechanics and the realist’s affirmation of an independent reality, independent not only in its existence but also in its determinate structure and character. The conflict first arose from Heisenberg’s principle of uncertainty, which has also been called the principle of indeterminacy.

In subatomic physics, the velocity of the electron’s motion within the atom and its spatial position at the same time cannot both be measured with complete accuracy. The measuring process itself so affects the electron being measured that it prevents us from ascertaining, at the same time, both velocity and position with exactitude. In addition, according to the special character of the experimental measurement, the electron is either a wave or it is a particle. As one shifts from one mode of experimentation to another, the electron appears to change its character.

The question then arises whether the indeterminacy exists In reality or should be regarded instead as indeterminability by us—an unavoidable limitation upon our knowledge of reality rather than a feature of reality itself. Almost all quantum physicists are firmly committed to the position that the indeterminacy exists in reality. If that is the case, then reality is not determinate in all respects. It is false to say that the electron has, at a given time, a determinate position and velocity, even though we cannot exactly determine both at the same time.*

*See Werner Heisenberg’s *Physics and Philosophy* (1958), chapter 10, on language and reality in modern physics.

The underlying thesis that I am espousing runs counter to the position taken by most physicists. It is that the aspects of reality measurable by physicists are not all the aspects of reality that exist. Most physicists, on the contrary, appear to espouse the opposite thesis, that what they cannot measure does not really exist.

Take, for example, the statement by Professor N. David Mermin, a theoretical physicist, that "clocks do not measure some preexisting thing called 'time,' but that our concept of time is simply a convenient way to abstract the common behavior of all those things we call 'clocks.' "It is this view of time that, in the general theory of relativity, led Einstein to deny the existence of simultaneity between events at remote points in space. He converted the immeasurability of simultaneity into its nonexistence in reality.

Stephen Hawking, in his recent book *A Brief History of Time*, goes even further in the same direction. He quite explicitly espouses the thesis that what is not measurable by physicists does not really exist. Physicists cannot measure time before the big bang; therefore, it did not exist in reality. Physicists cannot measure time after the cosmos freezes up in the ultimate singularity of a black hole; therefore, time will come to an end. The correct title for Hawking's book should have been *A Brief History of Measurable Time*. The book is not about time as the philosopher understands it, much of which may be immeasurable.

Paradoxically, both Einstein and Hawking would appear to be involved in contradicting themselves. The same Einstein who denies simultaneity between remote events in space because of our inability to measure them also argues, against other physicists, that our inability to accurately measure the velocity and position of the electron does not mean that at a given moment in time the electron does not occupy a determinate position and does not have a determinate velocity.*

*For a revealing account of conflicting tendencies in the mind and in the thinking of Albert Einstein, see Stanley Jaki's *Angels, Apes, and Men* (1984), pp. 90-97; and for a penetrating critique of the mistake of attributing indeterminacy in reality to what is only indeterminability (or immeasurability) in quantum mechanics, see Jaki's Gifford lectures, *The Road of Science and the Ways to God*, chapters 11-14.

The same Hawking who, in his recent book, proceeds on the assumption that what is not measurable by physicists does not have any existence in reality also does not hesitate to refer to God and God's mind as if both had reality even though neither is measurable by physicists.

What is measurable by physicists are only certain partial aspects of reality; other aspects of reality exist even if they are not measurable by physicists. In addition, I think it can be argued cogently that our commonsense view of reality and the philosophical exposition of that view deals with aspects of reality more fundamental than the measurable aspects treated by physicists.*

*I have presented that argument in another book; see chapter 10 of *Ten Philosophical Mistakes* (1985).

I think the matter can be further clarified by the following considerations. In the first place, let us note Bohr's principle of complementarity, which said that conceiving the electron as a wave and conceiving it as a particle were not only alternative ways of conceiving it, but also complementary ways of doing so. As Heisenberg pointed out, these are "two complementary descriptions of the same reality. Any of these descriptions can be only partially true; these must be limitations to the use of the particle concept as well as of the wave concept, else one could not avoid contradictions. If one takes into account those limitations, which can be expressed by the uncertainty relations, the contradictions disappear."* In other words, Bohr's principle affirms the principle of noncontradiction as governing our thought, and it is a correct rule of thought only if noncontradiction is an ontological principle also governing reality.**

*Werner Heisenberg, *Physics and Philosophy: The Revolution in Modern Science* (1958), p. 43.

**In this same book, Heisenberg also points out that "this again emphasizes the subjective element in the description of atomic events, since the measuring device has been constructed by the observer, and we have to remember that what we observe is not nature itself, but nature exposed to our method of questioning ... [and our] trying to get an answer from experiment by the means at our disposal" (p. 58).

