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Searches for baryon number violation via neutron conversions at the European Spallation Source

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The observation of neutrons converting to antineutrons and/or sterile neutrons would demonstrate Baryon Number Violation (BNV) for the first time. BNV is an essential condition needed to produce the matter/anti-matter asymmetry in the universe and appears in a number of theories beyond the Standard Model. The existence of sterile neutrons would address the issue of a possible dark sector of particles. The HIBEAM/NNBAR project is a proposed series of experiments for the European Spallation Source (ESS) that can open up a discovery window for BNV by observing free neutrons transforming to antineutrons and/or sterile neutrons. A series of competitive searches are planned with an ultimate improvement in sensitivity of three orders of magnitude compared with the previous free neutron to anti-neutron search at Institut Laue-Langevin. This talk describes the HIBEAM/NNBAR experiment. The motivation for the experiment and theories predicting neutron conversions are described, followed by a description of the ESS and those ESS facilities which can be exploited for the experiment. The set-ups and sensitivities of the neutron conversion searches are shown. Special focus is placed on the annihilation detector which would use a Time Projection Chamber and calorimeter system exploiting scintillators and lead-glass. Geant-based simulations of the annihilation signature within a detector are shown and compared with background predictions. Finally, it is also shown how the program of work benefits from important but lower sensitivity searches ongoing by the Oak Ridge National Laboratory and being performed by many of the same collaborators as those on HIBEAM/NNBAR. Although it is a dedicated particle physics experiment, HIBEAM/NNBAR is a multi-disciplinary milieu, bringing together experts in neutronics, magnetics, detector design, and data analysis.

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