Granular gases as a paradigm of the Mpemba effect

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The Mpemba effect is a counterintuitive phenomenon according to which, given two samples of fluid, the initially hotter one may cool more rapidly than the initially cooler one [1, 2]. A necessary condition for the effect to take place is that the thermal rate of change depends not only on the instantaneous temperature but also on additional variables. In this talk, I will show that the simplest model of a granular gas, both in the uniformly heated and in the freely cooling settings, exhibits a Mpemba effect [3]. By assuming that the most relevant variable to determine the thermal rate of change, apart from the granular temperature itself, is the excess kurtosis of the velocity distribution of the grains, analytical quantitative predictions for how differently the system must be initially prepared to observe the effect are obtained. An inverse Mpemba effect [4] (whereby a cooler fluid heats more rapidly than a hotter one) is also predicted in the case of uniformly heated systems. The theoretical predictions are numerically confirmed by the direct simulation Monte Carlo method and by molecular dynamics. Time depending, it will be shown that the effect is also present in molecular gases subject to a nonlinear drag.

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