13.11: Quantum Mechanics- Interpretation

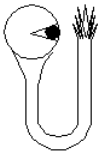
Albert Einstein - Einstein objected to the Quantum Theory on several grounds. Firstly it does not seem to give objective reality to individual events; he believed that an objective world exists, independent of any observer or observing process. Yet Quantum theory seems to imply that our method of observation determines what we will see. Secondly it does not seem to be a complete theory; it is essentially statistical in its predictions and cannot completely describe individual quantum events. His other objections were formalized in the Einstein-Podolsky-Rosen paper, and concerned what he called "spooky actions at a distance". (**NOTE:** in this area at least, Einstein seems to have been wrong. Bell's Theorem and the experiments of Aspect et al have proven conclusively that EITHER there is no objective reality OR that these "spooky" non-local interactions exist).

Neils Bohr - *the Copenhagen collapse*. Bohr believed that the wave function represents our knowledge of the physical phenomena we are studying, not the phenomena itself. In this sense, it is a potential which is realised only when we make an observation; this observation causes the wave function to "collapse" into the actual manifestation of the route taken.

David Bohm - *A Higher Multi-Dimensional Order*. In his book "Wholeness and the Implicate Order" Bohm suggests that the strange effects of the Quantum world may imply the existence of a a deeper, non-local level of reality. At this level - called the implicate order - all things are interconnected in an unbroken whole; "everything interpenetrates everything". Our observational world - which Bohm calls the explicate order - has access to this underlying reality in only a partial and incomplete fashion. Bohm's view has been likened to the suggestion that the Universe is a multi-dimensional hologram; any little piece of the hologram will recover the image, but not the full reality. We are reminded of Blake's wish - "to see the world in a grain of sand".

Eugene Wigner - *Human consciousness*. Wigner goes even further than Bohm by claiming that it is the entry of human consciousness into the picture that causes the wave function to collapse. The Cartesian mind-body dualism is re-established and the influence of the mind on the physical world is explicit. Wigner believes that the Newtonian concept of action-reaction and quantum physics both are evidence for this belief.

John Wheeler - *The Participatory Universe*. The renowned mathematician, John von Neumann was also an adherent to this view, which claims that the universe does not exist until a human mind is there to observe it. In this view, the universe is a self-observing system; the early stages of the universe can be promoted to concrete reality through its later observation by conscious ness, which itself depends on that reality (!!)



Hugh Everett and Bryce de Witt - *The Many Worlds Interpretation*. Far-fetched though this sounds it provides one of the cleanest explanations of the wave function collapse. The idea is that at each observation of the world ALL possibilities allowed by the wave function of the system are actually realised. The universe splits into branches, each corresponding to one of the possibilities available to it. Each branch is completely independent of the others, and no communication can take place between branches.

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