Kinetic Theory for Inertial Suspensions

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We consider the averaged flow properties of a suspension in which the Reynolds number based on the particle diameter is finite so that the inertia of the fluid phase is important. When the inertia of the particles is sufficiently large, their trajectories between successive particle collisions are only weakly affected by the interstitial fluid. If the particle collisions are nearly elastic the particle velocity distribution is close to an isotropic Maxwellian. The rheological properties of the suspension can then be determined using kinetic theory, provided that one knows the granular temperature (energy contained in the particle velocity fluctuations). This energy results from a balance of the shear work with the loss due to the viscous dissipation in the interstitial fluid and the dissipation due to inelastic collisions. We use lattice-Boltzmann simulations, to calculate the viscous dissipation as a function of particle volume fraction and Reynolds number (based on the particle diameter and granular temperature). The Reynolds stress induced in the interstitial fluid by the random motion of the particles is also determined. We also consider the case where the interstitial fluid is moving relative to the particles, as would be the case if the particles experienced an external body force.