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New Searches for Neutron Oscillations at ORNL

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Two critical questions in particle physics remain unanswered—what is the particle nature of dark matter, and why is there no antimatter in the universe? Searches for neutron oscillations are an essential component of the worldwide program to understand baryon number violation and what comprises dark matter, but are underexplored experimentally. If dark matter is made up of a rich hidden sector such as “mirror matter,” neutral particles such as the neutron might oscillate into their dark twin. This phenomenon was suggested as the source of the long-standing discrepancy between the cold neutron appearance (“beam”) and ultracold neutron disappearance (“bottle”) techniques for measuring the neutron lifetime. I will describe a new search for mirror neutron oscillations recently performed at ORNL’s Spallation Neutron Source that has ruled out this explanation of the neutron lifetime puzzle. I will also discuss plans for additional searches at ORNL and the ESS, including searches for neutrons transforming into mirror neutrons and back into antineutrons. This program will inform a future high sensitivity search for neutrons transforming directly into antineutrons in the NNBAR experiment, which can improve sensitivity by three orders of magnitude over the previous direct search.

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