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Searching for Axions with Magnetic Resonance Force Microscopes

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We propose a magnetic resonance force microscopy (MRFM) search for axion dark matter around $m_a \sim \mathrm{GeV}$. The experiment leverages the axion's derivative coupling to electrons, which induces an effective A.C. magnetic field on a sample of electron spins polarized by a D.C. magnetic field and a micromagnet. A second pump field at a nearby frequency enhances the signal, and the detuning is matched to the resonant frequency of a magnet-loaded mechanical oscillator. The resulting spin-dependent force is detected with high sensitivity via optical interferometry. Accounting for the relevant noise sources, we show that current technology can be used to put constraints competitive with those from laboratory experiments with just a minute of integration time. Furthermore, varying the D.C. magnetic field and pump field frequency allows one to scan the axion mass. Finally, we explore this setup's capability to put constraints on other axion- Standard Model couplings.

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