Understanding the Copenhagen Conundrum: A Perspective on Electron Diffraction and Pilot Waves

ChatGPT Writing on behalf of and from information provided by Mukesh Prasad, 55NDA India, 1988 MPhil Yale, USA

When ChatGPT writes "I" and "my" below, it is referring to Mukesh Prasad

Electron diffraction experiments have long fascinated physicists. In these experiments, electrons fired from an electron gun pass through two slits and produce patterns of reinforcement and cancellation on a detection screen. These patterns closely resemble interference effects seen in water waves. For instance, if two pebbles are dropped into a calm lake near each other, the waves spreading out from the impact points interact, creating regions of reinforcement and cancellation. The diffraction patterns suggested that electrons exhibited wave-like behavior.

However, the mystery deepened when this interference pattern persisted even when electrons were fired one at a time. With only a single electron passing through the apparatus, what could it possibly be interfering with? This observation presented a profound challenge to classical notions of particles and waves.

The Probability Wave Hypothesis

The dominant explanation at the time was to interpret the "wave" not as a physical entity but as a probability distribution—a mathematical representation of where the electron *might* be found. In this view, the wavefunction (probability wave) leaks through both slits and interferes with itself. This self-interference determines the probability of detecting the electron at specific positions on the screen. While mathematically elegant, this interpretation is fundamentally abstract, relying on probabilities to account for a physical phenomenon without specifying a concrete mechanism.

Bohm's Pilot Wave Theory

Dissatisfied with the nebulous nature of probability waves, David Bohm, building on earlier ideas by de Broglie, proposed an alternative: real, physical pilot waves. In this theory, an electron is guided by a pilot wave, which interacts with both slits and creates interference patterns. The electron's trajectory follows the contours of these interference patterns, offering a clear and intuitive mechanism for the observed results.

Resolving the Dichotomy: Probability Waves vs. Pilot Waves

The debate boils down to this: are the observed effects a consequence of abstract probabilities or tangible pilot waves? The two models are mutually exclusive—you can't have both. Based on my work uncovering the actual mechanism underlying Bohm's pilot waves, I conclude that pilot waves provide the correct explanation. With a concrete mechanism in place, the probability wave interpretation and its broader implications—such as those invoked in support of quantum computing—become unnecessary.

Credit: ChatGPT brought out the reference to de Broglie, I did not know prior to ChatGPT's mention that Bohm's work was based on earlier work by de Broglie – Mukesh Prasad