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P4.1029 High-order time-stepping algorithm for tracking fast ions in fusion reactors

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Fast ions play an important role in the heating of Tokamak plasmas, e.g. by NBI (Neutral Beam Injection) and other sources. Numerical particle trackers are employed to simulate huge numbers (often of the order of millions) of trajectories of fast ions in Tokamaks. Such simulations can require high numerical accuracy and thus take a long time, even on modern high performance clusters.
We will present the high order algorithm GMRES-Boris-SDC [1] for solving the Lorentz equations, based on Boris-SDC [2], a combination of the widely used classical Boris method [3] for the Lorentz equations and Spectral Deferred Corrections (SDC), plus a GMRES-based convergence accelerator [4]. Integrating the GMRES-based convergence accelerator leads to faster convergence and a substantial improvement in the long-term energy error compared to original Boris-SDC.
The GMRES-Boris-SDC algorithm has been implemented into the GPU-accelerated LOCUST simulation suite [5]. LOCUST leverages the high performance of modern Nvidia GPU hardware, employs realistic equilibrium including fields outside the separatrix and has the ability to perform very high statistics simulations in a comparatively short time. The performance of the GMRES-SDC algorithm will be compared against the "classical" Boris integrator for several fusion related benchmarks, using magnetic fields similar to those in the DIII-D and JET experimental reactors.
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