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Searching for Fifth-Forces, Dark Matter, and Gravitational waves with AMO-based sensors[1]

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We normally think of large accelerators and massive detectors when we consider the frontiers of elementary particle physics, pushing to understand the universe at higher and higher energy scales. However, several tabletop low-energy experiments are positioned to discover a wide range of new physics beyond the Standard model, where feeble interactions require precision measurements rather than high energies. In high vacuum, optically-levitated dielectric nanospheres achieve excellent decoupling from their environment, making force sensing at the zeptonewton level (10-21 N) achievable. In this talk I will describe our progress towards using these sensors for tests of the Newtonian gravitational inverse square law at micron length scales. Optically levitated dielectric objects and optical cavities show promise for a variety of other applications, including searches for gravitational waves and Dark Matter. Finally, I will discuss the Axion Resonant InterAction Detection Experiment (ARIADNE), a precision magnetometry experiment using laser-polarized 3-He gas to search for a notable dark-matter candidate: the QCD axion.

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