Mixing and un-mixing by incompressible flows

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In this talk, we consider the questions of efficient mixing and un-mixing by incompressible flows, under the constraint that the W^{1,p} Sobolev norm of flow is uniformly bounded in time. We construct some explicit flows to show that for any bounded initial density, it can be mixed to scale epsilon in time O(|log(epsilon)|) for p<(3+sqrt{5})/2 and in time O(|log(epsilon)|^{1/3}) for p>=(3+sqrt{5})/2, where the constants in both results are independent of the initial data. Known lower bounds show that this rate is optimal for p between 1 and (3+sqrt{5})/2. For un-mixing, we show that any set which is mixed to scale epsilon but not much more than that can be un-mixed to a rectangle of the same area (up to a small error) in time O(|log epsilon|^2).

This is a joint work with Andrej Zlatos.