Superstructures and turbulent heat and momentum transport in inclined low-Prandtl-number convection

The project is aimed on the understanding of the origin and dynamics of the flow superstructures, namely the clusters of the thermal plumes and the large-scale fluid circulation, in inclined layer thermal convection. For this purpose the algorithms will be developed or advanced, which will allow to detect, extract and analyze the geometrical and physical properties of the superstructures from the flow fields, obtained in our direct numerical simulations. Further, we will investigate the contributions of the thermal plumes clusters and the large-scale circulation to the global transport of heat and momentum, reflected in the Nusselt number and Reynolds number, respectively. Here we will study the influence on the dynamics of the superstructures and on their contributions to the mean heat and momentum transport of the main input parameters of the inclined convection system, such as the Rayleigh and Prandtl numbers, the aspect ratio of the convection cell and the inclination angle of the cell. The main accent in the studies will be made on low-Prandtl-number fluids and elongated containers (see figure), where a felicitous combination of buoyancy and shear in inclined layer thermal convection can lead to a significant enhancement of the mean heat flux, compared to the case of classical Rayleigh–Bénard convection without any tilt of the convection cell. The main goal of the study is to develop a physical model to predict the mean heat and momentum transport as functions of the above mentioned input parameters in inclined thermal convection. The project will be conducted in collaboration with colleagues from applied mathematics, theoretical and experimental physics.