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Acoustic measurement of a granular density of state

ELI OWENS, KAREN DANIELS, North Carolina State University —

Measurements of the vibrational density of states $D(\omega)$ in glasses reveal that an excess number of low-frequency modes is associated with a loss of mechanical rigidity. An excess number of such modes has also been observed in both simulations of idealized granular materials near the jamming point, and in experiments on colloids. We experimentally investigate similar features in a jammed, quasi-two-dimensional granular material. We mimic thermal fluctuations using an electromagnetic driver to inject acoustic white noise, while piezoelectric sensors embedded inside a subset of the particles provide measurements of single-particle velocities. By analogy with conventional thermal techniques, we calculate a $D(\omega)$-like quantity via the spectrum of the velocity autocorrelation function. We measure $D(\omega)$ as a function of the confining pressure and find that the peak in the density of states shifts to higher frequency with system pressure. At low pressure, disordered systems have more low frequency modes than do hexagonally-packed systems.

Eli Owens
North Carolina State University

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