VANISHING VISCOSITY AND RUGOSITY LIMIT

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Abstract. We study the high Reynolds number limit of a viscous fluid in the presence of a rough boundary. We consider the two-dimensional incompressible Navier-Stokes equations with Navier slip boundary condition, in a domain whose boundaries exhibit fast oscillations in the form $x_2 = \varepsilon^{1+\alpha}\eta(x_1/\varepsilon)$, $\alpha > 0$. Under suitable conditions on the oscillating parameter ε and the viscosity ν, we show that solutions of the Navier-Stokes system converge to solutions of the Euler system in the vanishing limit of both ν and ε. The main issue is that the curvature of the boundary is unbounded as $\varepsilon \to 0$, which precludes the use of standard methods to obtain the inviscid limit. Our approach is to first construct an accurate boundary layer approximation to the Euler solution in the rough domain, and then to derive stability estimates for this approximation under the Navier-Stokes evolution. This work is in collaboration with D. Gerard-Varet, T. Nguyen and F. Rousset.