

Finite Element Methods for Maxwell's Equations

Peter Monk, University of Delaware

In the last few decades, conforming finite element methods for approximating the time harmonic Maxwell system governing electromagnetic wave propagation have undergone profound changes. Whereas in the 1980's there was confusion about how to choose the finite elements to obtain a convergent solver, it is now clear not only how to discretize the Maxwell system using edge elements, but also how to analyze the resulting method. Spin-offs from this analysis include the Finite Element Exterior Calculus and the realization that the discrete de Rham diagram is a useful tool to guarantee conservation of charge.

More recently several open source implementations of common finite element families for the Maxwell system have appeared making edge elements much more accessible. I shall give a historical survey of the finite element method for Maxwell's equations and comment on some of the main open problems still facing users. I shall also present current uses of finite elements in computational photonics, particularly light transport in nanoscale diffraction gratings where unusual surface phenomena have been observed. A particular application of this analysis is in the design of thin film solar cells.