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Thermal collapse of a granular gas under gravity[1] LEV S. TSIMRING, University of California at San Diego, DMITRI VOLFSON, University of California at San Diego, BARUCH MEERSON, Hebrew University of Jerusalem —

Free cooling of a gas of inelastically colliding hard spheres is a central paradigm of the kinetic theory of granular gases. At zero gravity the temperature of a freely cooling homogeneous granular gas follows a power law in time. How does gravity affect the cooling? We consider a semi-infinite layer of granular gas bounded from below by an elastic wall. An initially isothermal dilute granular gas is prepared in the state of hydrostatic equilibrium with barometric density distribution. We combine molecular dynamics simulations, a numerical solution of granular hydrodynamic equations and an analytic theory to show that the cooling gas undergoes thermal collapse: it condenses on the bottom of the container and cools down to zero temperature in a finite time t_c as $T \sim (t_c - t)^2$. The cooling scenraio is determined by the interplay between the collisional energy loss and heat conduction, while the collapse time t_c is much longer than the typical free fall time of the grains if the inelasticity of the particle collisions is small. The hydrodynamic description is found to be in excellent agreement with molecular dynamics simulations until very close to t_c.

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