MYSTERIOUS QUANTUM EFFECTS OBSERVED WITH NEUTRONS

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S u m m a r y

Single-particle interference phenomena can be observed with neutrons, and the "entanglement of degrees of freedom", i.e. the contextuality, can be verified and used in further experiments. Entanglement of two photons or atoms is a complementary situation to the double-slit diffraction of a single photon, neutron, or atom. In this respect, neutrons are proper tools for testing quantum mechanics, because they are massive, they couple to electromagnetic fields due to their magnetic moment, and they are subject to all basic interactions, and they are sensitive to topological effects as well. The 4π-symmetry of spinor wave functions, the spin-superposition law, and many topological phenomena can be made visible, which shows interesting intrinsic features of quantum physics. Related experiments will be discussed. Deterministic and stochastic partial absorption experiments can be described by Bell-type inequalities. Recent neutron interferometry experiments based on post-selection methods have renewed the discussion about quantum non-locality and the quantum measuring process. It has been shown that interference phenomena can be revived even when the overall interference pattern has lost its contrast. This indicates a persisting coupling in the phase space even in cases of spatially separated Schrödinger cat-like situations. These states are extremely fragile and sensitive against any kind of fluctuations and other de-coherence processes. More complete quantum experiments also show that a complete retrieval of quantum states behind an interaction volume becomes impossible in principle.