APR21-2021-000894

Abstract for an Invited Paper
for the APR21 Meeting of
the American Physical Society

Accelerating dark matter searches using entangled microwave cavities[1]

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Recent experimental progress definitively establishes that quantum enhanced sensing can benefit a search for axionic dark matter. But for these methods to dramatically expand the reach of laboratory scale experiments, they must achieve much greater quantum enhancement. These quantum enhanced experiments use superconducting circuits to measure and manipulate the quantum state of the microwave cavities that couple to the hypothetical dark matter. And learning to use these circuits most effectively in dark matter searches is a new frontier of experiment design. In this talk, I describe a concept that uses simultaneous entanglement and state exchange between two microwave resonant modes to accelerate an axion dark matter search by a factor of 20 over the quantum limited value. The concept builds upon the squeezed state receiver recently deployed in the HAYSTAC apparatus, which demonstrated a doubling of the quantum limited scan rate, but overcomes its primary limitation. Importantly, the mode entanglement concept is no more complex to operate than the squeezed state receiver. Indeed, the design of dark matter search experiments should now compare the resources needed to enhance the dark matter signal to those required to suppress quantum noise.

[1]Support from the DOE and the NSF through the Q-SEnSE QLCI