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Self-Adaptive Event-Driven Simulation of Multi-Scale Plasma Systems YURI OMELCHENKO, SciberQuest, Inc, HOMAYOUN KARIMABADI, SciberQuest, Inc — Multi-scale plasmas pose a formidable computational challenge. The explicit time-stepping models suffer from the global CFL restriction. Efficient application of adaptive mesh refinement (AMR) to systems with irregular dynamics (e.g. turbulence, diffusion-convection-reaction, particle acceleration etc.) may be problematic. To address these issues, we developed an alternative approach to time stepping: self-adaptive discrete-event simulation (DES). DES has origin in operations research, war games and telecommunications. We combine finite-difference and particle-in-cell techniques with this methodology by assuming two caveats: (1) a local time increment, dt for a discrete quantity f can be expressed in terms of a physically meaningful quantum value, df; (2) f is considered to be modified only when its change exceeds *df*. Event-driven time integration is self-adaptive as it makes use of *causality* rules rather than *parametric* time dependencies. This technique enables asynchronous flux-conservative update of solution in accordance with local temporal scales, removes the curse of the global CFL condition, eliminates unnecessary computation in inactive spatial regions and results in robust and fast parallelizable codes. It can be naturally combined with various mesh refinement techniques. We discuss applications of this novel technology to diffusion-convection-reaction systems and hybrid simulations of magnetosonic shocks.

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