A Dynamics-solver-consistent Minimum Action Method for Navier-Stokes Equations

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In this talk we discuss the necessity and strategy to unify the development of a dynamic solver and a minimum action method (MAM) for a spatially extended system when employing the large deviation principle (LDP) to study numerically the effects of small random perturbations. In particular, we pay attention to Navier-Stokes equations. A dynamic solver is used to simulate the unperturbed system, and a minimum action method is used to minimize the action functional defined by the large deviation principle, which corresponds to solving an Euler-Lagrange equation related to but more complicated than the unperturbed system. We will clarify possible inconsistencies induced by independent numerical approximations of the unperturbed system and the LDP, based on which we propose to define both the dynamic solver and the MAM on the same approximation space for spatial discretization. We achieve this methodology for the two-dimensional Navier-Stokes equations using a divergence-free approximation space. The method developed can be used to study the nonlinear instability of wall-bounded parallel shear flows.