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Axion Search with HAYSTAC Phase III Multi-Rod Cavity Upgrade

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QCD axions are doubly motivated due to their ability to comprise dark matter and solve the strong CP problem. This makes them one of the most promising dark matter candidates. Haloscopes are axion detection experiments that use tunable microwave cavities to resonantly enhance signals from the axion-photon coupling that occurs in the presence of a strong magnetic field. Because the haloscope cavity readout is quantum-limited, they are coupled to superconducting readout lines containing low-noise amplifiers. The Haloscope At Yale Sensitive To Axion CDM (HAYSTAC) is the first haloscope to use quantum squeezing to noiselessly amplify its cavity readout. This broadens the sensitivity bandwidth, allowing HAYSTAC to achieve a maximum scan-rate enhancement of 2x. HAYSTAC has placed exclusions on axion parameter space between 4.1 −5.8 GHz (16.96-24.0 μeV) using a cylindrical microwave cavity with a single tuning rod during data-taking Phases I & II. In preparation for Phase III, HAYSTAC is currently upgrading to a multi-rod cavity that can perform high-frequency searches with a high FOM, allowing searches between 5.5-7.3 GHz (22.75-30.19 μeV). This talk will provide an overview of HAYSTAC and the seven-rod cavity design, summarize the testing and commissioning of the new cavity at Yale, as well as discuss outlooks for HAYSTAC Phase III.

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