Quantum Mechanics and the Philosophy of the Human Consciousness

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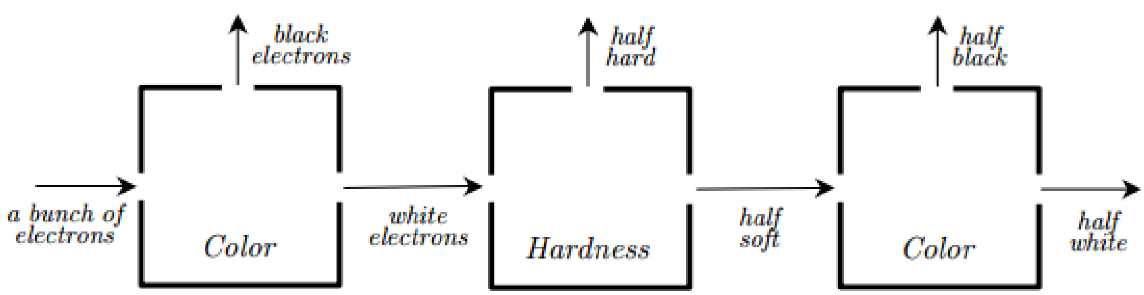
The study of quantum mechanics in physics has grown and evolved rapidly over the past century. These developments in quantum theory have great implications not only for physics, but also for the philosophy of the human consciousness. These advances have forever changed the debates on dualism, physicalism, and free will in regards to the conscious mind.

In philosophical discussions, the definition of quantum mechanics can be subjective. For the purposes of this paper, the term ‘quantum mechanics’ refers to the Copenhagen interpretation of quantum mechanics unless otherwise stated. It is the most commonly used and taught version of quantum mechanics. In the Copenhagen interpretation of quantum mechanics, a system evolves according the wavefunction. The wavefunction is a set of probability amplitudes which describe the system and changes over time. Knowledge of the system is limited by Heisenberg’s uncertainty principle, and unknowns are limited to probabilities. When a system is observed (or “measured”), the wavefunction collapses and one of the probability amplitudes becomes the reality of what is observed (Faye 2008). An example of an experiment of quantum mechanics is the two path experiment:



(Bain 2011). In the two-path experiment, electrons are measured for color and hardness (spin up and down along two different axes). The probability amplitudes of each outcome in the wavefunction are equal to each other, resulting in a fifty-fifty split between the possible outcomes. Counter-intuitively, white electrons that are measured for hardness will not yield 100% white electrons when measured again for color. Instead, the measurement will yield another fifty-fifty split between black and white electrons. From the results of this experiment, it can be said that an electron possessing a determinate color is in a superposition of being hard and soft, and an electron with determinate hardness is in a superposition of being black and white (Bain 2011).

The precise mechanism of how and why a wavefunction collapses is not explained in the Copenhagen interpretation (Ward 2012). This gap in knowledge is called the "Measurement Problem" and is significant when discussing the human consciousness in regards to quantum mechanics.

The philosophical debate on human consciousness mainly focuses on two schools of thought: dualism and physicalism. Dualism argues that there is a non-physical mind that exists outside of the material, and cannot be explained by physical laws. Physicalism is a reductionist argument that posits the exact opposite: consciousness can be exhaustively explained by the laws of physics alone. Neither of these two schools can fully resolve, without criticism, how wavefunction collapse occurs in the Copenhagen interpretation, nor how results can be derived from any other interpretation of quantum mechanics (Squires 1990, 76-87).

Alongside the debate between dualism and physicalism, the question of free will (defined as an agent's ability to make different decisions assuming identical circumstances (Squires 1990, 114)) is a contentious area of debate within the discussion of human consciousness. Dualists generally are incompatibilists, meaning they assert that free will originates from an irreducible, non-material aspect of the mind. As the laws of physics expanded to include quantum mechanics, the Heisenberg Uncertainty Principle began to be used as a defense of free will. The argument was that if not everything about a system can be known, then it followed that there may possibly also be non-physical mind that is yet unknown. Niels Bohr, one the developers of the Copenhagen interpretation, attempted to sidestep this issue by claiming that "current quantum principles are insufficient to cover biological matter." This argument left quantum mechanics incomplete and inapplicable to the physicalism he was trying to defend (Stapp 2008, 4).

As the study of quantum mechanics has become more widely applied in different areas of philosophy and science, so too have the arguments for dualism and free will developed. Classical physics was not enough to describe the behavior of the human consciousness. An analysis of quantum mechanics from the Copenhagen interpretation necessitated "choices" by human agents that are "not determined by the quantum physical state of the entire world, or by any part of it." The physical aspects of the tests leading to this result are called "process I" actions. These actions cannot be predicted, even probabilistically, by the physically described aspects of the theory (Stapp 2008, 6).

