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Uncovering edge plasma dynamics via deep learning of partial observations[1] ABHILASH MATHEWS, JERRY HUGHES, MANAURE FRANCISQUEZ, Massachusetts Institute of Technology MIT, DAVID HATCH, University of Texas at Austin, ANNE WHITE, Massachusetts Institute of Technology MIT —
Developing improved reduced models of edge-pedestal plasma transport is an essential step towards better understanding, predicting, and optimizing tokamak performance. In the past, various drift-reduced fluid theories have been applied to model aspects relevant to the edge (e.g. pedestal formation, blob dynamics). As an initial step towards training against plasma diagnostics, this work explores the potential of validating and/or learning unobserved dynamics in 3-dimensional plasma turbulence directly from partial measurements. A synthetic plasma is numerically simulated using a reduced version of the two-fluid global drift-ballooning (GDB) code and carried out at edge reference densities, temperatures, and magnetic field relevant to boundary plasmas in high-field tokamaks using shearless field-aligned coordinates. Learning from partial observations is accomplished via physics-informed neural networks to accurately determine hidden dynamics of the radial electric field simply from measurements of turbulent electron density and temperature of limited spatial and temporal extent. This is a key stepping stone before training directly against experimental plasma discharges and demonstrates the ability to infer unmeasured quantities.

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