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Highly efficient quasi-static particle-in-cell algorithm using azimuthal Fourier decomposition based on QuickPIC[1] FEI LI, WEIMING AN, VIKTOR DECYK, WARREN MORI, University of California, Los Angeles — The particle-in-cell (PIC) algorithm based on quasi-static approximation (QSA) is widely utilized to model high-energy charged particles and short laser pulses interacting with plasma. Compared to computationally intensive full 3D explicit PIC codes, the quasi-static codes can speed up the simulations by orders of magnitude, which allows for modeling problems that require large computing resources, including the hosing instability of particle beams and ion motion for matched particle beams in plasma accelerators. In addition to QSA, the Fourier azimuthal decomposition (FAD) is another effective speedup technique already applied in some general-purpose PIC codes. However, this approach has never been combined with the quasi-static approach. We present details on a new PIC code based on the workflow and structure of QuickPIC. It combines QSA and FAD together. FAD expands the fields, charge and current density into azimuthal harmonics and truncates the expansion. The complex amplitudes of fields on an r-z grid are then solved through Maxwell's equations under QSA using finite difference solvers in conjunction with the multigrid method. Benchmarks against the full 3D and 3D quasi-static codes are presented. We call this new code QPAD for QuickPIC with Azimuthal Decomposition.

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