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Impact of cavities on the detection of quadratically coupled ultra-light dark matter

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Ultra-light scalar fields may explain the nature of the dark matter in our universe. If such scalars couple quadratically to particles of the Standard Model the scalar acquires an effective mass which depends on the local matter energy density. The changing mass causes the field to deviate from its cosmological value in experimental environments. In this work we show that the presence of a local over-density enclosing the experiment, for example a cavity, vacuum chamber, or satellite can strongly suppress the value of the scalar and its gradient in the interior. This makes detection of such scalar dark matter challenging, and significantly relaxes constraints on strongly coupled models. We also discuss the possibility that quadratically coupled ultra-light scalar dark matter could be detected by the differential measurement of the force on two cavities of the same mass but different internal structure.

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