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The DAMNED Experiment : Dark matter Scalar field search with Optical Cavity and an Unequal-Delay Interferometer

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The DAMNED experiment is a new type of experiment that compares the frequency of a clock to itself in the past, by “storing” photons in a fibre delay line.

In ultra-light oscillating dark matter (DM) models, the coupling of DM to the standard model fields yields an oscillation of fundamental constants, which in turn leads to oscillations of the cavity and fibre lengths and of the fibre refractive index. Additionally, the sensitivity is significantly amplified around the mechanical resonance frequencies of the cavity. We present experimental result of such an experiment and report no evidence of DM for frequencies in the [10, 200] kHz region [Savalle et al., PRL 126, 051301 (2021)].

In order to take into account the stochastic property of the DM scalar field, we have developed and used a Bayesian analysis method whose versatility allows it to be applied to similar experiments.

Taking advantage of the experiment enhanced sensitivity and the tailored data analysis, we are able to improve constraints on the involved coupling constants by one order of magnitude in a standard galactic DM model, at the mass corresponding to the resonant frequency of our cavity.

Furthermore, in the model of relaxion DM, we improve on existing constraints over the whole DM mass range by about one order of magnitude, and up to six orders of magnitude at resonance.

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