# Numerical results for the radiation by a dipole antenna on the axis of a circular hole in a metallic plane covered by DPS and DNG oblate spheroidal lenses

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The geometry of the problem consists of a circular hole in a perfectly electric conducting ground plane. The hole is covered with two oblate spheroidal lenses of equal size, located on opposite sides of the hole. The hole circumference is the focal circle for the oblate spheroidal lenses. Both lenses are made of lossless materials. One lens is made of a double-positive (DPS) medium characterized by a real positive electric permittivity and a real positive magnetic permeability. The other lens is made of a double-negative (DNG) metamaterial characterized by a real negative permittivity and a real negative permeability.

The semi-infinite space surrounding the structure on either side of the conducting plane is such that the DPS lens is isorefractive to the surrounding space, while the DNG lens is anti-isorefractive to the surrounding space, and the two lenses are anti-isorefractive to each other. This system is illuminated by an electric Hertzian dipole located on the axis of the circular hole and is axially oriented.

The analysis is conducted in the phasor domain with time-dependence factor $e^{(i\omega t)}$. This work completes the analytical solution, without any numerical results, provided in in (D. Erricolo, P.L.E. Uslenghi, "Radiation by a Dipole Antenna on the Axis of a Circular Hole in a Metallic Plane Covered by DPS and DNG Oblate Spheroidal Lenses," International Conference on Electromagnetics in Advanced Applications (ICEAA), Torino, Italy, Sept. 9-13, 2013)

The numerical solution consists on the evaluation of the exact analytical solution to the boundary-value problem obtained in terms of infinite series of products of radial and angular oblate spheroidal functions.
The modal expansion coefficients are determined analytically by imposing the boundary conditions on the metallic plane and at the interfaces between penetrable materials, and the radiation condition at infinity. The fact that angular oblate spheroidal functions are even functions of the wavenumber makes it possible to satisfy the boundary conditions separately for each mode across the hole that separates the DPS and DNG lenses, and at the interfaces between lens and surrounding space.
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