Integral-Equation Modeling of Metamaterials and Plasmonic Systems: Theory and Practice

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The finite-difference (FD) and finite-element (FE) approaches to electromagnetic (EM) simulation are familiar to nearly all practitioners of the EM modeling arts, and the ready availability of high-quality open-source solvers makes it easy for researchers to master these methods and add them to their arsenal of tools. In contrast, the integral-equation (IE) [or "method-of-moments (MOM)"] approach to Maxwell's equations—which includes both surface-integral-equation (SIE) and volume-integral-equation (VIE) methods—has remained somewhat obscure to many researchers, due both to the relative difficulty of implementing IE methods and the absence of freely available general-purpose solvers with which to learn and experiment. The purpose of this talk is to argue that this situation is both **(a)** unfortunate, as IE methods offer clear advantages in many situations of practical interest, and **(b)** anachronistic, as large-scale open-source IE solvers are now available for researchers everywhere to learn, explore, and add to their own toolbox. I will illustrate these points by showing how many problems in science and engineering, including examples from the domains of metamaterials, plasmonics, and RF device modeling, can be studied easily and efficiently using the open-source SIE solver SCUFF-EM (http://homerreid.github.io/scuff-em-documentation).

The talk will complement other talks at this conference by showing how results of FDTD or FEM calculations presented by other speakers can be reproduced by IE methods, comparing and contrasting the relative advantages of the various approaches. In addition to providing a brief review of the theoretical foundations of IE solvers, the talk will be partially tutorial in nature, illustrating how researchers can get started immediately using SCUFF-EM for their own modeling problems.