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Scattering by Wedges and Cones Filled with DNG Metamaterial

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The scattering of a plane electromagnetic wave by wedges and circular cones filled with lossless anti-isorefractive DNG metamaterial and immersed in free space is considered, in the phasor domain and with a time-dependence factor *exp(+jωt)* omitted throughout. The surrounding medium has positive permittivity ε and permeability μ, and the metamaterial has negative permittivity - ε and permeability - μ. By causality, the two media have the same intrinsic impedance, but opposite refractive indexes [1], which implies total transmission of a plane wave across a planar interface separating the two media. For both wedges and cones, the incident plane wave is assumed to illuminate fully the interface.

For the two-dimensional problem of a DNG wedge with aperture angle α on which the incident plane wave propagates perpendicularly to the edge of the wedge, two particular cases yield an exact geometrical optics (GO) solution to the scattering problem. For $\alpha = \pi$, an incident plane wave of arbitrary polarization is totally transmitted across an infinite planar interface. For $\alpha = \pi/2$ (right-angle wedge), the incident wave is back-reflected, resulting in a standing wave pattern of the total field both outside and inside the wedge [2]. This study examines the more general case of a wedge angle α different from both π and $\pi/2$.

The case of a circular DNG cone with aperture angle α is more challenging than the wedge, because it is a truly three-dimensional problem in which polarization plays an important role. The GO solution is explored, with special attention to axial incidence, in which case a back-scattered field is the GO solution for a cone with $\alpha = \pi/2$ radian.

References

[1] R.W. Ziolkowski and E. Heyman, "Wave propagation in media having negative permittivity and permeability", *Phys. Rev. E*, **64**, 056625, October 30, 2001; doi: 10.1103/PhysRevE.64.056625.

[2] P.L.E. Uslenghi, "Exact geometrical optics scattering by a right-angle wedge made of double-negative material", *IEEE Trans. Antennas Prop.*, **54**, 8, august 2006, pp.2301-2304.