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Normal Mode Spectrum of Finite Sized Granular Systems: The Effects of Fluid Viscosity at the Grain Contacts
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We investigate the effects of adsorbed films on the attenuative properties of loose granular media occupying a finite sized rigid container, which is open on the top. We measure the effective mass, $\tilde{M}(\omega)$, of loose tungsten particles prepared under two different sets of conditions: 1) We lightly coat tungsten grains with a fixed volume fraction of silicone oil (PDMS), where the liquid viscosity is varied for individual realizations. 2) In the other set of experiments we vary the humidity. On a theoretical level we are able to decompose the effective mass into a sum over the contributions from each of the normal modes of the granular medium. Our results indicate that increasing either the PDMS viscosity or the humidity, as the case may be, does markedly increase the damping rate of each normal mode relevant to our measurements. However, there is appreciable damping even in the absence of any macroscopic film. With a notable exception in the case of the highest humidity in the humidity controlled experiments, all the relevant modes are weakly damped in the sense of a microscopic theory based on damped contact forces between rigid particles.

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