Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Analysis of Fluid Flows via Spectral Properties of the Koopman Operator IGOR MEZIĆ, University of California, Santa Barbara — We discuss theory and applications of Koopman modes in fluid mechanics. Koopman mode decomposition is based on the fact that normal modes of linear oscillations have its natural analogue - Koopman modes - in the context of nonlinear dynamics. To pursue this analogy, one must change the representation of the system from the state-space representation to the dynamics governed by the linear Koopman operator on an infinite-dimensional space of observables. The analysis is based on spectral properties of the Koopman operator. The point spectrum corresponds to isolated frequencies of oscillation present in the fluid flow, and also to growth rates of stable and unstable modes. The continuous part of the spectrum corresponds to chaotic motion on the attractor. A theoretical method of computation of the spectrum and the associated Koopman modes is given, in terms of the Generalized Laplace Analysis. A computational alternative is given by Arnoldi-type methods, leading to the so-called Dynamic Mode Decomposition (DMD). Koopman mode theory is shown to unify and provide a rigorous background for a number of different concepts that have been advanced in fluid mechanics, including Global Mode Analysis, triple decomposition and Dynamic Mode Decomposition.

Igor Mezić
University of California, Santa Barbara

Date submitted: 03 Aug 2012 Electronic form version 1.4