In the second place, let us observe the extraordinary difference between experimental measurements performed by scientists in the realm of classical or macroscopic physics—the realm of all objects larger than the atom. Here the properties of the object being measured by the physicists are properties inherent in the objects themselves and would exist in reality as such whether measured by physicists or not. In other words, the physical properties of the object and the object itself are not in any way affected by the scientific measurement of them.*

*For example, the measurements in the research that resulted in the Table of Atomic Weights did *not* confer on the atoms the weights assigned to them. They were properties inherent in the atoms weighed.

The difference between quantum theory and classical physics lies in the fact that when we try to measure what is happening *inside* the atom (and thus are dealing with objects smaller than the atom), our experimental measurements are intrusive, affect the object being studied, and confer upon the subatomic entities or events the properties attributed to them. Unlike the supra-atomic physical objects or events, these subatomic objects or events do not have in themselves well defined intrinsic properties. Their properties are conferred upon them by the experimental measurements made by the quantum physicists.

The crucial problem to be solved, which Einstein tried but failed to solve, can be formulated by two alternative questions as follows: (1) Is the physical reality of objects and events within the interior of the atom in itself determinate in character? (2) Is reality at the level of subatomic objects and events indeterminate in itself? If the first question is answered affirmatively, then Einstein was right in maintaining that quantum theory is an incomplete account of subatomic reality.

The question was not answered satisfactorily by the thought experiment called the "Einstein-Podolsky-Rosen Paradox." The later thinking and experimental work that led to the confirmation of the Bell theorem favors the second answer. Almost all quantum physicists today accept the answer as correct. They think they *know* that subatomic reality, unlike supra-atomic reality, is indeterminate in character. The indeterminacy attributed to subatomic objects and events by Heisenberg's uncertainty principles is not just their indeterminability *by us*; it is intrinsic to subatomic reality.

Many quantum physicists are quite content to embrace the paradox that supra-atomic and subatomic reality are strikingly different in character—the one intrinsically determinate in character, the other intrinsically indeterminate. But from a philosophical point of view, that difference between supra atomic and subatomic reality—both in their different intrinsic characters, independent of the human mind—is a mystery that calls for further thought. It is just possible that quantum physicists may not be correct in their present view of the matter.

The two questions to which the quantum physicists think they know the right answers are philosophical, not scientific questions—questions which, if they can be answered at all, can be answered only by thought, not by research. Unfortunately, for it has an effect on twentieth century thought, the quantum physicists presume to answer the questions *as if* the questions were answerable only by them in the light of their research findings. That is a serious mistake on their part. It is an egregious example of the presumption that scientists in many fields have frequently made in the twentieth century.

A brief history of the atom may help us to do the philosophical thinking that is called for. Atomic theory began in the sixth century B.C. with the physical speculations of Democritus and Leucippus. The atom was then thought to be a solid and indivisible particle of matter, with no interior. That conception of the atom was espoused by such sixteenth- and seventeenth-century physicists as Galileo and Newton, and by such seventeenth and eighteenth-century philosophers as Hobbes and Locke.

In all these centuries, from antiquity down to the first half of the nineteenth century, the atom, thus conceived, was regarded as belonging to the realm of *entia rationis*, not to the realm of *entia reale*: that is, it was regarded as a scientific fiction or theoretical construct, the real existence of which had not been experimentally established. Only in the first years of the twentieth century did the experimental work on atomic radiation establish two physical facts: *one*, that atoms had real physical existence; and *two*, that they were not solid particles of matter but had discrete interior constituents. This led a little later to the hypothesis that they might even be divisible.

During all this time, the interior of the atom was not explored by Intrusive measuring devices. That occurred later in the twentieth century and led to the first atomic fission in the 1940s. Quantum mechanics—the experimental and theoretical study of the interior structure of the atom— became the great revolution in twentieth-century physics, presenting us with the mysterious difference between subatomic and supra-atomic reality. That, philosophically, is more revolutionary than quantum mechanics itself.

Atoms existed in the centuries preceding the scientific work that established their real existence. Atoms had interiors, in which physical entities existed and physical events occurred, in all the centuries before it was scientifically established that atoms had Interiors in which subatomic entities existed and subatomic events occurred. It is certainly fair to ask what the subatomic physical reality was like in all those centuries. Was it like the subatomic reality described by twentieth century quantum theory? Was it a physical reality having the intrinsic character of indeterminacy, or was it an intrinsically determinate physical reality like the supraatomic reality of classical physics?

