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First search for new forces at the micron scale using optically levitated microspheres

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We report on a search for non-Newtonian forces that couple to mass, with a characteristic scale of $\sim$10 μm, using an optically levitated microsphere as a precision force sensor. A silica microsphere trapped in an upward-propagating, single-beam, optical tweezer is utilized to probe for interactions sourced from a nanofabricated attractor mass with a density modulation brought into close proximity to the microsphere and driven along the axis of periodic density in order to excite an oscillating response. We obtain force sensitivity of $<10^{-16}$ N$/\sqrt{\text{Hz}}$. Separately searching for attractive and repulsive forces results in the constraint on a new Yukawa interaction of $|\alpha| > 10^8$ for $\lambda > 10$ μm. This is the first test of the inverse-square law using an optically levitated test mass of dimensions comparable to λ, a complementary method subject to a different set of system effects compared to more established techniques.

Reference to paper (DOI or arXiv)

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