

中性子を用いた素粒子物理学実験

Monday, September 1, 2025 2:00 PM (1 hour)

The neutron is a unique particle, which is a smallest nucleus, has no charge, and sensitive to four interactions: strong, electromagnetic, weak, and gravity. Thanks to the features, neutrons have been used in a variety of fundamental physics research. In this talk, fundamental physics experiments using neutrons are reviewed.

The neutron lifetime is an important parameter for elemental particles and astrophysics. So far, the neutron lifetime measured by counting decay of thermal neutron and storing ultra-cold neutrons (UCNs) gives different results. It is so-called “neutron lifetime puzzle”, and not yet unsolved. We are promoting a new neutron lifetime experiment using pulsed neutrons at J-PARC.

Neutron interferometry using Si single crystals has been a great success in the field of fundamental physics. Recently, a neutron interferometer with multilayer mirrors has been successfully demonstrated with the pulsed neutron at J-PARC. It can be applied for measurements of scattering lengths of nuclei, and going to try to be further sensitivity for new physics.

Quantum mechanics and general relativity are two important frameworks that were successfully describe the dynamics, but the two have not yet been integrated. Low-energy neutrons are good probes to search for quantum and gravitational properties simultaneously, and experiments are underway to observe the gravitational quantum states of neutrons. These experiment can search the short range gravity, which is predicted to solve the the hierarchy problem. We are promoting a new experiment using small neutron nuclear scattering by vanadium nanoparticle targets.

The search for time-reversal symmetry breaking has been vigorously pursued to explain the matter-dominated universe. The neutron EDM search is one of the most strongly constrained of these experiments, and a new time-reversal symmetry breaking search experiment based on the amplification of parity breaking is being planned and developed at J-PARC.

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