Separation of time-scales in fluid mechanics

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We present recent results on time-scales separation in fluid mechanics. The fundamental mechanism to detect in a precise quantitative manner is commonly referred to as fluid mixing.

Its interaction with advection, diffusion and nonlocal effects produces a variety of time-scales which explain many experimental and numerical results related to hydrodynamic stability and turbulence theory.

In this talk, we analyze the case of shear flows, which is essentially the only one that is now well understood. A general enhanced dissipation rate for shear flows with a finite number of critical points was proved in [1], by using hypocoercivity methods. Similar ideas, combined with a technique known as the *vector field method*, can be used to prove stable mixing estimates in the infinite Péclet number limit [2]. Finally, using a probabilistic interpretation of enhanced dissipation, it can be proven that all the rates obtained are sharp [3].

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References

[1] J. Bedrossian, M. Coti Zelati, Enhanced dissipation, hypoellipticity, and anomalous small noise inviscid limits in shear flows, *Arch. Ration. Mech. Anal.* **224** (2017), 1161–1204.

[2] M. Coti Zelati, *Stable mixing estimates in the infinite Péclet number limit*, Submitted.

[3] M. Coti Zelati, T. D. Drivas, *A probabilistic approach to enhanced dissipation*, Submitted.