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Slurm: An innovative Particle-in-Cell Method for Magnetohydrodynamics[1] FABIO BACCHINI, VYACHESLAV OLSHEVSKY, GIOVANNI LAPENTA, Katholieke Universiteit Leuven —
We present a new Particle-in-Cell method for plasma simulations. This is based on the original algorithm of FLIP-MHD, which uses a Lagrangian formulation of the macroscopic equations. A finite-difference approximation of the equations of motion is solved on a fixed (non-moving) grid, while convection of the quantities is modelled with the support of Lagrangian particles. Interpolation with first-order b-splines is used to project the conserved quantities from particles to the grid and back. In this work, we introduce two modifications of the original scheme. A particle volume evolution procedure is adopted to reduce the computational error, based on the Material Point Method for solid mechanics. The additional step introduces little to none computational diffusion and efficiently suppresses the so-called ringing instability, allowing the use of explicit time differencing. Furthermore, we eliminate the need for a Poisson solver in the magnetic field computation with the use of a vector potential. The vector potential evolution is modelled with a moving grid and interpolated to the fixed grid points to obtain a solenoidal magnetic field. The results of a number of HD and MHD tests show good agreement with the reference solutions and rather fast time and space convergence.

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