Ghost Effect by Curvature

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The diffusive hydrodynamic limit of the Boltzmann equation in the low Mach number regime is usually described by the incompressible Navier-Stokes-Fourier equations. In some situations however, the macroscopic equations contain some extra terms reminiscent of the limiting procedure such as some heat flow induced by the vanishingly small velocity field. Such terms could never arise from the similar scaling limit performed on the compressible Navier-Stokes equations. Thus they are genuine kinetic effects. Y. Sone has given the suggestive name of "ghost effects" to such phenomena.

In this talk, after presenting some general background on the ghost effects, I shall focus on a particular ghost effect arising when one considers a particular scaling limit for a kinetic gas between two coaxial rotating cylinders kept at fixed temperatures. When the radius of the inner cylinder is sent to zero while the difference of the radii is kept fixed.

If we start from the Boltzmann equation, with a suitable scaling the result differs from the usual planar Couette flow for terms reminiscent of the curvature of the cylinders, which on the other hand goes to zero in this scaling limits, hence a ghost effect in the sense of Sone. The presence of such extra terms is responsible of a bifurcation phenomenon which is absent in the standard planar Couette flow. Such a bifurcation was pointed out by Sone and Doi.

In a joint work in preparation with L. Arkeryd, R. Marra and A. Nouri, we prove the bifurcation on the hydrodynamic level and construct the corresponding stationary solutions to the Boltzmann equation. The analysis is based on a two parameters expansion and a new spectral gap estimate for the linearized Boltzmann operator previously successfully employed to show existence of roll solutions to the Benard problem for the Boltzmann equation and exponentially fast in time decay of small initial perturbations.