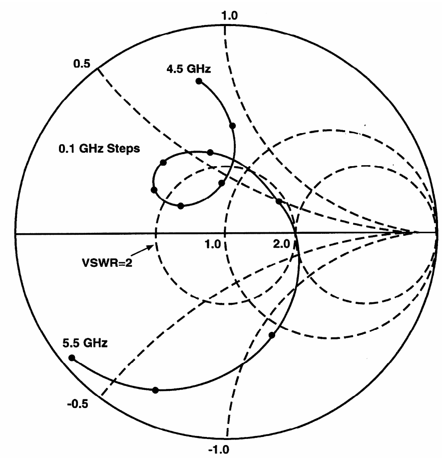

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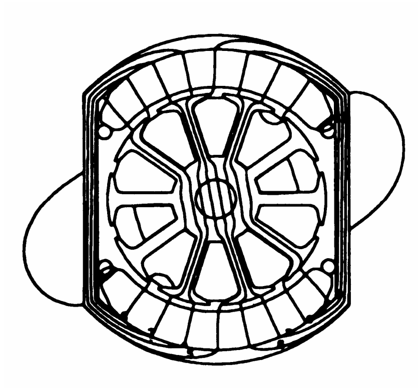

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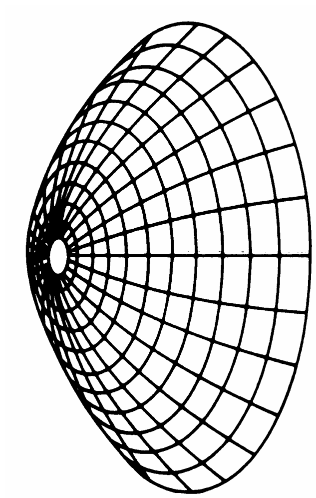

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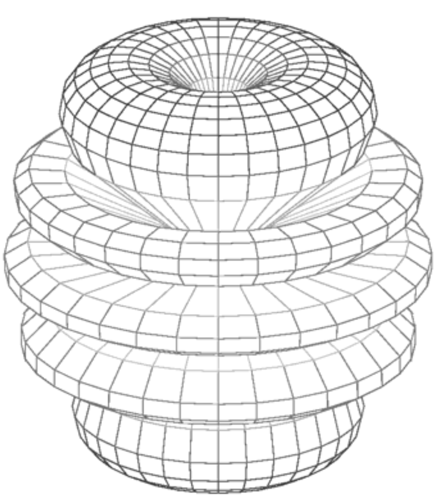

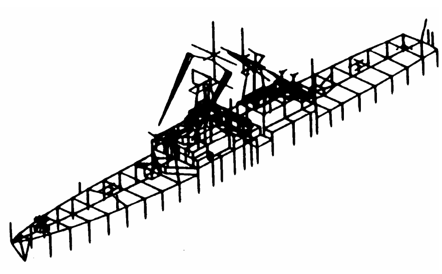

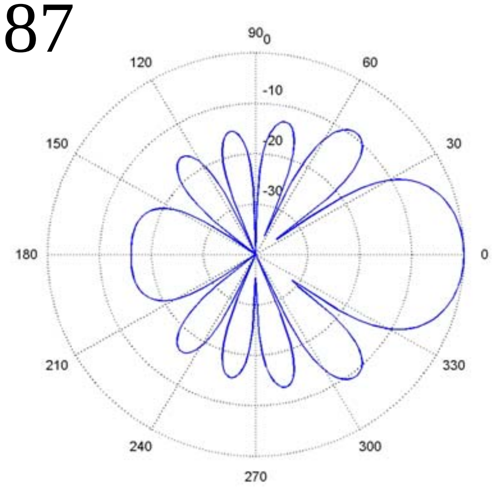

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Raj Mittra

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Preface

Recently, there has been great interest on part of the Computational Electromagnetics (CEM) community in developing innovative techniques for solving real-world antenna and scattering problems involving a large number of degrees of freedom, or DoFs, which can often run upwards of millions. The advent of high performance computers has made the task somewhat easier, in many cases, though not all, because not all algorithms scale well on parallel machines.

Historically, before the introduction of the Fast Multipole Method, there were no systematic approaches available for solving large EM problems, except perhaps by using asymptotic methods, such as the GTD (geometrical theory of diffraction) and PTD (Physical Theory of Diffraction). However, such asymptotic methods were not numerically rigorous, and they could only handle scatterers with canonical shapes and perfectly conducting nature.

The advent of the Fast Multipole Method changed the computing landscape dramatically and enabled us to solve very large problems without either storing the associated MoM (Method of Moments) matrix, or solving it directly. It was essentially the "only game in town," for about a decade or so, since there was no other algorithm that could come even close to competing with it. The FMM technique is reviewed in this Special issue by Vikram and Shanker. An approach to accelerating the FMM is discussed in a contribution by Chen and his colleagues

Four other approaches to solving large problems, that have been developed more recently, are presented in the Special issue, all of which follow different strategies for solving large CEM problems than that employed by the FMM. The first of these is the IE-FFT approach by Seo et al., which takes advantage of the efficiency of the FFT algorithm to perform the matrix-vector products needed in the iterative solution, and which the FMM does by using multipole methods. An alternative method is employed by Gedney and his colleagues, who utilize a preconditioner developed by using a Sparse Direct solver. Next, methods based on the use of macro-basis functions, which enable one to reduce the size of the original MoM matrix significantly, are described by Matekovits and his co-workers, and also by Casaletti and his colleagues.

Next, three contributions by Maaskant et al., Delgado et al. and Mittra, all present techniques based on the Characteristic Basis Function Method (CBFM), which also may be viewed as being based on the use of macro-basis functions. The issue of solving large problems on parallel machines using the CBFM is addressed in the Mittra paper.

Additionally, an innovative approach that takes advantage of the identical nature of the array elements to solve a phased-array-type problem, and a hybrid method that combines FEM with the Mode matching method to also address the array problem, are contributed by Craye et al. and Pellegreni and her colleagues, respectively.

Finally, an interesting takeoff on the Physical Optics approach, which employs iteration, is discussed by the contribution from Burkholder et al.

We firmly believe that this Special issue would be secure its place in the literature as a major contribution in CEM, and we hope that the various techniques described in this issue, which cover a wide spectrum, would find a very receptive as well as appreciative audience, both among the researchers and practitioners of CEM.

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