Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Least Squares Shadowing and Lyapunov Covariant Modes of a 3-D cylinder flow at Reynolds number 525 ANGXIU NI, UC Berkeley, QIQI WANG, MIT — Many scientific and engineering applications concern how the statistics of chaotic and turbulent flows respond to perturbations in forcing, parameter, geometry, mesh, or boundary conditions. In these flows, a small perturbation in typically results in a large difference in the instantaneous flow field later on, computationally polluting the sensitivity of statistics. Nevertheless, such divergence can be avoided by simultaneously perturbing the initial condition. The Least Squares Shadowing algorithm finds a new flow field satisfying infinitesimally perturbed governing equation such that its difference to the old flow field remains small as time evolves. Such two flow fields are said to be shadowing each other. In this talk, for the flow past a 3-D cylinder at Reynolds number 525, we analyze the shadowing directions computed by the Least Squares Shadowing algorithm. We also study byproduct of the algorithm, the Characteristic Lyapunov Modes, which are solutions to the linearized equation that grow or decay at different rates. By doing so, we will reveal the chaotic attractor associated with this flow field and predict how various statistics of the chaotic flow respond to infinitesimal parameter perturbations.

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Date submitted: 31 Jul 2017 Electronic form version 1.4