A search for light scalar dark matter in the radio-frequency band with atomic spectroscopy

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The fundamental constants of nature are invariant in time within the standard model of particle physics but become dynamical in a number of theories beyond the standard model. The notion that these constants oscillate rapidly has recently received attention, as such oscillations can arise in models that explain the origin of the dark matter relic abundance, assuming it is of the form of a light scalar[1]. The relaxion, a particle introduced to provide a cosmological solution to the hierarchy problem[2], was shown within minimal models to be a viable light dark matter candidate. Furthermore, such particles might form boson stars, thereby increasing dark matter density locally and enhancing the potential observability of this scenario.

We report the results of a recent experiment that employs spectroscopy in atomic cesium to probe fast oscillations of the fine structure constant and the electron mass, in the 0.02 100 MHz frequency range [3]. Our measurements provide constraints on couplings of the dark matter field to standard-model matter, which within relaxion star scenarios, compete with constraints coming from equivalence principle and fifth force experiments.

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