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Two-step Perfectly Matched Layer for Arbitrary-Order Pseudo-Spectral Analytical Time-Domain Method

Numerical simulation of an electrodynamic system in empty space requires the implementation of open boundary conditions (BC) to terminate the solution of Maxwell's equations on the boundaries of the computational domain.
The Perfectly Matched Layer (PML) has become the method of choice for open BC with wave equations, as it is straightforward and relatively easy to implement, and offers very efficient and user-adjustable absorption rates. PMLs are most often employed with the Finite-Difference Time-Domain (FDTD) algorithm, which in its most common implementation offers second-order accuracy in space and time on Cartesian grids. Yet, simulations (including some class of electromagnetic Particle-In-Cell simulations) that require higher precision may resort to higher-order Maxwell solvers employing extended finite-difference stencils, or even to pseudo-spectral Maxwell solvers, for which a general, versatile and efficient formulation of the PML has been missing so far. We propose a novel "two-step" formulation of the PML that is applicable to a large class of Maxwell solvers including the arbitrary-order Pseudo-Spectral Analytical Time-Domain (PSATD) solver, which offers arbitrarily low numerical dispersion when increasing solver order and becomes dispersion-free at infinite order.
Analysis and numerical simulations demonstrate that the new formulation is as efficient as the standard PML formulation, both for the FDTD and the PSATD implementations.

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