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Search for Dark Matter Decay of the Free Neutron from 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. It has been proposed recently that a previously unobserved neutron decay branch to a dark matter particle (χ) could account for the discrepancy in the neutron lifetime observed in experiments that use two different measurement techniques. One of the possible final states discussed includes a single χ along with an e^+e^- pair. We use data from the UCNA (Ultracold Neutron Asymmetry) experiment to set limits on this decay channel. Coincident electron-like events are detected with $\approx 4\pi$ acceptance using a pair of detectors that observe a volume of stored Ultracold Neutrons (UCNs). The summed kinetic energy ($E_{e^+e^-}$) from such events is used to set limits, as a function of the χ mass, on the branching fraction for this decay channel. For χ masses consistent with resolving the neutron lifetime discrepancy, we exclude this as the dominant dark matter decay channel at $\approx 5\sigma$ level for 100 keV $< E_{e^+e^-} <$ 644 keV. If the $\chi + e^+e^-$ final state is not the only one, we set limits on its branching fraction of $< 10^{-4}$ for the above $E_{e^+e^-}$ range at $> 90\%$ confidence level.

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