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Levitated Optomechanics for Precision Gravitational Measurements[1]

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We set out to combine a mechanical system in which classical mechanics breaks down and quantum mechanics must be used with a seemingly unlikely application, measurement of the strength and effects of gravity. Our optomechanical system consists of a silica microsphere levitated in ultra-high vacuum in a magneto-gravitational trap. The microsphere is trapped in a magnetic field gradient created by permanent magnets and ferromagnetic pole pieces using the weak diamagnetism of the particle. With optical position measurements and feedback, the mechanical motion can be cooled by several orders of magnitude, ideally reaching the quantum ground state. The extreme sensitivity of this optomechanical system to external forces makes it a promising approach to a new measurement of the Newtonian gravitational constant. Furthermore, by measuring the decoherence rate of non-classiscal motional states of the trapped particle, it may be possible to place limits on theories of gravitational decoherence.

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