To answer that question philosophically, it is necessary to bear in mind one point that the quantum physicists appear to forget or overlook. At the same time that the Heisenberg uncertainty principles were established, quantum physicists acknowledged that the intrusive experimental measurements that provided the data used in the mathematical formulations of quantum theory *conferred on subatomic objects and events that indeterminate character.*

The foregoing italicized words imply that the indeterminate character of subatomic objects and events is not intrinsic to them—*not* properties they have quite apart from their being affected in any way by the measurements made by intrusive experimental devices.

If the cause of the indeterminacy attributed to the subatomic objects and events by quantum theory is the intrusive and disturbing measurement of those objects and events, which confers upon them properties (namely, intrinsic determinacy) not possessed by supra atomic physical objects and events, then *does not elimination of the cause also eliminate the effect?*

Philosophically speaking, the answer to that question must be affirmative. The opposite answer, given by the quantum theorists, *as if* they knew it to be the right answer as a result of their scientific research, cannot draw any support from the fact that their theory, which is based on their own intrusive measurements, gives rise to completely verifiable predictions.

If the cause of indeterminacy attributed to subatomic objects and events in quantum theory is the intrusive and disturbing measurement of those objects and events that confers upon them properties that supra atomic physical objects and events do not possess, then does not the elimination of that cause also eliminate its effect?

In other words, was not the physical reality of subatomic objects not different from but like the physical reality of supra atomic events, in all those earlier centuries when the atom existed and had an interior that the experimental measurements of quantum mechanics did not intrude upon and disturb?

The following imaginary example may help us to understand the philosophical answer to the questions posed. Imagine a pool of water in a hermetically sealed house that has endured for centuries with no human beings ever inside it. During all that time, the character of the water in the pool is completely placid. Then suddenly human beings find the house and find a way of opening it up to outside influences such as winds; and, in addition, they enter the house and jump into the pool without first looking at the surface of the water. The water in the pool affected by outside influences *and especially* by the humans lumping into the pool is disturbed and no longer has the character of complete placidity. The humans describe the pool as it appeared to them after they jumped into it and attribute wave motions and other properties to it.

Can quantum mechanics, through its experimentally performed measurements, be a disturbing and intrusive influence that affects the character of subatomic reality, and at the same time, can its exponents be certain that subatomic reality has the intrinsic indeterminacy that quantum theory attributes to it? Is the *unexamined* interior of the atom intrinsically Indeterminate in character, or is it like the determinate character of supra atomic reality?
God knows the answer, as Einstein at the beginning of his controversy with Bohr declared when he said that God does not throw dice, which implied that the *unexamined* subatomic reality is as determinate as a supra-atomic reality.

Whether or not God knows the answer, experimental science *does not know it*. Nor does philosophy know it with certitude. But philosophy can give a good reason for favoring the answer that affirms similitude between the character of subatomic and of supra-atomic reality—both intrinsically determinate. The reason is that quantum theorists repeatedly acknowledge their intrusive and disturbing measurements are the cause of the indeterminacy they attribute to subatomic objects and events. it follows, therefore, that indeterminacy cannot be intrinsic to subatomic reality.

Unfortunately, in this century, quantum theory has inadvertently given undue comfort to the worst tendency in contemporary thought—its philosophical idealism or constructivism, which denies a reality that exists completely independent of the human mind and has whatever intrinsic character it has without being affected by how the human mind knows it or thinks about it.*

*The great English mathematician G. H. Hardy has a comment on this worth quoting: “It may be that modern physics fits best into some framework of idealistic philosophy. I do not believe it, but there are some eminent physicists who say so. Pure mathematics, on the other hand, seems to me a rock on which all idealism founders: 317 is a prime, not because we think so, or because our minds are shaped in one way rather than another, but *because it is so*, because mathematical reality is built that way.” G. H. Hardy, *A Mathematician’s Apology* (1940), p. 130.

To sum up: the quantum theory is a theory of the examined interior of the atom. The scientific examination of that interior is, according to quantum theory, an intrusive disturbance of what is going on there. It follows that further developments of quantum theory and additional scientific investigation cannot tell us about the character of the unexamined atomic interior.

Einstein was right that the quantum theory is an incomplete account of subatomic reality, but he was wrong in thinking that that incompleteness could be remedied by any means at the disposal of science. Why? Because the question that quantum theory and subatomic research cannot answer is a question for philosophy, not science.

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THE GREAT IDEAS ONLINE

is published weekly for its members by the

CENTER FOR THE STUDY OF THE GREAT IDEAS

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A not-for-profit (501)(c)(3) educational organization.

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