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Accelerating Kinetic Simulations of the Tokamak Edge Utilizing Encoder-Decoder Neural Networks to Solve the Nonlinear Fokker-Planck Collision Operator[1] MICHAEL CHURCHILL, Princeton Plasma Physics Laboratory, ANDRES MILLER, Columbia University, ALP DENER, Argonne National Laboratory, CHOONGSEOK CHANG, Princeton Plasma Physics Laboratory, TODD MUNSON, Argonne National Laboratory, ROBERT HAGER, Princeton Plasma Physics Laboratory — The nonlinear Fokker-Planck (FP) collision operator is an important component of high-fidelity plasma codes that contain non-Maxwellian plasmas (caused by neutral beam injection, alpha particles, or edge effect), yet when simulating multiple impurity charge states, numerically solving for the FP operator becomes prohibitively expensive. We present here a machine learning method, based on an encoder-decoder neural network, which accelerates the numerical solution of a multi-species, fully nonlinear FP operator. This neural network is trained on particle distribution function data generated from the XGC code, which is a massively parallel, gyrokinetic turbulence code focused on simulating the edge of tokamak plasmas. The network is trained such that its objective includes not only matching the output distribution function from the collision operator, but also a penalty to enforce physical conservation properties (mass, momentum, energy) of the FP operator. Relative conservation error on the order $10^{-}4 hasbeenso-$
$farachievedinthemodeltraining, andstillimproving. Implementationdetailsincludingcomparisonsofthe$

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