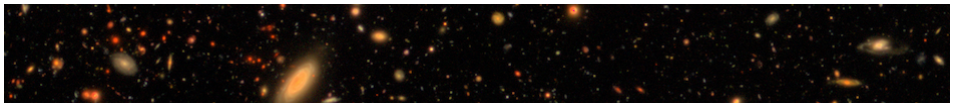

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Direct limits for scalar field dark matter from a gravitational-wave detector

Tuesday, 28 September 2021 16:45 (25 minutes)

We report on the first direct search for scalar field dark matter utilising a gravitational-wave detector. Scalar field dark matter is predicted to cause oscillations of fundamental constants, which in turn would drive oscillations of the size and index of refraction of the beamsplitter in an interferometer. This would thus produce an oscillatory signal in a gravitational-wave detector at a frequency set by the mass of the dark matter particle. We set new upper limits for the coupling constants of scalar field dark matter as a function of its mass, by excluding the presence of possible dark matter signals in data from the GEO600 interferometer. The new constraints improve upon bounds from previous direct searches by more than six orders of magnitude, and are in some cases more stringent than limits obtained in tests of the equivalence principle by up to four orders of magnitude. Our work demonstrates that scalar field dark matter can be probed or constrained with direct searches using gravitational-wave detectors, and highlights the potential of quantum-enhanced interferometry for dark matter detection.

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