Local strain fluctuations in granular media

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Abstract

Solids respond elastically to shear stress at low strain, then progressively yield and eventually fail. In the case of heterogeneous and discrete solid systems made of particles such as foams, emulsions, colloidal glasses or granular media, yielding at the macroscopic scale is well described by some constitutive laws such as Herschel-Buckley. However, the microscopic mechanisms involved in the elastic-to-plastic transition seem specific to a given system. In granular media, the local mechanisms at the source of elasto-plasticity are not clearly identified yet. In this context, it is useful to develop experimental methods able to resolve particle rearrangementsin the bulk of granular media. Here, we study a dense granular under oscillatory shear stress in the plastic regime. By combining optical tracking of the grains and correlation of multiply scattered ultrasound signals, we show that the strain at the scale of the grains is mainly diffusive. We obtain a consistent signature of plasticity in oscillatory shearing, dominated by the intensity of the anticorrelation between local strain cells that depend on the maximum applied strain and on the density of the packing through the available free volume.

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