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Status and recent developments of the QUAX haloscope at Legnaro National Laboratories

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The QUaerere AXion (i.e. QUest for AXions, in short QUAX) experiment is an haloscope-based galactic axion search effort aiming to probe theoretically-relevant axion-photon couplings in the 8.5-11 GHz frequency window.
This frequency range will be covered by two haloscope setups, located at LNL- and LNF-INFN laboratories in Italy respectively. In this talk we will focus on the recent results obtained at LNL, starting with the detailed analysis of the summer 2022 data run. The proof-of-concept acquisition covered a 200 kHz frequency range around 10.35345 GHz, demonstrating the highest sensitivity yet obtained above 10 GHz.
The employed resonator was a TM030 dielectric cavity with loaded Q factor of ∼250000 in overcoupled conditions, while a Nb-Ti superconducting magnet provided an 8 T magnetic field. The run took advantage of the low temperatures provided by a dilution refrigerator, allowing the installation of a low noise Traveling Wave Parametric Amplifier (TWPA) developed by the group of N. Roch (Grenoble).
Total noise temperature of the setup was measured as 2.06 +/- 0.13 K, resulting in peak sensitivity of $g_{a\gamma\gamma} < 2.05 \cdot 10^{14}$ GeV^{-1} at 95% C.L. We will also detail recent developments at LNL, such as testing of an easily tuning mechanism for empty cavities and of a high C-factor TM030 Bragg resonator. Additionally, we will present the results concerning a novel coaxial polygonal cavity, which promises both very high effective volumes and frequency tunability. Finally, we will give an overview of the near-future perspectives for the experiment, detailing the plans to upgrade the current setup to a fully operational haloscope.

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