On vorticity concentration at the zero viscosity limit for the Navier-Stokes flows in the half plane

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Abstract

In this talk we consider the Navier-Stokes equations for viscous incompressible flows in the half plane under the no-slip boundary condition. In particular, we are interested in the behavior of vorticity fields at the zero viscosity limit, where the formal analysis indicates the presence of the boundary layer that brings high concentration of vorticity fields. However, so far the vorticity concentration with concrete estimates has been mathematically observed only under some restricted situations. In this talk we show the asymptotic expansion of vorticity fields at the zero viscosity limit near the initial time. This expansion holds at least up to the time $c\nu^{1/3}$, where ν is the viscosity coefficient and c is a constant. As a consequence, we get a natural sufficient condition on the initial data for the vorticity to blow up in the limit $\nu \to 0$ together with explicit estimates. Compared with the previous results, the initial data we handle with are rather general; they are just assumed to belong to some Sobolev space. Our approach relies on the vorticity formulation of the Navier-Stokes equations in the half plane, which helps to analyze vorticity fields (or vorticity equations) directly including in the region near the boundary.