# Dynamics of an inelastic tagged particle under strong confinement

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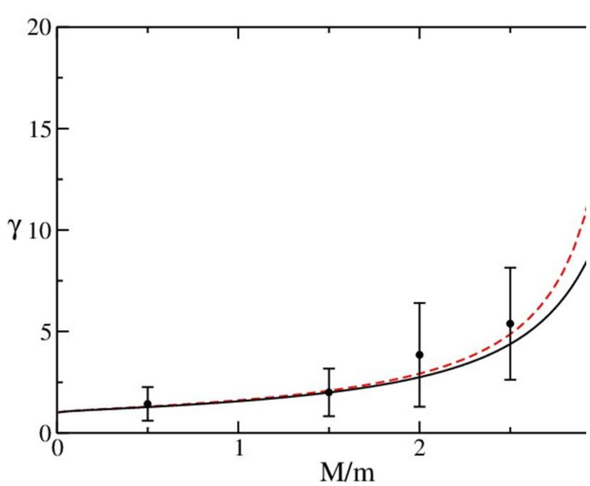
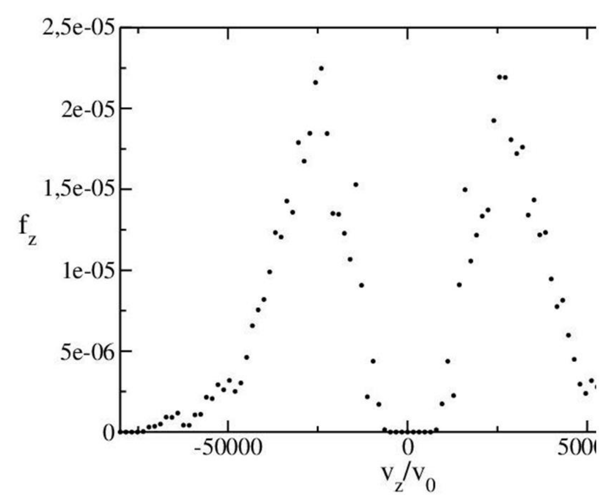
The dynamics of a tagged particle immersed in a fluid of particles of the same size but different mass is studied when the system is confined between two hard parallel plates separated a distance smaller than twice the diameter of the particles. The collisions between particles are inelastic while the collisions of the particles with the hard walls inject energy in the direction perpendicular to the wall, so that stationary states can be reached in the long-time limit. The velocity distribution of the tagged particle verifies a Boltzmann-Lorentz-like equation that is solved assuming that it is a spatially homogeneous gaussian distribution with two different temperatures (one associated to the motion parallel to the wall and another associated to the perpendicular direction). It is found that the temperature perpendicular to the wall diverges when the tagged particle mass approaches a critical mass from below, while the parallel temperature remains finite.

Molecular Dynamics simulation results agree very well with the theoretical predictions for tagged particle masses below the critical mass. In the first figure the quotient between the vertical and horizontal temperature, γ, is plotted as a function of M/m. M is the mass of the intruder and m the mass of the bath particles. The number of particles is 600, the collisions between the intruder and the bath particles are elastic and the collisions between the bath particles are slightly ineslastic. For these values of the parameters the critical mass of the intruder is of the order of 4.5.

The measurements of the velocity distribution function of the tagged particle confirm that it is gaussian if the mass is not close to the critical mass, while it deviates from gaussianity when approaching the critical mass. Above the critical mass, the velocity distribution function is very far from a gaussian, being the marginal distribution in the perpendicular direction bimodal and with a much larger variance than the one in the parallel direction [1]. In the second figure, for the same values of the parameters than in the previous figure, the marginal distribution in the perpendicular direction is plotted as a function of the velocity component perpendicular to the planes scaled with the thermal velocity. The bimodal character of the distribution can be clearly appreciated.




References

[1] P. Maynar, M. I. Garcia de Soria, J. J. Brey, Phys. Fluids 34, 123321 (2022).