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Extension of Discontinuous Galerkin Algorithms To Preserve the Locality of Parallel Gyrokinetic Dynamics[1] G.W. HAMMETT, A. HAKIM, Princeton Plasma Physics Laboratory — A wide range of physics problems, including gyrokinetics, have an underlying Hamiltonian structure that can be expressed in terms of a Poisson bracket, which leads to two quadratic invariants, such as the energy and enstrophy invariants in 2-D hydrodynamics or Hasegawa-Mima equations. A type of Discontinuous Galerkin (DG) algorithm has been developed in the literature that can preserve both invariants, by coupling the DG algorithm for the advection part of the problem with a continuous Finite Element Method for the elliptic field equations. This algorithm can preserve both invariants if centered fluxes are used, and still preserves energy conservation even if upwind fluxes are used. However, when applied to gyrokinetics, the weak form of the continuous finite-element part of the algorithm causes a coupling along the field line that would require a full 3-D elliptic solver. We show a new type of DG algorithm that allows the potential to be discontinuous along the field line, just as the particle distribution function can be, thus restoring the property that the fields in gyrokinetics can determined by a set of uncoupled 2-D elliptic problems. By accounting for the delta-function electric field as particles cross cell boundaries, energy can still be preserved.

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