Abstract

In this work we study the long time, inviscid limit of the 2D Navier-Stokes equations near the periodic Couette flow, and in particular, we confirm at the nonlinear level the qualitative behavior predicted by Kelvin’s 1887 linear analysis. At high Reynolds number Re, we prove that the solution behaves qualitatively like 2D Euler for times $t \ll Re^{1/3}$, and in particular exhibits “inviscid damping” (e.g. the vorticity mixes and weakly approaches a shear flow). For times $t \gg Re^{1/3}$, which is sooner than the natural dissipative time scale $O(Re)$, the viscosity becomes dominant and the streamwise dependence of the vorticity is rapidly eliminated by a mixing-enhanced dissipation effect. Afterwards, the remaining shear flow decays on very long time scales $t \gg Re$ back to the Couette flow. The class of initial data we study is the sum of a sufficiently smooth function and a small (with respect to $Re^{-1}$) $L^2$ function. Joint with Nader Masmoudi and Vlad Vicol.