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Asynchronous Multi-Dimensional Hybrid Simulations of Magnetized Plasmas Y.A. OMELCHENKO, H. KARIMABADI, Sciberquest/UCSD, M. BROWN, Swarthmore College, U.V. CATALYUREK, E. SAULE, Ohio State University — Hybrid simulations provide important insight into the physics of magnetized plasmas with energetic ion components. Ion-driven processes are crucial for understanding the behavior of complex plasma systems such as the Earth magnetosphere and the Field-Reversed Configuration (FRC). Largely varying time and length scales often prevent simulating these systems with adequate resolution. To resolve this issue we developed an asynchronous, uni-dimensional hybrid code, HYPERS. Instead of stepping all simulation variables uniformly in time, HYPERS tracks meaningful changes to individual particles and cell-based electromagnetic fields via discrete events. HYPERS has recently been parallelized with the Preemptive Event Processing (PEP) technique. The parallel algorithm enables arbitrary domain decompositions and processor configurations on restarts. This is a critical prerequisite for implementing a full load balancing functionality. We validate HYPERS by simulating the interaction of streaming plasmas with dipole magnetospheres and show that our approach results in superior numerical metrics (stability, accuracy and speed) compared to conventional techniques. As the first step towards simulating the FRC, we apply HYPERS to study magnetically-driven plasma compression in two dimensions.

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