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Advanced Discontinuous Galerkin Algorithms and First Open-Field Line Turbulence Simulations[1] G. W. HAMMETT, A. HAKIM, Princeton Plasma Physics Laboratory, E. L. SHI, Princeton University — New versions of Discontinuous Galerkin (DG) algorithms have interesting features that may help with challenging problems of higher-dimensional kinetic problems. We are developing the gyrokinetic code Gkeyll based on DG. DG also has features that may help with the next generation of Exascale computers. Higher-order methods do more FLOPS to extract more information per byte, thus reducing memory and communications costs (which are a bottleneck at exascale). DG uses efficient Gaussian quadrature like finite elements, but keeps the calculation local for the kinetic solver, also reducing communication. Sparse grid methods might further reduce the cost significantly in higher dimensions. The inner product norm can be chosen to preserve energy conservation with non-polynomial basis functions (such as Maxwellian-weighted bases), which can be viewed as a Petrov-Galerkin method. This allows a full-F code to benefit from similar Gaussian quadrature as used in popular δf gyrokinetic codes. Consistent basis functions avoid high-frequency numerical modes from electromagnetic terms. We will show our first results of $3x + 2v$ simulations of open-field line/SOL turbulence in a simple helical geometry (like Helimak/TORPEX), with parameters from LAPD, TORPEX, and NSTX.

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