Measuring effective temperatures in sheared, athermal systems at fixed normal load

NING XU, Yale University, COREY O’HERN — We perform molecular dynamics simulations of repulsive athermal systems sheared at fixed normal load to study the effective temperature $T_L$ defined from time-dependent fluctuation-dissipation relations for density. We show that these systems possess two distinct regimes as a function of the ratio $T_S/V$ of the granular temperature to the potential energy per particle. At small $T_S/V$, these systems are pressure-controlled and $T_L$ is set by the normal load. In contrast, they behave as quasi-equilibrium systems with $T_L \approx T_S$ that increases with shear rate at large $T_S/V$. The fact that $T_L$ is slaved to the pressure at small $T_S/V$ indicates that the variables $T_L$, pressure, and density are not sufficient to describe dense, slowly-sheared athermal systems. Another important implication for systems at small $T_S/V$ is that $T_L$ for two systems placed in contact will not equilibrate when a pressure gradient is maintained between them. Thus, $T_L$ does not behave as a thermodynamic temperature variable in the pressure-controlled regime and new definitions of effective temperature should be explored.