Energy decay of a two-dimensional granular gas under gravity

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ABSTRACT

When someone leave a granular gas under gravity force, it will sediment in a finite time. Before the collapse occurs there is a transition regime which includes shock waves that was studied in a previous work [1] but here we will focus only in the last stage of the sedimentation.

Few years ago Volfson et.al.[2] predicted analytically under some assumptions the energy decay with a power law $E(t) \sim (t_c-t)^2$. After that, Son et.al.[3] did the experiment and they could not find the exponent decay for the power law 2 but higher value. After that Kachuck et.al.[4] did a MD simulation and they obtained a similar result as in experiments, the decay is the power law, but the exponent changes depending on different factors.

We studied the same system but considering the granular gas as a continuum media solving numerically the Navier-Stokes equations for a granular fluid composed of smooth inelastic hard disks with constant coefficient of restitution with the Jenkins-Richman transport coefficients [5]. When we were close to the collapse, it means $t \rightarrow t_c$, we did the fitting for $E(t) \sim (t_c-t)^\beta$ obtaining a very good agreement with the experiment [3] and the MD simulation [4] with $\beta \neq 2$. The simulation has been performed for different initial coefficient of restitution α ranges from 0.95 to 0.995. We are able to reproduce the power law predicted in the theory [2] when we are in a nearly elastic system with $\alpha = 0.995$ but not when the system is more inelastic where the power law exponent was higher.

The collapse time t_c is a finite number that depend on the coefficient of restitution, and it decrease when the system is more elastic. Nevertheless, we cannot find a relation with the power law exponent β and the coefficient of restitution.

One of the reasons why the exponent that we found is not as they predicted is because they consider the ideal gas pressure without taking into account the pressure for dense regimes which is necessary and relevant if we study the collapse.

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