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Status and Future Plans for the HAYSTAC Experiment

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HAYSTAC (Haloscope At Yale Sensitive To Axion CDM) is a microwave cavity experiment designed both as a data pathfinder and innovation test-bed, in the 3–12 GHz (12–50 μeV) mass range. The Phase I run program (2016–17) covered a small region of mass around 24 μeV, achieving a sensitivity in axion-photon coupling well into the range of realistic axion models for a standard halo density. With a tunable annular copper cavity of only 1.5 L volume in a 9 T superconducting magnet, HAYSTAC achieved a system noise temperature of only 2× the Standard Quantum Limit ($k_B T_{SYS} = h\nu$), an order of magnitude improvement over any other experiment; its extraordinary sensitivity owing to the first-ever use of Josephson Parametric Amplifiers (JPA) and a dilution refrigerator in a microwave cavity experiment. Currently, a 2-JPA squeezed-vacuum state receiver is being integrated into the experiment that will enable a significant speed up of data taking; commissioning will begin early summer. Innovations in microwave resonators will also be described, such as Photonic Band Gap structures to eliminate interference from unwanted TE-modes with the TM010-like mode of interest, which couples to the axion field.

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Collaboration name

HAYSTAC

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