Observation of the Gravitationally Bound Quantum States of Ultracold Neutrons with Submicron Spatial Resolution

G. Ichikawa, S. Komamiya, Y. Kamiya

Department of Physics, Graduate School of Science, and International Center for Elementary Particle Physics, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan

ichikawa@icepp.s.u-tokyo.ac.jp

Ultracold neutrons have very low kinetic energy, therefore they can be bound by terrestrial gravity above a reflecting mirror. The wave function of the bound state has a characteristic modulation. The experimental study of the gravitationally bound state is started in 2002 [1] but the observation of the spatial distribution of such a state is restricted by the several microns resolution of current slow neutron detectors.

To overcome the limitation, we developed a novel technique of magnifying the spatial distribution of the gravitationally bound state using a Ni-coated cylindrical rod as a convex mirror. The observed modulation is in good agreement with that prediction. The detector resolution is estimated to be 0.7 micron. This is the first observation of the gravitationally bound state of ultracold neutrons with submicron spatial resolution.


The distributions of UCNs for the data (points with errors) and for the prediction (lines) in which up to the 50th states are considered.