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Breakage of the energy equipartition and energy transfer in heated polydisperse granular gases

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Abstract

We investigate a system of polydisperse inelastic particles in order to characterise their non-equilibrium behaviour. Polydispersity of the system leads to a breakage of the energy equipartition, and this effect has been paid much attention recently [1, 2, 3]. As a result of this energy equipartition breakage, it is not possible to assign a unique thermodynamic temperature to the system. Instead, the system can be considered as a mixture of subsystems with their own temperatures, and the internal heat transfer does not thermalise the whole system.

Apart from the dissipative particle interaction, the main reason for this behaviour is due to the mass difference of the colliding particles, causing an asymmetric energy loss of particles. We split the total energy loss into the symmetric and antisymmetric parts, and show that the symmetric part is responsible for the net dissipation. The antisymmetric part arises only in the polydisperse case, and describes the energy transfer among the different sized particles, which is responsible for the breakage of the energy equipartition, meaning that the system does not exhibit a unique temperature anymore. Applying external heating to compensate the symmetric part of the energy loss matrix, we can stabilise the system (stationarity), but it will never attain a unique temperature. Instead, the system obeys a spectrum of temperatures, depending on the size distribution of the granular particles.

References

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