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Towards the Detection of Ultralight Dark Photon Dark Matter Using Optomechanical Sensors

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Dark matter may exist as an ultralight bosonic particle, leading to the formation of an ever-present field that could interact with us via a new long-range fifth force. Recently, quantum sensing techniques have been shown to be promising avenues with which to detect such a dark matter candidate. However, these studies did not entirely capture the stochastic nature of the field, which is important to construct realistic exclusion limits and discovery regions. In this talk, I will show how an experiment employing an array of optomechanical sensors can be used to place leading bounds on ultralight dark photon dark matter via an improved statistical treatment. I will highlight the different statistical regimes required depending on how long the dark matter field is observed. In particular, I will show how, in the low-observation time regime, projected limits can suffer by an order of magnitude compared to previous estimates. Our results demonstrate that an array of optomechanical sensors would form a powerful probe of ultralight dark matter, with our study highlighting the experimental considerations necessary to optimise its sensitivity.

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