Granular gas experiments to investigate Non-Equilibrium Steady States

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Abstract

We present experiments in granular gases that allow to address topical issues of non-equilibrium statistical physics in a simple way. At macro-scale, we investigate processes where fluctuations dominate, in the same manner as in mesoscopic systems.
Our system is based on a Brownian rotator embedded in a steady-state granular gas. This rotator is passively excited by the random shocks of the beads, but can also be forced from outside.

Analysis of the work exchange with this NESS are compatible with the Fluctuation Theorem as well as the Fluctuation-Dissipation Theorem. These relations accordingly allow to define a parameter kT_eff playing the role of temperature in this dissipative macroscopic system, similar as temperature k_BT in an equilibrium system. A very specific and fruitful feature is that kT_eff_~10^{-7} J, which is very large compared to k_BT_~10^{-20} J. Indeed measurements are easier and more precise, but interesting questions arise about the comparison of these quantities.

We can couple the Brownian probes in distinct such systems and characterize transport of energy between energy reservoirs at different temperatures. (It is interesting to note that transport, linked to inhomogeneity, is a specific features of driven dissipative systems.) We can also vary the density of one of the gas systems, the other being kept constant, such that the mean flux is kept constant.
The parallel between 'mesoscopic' systems at equilibrium and these NESS 'macroscopic' systems is to be further explored and validated, tackling the following questions. When the density of the gas is decreased, the dimensionality of the bath is reduced accordingly (influence of fluctuations is enhanced). In which way is this affecting the motion of the Brownian probe, and transport properties?

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