Quantum Mechanics

Summary

http://quantumspotacademy.org/videos/quantum-mechanics/

Before quantum mechanics, there were two theories of light: the particle theory and the wave theory. These theories can be tested by performing the double slit experiment, in which a beam of light is passed through two small slits and is then observed on a screen. If light is made of particles, we should see two bars of scintillating points. But if light is made of waves, then we should see a fuzzy interference pattern. When the double slit experiment is performed, contrary to our expectations, we observe individual particles forming an interference pattern.

In quantum mechanics, all fundamental constituents of matter and energy exhibit wave-particle duality and are described by wavefunctions. The square modulus of a particle's wavefunction is a probability distribution, which tells us how likely we are to find a particle in a given place. A particle exists at all possible locations with different probabilities.

When a single photon is emitted from the light source, it passes through both slits in a superposition of two states, interfering with itself like a wave. Because of the probability distribution, we are more likely to see it in some places than in others. However, if we add a measuring device at the two slits, the interference pattern disappears. Each photon only passes through a single slit. This is called wavefunction collapse.

Quantum entanglement occurs when a pair of particles is in a superposition of two states so that measuring one particle collapses the wavefunction of the entire system.

If an electron is shot at a thin barrier, it has a small probability of appearing on the other side of the barrier. This is called quantum tunneling.

Classical physics serves as an excellent approximation for quantum mechanics at the scale of everyday life.

The fundamental probability of quantum mechanics adds a twist to the philosophy of determinism; we cannot determine particles' locations, only their wavefunctions. Some people have proposed "hidden variable" theories to remove probability from quantum mechanics; so far, none have been successful.