Investigation of low-energy antinucleon–nucleus interactions for an experiment to search for neutron–antineutron oscillations with ultracold neutrons

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Neutron–antineutron oscillations violate baryon number conservation and have important roles in testing theories beyond the Standard Model and understanding the origin of the baryon asymmetry in the universe [1]. Currently, the oscillation time is constrained to be >0.86·10^8 s for free neutrons, and > 2.7·10^8 s for neutrons bound in nuclei [2,3]. Recently, a number of ideas have been proposed that would substantially improve the sensitivity of the experiments. In this context, a new research reactor planned in Japan will provide a unique opportunity to conduct such an experiment with high-intensity ultracold neutrons (UCNs) [4-6]. A key for these new methods is an accurate understanding of low-energy antineutron-nucleus interaction [7,8].

To address this, we initiated a two-fold research program to investigate low-energy antinucleon–nucleus interactions. The first is X-ray spectroscopy of antiprotonic atoms, focusing on isovector component of the optical potential, which has been neglected up to now, but has a significant impact on deducing the antineutron scattering length from antiproton data. The second is direct measurement of antineutron–nucleus scattering lengths with low-energy antineutrons, which can potentially be conducted at the Antiproton Decelerator at CERN. A Letter of Intent outlining the basic design and feasibility of such a beamline was submitted to CERN this year [10,11].

In this seminar, I will outline the current experimental landscape, describe our strategy for constraining the antinucleon–nucleus interaction at low energies, and discuss how these developments can contribute to particle physics using neutrons, and hadronic physics of antinucleon–nucleus interactions.

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