Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Koopman mode representations of vortex dynamics in viscous flows[1] KE-CHU LEE, SAM KAUFMAN-MARTIN, SAMANEH SADRI, POORVA SHUKLA, IGOR MEZI, PAOLO LUZZATTO-FEGIZ, University of California, Santa Barbara — Vortex dynamics plays an important role in transitional and turbulent flows, where instabilities introduce important criteria for safety and performance of systems like turbomachinery and aerospace vehicles. In order to control these vortical flows, accurate, general and efficient models of vortex dynamics are needed. Here we explore the ability of Koopman mode decomposition (KMD) to provide such models and uncover physical mechanisms. Using pseudo-spectral simulations, we consider vortex dynamics in viscous flow for different Reynolds numbers and different initial vortex geometries. We start with co-rotating vortex pairs, for which we find that KMD modes and eigenvalues are in close agreement with linear stability predictions. We find that the onset of symmetry-breaking is weakly sensitive to Reynolds number, but highly sensitive to small details in the initial conditions. We provide a detailed comparison of the relative abilities of KMD and proper orthogonal decomposition (POD) to capture this behavior. Finally, we consider implications for modeling and controlling more general vortex flows.

[1]Funding: ARO MURI W911NF-17-1-0306

Ke-Chu Lee
University of California, Santa Barbara

Date submitted: 05 Aug 2019 Electronic form version 1.4