CLUSTERING, SINGULARITIES AND SHOCKS IN A FREELY COOLING GAS OF INELASTIC HARD SPHERES

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A gas of inelastically colliding hard spheres (the so called granular gas) is a simple model of flow of granular materials. This model can also capture some of the physics of optically thin gases and plasmas that cool by their own radiation and of relevance in astrophysics [1]. When a granular gas evolves freely it exhibits *clustering*: a fascinating spontaneous symmetry-breaking instability. Nonlinear theory of this instability remains one of the major unresolved problems of granular dynamics. We simplified this problem by focusing on the dynamics of a freely cooling granular gas in a long and narrow box, so that the coarse-grained flow is one-dimensional. Our hydrodynamic simulations showed that, at a nonlinear stage of the instability the gas exhibits collapse: the velocity gradient and the gas density diverge at some locations [2]. Molecular dynamics (MD) simulations of this system [3] agree with the hydrodynamic predictions until very close to the time of attempted collapse. The attempted collapse is arrested only when close packing density of hard spheres is reached. The MD simulations also show that later dynamics of the system are describable by the Burgers equation with vanishing viscosity. This makes it possible to predict dynamic scaling laws that characterize the late-time relaxation of the system in terms of a ballistic motion and mergers of large densely packed clusters of particles.

References

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