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Regionally Implicit Discontinuous Galerkin Schemes for the Relativistic Vlasov-Maxwell System.

The relativistic Vlasov-Maxwell system (RVM) models the behavior of collisionless plasma. Solving these equations is important in many application problems, including in the development of laser wakefield accelerators for medical imaging applications. The goal of the current work is to develop a new class of high-order accurate numerical methods for solving kinetic Vlasov models of plasma. The main discretization in configuration space is handled via a high-order finite element method called the discontinuous Galerkin method (DG). One difficulty is that standard explicit time-stepping methods for DG suffer from time-step restrictions that are significantly worse than what a simple Courant-Friedrichs-Lewy (CFL) argument requires. In this work, we overcome this difficulty by introducing a novel time-stepping strategy: the regionally-implicit discontinuous Galerkin method. Upon the development of the general RIDG method, we apply it to the non-relativistic 1D1V Vlasov-Poisson equations and the relativistic 1D2V Vlasov-Maxwell equations. For each we validate the high-order method on several test cases. In the final test case, we demonstrate the ability of the method to simulate the acceleration of electrons to relativistic speeds in a simplified laser wakefield accelerator example. (Received July 14, 2017)