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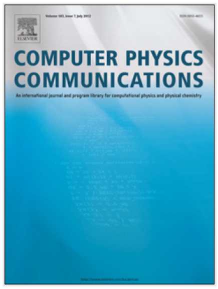

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Development of an explicit non-staggered scheme for solving three-dimensional Maxwell's equations

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Abstract

An explicit finite-difference scheme for solving the three-dimensional Maxwell's equations in non-staggered grids is presented. We aspire to obtain time-dependent solutions of the Faraday's and Ampère's equations and predict the electric and magnetic fields within the discrete zero-divergence context (or Gauss's law). The local conservation laws in Maxwell's equations are numerically preserved using the explicit second-order accurate symplectic partitioned Runge-Kutta temporal scheme. Following the method of lines, the spatial derivative terms in the semi-discretized Faraday's and Ampère's equations are approximated theoretically to obtain a highly accurate numerical phase velocity. The proposed fourth-order accurate space-centered finite difference scheme minimizes the discrepancy between the exact and numerical phase velocities. This minimization process considerably reduces the dispersion and anisotropy errors normally associated with finite difference time-domain methods. The computational efficiency of getting the same level of accuracy at less computing time and the ability of preserving the symplectic property have been numerically demonstrated through several test problems.

keywords: Maxwell's equations; non-staggered grids; zero-divergence; symplectic partitioned Runge-Kutta; fourth-order; dispersion relation equation; exact and numerical phase velocities.

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