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Three-Dimensional Hybrid Simulations of Magnetized Plasmas[1]

Y.A. OMELCHENKO, H. KARIMABADI, H.X. VU, Sciberquest, Inc — Quasi-neutral hybrid simulations enable macroscopic (confinement, stability, translation) and microscopic (turbulence, reconnection and ion energization) properties of finite-beta plasmas. Target applications, among others, include magnetized plasmas generated by pulsed power systems and laboratory astrophysics experiments (e.g., FRCs, z-pinches and theta-pinches, spheromaks, magnetic dipole configurations). We conduct large-scale hybrid simulations to study ion energy budget, turbulence and flow in laboratory and space plasmas. This is done with a unique, uni-dimensional, event-driven code, HYPERS, which remarkably differs from standard hybrid codes in the way simulation is performed. HYPERS does not step spatially distributed variables synchronously in time but instead performs time integration by executing discrete events: asynchronous updates of particles and fields. Updates are carried out as frequently as dictated by their local physical time scales. This technique results in stable, accurate and fast simulations of strongly inhomogeneous plasmas. We also discuss a new low-frequency plasma simulation capability (X-hybrid) that incorporates transient radiation and finite electron mass effects in low-density plasma and vacuum regions into the hybrid approximation.

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Y.A. Omelchenko
Sciberquest, Inc

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