## Computational methods for Lagrangian transport

Transport of mass, heat, or other conserved quantities by superstructures is of fundamental physical importance. The actual contribution to transport by coherent superstructures remains a controversial open question. The controversy is to a large extent due to the application of Eulerian approaches to the detection of coherent structures. The motion of Eulerian flow field features is in general unrelated to the actual motion of the fluid, which makes it difficult to address the question of relevance of coherent structures in transport processes.

The same question of transport across sections by Lagrangian coherent structures is far more involved. This is due to the fact that Lagrangian features are explicitly defined at a single time instance, and implicitly extended to other time instances by the action of the flow. Under that action, however, the geometry of a flow structure of interest may become very complicated, and a transport computation along the lines of the Eulerian approach infeasible. To overcome this, a Lagrangian approach to compute transport of conserved quantities by volume-preserving flows has been recently developed.

Within this project, we are going to extend the Lagrangian transport approach to non-volume-preserving flows and develop efficient numerical procedures for two- and three-dimensional flows. We will apply our methodology to data sets generated within the SPP from physical and direct numerical simulation experiments in order to quantify fluxes due to Lagrangian coherent structures.

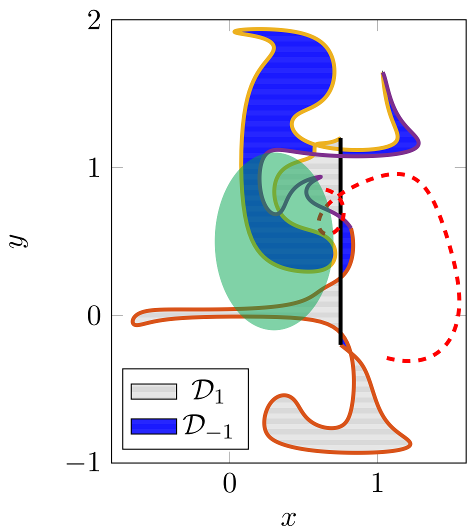


Figure 1: A decomposition of the set of initial conditions according to their net contribution to flux across the straight black line over a finite time interval: $\mathcal{D}_1$ cross the section once from left to right, $\mathcal{D}_{-1}$ cross it once from right to left in a net sense. The green ellipse corresponds to a material set of interest.

The above project is part of the joint project “Computational methods for coherent sets and coherent transport” with Oliver Junge.