

A Least-Squares Approach To Two-Fluid Electromagnetic Plasma

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A two-fluid plasma (TFP) model is presented, both as a stand-alone solver and as the preconditioner to a fully implicit, particle-in-cell (PIC) simulation. The model couples fluid conservation equations for ions and electrons to Maxwell's equations. A Darwin approximation of Maxwell is used to eliminate spurious light waves. After scaling and modification, the TFP-Darwin model yields a nonlinear, first-order system of equations whose Frechet derivative is shown to be uniformly H^1 -elliptic. This system is addressed numerically by nested iteration (NI), a First-Order System Least Squares (FOSLS) discretization, adaptive local mesh refinement, and scaled AMG system solver. Numerical tests demonstrate the efficacy of this approach, yielding an approximate solution within discretization error in a relatively small number of computational work units.