DOMAIN DECOMPOSITION METHOD FOR MODELING METAMETERIALS IN ELECTROMAGNETICS

Vouvakis, M. N., Lee, S.-C., Lee, J.-F.
ElectroScience Laboratory, The Ohio State University

In recent years, there are significant interests in studying and investigating various types of metamaterials. For example, in (J. B. Pendry, A. J. Holden, D. J. Robbins, and W. J. Stewart, *IEEE Trans. Microwave Theory and Techniques*, **47**, 2075-2084, 1999) Pendry et al utilized an array of splitring-resonators (SRR) and proclaimed the physical realization of the negative index medium or left-handed media (LHM). Later, Eleftheriades et. al (G. Eleftheriades, A. K. Iyer, and P. C. Kremer, *IEEE Trans. Microwave Theory and Techniques*, **50**, 2702-2712, 2002) proposed the use of dual-transmission line, by inverting the L and C in conventional transmission line construction, to realize the LHM and subsequently demonstrate a perfect lens (A. Grbic, G. Eleftheriades, *IEEE Antennas and Wireless Propagation Letters*, **2**, 186-189, 2003) using such a structure. Also, another class of metamaterials is the magnetic photonic crystals recently proposed by Figotin and Vitebsky (A. Figotin and I. Vitebsky, *Physical Review*, **63**, 066609, 2001). It is shown that by proper spatial arrangement of magnetic and dielectric components, the MPC can produce the so-called frozen mode, which corresponds to a block wave with zero group velocity. It goes without saying that it is then becoming very crucial to have a reliable and efficient numerical simulation tool, which can solve the full-wave Maxwells equations in the presence of these exotic metamaterials. However, both the focusing effects exhibited in the NIM as well as the frozen mode phenomena described by A. Figotin require extremely fine resolution within certain regions in the numerical simulation. For example, an extremely non-uniform mesh is needed to efficiently simulate the dual-transmission line lenz proposed by Eleftheriades. The entire structure is electrically small (on the order of $1/2\lambda$), however, it took roughly 2 million p=2 higher order vector finite elements in order to provide the resolution needed. It would quickly become prohibitive to employ numerical simulation once more combination of materials and complexities are added into the structure. Fortunately, almost all of these metamaterials constructed/proposed are periodic in nature (though finite). Consequently, they are well-suited for the application of the advanced computational techniques such as domain decomposition method. In this presentation, we shall share our experiences and our findings in using a newly developed domain decomposition method described in (S. C. Lee, M. Vouvakis, and J. F. Lee, *Accepted for publication in J. Comp. Physics*) to solve for such electromagnetic problems with metamaterials.

Abstract Submission Form

2004 National Radio Science Meeting

Abstract: vouvakis22558

Date Received: September 24, 2004

1. (a)
Marinos Vouvakis
ElectroScience Laboratory
The Ohio State University
1320 Kinnear Road
Columbus, OH
43212 USA
`vouvakis.1@osu.edu`
   (b) 614-292-7981
   (c) 614-292-7297
2. B - Fields and Waves
3. (a)
4. I - Invited Paper, Program chair: John Volakis and George Eleftheriades
5. No special instructions