Motion of fluids: applications in astrophysics, in medicine and in other areas

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The main goal of the study is to develop a complete mathematical theory for system of partial differential equations describing the full thermomechanical behaviour of fluids (non-homogeneous) with (without) complicated rheological properties or with fixed (varying) boundary. Problems of this type arise naturally in industry, biomedicine (e.g. blood flow), astrophysics, and in environmental sciences (oceanography, meteorology). Let us mention some of our motivations and aims of our work.

- One of our motivation in this work is the study of the equations describing objects called "accretion disk" which are quasi planar structures observed in various places in the universe. From a naive point of view, if a massive object attracts matter distributed around it through Newtonian gravitation in presence of a high angular momentum, the matter is not accreted isotropically around the central object but forms a disk around it.

- Another motivation is the investigation of flows of a viscous incompressible (compressible) fluid around a rigid body belongs to widely studied fundamental questions of the theoretical and experimental fluid dynamics. Naturally, a body moving in the fluid influences the fluid flow and vice versa. This is a special case of the "fluid–structure interaction".The investigation of the fluid–structure interaction plays a crucial role in mechanical and civil engineering (e.g. in the design of aircrafts, bridges, etc), and it must also be taken into account in studies of the blood flow (the aneurysms in large arteries, artificial heart valves, etc).

The aims are the following:

- We consider asymptotic regimes for the compressible Navier-Stokes-Fourier system coupled to the radiation when the radiative intensity is driven either to equilibrium or to non-equilibrium diffusion limit, depending the scaling performed, and we study the convergence of the system toward the aforementioned limits.

- Reduction - dimension limit

- Qualitative analysis of the motion of fluid around rigid body with or without prescribed rotation and translation of a body