

## Open systems

Research focus of the current project is directed to open systems, mostly but not only, in the framework of continuum thermodynamics. Significant part of the available mathematical results in this area concern closed systems, meaning that the system does not exchange any matter with its surroundings or even isolated systems that do not exchange neither any matter nor energy. Our interest concerns open systems, i.e. such systems that can exchange energy and matter.

We are used to description of biomaterials, in particular hard and soft tissues, which have the ability to adapt not only their external shape but also their internal microstructure to environmental changes. The mathematical models in biomathematics, very often based on (linear) transport equation, although consist of rather simple equation, but the boundary conditions, which complete the whole problem to an open system, give rise to subtle difficulties.

The situation in the studies of continuum thermodynamics is very much different. The system describing the evolution of the flow arises from physical system of balance laws. Once all the effects of compressibility of the flow and thermal effects are of interest, then we work with a complex system of nonlinear partial differential equations. With overwhelming difficulties arising in case of Navier-Stokes-Fourier system, like lack of proper estimates and compactness, the most often studied case, at least for simplicity, is the choice of impermeable boundary.

The plan of our research includes the questions of well-posedness of weak solutions, their qualitative properties and analysis of stochastically forced fluid flows.

Finally, a deep understanding of the phenomenon of convection will allow to new results in more prominent applications like dynamics of stellar and planetary interiors and atmospheres. These problems, for completeness of considerations need often to include also magnetic effects. Convection is then responsible for the hydromagnetic dynamo effect - the generation of magnetic field of astrophysical bodies.

Summarizing, in the real world applications boundary conditions may be quite complicated and of substantial influence on the fluid motion. For the understanding of physical problem neglecting these boundary phenomena, like assuming always impermeability condition, might be often too serious simplification. One of the benefits of this project is to underline the relationships between, on the one hand, new mathematical questions and, on the other hand, classical issues in turbulence theory.