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The Cosmic Axion Spin Precession Experiment (CASPEr)

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The nature of dark matter is a key problem in modern physics, and it is important to develop techniques to search for a wide class of dark-matter candidates. Axions, originally introduced to resolve the strong CP problem in Quantum Chromodynamics (QCD), and axion-like particles (ALPs) are strongly motivated dark matter candidates. Nuclear spins interacting with a background axion/ALP field experience an energy shift which oscillates at a frequency equal to the axion/ALP Compton frequency. The Cosmic Axion Spin Precession Experiment (CASPEr) uses precision magnetometry and NMR techniques to search for the effects of this interaction. The experimental signature is precession of the nuclear spins under the condition of magnetic resonance: when the bias magnetic field is tuned such that the nuclear spin sublevel splitting is equal to the axion/ALP Compton frequency. These experiments have the potential to detect axion-like dark matter in a wide mass range (10^{-12} eV to 10^{-6} eV) and with coupling strengths many orders of magnitude beyond the current astrophysical and laboratory limits, and eventually all the way down to the QCD axion.

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