# Active particles in chaotic advection

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The transport of biologically or chemically active substances by fluid flows is of great importance in marine environmental problems. In particular the patchiness of phytoplankton is a result of the interaction between biological growth processes, diffusion and advection. We study the spatial patterns of active particles (biological species or chemical substances) in the wake of a chain of islands using methods from nonlinear dynamical systems theory.

To couple biological activity and transport we use the approach of approximating the hydrodynamical flow on the surface of the water by a suitable two-dimensional streamfunction which has been obtained by analyzing simulations of the Navier-Stokes-Equations [1]. Thus we can use an analytical model to describe the fluid flow beyond the chain of islands. Using a periodically forced flow, the motion of the particles beyond the chain of islands becomes chaotic. This chaotic advection gives rise to spatial pattern which are characterized by a filamental fine structure. We analyze these spatial structures and show, how stable and unstable manifolds of unstable periodic orbits embedded in the chaotic flow determine the spatial patterns of particles. Furthermore we use simple models for plankton dynamics to demonstrate the interplay between biological growth and chaotic transport. Finally, we compare our theoretical investigations of the motion beyond the island chain with results from simulations with realistic velocity fields beyond the East Frisian Islands [2].

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## References

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