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Search for Anomalous Decay of the Free Neutron Using the UCNA Experiment: $n \to \chi + e^+ + e^-$

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The neutron lifetime is currently measured by two different types of experiments: 'beam' and 'bottle'. These two measurement techniques have a 4σ discrepancy in measured lifetime. A recent paper proposes to resolve this issue by introducing a dark sector particle, χ, that could offer an alternative decay channel for the neutron. This decay channel could resolve the discrepancy since beam experiments measure final decay products and bottle experiments measure remaining neutron population. The proposed theory allows for an e^+e^- pair produced in addition to a hypothesized χ. The UCNA (Ultra Cold Neutron Asymmetry) experiment has sensitivity to this particular decay signature, since it would appear as a mono-energetic peak over a standard β decay spectrum. In this experiment, polarized neutrons decay in a trap and their charged products are guided by a 1 T magnetic field to detectors on either side, thus effectively giving 4π detection coverage. Timing information and energy reconstruction is done on each β decay. We use results from the UCNA experiment's 2012–2013 dataset to set limits on the branching fraction of this decay channel. In the case of a candidate e^+e^- pair, the summed reconstructed energy from both sides is used to set limits on the branching ratio of this decay channel, as a function of the mass of the hypothesized χ. We present an overview of the calibration process and the limits on a neutron dark decay channel set by the UCNA experiment.

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