Washing Up with Hot and Cold Running Neutrons: Tests of Fundamental Physical Laws

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The properties of the Neutron and its interactions with matter have been long applied to tests of fundamental physical principles. An example of such an application is a tests of the stability of the fundamental constants of physics based on possible changes in low-energy absorption resonances and the isotopic composition of a prehistoric natural reactor that operated two billion years ago in equatorial Africa. A recent re-analysis of this event indicates that some fundamental constants have changed. The focus of the presentation will be on the uses of cold and ultracold neutrons (UCNs), and in particular, the experimental search for the neutron electric dipole moment (EDM) which would be evidence for time-reversal asymmetry in the microscopic interactions within the neutron. Ultracold neutrons are neutrons with kinetic energy sufficiently low that they can be reflected from material surfaces for all angles of incidence, allowing UCNs to be stored in material bottles for times approaching the beta decay lifetime of the neutron. Vagaries associated with the production, transport, and storage of UCNs will be described, and an overview progress on development of a new neutron EDM experiment to be operated at LANSCE will be presented. This new experiment has potential to improve the measurement sensitivity by a factor of 100. Although an EDM has not be observed for any elementary particle, experimental limits have been crucial for testing extensions to the so-called Standard Model of Electroweak Interactions. Our anticipated sensitivity will be sufficient to address questions regarding the observed matter-antimatter asymmetry in the Universe.

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