Understanding and utilising relationships between coherent structures and almost invariant sets in function space

Turbulent Superstructures have a crucial influence on the dynamical behaviour of fluids, for example the transport of mass, momentum and energy. They are a special case of so-called coherent sets, which are investigated in the theory of dynamical systems. In fluid dynamics, there are two fundamental points of view: a “physical” perspective, which describes the movement of points in three-dimensional space, and an abstract point of view, from which the evolution of the velocity field is described by a differential equation in a certain function space setup. So far, the development of turbulent superstructures and, more generally, of coherent sets in fluid flows has mainly been analysed from the first perspective. The basic idea of this project is to analyse fluid flows from the function space perspective and to develop a novel approach for the analysis of numerous problems related to the development of turbulent superstructures. In this context it is in particular of interest to investigate the relationship between (almost) invariant sets in function space and coherent sets in physical space. To this end, we develop numerical methods for the detection of invariant and, more generally, of almost invariant sets in function space for fluid flow systems. In the long run we expect to gain new insight into phenomena such as the “El Niño” southern oscillation.