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Ultralight Dark Matter Detection with Levitated Superconductors

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Kinetically mixed dark photons and axionlike particles are both viable ultralight candidates for dark matter. These candidates can source an oscillating magnetic field signal inside an experimental apparatus. Existing experiments search for this signal by taking advantage of resonant enhancements, e.g. from a lumped-element circuit or resonant cavity, but such techniques become difficult for frequencies below a kHz (corresponding to dark-matter masses $m_{\rm DM}$
$lesssim 10^{-12}\,\mathrm{eV}$). In this talk, I will demonstrate that magnetically levitated superconducting particles (SCPs) can be utilized to detect dark matter at lower frequencies. A SCP must screen magnetic fields out of its interior, and so it tends to settle at the point of smallest magnetic field. This effect can be used to trap a SCP at the center of a quadrupole field. The magnetic field signal from dark matter can perturb the equilibrium point of this trap, resulting in an oscillatory motion of the particle. When the frequency of this oscillation (set by the dark matter mass) matches the trapping frequency, this motion experiences a resonant enhancement. I will discuss both broadband and resonant schemes for utilizing SCPs to detect dark matter. I will show that in the Hz
$lesssim f_{\rm DM}$
$lesssim$kHz frequency range, levitated SCPs can achieve the leading sensitivity amongst laboratory probes of dark matter.

Authors: Dr HIGGINS, Gerard (Institute for Quantum Optics and Quantum Information (IQOQI), Vienna, Austria); KALIA, Saarik (University of Minnesota); LIU, Zhen

Presenter: KALIA, Saarik (University of Minnesota)

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