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Irreversible interaction of sound waves with dense granular matter

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In this talk, we will describe quantitatively the irreversible interaction between sound and the granular medium under low confining pressure (< 0.1 MPa). Both resonance measurement and pulsed wave propagation show that as the acoustic pressure goes up to a few percent of the confining pressure, the dynamic bulk modulus and shear one can be reduced to 10% and 20%, respectively. This observation of modulus softening is qualitatively in agreement with the prediction by a model based on the Mindlin hysteretic nonlinearity at the grain contact level. Beyond certain thresholds of acoustic amplitude, the irreversible sound-granular matter interaction is accompanied by continue or intermittent sample compactions. No visible grain motion is observed at this stage; however the multiply scatted shear waves [1] allow probing a significant evolution of the contact networks, which coincide with slow recovery of elastic moduli. This work may have the implication for better understanding the physical origin of dynamic triggering of the fault core [2].
[1] X. Jia, "Coda-like multiple scattering of elastic waves in dense granular media," Phys. Rev. Lett. 93, 154303 (2004) [2] P.A. Johnson & X. Jia, "Nonlinear dynamics, granular media and dynamic earthquake triggering," Nature 437, 871-874 (2005)