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Towards the development of the ferromagnetic haloscope: status report of QUAX

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The search of dark matter in the form of Axions, extremely light and weakly interacting particles, can be performed with detectors called haloscopes. These setups usually test the coupling of Axions with photons, but recently ferromagnetic haloscopes have been proposed to probe the interaction of Axions with the electrons of a magnetic material [1].
The QUAX experiment aims at implementing this idea. The first setup was operated at cryogenic temperatures and the results were presented in [2] for a limited range of the Axion mass. The apparatus demonstrates the possibility of using electron spin resonance in a microwave cavity at 4 K to measure Axion-induced excesses of magnetization in a sizable quantity of material.
However, such prototype is still far from the sensitivity needed for a QCD-Axion search, and more developments are necessary in terms of measurement precision and maximization of the signal.
The most recent improvements in this direction will be presented. These include the implementation of an apparatus at mK temperatures featuring a Josephson Parametric Amplifier, of a superconducting cavity operating in a high magnetic field, and of drastically increased material volume.
Eventually, the potential bandwidth of such haloscopes is under study through a tool which ultimately could also be used to get an absolute calibration of the setup.

[1] "Searching for galactic axions through magnetized media: The QUAX proposal", R. Barbieri *et al.* Phys. Dark Univ. 15: 135 (2017) https://doi.org/10.1016/j.dark.2017.01.003.

[2] "Operation of a ferromagnetic axion haloscope at $m_a = 58\,\mu\mathrm{eV}$", N. Crescini *et al.* Eur. Phys. J. C 78: 703 (2018) https://doi.org/10.1140/epjc/s10052-018-6163-8.

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