

Quantum Sensors for Ultra-light Dark Matter Detection

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Abstract— Quantum sensors can greatly enhance the science reach of searches for ultralight (sub- μeV), wavelike dark matter candidates including axions and hidden photons. We are developing the Radio Frequency Quantum Upconverter (RQU), a Josephson-junction-based device capable of measuring low-frequency electromagnetic signals more sensitively than the Standard Quantum Limit. In particular, these sensors will be used to search for QCD axion dark matter in the Dark Matter Radio experiment at masses from 10neV to 1 μeV . The RQU is a quantum sensor capable of implementing multiple quantum coherent measurement techniques below 300 MHz, including two-mode squeezing, sideband cooling, and backaction evasion. I will describe the implementation of an RQU with superconducting microwave circuit elements and quantum coherent measurement protocols appropriate for ultra-light dark matter detection.

Keywords (Index Terms) — Axion, dark matter, quantum sensor.

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