

IMplicit-EXplicit (IMEX) schemes for 10-Moment Plasma Equations

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10-moment plasma equations are a generalized form of the ideal MHD equations in which the electrons and ions are considered separately and modeled using 10-moment flow equations. In addition to discretization of flux terms, a major difficulty in the design of efficient numerical algorithms for these equations is the presence of stiff source terms, particularly for realistic charge to mass ratios. In this work, we design implicit-explicit (IMEX) Runge-Kutta (RK) time stepping schemes for these equations. The numerical flux is treated explicitly with strong stability preserving (SSP)-RK methods and the stiff source term is treated implicitly using implicit Runge-Kutta methods. The special structure of the equations enable us to split the source terms carefully and ensure that only local (in each cell) equations need to be solved at each time step. Furthermore the resulting algebraic system of equations is solved exactly. Benchmark numerical experiments are presented to illustrate the efficiency of this approach.