Transport coefficients for a model of confined granular fluid

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ABSTRACT

Granular matter confined in horizontal shallow fluidized beds vibrated in the vertical direction is an interesting system from the experimental, theoretical and simulational point of view [1]. The system can develop a stationary homogenous fluid state generated by the mechanism of injection and dissipation of energy that happens in the system. Under appropriate conditions of density and the parameters of vibration this homogenous state can became unstable exhibiting a dynamics with liquid-solid phase separation [1].

The stationary homogenous regime is interesting by itself because it is possible to study the behaviour of an out of equilibrium system in which energy is injected everywhere through the system at the same time it is dissipated by collisional mechanisms. We have recently proposed a simple collisional model that capture this behaviour and that can be extended to model more complex situations [2]. The model consists in projecting the motion of a system of inelastic hard spheres in the horizontal directions by modifying the collision rule: besides the restitution coefficient that accounts for the energy dissipation in each collision an extra velocity is added in the horizontal normal direction between the center of the grains. The extra energy added in each collision mimics the effect of the energy injection through the transversal vertical vibration. The two mechanisms balance on average producing stationary homogenous states [2,3]. In [2] we study the hydrodynamic modes of confined granular material in a general framework and the predictions that follows from the decay of the time correlation functions where compared with event-driven molecular dynamics simulations of the model. A crossover between two regimes (inelastic and quasi-elastic) was found in good agreement with theory. A Boltzmann-like equation can be written for the model and in the stationary regime the granular temperature and the behaviour of the first cumulants of the distribution can be obtained. The results were compared with event-driven molecular dynamics simulations of the model in the full range of inelasticity. In spite that the stationary distribution function departs from a Maxwellian the cumulants remain small in the whole range of inelasticities [3,4,5]. In the present work a Grad method moment expansion of the distribution is used to obtain the viscosity and the thermal conductivity transport coefficients of the model in the linear approximation and the predictions are compared with event-driven molecular dynamics simulational results and with previous published results for the viscosity obtained in the frame of linear response theory [5]. Very good agreement is found. Extensions of the model that grasp more complex dynamics will be present and discussed.

REFERENCES

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