Nonlinear Instability of Two-dimensional Poiseuille Flows in a Long Channel

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In this work, we study the nonlinear instability of two-dimensional Poiseuille flows in a long channel from the large deviation point of view. We start from the Navier-Stokes equations perturbed by small space-time white noise. When the amplitude of the noise goes to zero, the Frendlin-Wentzell (F-W) large deviation theory for random perturbations of dynamical systems provides the insight for the transition between metastable states in the phase space through the minimizer of the F-W action functional. We use numerical techniques to minimize the F-W action functional and use it to define a new critical Reynolds number for the nonlinear instability. The new stability theory is applied to study two-dimensional Poiseuille flows in a long channel.