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Experimental signatures of semiclassical gravity and the many-body Schrödinger-Newton equation BASSAM HELOU, Caltech, HAIXING MIAO, University of Birmingham, HUAN YANG, Perimeter Institute, YANBEI CHEN, Caltech — In semiclassical gravity, the many-body Schrödinger-Newton (SN) equation, which governs the evolution of a many-particle system under self gravity, predicts that classical and quantum eigenfrequencies of a macroscopic mechanical oscillator are different. For high-Q and low-frequency ($\sim$10s of mHz) torsional pendulums made with atoms with small internal motion fluctuations, such as Tungsten or Platinum, this difference can be considerably larger than the classical eigenfrequency of the pendulum. We exploit this split in the design of an optomechanics experiment which, in contrast with experiments that test for quantum gravity, is feasible with current technology and which distinguishes, at low temperatures and within about a year, between the predictions of the SN equation and standard quantum mechanics. Specifically, we propose using light to probe the motion of such oscillators. Moreover, the nonlinearity induced by the SN equation forces us to revisit the wavefunction collapse postulate, resulting in two proposed prescriptions for how the measurement of the light is performed. Each predict a noticeable feature in the spectrum of the outgoing light that is separate from the features of classical force noise.

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