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Shear-transformation-zone theory of plasticity in hard-sphere materials CHARLES K.C. LIEOU, JAMES S. LANGER, AHMED E. ELBANNA, JEAN M. CARLSON, Department of Physics, University of California, Santa Barbara — The dynamics of sheared, dense granular materials exhibits features, such as a dynamic yield stress and a glass transition, similar to those of other amorphous solids. However, strictly granular, hard-sphere systems fundamentally differ from traditional glassy and colloidal systems because at microscopic scales their dynamics and interaction energies are insensitive to thermal temperature. In this talk we present a theory of plasticity for sheared, granular materials that combines Shear Transformation Zone (STZ) theory with Edwards' statistical theory of granular materials. We find that the dynamics of a strictly granular system, like other amorphous solids, can be captured statistically in terms of entropic mechanisms. In our analysis of sheared hard spheres, the volume V replaces the energy E as a function of entropy S in conventional statistical mechanics. In place of an effective disorder temperature, a central feature of the STZ theory for traditional glassy systems, the compactivity $X = \partial V / \partial S$ characterizes the internal state. We derive the STZ equations of motion for a granular material accordingly, and predict its macroscopic properties such as shear viscosity and macroscopic frictional coefficient under different shearing conditions.

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