Exact Electromagnetic Scattering from a Dipole Antenna Located inside a Multilayer Metamaterial Oblate Spheroidal Cavity

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The geometry of the problem consists of a perfect electric conductor (PEC) ground plane with a circular hole. Flush mounted underneath the hole there is a PEC wall, shaped as a half oblate spheroid, which determines a cavity. Inside the cavity there are two layers, one made of ordinary double positive (DPS) material with positive dielectric permittivity and positive magnetic permeability, the other made of double negative (DNG) metamaterial with negative dielectric permittivity and negative magnetic permeability. The material outside the cavity and above the ground plane is DPS. The DPS and DNG materials are anti-isorefractive to each other.

An analytic exact solution is obtained for a dipole source located inside either one of these layers within the cavity, along the axis of symmetry of the structure and axially oriented. The solution is expressed in terms of infinite series containing oblate spheroidal functions, according to the notation of Flammer (C. Flammer, *Spheroidal Wave Functions.*, Stanford Univ. Press, 1957). The analytical solution is expressed in the phasor-domain, where the time dependence $e^{i\omega t}$ is assumed and suppressed throughout. Numerical results will be presented.

A related geometry with the cavity filled with isorefractive material was investigated in (C. Berardi, D. Erricolo, and P. L. E. Uslenghi, ``Exact dipole radiation for an oblate spheroidal cavity filled with isorefractive material and aperture coupled to a half space," *IEEE Trans. Antennas Propag.*, vol. 52, no. 9, pp. 2205-2213, Sep. 2004), whereas the cavity filled with DNG metamaterial was investigated in (A. N. Askarpour and P. L. E. Uslenghi, ``Exact dipole radiation from an oblate semispheroidal cavity filled with DNG metamaterial,"*IEEE Trans. Antennas Propag.*, vol. 59, no. 7, pp. 2473-2479, Jul. 2011), while a cavity with two layers, but the dipole source located outside of the cavity was investigated in (T. Negishi, D. Erricolo, P.L.E. Uslenghi, ``Metamaterial spheroidal cavity to enhance dipole radiation," *IEEE Transactions on Antennas and Propagation*, Vol. 63. No. 6, Jun. 2015, pp. 2802-2807).