Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Sparse Identification of Nonlinear Dynamics in 2D Chaotic Electrohydrodynamic Convection IGOR NOVOSSELOV, YIFEI GUAN, STEVEN BRUNTON, University of Washington — This study focuses on developing a reduced-order model for the chaotic electro-hydrodynamic (EHD) convection flow between two parallel electrodes with unipolar charge injection. A Lattice Boltzmann Method with two-relaxation times solver [1] is used to obtain a numerical data set for electroconvective instabilities. Under strong charge injection and high electrical Rayleigh number, the system transitions from structured electroconvective vortices to chaotic motion. The chaos in this system is related to the standard Lorenz model obtained from Rayleigh-Benard convection, although this model system exhibits a more complex three-way coupling between the fluid, the charge density, and the electric field. Fluid coherent structures are extracted from the temporally and spatially resolved chaotic system via proper orthogonal decomposition (POD). A nonlinear model is developed for the chaotic time series of these POD coefficients with the sparse identification of nonlinear dynamics (SINDy) algorithm [2]. The resulting sparse nonlinear model captures a similar phase portrait and the dominant chaotic dynamics of the original system. References: [1] Y. Guan and I. Novosselov, Two Relaxation Time Lattice Boltzmann Method Coupled to Fast Fourier Transform Poisson Solver: Application to Electroconvective Flow, Journal of Computational Physics (accepted for publication) (2019). [2] S. L. Brunton, J. L. Proctor, and J. N. Kutz, Discovering governing equations from data by sparse identification of nonlinear dynamical systems, Proceedings of the National Academy of Sciences 113, 3932 (2016).

Yifei Guan
University of Washington

Date submitted: 30 Jul 2019 Electronic form version 1.4