Texas Tech University. Joint Applied Mathematics / BioMathematics Seminar.

Analysis of High Order FDTD Methods for Maxwell's Equations in Dispersive Media

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ABSTRACT. We study the stability properties of, and the phase error present in, several higher-order (in space) staggered finite difference schemes for Maxwells equations coupled with a Debye or Lorentz polarization model.We present a novel expansion of the symbol of finite difference approximations, of arbitrary (even) order, of the first-order spatial derivative operator. This alternative representation allows the derivation of a concise formula for the numerical dispersion relation for all (even-) order schemes applied to each model, including the limiting (infinite-order) case. We further derive a closed-form analytical stability condition for these schemes as a function of the order of the method. Using representative numerical values for the physical parameters, we validate the stability criterion while quantifying numerical dissipation. Lastly, we demonstrate the effect that the spatial discretization order, and the corresponding stability constraint, has on the dispersion error.