On the application of kinetic theory to granular gases

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It is well established that when granular matter is externally excited, the external work done on the system provides kinetic energy to the grains that compensate for energy dissipated by collisions and the effects of gravity. In this regime (rapid-flow conditions), the motion of grains resembles the random motion of atoms or molecules in an ordinary or molecular gas and hence, they admit a hydrodynamic-like type of description [1]. The corresponding hydrodynamic equations can be derived from a fundamental point view by extending the conventional kinetic theory of classical gases (which can be considered as a mesoscopic description intermediate between statistical mechanics and hydrodynamics) to dissipative dynamics. This approach has been widely employed in the past few years to obtain the granular hydrodynamic Navier–Stokes equations with explicit forms of the transport coefficients [2].

In this talk, I will consider the inelastic version of the Enskog kinetic equation (which applies to moderate densities) for a simple model of granular gases: a gas of *smooth* hard spheres where the inelasticity in collisions is accounted for via a (positive) constant coefficient of normal restitution. In contrast to previous theoretical attempts [1], the dynamic properties of the granular gas will be obtained for the whole range of values of the coefficient of restitution and the remaining parameters of the system [3]. The study will cover not only monocomponent systems, but also multicomponent granular systems. The knowledge of the dynamic properties will allow us to address some interesting applications, such as the stability of the homogeneous cooling state and the hydrodynamic description of vibrating steady states. The reliability of the theoretical results will be confronted against Monte Carlo and molecular dynamics simulations as well as real experiments. Since the comparison shows in general good agreement (even for strong inelasticity and/or moderately high densities), one can conclude that kinetic theory can be considered as a reliable tool for describing granular flows in rapid-flow conditions. Finally, a recent connection with the random walk description of the diffusion properties of an intruder in a granular gas will be also provided [4, 5].

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