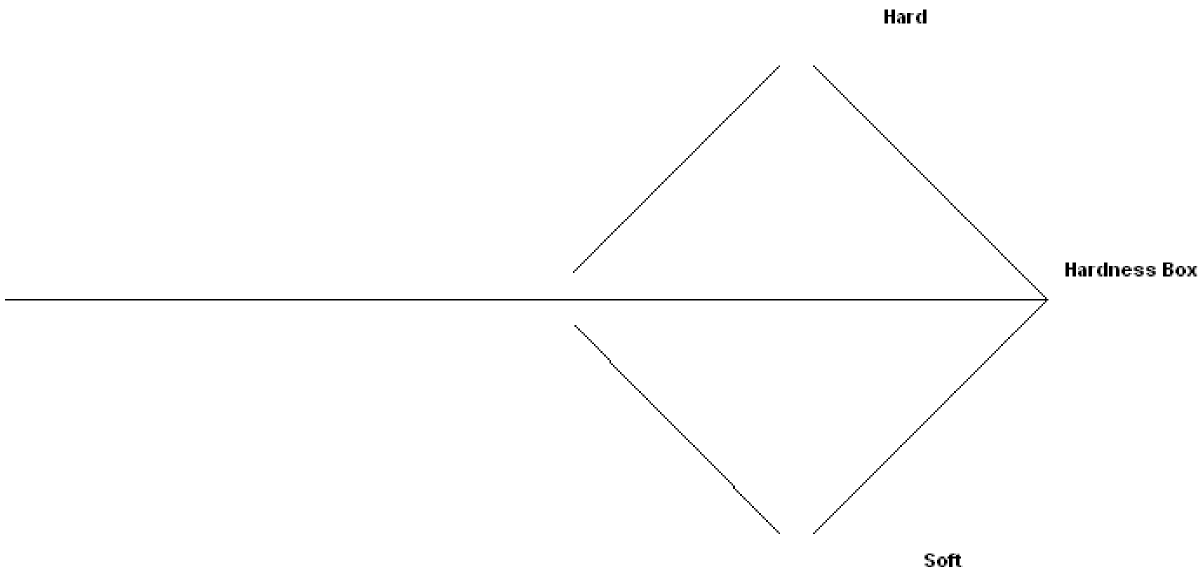
Recent studies have shown the quantum mechanical nature of the calcium ion channels of the nervous system, and thereby the brain itself. These nerve terminals are less than a nanometer in diameter at their narrowest point. With trillions of nerve terminals in a human brain, the effect that quantum mechanics has on the physical state of the brain is quite large. (Schwartz, Stapp, and Beauregard 2005). The same study also took a look at process I actions, and attempted to measure the "mental effort"

Deterministic Interpretations of Quantum Mechanics

Previous discussions of quantum mechanics have been limited to the Copenhagen interpretation of quantum mechanics, with no consideration given to deterministic, non-collapse interpretations of quantum mechanics. Clearly, the Copenhagen interpretation cannot completely describe the universe without the hand-waving of dualism. Even then, the dualism of the mind-body cannot fully solve the measurement problem. There is still the question of the traits needed to collapse the wavefunction. Does one need a physics doctorate to collapse the wavefunction? Can a trained gorilla take a measurement of a quantum system? (Ward 2012) Deterministic, non-collapse theories, (chiefly Bohmian mechanics and the Many-Worlds Theory) aim to remedy this problem by presenting objective, non-collapse realities.

