Abstract Submitted
for the DPP20 Meeting of
The American Physical Society

Robust data-driven discovery of reduced plasma physics models from fully kinetic simulations[1] E. PAULO ALVES, FREDERICO FIUZA, SLAC National Accelerator Laboratory — The development of accurate reduced plasma models is crucial to enable predictive and computationally efficient multi-scale models for Inertial Confinement Fusion (ICF) and High-Energy-Density (HED) plasma dynamics. Computationally intensive fully kinetic plasma simulations play a pivotal role in our understanding of the complex nonlinear physics from first-principles, but distilling reduced plasma models from such simulations remains an outstanding challenge. Here we show how sparse regression techniques can be used to uncover reduced plasma physics models [in the form of interpretable partial differential equations (PDEs)] directly from the data of fully kinetic particle-in-cell (PIC) simulations. We introduce an integral formulation for the discovery of PDEs and demonstrate that it is critical to enable robust inference from noisy data associated with PIC and other particle-based approaches. We discuss how this methodology can complement traditional analytically derived reduced models, and bring important advantages to the discovery of kinetic-fluid closure models for ICF and HED plasmas.

[1]This work is supported by DOE FES under FWP 100331.

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Date submitted: 29 Jun 2020 Electronic form version 1.4