2 Human Knowledge as the Foundation of Science

In the introduction to his book *Quantum Theory and Reality* the philosopher of science Mario Bunge (1967, p. 4) said:

> The physicist of the latest generation is operationalist all right, but usually he does not know, and refuses to believe, that the original Copenhagen interpretation – which he thinks he supports – was squarely subjectivist, i.e., nonphysical.

Let there be no doubt about this point. The original form of quantum theory is subjective, in the sense that it is forthrightly about relationships among conscious human experiences, and it expressly recommends to scientists that they resist the temptation to try to understand the reality responsible for the correlations between our experiences that the theory correctly describes. The following brief collection of quotations by the founders gives a conspectus of the Copenhagen philosophy:

> The conception of objective reality of the elementary particles has thus evaporated not into the cloud of some obscure new reality concept but into the transparent clarity of a mathematics that represents no longer the behavior of particles but rather our knowledge of this behavior. (Heisenberg 1958a, p. 100)

> [...] the act of registration of the result in the mind of the observer. The discontinuous change in the probability function [...] takes place with the act of registration, because it is the discontinuous change in our knowledge in the instant of registration that has its image in the discontinuous change of the probability function. (Heisenberg 1958b, p. 55)

> When the old adage "Natura non facit saltus" (Nature makes no jumps) is used as a basis of a criticism of quantum theory, we can reply that certainly our knowledge can change suddenly, and that this fact justifies the use of the term 'quantum jump'. (Heisenberg 1958b, p. 54)

H.P. Stapp, *Mindful Universe*, 2nd ed., The Frontiers Collection,
DOI 10.1007/978-3-642-18076-7_2,

> It was not possible to formulate the laws of quantum mechanics in a fully consistent way without reference to the consciousness. (Wigner 1961b, p. 169)

> In our description of nature the purpose is not to disclose the real essence of phenomena but only to track down as far as possible relations between the multifold aspects of our experience. (Bohr 1934, p. 18)

> Strictly speaking, the mathematical formalism of quantum mechanics merely offers rules of calculation for the deduction of expectations about observations obtained under well-defined classical concepts. (Bohr 1963, p. 60)

> [...] the appropriate physical interpretation of the symbolic quantum mechanical formalism amounts only to prediction of determinate or statistical character, pertaining to individual phenomena appearing under conditions defined by classical physics concepts. (Bohr 1958, p. 64)

The references to 'classical (physics) concepts' is explained by Bohr as follows:

> [...] it is imperative to realize that in every account of physical experience one must describe both experimental conditions and observations by the same means of communication as the one used in classical physics. Bohr (1958, p. 88)

> [...] we must recognize above all that, even when phenomena transcend the scope of classical physical theories, the account of the experimental arrangement and the recording of observations must be given in plain language supplemented by technical physical terminology. (Bohr 1958)

Bohr is saying that scientists do in fact use, and must use, the concepts of classical physics in communicating to their colleagues the specifications on how the experiment is to be set up, and what will constitute a certain type of outcome. He in no way claims or admits that there is an actual objective reality out there that conforms to the precepts of classical physics.

In his book *The Creation of Quantum Mechanics and the Bohr–Pauli Dialogue*, the historian John Hendry (1984) gives a detailed account of the fierce struggles by such eminent thinkers as Hilbert, Jordan, Weyl, von Neumann, Born, Einstein, Sommerfeld, Pauli, Heisenberg, Schroedinger, Dirac, Bohr and others, to come up with a rational way of comprehending the data from atomic experiments. Each man had his own bias and intuitions, but in spite of intense effort no rational comprehension was forthcoming. Finally, at the 1927 Solvay conference a group including Bohr, Heisenberg, Pauli, Dirac, and Born come into concordance on a solution that came to be called the Copenhagen interpretation, due to the central role of Bohr and those working with him at his institute in Denmark.

Hendry says: “Dirac, in discussion, insisted on the restriction of the theory’s application to our knowledge of a system, and on its lack of ontological content.” Hendry summarized the concordance by saying: “On this interpretation it was agreed that, as Dirac explained, the wave function represented our knowledge of the system, and the reduced wave packets our more precise knowledge after measurement.”

These quotations make it clear that, in direct contrast to the ideas of classical physical theory, orthodox Copenhagen quantum theory is about ‘our knowledge’. We, and in particular our mental aspects, have entered into the structure of basic physical theory.

