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In-situ System Noise Measurement for Axion Haloscopes with JPAs

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The Axion Dark Matter eXperiment (ADMX) is one of the world's leading direct detection experiments searching for an elusive dark matter particle candidate known as the axion. The axion's origin lies in the realm of particle physics, initially coming into existence as a solution to the strong CP problem. Since its inception however, physicists have been interested in it not only for its ability to solve this mystery, but also for its characteristics that make the axion a compelling cold dark matter candidate. One of two benchmark models, designated as DFSZ, has been of particular interest due to its compatibility with GUT, however it has notably weak axion-photon couplings making it difficult to detect. To date, the ADMX collaboration has excluded axion-photon couplings predicted by the KSVZ (DFSZ) model for the axion between 2.66-4.2 μeV (2.66-3.3 μeV & 3.9-4.1 μeV). This feat was accomplished by making use of a dilution refrigerator to reduce thermal noise, as well as the application of low-noise quantum electronics to minimize receiver noise. Namely, we utilize a superconducting Josephson Parametric Amplifier (JPA) as our first stage amplifier, which requires sufficient understanding of the noise in our receiver chain. In this talk, I will discuss the procedure for calibrating system noise in an axion haloscope, with a particular focus on the experimental set up used in our most recent data taking run. I will speak to the different types of measurements taken, the noise models used, as well as the operation and performance of our JPA.

Early Career

Yes

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