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Acoustic Detection with an Optically Trapped Silica Microsphere
JORDAN ZESCH, DINEY ETHER, LOGAN HILBERRY, YI XU, M.G. RAIZEN, University of Texas at Austin, RAIZEN GROUP TEAM — An ideal acoustic detector would operate near the quantum limit of sensitivity and with a bandwidth that could resolve the fastest signals of interest. We report here on our progress towards the development of such a detector based on our earlier observation of short-time ballistic Brownian motion, as first predicted by Einstein in 1907. We employ a dual-beam optical tweezer to trap glass microspheres in air, together with a novel detection system that can track the center-of-mass motion with ultra-high resolution in space and in time. High frequency acoustic signals are detected through their perturbations of the microsphere, and the noise floor is set by the quantum nature of light rather than by thermal motion. In addition, our system enables much greater detection bandwidth than existing microphones, including high-frequency resonant sensors. Fast and ultra-sensitive acoustic detection has many potential applications, ranging from the search for dark matter and cosmogenic neutrinos in bubble chambers to localizing the stopping point of protons in a patient's body for more precise proton cancer therapy.

Jordan Zesch
University of Texas at Austin

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