MORE ON TRANSPARENCY OF OBJECTS USING PLASMONIC METAMATERIALS

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In a recent presentation, we discussed the possibility of reducing the total scattering cross section of a small dielectric sphere or a thin cylinder by adding over it a layer of metamaterial with negative real parts for permittivity and/or permeability or metamaterial with low (positive) permittivity or permeability. (A. Alu and N. Engheta, Reducing Scattering from Cylinders and Spheres Using Metamaterials presented at the 2004 USNC/URSI National Radio Science Meeting, Monterey, CA, June 20-25, 2004, p. 231.) We pointed out how the addition of such a metamaterial layer over the object can nullify the scattering coefficient for a specific spherical (or cylindrical) scattering mode, and when such a scattering coefficient is the dominant term of scattering for the uncovered sphere, the nullification of this coefficient due to the presence of the layer can thus lead to reduction of the total scattering cross section of this object. As was mentioned then, this effect is essentially opposite to the resonance phenomenon that may be induced by properly covering a homogeneous dielectric sphere or cylinder with a concentric shell of metamaterials with negative effective constitutive parameters [A. Alu, N. Engheta, Proceedings of the ICEAA03 Meeting, Torino, Italy, Sept. 8-12, pp. 435-438].

In the present work, we extend our investigation to the case of spheres that are not necessarily small compared with the wavelength of operation. In such a scenario, the role of higher-order mutlipoles in scattering should also be taken into account. By adding the metamaterial layers with negative or low-positive permittivity, one can reduce the scattering coefficient due to the TM dipolar term, which is in general a dominant term, but one also needs to be aware of other scattering terms such as TE dipolar term, TM and TE quadrupolar terms, etc. It can be shown that by properly selecting the values for both permittivity and permeability of the cover layer (i.e., having negative or low-positive permittivity and permeability), one can significantly reduce both TM and TE dipolar scattering terms, leading to further reduction of the total scattering cross section of the object. It is also possible that by adding more metamaterial layers, one can increase the degrees of freedom that can be used to reduce higher order scattering coefficients and thus to decrease the total cross section even further.

In this talk, we will present some of our new findings on the field distributions and the Poynting vector variation in this problem, and we will provide physical insights and intuitive remarks into these results.

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2. B - Fields and Waves

3. (a) B-Metamaterials and Other Complex Materials for Radio Frequency Applications

4. I - Invited Paper, Program chair: Professor Eleftheriades and Professor Volakis

5. No special instructions