Kinetic equation for a confined quasi-two dimensional gas of hard spheres. The elastic and inelastic cases.

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ABSTRACT

A system of hard spheres enclosed between two infinite horizontal parallel plates separated a distance between one and two particle diameters is considered in the dilute limit. A Boltzmann-like kinetic equation is derived by using heuristic arguments, which incorporate the effect of the confinement on the possible particle collisions occurring in the system [1]. If the collisions are elastic, a Liapunov entropy function can be constructed by adding to the Boltzmann expression a confinement contribution. It is shown that this function increases monotonically in time, until the distribution function takes a form describing a stationary inhomogeneous state. The expressions for the steady entropy and density profiles are derived and shown to agree with results obtained by means of functional density limit [2], in the appropriate limit. The theoretical predictions are compared with molecular dynamics simulation data and a good agreement is found. Then, the extension to smooth inelastic hard spheres with a constant coefficient of normal restitution is addressed. As a first issue the possible generalization of the homogeneous cooling state to the confined system is discussed, keeping in mind that the new state is necessarily inhomogeneous. Even more, it is anisotropic, in the sense that the second moment of the components of the velocity in the direction perpendicular to the plates and parallel to them are different. Actually, to describe the time evolution of the temperature field, one has to consider the equation for both, the vertical and horizontal components of the temperature. These equations are derived in some mean field homogeneous approximation and the theoretical predictions compared with molecular dynamics simulation results.

In the near future, our interest focuses in the behaviour of the quasi-two-dimensional fluid seen when looking at the system from above or below, trying to understand the very rich phenomenology observed when the system is continuously vibrated. Perspectives along these lines as well as the relevance of previous effective models [3,4] are discussed.

REFERENCES

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