This profound shift in physicists’ conception of the basic nature of their endeavor, and of the meanings of their formulas, was not a frivolous move: it was a last resort. The very idea that in order to comprehend atomic phenomena one must abandon physical ontology, and construe the mathematical formulas to be directly about the knowledge of human observers, rather than about external reality itself, is so seemingly preposterous that no group of eminent and renowned scientists would ever embrace it except as an extreme last measure. Consequently, it would be frivolous of us simply to ignore a conclusion so hard won and profound, and of such apparent direct bearing on our effort to understand the connection of our conscious thoughts to our bodily actions.

Einstein never accepted the Copenhagen interpretation. He said:

> What does not satisfy me, from the standpoint of principle, is its attitude toward what seems to me to be the programmatic aim of all physics: the complete description of any (individual) real situation (as it supposedly exists irrespective of any act of observation or substantiation). (Einstein 1951, p. 667; the parenthetical word and phrase are part of Einstein’s statement.)

and

> What I dislike in this kind of argumentation is the basic positivistic attitude, which from my view is untenable, and which seems to me to come to the same thing as Berkeley's principle, esse est percipi. [Transl: To be is to be perceived] (Einstein 1951, p. 669)

Einstein struggled until the end of his life to get the observer's knowledge back out of physics. He did not succeed! Rather he admitted (ibid. p. 87) that:

> It is my opinion that the contemporary quantum theory constitutes an optimum formulation of the [statistical] connections.

He also referred (ibid, p. 81) to:

> [. . .] the most successful physical theory of our period, viz., the statistical quantum theory which, about twenty-five years ago took on a logically consistent form. This is the only theory at present which permits a unitary grasp of experiences concerning the quantum character of micro-mechanical events.

One can adopt the cavalier attitude that these profound difficulties with the classical conception of nature are just some temporary retrograde aberration in the forward march of science. One may imagine, as some do, that a strange confusion has confounded our best minds for seven decades, and that the weird conclusions of physicists can be ignored because they do not fit a tradition that worked for two centuries. Or one can try to claim that these problems concern only atoms and molecules, but not the big things built out of them. In this connection Einstein said (ibid, p. 674): "But the 'macroscopic' and 'microscopic' are so inter-related that it appears impracticable to give up this program [of basing physics on the 'real'] in the 'microscopic' domain alone."

These quotations document the fact that Copenhagen quantum theory brings human consciousness into physical theory in an essential way. But how does this radical change in basic physics affect science's conception of the human person?

To answer this query I begin with a few remarks on the development of quantum theory.

The original version of quantum theory, called the Copenhagen quantum theory, or the Copenhagen interpretation, is forthrightly pragmatic. It aims to show how the mathematical structure of the theory can be employed to make useful, testable predictions about our future possible experiences on the basis of our past experiences and the forms of the actions that we choose to make. In this initial version of the theory the brains and bodies of the experimenters, and also their measuring devices, are described fundamentally in empirical terms: in terms of our experiences/perceptions pertaining to these devices and their manipulations by our physical bodies. The devices are treated as extensions of our bodies. However, the boundary between our empirically described selves and the physically described system we are studying is somewhat arbitrary. The empirically described measuring devices can become very tiny, and physically described systems can become very large, This ambiguity was examined by von Neumann (1932) who showed that we can consistently describe the entire physical world, including the brains of the experimenters, as the physically described world, with the actions instigated by an experimenter's stream of consciousness acting directly upon that experimenter's brain. The interaction between the psychologically and physically described aspects in quantum theory thereby becomes the mind–brain interaction of neuroscience and neuropsychology.

It is this von Neumann extension of Copenhagen quantum theory that provides the foundation for a rationally coherent ontological interpretation of quantum theory – for a putative description of what is really happening. Heisenberg suggested an ontological description in his 1958 book *Physics and Philosophy* and I shall adhere to that ontology, formulated within von Neumann's framework in which the brain, as part of the physical world, is described in terms of the quantum mathematics. This localizes the mind–matter problem at the interface between the quantum mechanically described brain and the experientially described stream of consciousness of the human agent/observer.

My aim in this book is to explain to non-physicist the interplay between the psychologically and physically described components of mind–brain dynamics, as it is understood within the orthodox (von Neumann–Heisenberg) quantum framework.

Springer

http://www.springer.com/978-3-642-18075-0

Mindful Universe
Quantum Mechanics and the Participating Observer
Stapp, H.P.
2011, XIII, 212 p., Hardcover
ISBN: 978-3-642-18075-0