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Detecting short-range forces with levitated laser-cooled microspheres ANDREW GERACI, University of Nevada, Reno, SCOTT PAPP, JOHN KITCHING, NIST, Boulder, CO — Optically levitated and cooled dielectric microspheres in ultra- high vacuum show great promise as resonant force detectors. By eliminating the need to tether the spheres to a solid substrate, excellent environmental decoupling is achieved, potentially leading to sub-attonewton sensitivity. Hence, they can be used to investigate Casimir forces or for testing non-Newtonian gravity [1]. We consider an experimental setup involving trapping a sub-wavelength silica microsphere in an optical cavity. The cavity is filled with two light fields to trap and cool the center of mass motion of the sphere, respectively. The sphere is trapped in an anti-node of the trapping light close to an end-mirror of the cavity. Casimir forces due to the end-mirror can be measured as a frequency shift of the oscillator, and non-Newtonian gravity-like forces can be measured by monitoring the displacement of the sphere as a mass is brought behind the cavity mirror. The technique we describe could potentially extend the search for non-Newtonian gravity by several orders of magnitude at the micrometer length scale.

[1] A.A.Geraci, S.B.Papp, and J.Kitching, Phys. Rev. Lett. 105, 101101 (2010).

Andrew Geraci
University of Nevada, Reno

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