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**Weighing an Optically-Trapped Glass Microsphere Using Short-Time Brownian Motion** YI XU, LOGAN HILLBERRY, SEBASTIAN MIKI-SILVA, DINEY ETHER, MARK RAIZEN, University of Texas at Austin — We report the weighing of an optically trapped single silica microsphere in air, relying on our earlier work that resolved the instantaneous velocity of Brownian motion. Weighing experiments are typically limited by uncertainty in the microspheres density. We overcome this limitation by first deducing the radius of the sphere in a very weak dual-beam optical trap such that its power spectrum is independent of density. We then fix the radius and fit for the density of the sphere, detector calibration constant, and trap strength at arbitrary trapping laser powers. While effective, this method requires a large amount of data to sufficiently smooth the experimental power spectrum. However, once the calibration constant is found for a given trap strength, the equipartition theorem for short-time Brownian motion may be used to monitor mass changes on shorter timescales. We find agreement between the two methods. The equipartition method resolves our mass of 25 picograms in 100 milliseconds with a statistical uncertainty of $\sim$0.5 percent and a systematic uncertainty of $\sim$8.5 percent. Fast detection of the microspheres mass has applications in ice nucleation studies in which the formation of a thin layer of ice causes the mass to change with time.

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