DIRECT SIMULATION OF KINETIC EQUATIONS (DSK): RELAXATION OF A FREE MOLECUAL GAS

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In this project we consider the trend to equilibrium of a gas. More precisely, a free-molecular gas contained in bounded fixed domain with a uniform temperature is considered. The relaxation of the velocity distribution function of the gas molecules from a given initial distribution to the uniform equilibrium state at rest is investigated numerically under the diffuse reflection boundary condition.

Recently, T. Tsuji, K. Aoki and F. Golse have shown that for a spherical vessel, the velocity distribution function approaches the final uniform equilibrium distribution in such a way that their difference decreases in proportion to an inverse power of time. This is slower than the known result for a rarefied gas with molecular collisions.

The goal of this project is to design a systematic numerical method to approximate the long time behavior of the exact solution.

We consider the free transport equation

$$\frac{\partial f}{\partial t} + v\nabla_x f = 0, \quad x \in (0, L), v \in \mathbb{R}$$

with diffusive boundary conditions.

- A finite volume method will be applied to discretize physical space and a spectral method will be applied for the velocity space.
- Boundary conditions will be treated with a particular attention.

Then, collisions may be considered (e.g. with the Boltzmann collision operator), to take into account binary collisions in the gas.

References

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