

First Search for Ultralight Dark Matter Using a Magnetically Levitated Particle

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There has been growing interest in using quantum sensing technologies for novel particle physics measurements. We perform the first search for ultralight dark matter using a magnetically levitated particle at Leiden University. A sub-millimeter permanent magnet is levitated in a superconducting trap with a measured force sensitivity of $\sqrt{0.2} \text{ fN}/\sqrt{\text{Hz}}$. We find no evidence of a signal and derive limits on dark matter coupled to the difference between baryon and lepton number, $B - L$, in the mass range $(1.10360-1.10485) \times 10^{-13} \text{ eV}/c^2$. Our most stringent limit on the coupling strength is $g_{B-L} \lesssim 2.98 \times 10^{-21}$. We have proposed the POLONAISE (Probing Oscillations using Levitated Objects for Novel Accelerometry in Searches of Exotic physics) experiment, featuring short-, medium-, and long-term upgrades that will give us leading sensitivity in a wide mass range and demonstrating the promise of this novel quantum sensing technology in the hunt for dark matter.

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