A Radio For Hidden Photon Dark Matter

Main author:

CHAUDHURI Saptarshi

Co-authors:

Chaudhuri Saptarshi, Stanford University, Department of Physics

Graham Peter, Stanford Institute for Theoretical Physics, Stanford University

Irwin Kent, Stanford University, Department of Physics

Li Dale, SLAC National Accelerator Laboratory, Stanford University

Mardon Jeremy, Stanford Institute for Theoretical Physics, Stanford University

Rajendran Surjeet, University of California, Berkeley

Zhao Yue, Stanford Institute for Theoretical Physics, Stanford University

We propose a new dark matter search at 100 mK using SQUIDs and parametric amplifiers that will provide unprecedented sensitivity over the mass range of ultra-light hidden photon dark matter. The hidden photon (also known as the dark photon) is a well-motivated dark matter candidate, appearing in many extensions of the Standard Model. It can be produced athermally, in the same manner as axions, or as recently discovered, through inflationary fluctuations. Nevertheless, the hidden photon phase space remains largely unprobed. Here, we describe a novel concept for a hidden photon search based on a superconducting tunable lumped-element resonator--essentially a radio for hidden photons. This approach will ultimately exclude, or detect, hidden photon dark matter over six orders of magnitude in coupling--down to mixing angles of 10^-17-- and nine orders of magnitude in mass--from 100 Hz to 700 GHz. We describe cavity and shielding geometries fundamental to the detection scheme. Additionally, we show, through considerations of amplifier backaction, that we can obtain a cavity quality factor of 10^6, at which the signal-to-noise is maximized. We discuss three separate readout architectures and demonstrate how the thermal noise of the cavity can be resolved--as required for optimal performance--in each architecture: dc SQUIDs from 100 Hz to 10 MHz, microwave SQUIDs from 10 MHz to 1 GHz, and quantum-limited parametric amplifiers from 1 GHz to 700 GHz.