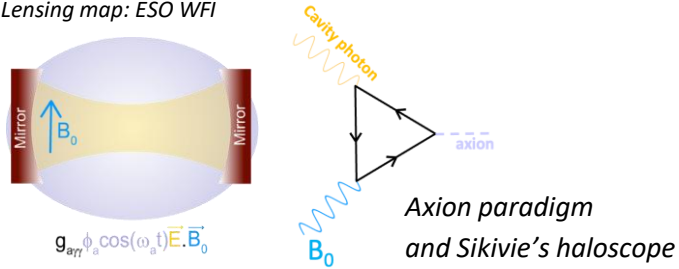


QRADES (Quantum Relic axion detection sensors)

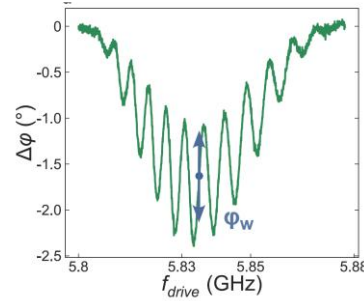
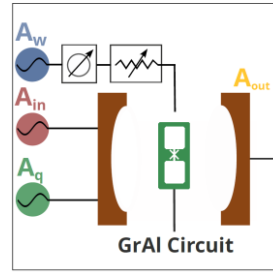
Starting date : April, 1st , 2024 End date : March, 31st , 2027



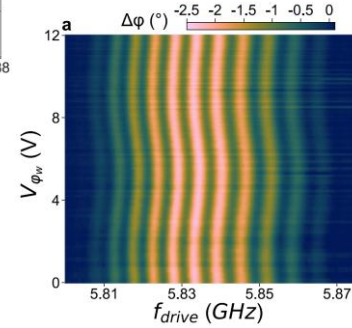
The bullet cluster (ESA) : X-ray: NASA/CXC/CfA/ M.Markevitch, Optical and lensing map: NASA/STScI, Magellan/U.Arizona/D.Clowe, Lensing map: ESO WFI



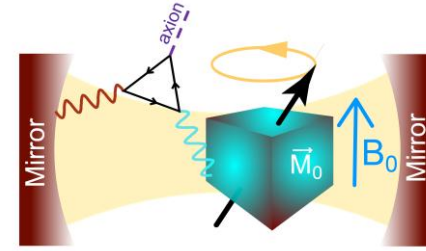
Pathfinder experimental setup



Ramsey fringes



10⁻⁵ in 400ms sensitivity. C. Fruy, A. Théry et al. in preparation

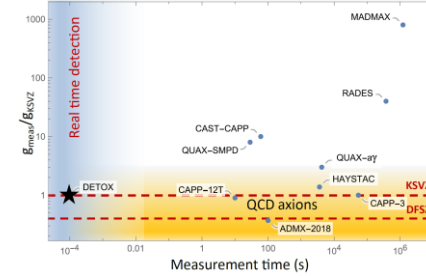
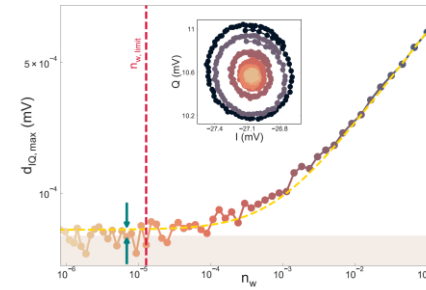


Phase resolved protocol for axion dark matter detection.

A. Cottet and T. Kontos '25

Use of non-linear cavity gyromagnetic modes

$$\hat{H}_{a,eff} = \hbar(\tilde{\omega}_a + 2K_{am}\sqrt{n_{ax}}\sqrt{n_m}\cos(\phi_{ax} - \phi_2))\hat{a}^\dagger\hat{a} + \tilde{K}_a\hat{a}^{\dagger 2}\hat{a}^2 + \tilde{\epsilon}(t)\hat{a}^\dagger + \tilde{\epsilon}^*(t)\hat{a}$$



Prospect sensitivity of DETOX haloscope

The project. Axions, or axions-like particles, are important candidates for dark matter in the universe. The QRADES project is devoted to their quantum enhanced detection in the Milky Way halo. The focus of the project will be the magneto-electric coupling term in Maxwell's equations expected to arise from the existence of axions. Theory predicts them to be with the maximum likelihood in the microwave range. The detection scheme developed in the project will be based on mature quantum sensing technology in the microwave range using superconducting quantum circuits and magnonics. We expect within the QRADES project to enable at least two orders of magnitude increase of the scanning range for the axion mass/frequency. The methods developed in the QRADES project will borrow both from the quantum physics of circuits and from particle physics. This will allow us to probe cosmologically relevant corrections to Maxwell's equations at the quantum limit. Our experiments will allow us either to detect for the first time prominent dark matter candidates or to put new constraints on the modifications of the standard model.

Use of quantum sensing techniques to probe the dark universe

The team.

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