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Searching for new short-range forces using optically levitated microspheres

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We are developing a novel technique to search for non-Newtonian gravitational forces at micron length scales using optically levitated dielectric microspheres. At high vacuum, dissipation of the microsphere's motion due to residual gas collisions becomes small, allowing sub-attonewton force sensitivity. As a first demonstration of the ability to perform sensitive force measurements with these techniques, we have searched for the presence of stable, millicharged particles bound in the microspheres. These techniques can also enable searches for screened scalar particles, such as the chameleon, which have been proposed to account for dark energy at cosmological distances, but which would also lead to detectable forces at distances below 100 μm. We will describe the experimental apparatus, the results from the search for millicharged particles, and the expected sensitivity of a search for non-Newtonian forces at micron length scales.

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