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Deep Learning Surrogate Model for Kinetic Landau-Fluid Closure with Collision (PhD Oral-24)[1] BEN ZHU, LLNL, LIBO WANG, Peking Univ, XUEGIAO XU, LLNL, CHENHAO MA, Google, YIAN LEI, Peking Univ — The kinetic Landau-fluid (LF) closure with collision and periodic boundary condition is used in the development of deep learning (DL) surrogate model. Classical neural network, namely feedforward neural network (FNN), is constructed and trained to learn the kinetic LF closure with static limit and arbitrary mean-free-path in configuration space. The preliminary relation between best hyperparameters and critical parameters for data generation is found. Comparing with the numerical approach (non-Fourier method) of the LF closure, the deep learning surrogate model shows an order of magnitude of improvement in terms of accuracy. The surrogate model closure has been integrated for the first time with fluid simulations. Our DL-enabled fluid simulations give the correct Landau damping rate for a wide range of wavevectors, while Hammett-Perkins closure cannot produce correct damping rate. We correctly connect collisionless Hammett-Perkins closure and collisional Braginskii closure to reproduce the intrinsic nonlocal feature of heat flux with DL techniques. The simulations with the deep learning surrogate model are as good as simulations with the analytic closure in terms of long-term numerical stability in the linear Landau damping test.

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