Finite-Difference Time-Domain Method for Complex Media

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The Finite-Difference Time-Domain (FDTD) method is a popular numerical method for solving the Maxwell's equations of electrodynamics. In this talk, we present FDTD based methods for problems involving complex media, including dispersive, anisotropic, and nonlinear media. Using transformation optics, we map a non-orthogonal grid to Cartesian grid and solve the resulting Maxwell's equations using a stable anisotropic FDTD solver, so it is superior to non-orthogonal FDTD solvers that usually suffer from late-time instability. Using overlapping grids, we have developed stable FDTD Maxwell solvers for the magneto-electric material based space-time cloak and for nonlinear optics. Furthermore, we will discuss the numerical solution to the dispersive and nonlinear Drude model for studying the second harmonic generation (SHG) from metallic nanostructures.