Contribution ID: **12** Type: **Talk**

Searching for Wavelike Dark Matter with SRF Cavities

Thursday 11 August 2022 11:50 (20 minutes)

Haloscopes consisting of a microwave cavity with a high quality factor (Q) connected to low noise electronics have been deployed to detect wavelike axions and dark photons. But the dark matter mass is unknown, so haloscopes must be tunable to search through the photon coupling vs. mass parameter space. Therefore, the scan rate for haloscope experiments is a crucial figure of merit and is proportional to the cavity's quality factor. State-of-the-art experiments like ADMX currently use copper cavities with $Q \sim 80000$. However, implementing superconducting cavities with $Q \sim 10^{10}$ can increase the scan rate by possibly a factor of 10^5.

This presentation will discuss the principles behind operating a haloscope whose bandwidth is much narrower than the dark matter halo energy distribution. I will then discuss proof-of-principle measurements that demonstrate that ultra-high Q cavities have unprecedented sensitivity to dark photon dark matter. Next, I will discuss plans to commission a dark photon dark matter search over a wide frequency range. Finally, I will discuss the applications of ultra-high Q cavities for axion searches and progress toward realizing ultra-high Q cavities under multi-Tesla magnetic fields.

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Session Classification: Contributed talks