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## Searching for dark matter using precision oscillators

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We present recent result that search for Dark Matter using precision oscillators. the first experiment searches for scalar dark matter via Coupling to Fundamental Constants through the comparison of photonic, atomic and mechanical oscillators. Specifically we compare a cryogenic sapphire oscillator (CSO), hydrogen maser (HM) atomic oscillator, and a bulk acoustic wave quartz oscillator (OCXO). This work includes the calculation of the dependence of acoustic oscillators on variations of the fundamental constants, and demonstration that they can be a sensitive tool for scalar DM experiments. Results are presented based on 16 days of data in comparisons between the HM and OCXO, and 2 days of comparison between the OCXO and CSO. No evidence of oscillating fundamental constants consistent with a coupling to scalar dark matter is found, and instead limits on the strength of these couplings as a function of the dark matter mass are determined, and is described in detail in [1]. The second experiment involves searching for frequency shifts between two cylindrical cavity modes, which up converts any low mass axion signal to microwave frequencies, a proof of principle experiment was undertaken and will also be discussed. To improve these experiments, new ways to build ultra-low phase noise oscillators are under development [3], and should significantly advance these experiment in the future.

[1] WM Campbell, BT McAllister, M Goryachev, EN Ivanov, ME Tobar, Phys. Rev. Lett. vol. 126, 071301, 2021.

[2] CA Thomson, BT McAllister, M Goryachev, EN Ivanov, ME Tobar, Phys. Rev. Lett., vol., 126, 081803, 2021.

[3] EN Ivanov, ME Tobar, "Noise Suppression with Cryogenic Resonators," IEEE Microwave and Wireless Components Letters, vol. 31, no. 4, 2021.

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