Mind, Matter and Quantum Mechanics (2nd edition)

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Book review

Mind, Matter and Quantum Mechanics (2nd edition)
H P Stapp
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Quantum mechanics is usually defined in terms of some loosely connected axioms and rules. Such a foundation is far from the beauty of, e.g., the 'principles' underlying classical mechanics. Motivated, in addition, by notorious interpretation problems, there have been numerous attempts to modify or 'complete' quantum mechanics. A first attempt was based on so-called hidden variables; its proponents essentially tried to expel the non-classical nature of quantum mechanics. More recent proposals intend to complete quantum mechanics not within mechanics proper but on a 'higher (synthetic) level'; by means of a combination with gravitation theory (R Penrose), with quantum information theory (C M Caves, C A Fuchs) or with psychology and brain science (H P Stapp). I think it is fair to say that in each case the combination is with a subject that, *per se*, suffers from a very limited understanding that is even more severe than that of quantum mechanics. This was acceptable, though, if it could convincingly be argued that scientific progress desperately needs to join forces.

Quantum mechanics of a closed system was a beautiful and well understood theory with its respective state being presented as a point on a deterministic trajectory in Liouville space—not unlike the motion of a classical N-particle system in its $6N$-dimensional phase-space. Unfortunately, we need an inside and an outside view, we need an external reference frame, we need an observer. This unavoidable partition is the origin of most of the troubles we have with quantum mechanics. A pragmatic solution is introduced in the form of so-called measurement postulates: one of the various incompatible properties of the system under consideration is supposed to be realized (i.e. to become a fact, to be defined without fundamental dispersion) based on 'instantaneous' projections within some externally selected measurement basis. As a result, the theory becomes essentially statistical rather than deterministic; furthermore there is an asymmetry between the observed and the observing. This is the point where consciousness may come in.

Complemented by an introduction and several appendices, Henry Stapp's book consists essentially of three parts: theory, implications, and new developments. The theory part gives a very readable account of the Copenhagen interpretation, some aspects of a psychophysical theory, and, eventually, hints towards a quantum foundation of the brain–mind connection. The next part, 'implications', summarizes some previous attempts to bridge the gap between the working rules of quantum mechanics and their possible consequences for our understanding of this world (Pauli, Everett, Bohm, Heisenberg). The last section, 'new developments', dwells on some ideas about the conscious brain and its possible foundation on quantum mechanics.

The book is an interesting and, in part, fascinating contribution to a field that continues to be a companion to 'practical' quantum mechanics since its very beginning. It is doubtful whether such types of 'quantum ontologies' will ever become (empirically) testable; right now one can hardly expect more than to be offered some consistent 'grand picture', which the reader may find more or less acceptable or even rewarding. Many practicing quantum physicists, though, will remain unimpressed.

The shift from synthetic ontology to analytic ontology is the foundation of the present work. This means that fundamental wholes are being partitioned into their ontologically subordinate components by means of 'events'. The actual event, in turn, is an abrupt change in the Heisenberg state describing the quantum universe. The new state then defines the tendencies associated with the next actual event. To avoid infinite regression in terms of going from one state of tendencies to the next, consciousness is there to give these events a special 'feel', to provide a status of 'intrinsic actuality'. The brain of an alert human observer is similar in an important way to a quantum detection device: it can amplify small signals to large macroscopic effects.

On the other hand, actual events are not postulated to occur exclusively in brains. They are more generally associated with the formation of records. Records are necessarily part of the total state of the universe: it is obvious that the state of the universe cannot undergo a Schrödinger dynamics and at the same time record its own history. 'The full universe consists therefore of an exceedingly thin veneer of relatively sluggish, directly observable properties resting on a vast ocean or rapidly fluctuating unobservable ones.'

The present ideas also bear on how the world should be seen to develop. While conventional cosmology encounters problems as to how to define the intial conditions, which would enter the governing equations of motion, here 'the boundary conditions are set not at some initial time, but gradually by a sequence of acts that imposes a sequence of constraints. After any sequence of acts there remains a collection of possible worlds, some of which will be eliminated by the next act.' Connected with those acts is 'meaning': there has always been some speculation about the special significance of local properties in our understanding of the world. One could argue that correlations (even the quantum correlations found, e.g., in the EPR-experiments) were as real as anything else. But also Stapp stresses the special role of locality: the 'local observable properties, or properties similar to them are the natural, and perhaps exclusive, carriers of meaning in the quantum universe. From this point of view the quantum universe tends to create meaning.' This sounds like an absolute concept: meaning not with respect to something else, but defined intrinsically—not easy to digest.

The role of consciousness in the developing quantum universe requires more attention. 'The causal irrelevance of our thoughts within classical physics constitutes a serious deficiency of that theory, construed as a description of reality.' This is taken to be entirely different within quantum mechanics. 'The core idea of quantum mechanics is to describe our activities as knowledge-seeking and knowledge-using agents.' '21st century science does not reduce human beings to mechanical automata. Rather it elevates human beings to agents whose free choices can, according to the known laws, actually influence their behaviour.' An example with respect to perception is discussed: 'Why, when we look at a triangle, do we experience three lines joined at three points and not some pattern of neuron firings?' The brain 'does not convert an actual whole triangle into some jumbled set of particle motions; rather it converts a concatenation of separate external events into the actualization of some single integrated pattern of neural activity that is congruent to the perceived whole triangle.'

How convincing is this proposal? It is hard to tell. I think Henry Stapp did a good job, but there are tight limitations to any such endeavour. Quantum mechanics is often strange indeed, but it also gives rise to our classical world around us. For the emergence of classicality jumps and measurement projections (the basic phenomena connected with those fundamental events of choice) are not needed. Therefore, I doubt whether the explanation of the evolution of our world really allows (or requires) that much free choice. On the other hand, most scientist will agree that empirical science was not possible without free will: we could not ask independent questions if this asking was part of a deterministic trajectory. The fact that the result of a quantum measurement is indeterminate (within given probabilities) does certainly not explain free will. How about the type of measurment? The experimentalist will have to assume that he can select the pertinent observable within some limits. But given a certain design the so-called pointer basis (producing stable measurement results) is no longer a matter of free choice.

'The main theme of classical physics is that we live in a clocklike universe.' Today it is often assumed that the universe was a big (quantum-) computer or a cellular automaton. Many would be all too happy to leave that rather restrictive picture behind. But where to go? Stapp suggests giving consciousness a prominent role: 'The most profound alteration of the fundamental principles was to bring consciousness of human beings into the basic structure of the physical theory.' How far we are able to go in this direction will depend on the amount of concrete research results becoming available to support this view.

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