Interferometry with Neutrons

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Neutrons are unique particles that play an instrumental role in nuclear physics but also are a powerful tool in both material science and fundamental physics. Neutrons exhibit many unique properties. For instance, unlike protons and electrons, neutrons can penetrate objects because of their charge neutrality. Neutrons have a magnetic moment such that they behave like tiny magnets and interact with magnetic fields. They are quantum particles with spin $\frac{1}{2}\hbar$ and de Broglie wavelengths of a few angstroms making them ideal probes of atomic structure.

Neutron interferometry makes use of the neutron's wave-like nature by 'splitting' a single neutron into two separate paths (i.e. placing the neutron in a quantum superposition) and later combining them. Neutron interferometry represents one of the most precise, clearest examples of self-interface and is used to study quantum mechanics and quantum information processes. What makes it a compelling device is its simple-to-interpret results and the ability to control and manipulate neutrons' wave function by simple macroscopic elements. In addition to studying quantum information, neutron interferometry has been used to study the strong force, gravity, and place limits on cosmological models. Recent interferometry work at the National Institute of Standards and Technology's Center for Neutron Research has been used to study quantum information processes with spin-polarized neutron beams. A second interferometry facility was added in 2011 specifically for quantum information and material science research. The speaker will talk about neutron interferometry's history and its role in understanding the quantum regime.