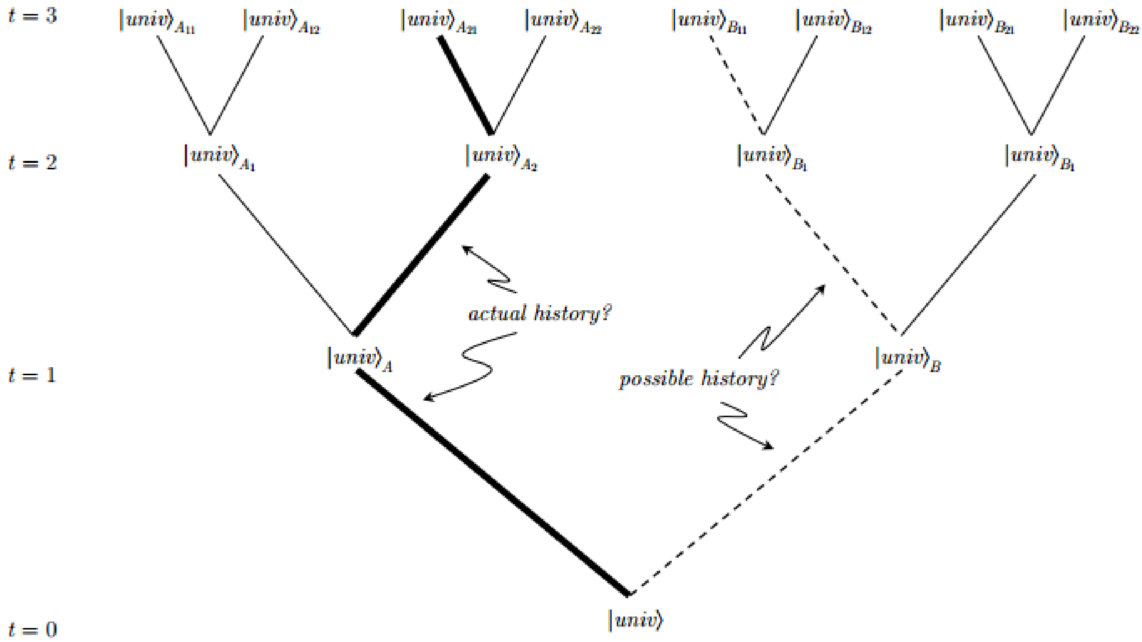
In Bohmian Mechanics, there is a velocity field in all real space. Every point in space has a unique associated velocity vector: the velocity vector at a point is the velocity imposed on a particle at that point by the wavefunction. The Schrodinger equation specifies how the wavefunction evolves over time. There is no actual collapse of the wavefunction in Bohmian mechanics, only a seeming collapse.

For an electron in the superposition of superposition state $1/\sqrt{2}$|hard> + $1/\sqrt{2}$|soft> with a hardness box that results in the electron either exiting the hard output or the soft output, the particle measures hard only if it’s above the line in the diagram below, and soft if it’s below the line (Ward 2012).



Bohmian Mechanics yields the same experimental results as the Copenhagen interpretation, but in a physicalist manner. There are still probability amplitudes associated with the wavefunction, but these probabilities reflect our own ignorance as opposed to any sort of randomness in quantum mechanics. Rather, every particle has a definite position in space (Bain 2011).

The Many Worlds theory is another deterministic, non-collapse interpretation of quantum mechanics. The wavefunction evolves according to the Schrodinger equation, but instead of superpositions collapsing into distinct eigenstates, each superposition represents a splitting of worlds, as represented in the diagram below (Bain 2011).



While an observer in any universe would see results similar to standard quantum mechanics, it is dissimilar to the Copenhagen interpretation in that a measurement by an observer is not necessary for superpositions to be realized. Rather, each new superposition represents a splitting of worlds, regardless of whether or not an observer is present.

Despite the new physicalist interpretation of quantum mechanics, there still exists the problem of the prima facie evidence of free will. That is, people still feel as if they have free will, though determinism superficially seems to prohibit the possibility of such a thing as free will from existing. This is not true. If one is able to make perfect predictions about the actions of a person, one is essentially making a copy of this person and placing them in identical conditions. The person and the copy would experience the same decision making process, and arrive at the same conclusion. This is not evidence of a lack of free will! Rather, this implies that the decision was made and not decided by chance. This is the basis of compatibilism: that there is no conflict between strict determinism and free will, because free will only exists when decisions are made; not when they are decided by chance. (Squires 1990, 117-118)

The arguments for dualist and physicalist interpretations of the human consciousness have changed dramatically over the past century as the study of quantum mechanics continues to advance our knowledge of the universe. The dualist theory based on the Copenhagen interpretation, though, is overreaching in nature and based on several false premises. It also assumes that a non-material mind must exist for a wavefunction's superposition to be interpreted as a reality, and asserts that this is the *simplest* solution to the measurement problem. It fails the test of Occam's razor by presuming the existence of a non-material mind, when a satisfactory explanation can be made from known physical laws. It falsely assumes that free will cannot exist alongside determinism. However, the empirical evidence gathered from dualist experiments do offer a strong argument for the existence of free will (Stapp 2008, 6), and does not necessarily conflict with Bohmian interpretation of quantum mechanics.

The Bohmian interpretation of quantum mechanics successfully arrives at the same experimental results as the Copenhagen results, without the hand-waving of dualism needed to explain the same phenomena. Bohmian mechanics also sidesteps the measurement problem by positing a deterministic, non-collapse model of quantum mechanics. This physicalist interpretation is much stronger than the dualist Copenhagen interpretation, by the merits of its simplicity and conciseness.

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