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High precision searches for baryon number violation via neutron conversions at the European Spallation Source

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The 2020 Update for the European Strategy for Particle Physics explicitly highlights the need for programs at the so-called intensity frontier which exploit the unique potential of European laboratories. The European Spallation Source (ESS), presently under construction, in Lund, Sweden, is a multi-disciplinary international laboratory that will operate the world's most powerful pulsed neutron source. Taking advantage of this, the HIBEAM/NNBAR collaboration[1] proposed a two-stage program of experiments to perform high precision searches for neutron conversion in a range of baryon number violation channels. This culminates in an ultimate sensitivity increase for neutron → antineutron oscillations of three orders of magnitude over the previously attained limit obtained at the Institut Laue-Langevin ILL. The opportunity for a three-orders-of-magnitude improvement in the test of a global symmetry is rare.

The observation of BNV via free neutron oscillations would be of fundamental significance, with implications for many open questions in modern physics which include the origin of the matter-antimatter asymmetry, dark matter, the possible unification of fundamental forces, and the origin of neutrino mass.
The first stage of this program HIBEAM (High Intensity Baryon Extraction and Measurement) will exploit the ESS fundamental physics beamline. This stage focuses principally on searches for neutron conversion to sterile neutrons n' that would belong to a "dark"sector and a search for neutron → antineutron via intermediate dark neutron states.

The second stage, NNBAR, will exploit a large beam port, specifically designed for this experiment in the ESS target station monolith to maximize the neutron flux and search directly for neutron → antineutron oscillations.
The NNBAR experiment would take neutrons produced from the ESS source which would then be reflected and focused through a magnetic field-free region towards a distant carbon target. The target is surrounded by a detector to observe a multi-pion state arising from the baryon number annihilation signal of an antineutron with a nucleon in a carbon nucleus.
Work is ongoing for conceptual design reports for both the HIBEAM and NNBAR states.
This talk will give an overview of the motivation of the experiment, the experimental techniques, and the current state of the research.

[1] A. Addazi et al., J.Phys.G 48 (2021) 7, 070501

In-person participation

Yes

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