

ON SIGN AND BRANCH OF CERTAIN PARAMETERS FOR SIMPLE, LOSSY DOUBLE-NEGATIVE MATERIALS

Arslanagic, S.¹, Breinbjerg, O.²

¹The University of Arizona, Electrical and Computer Engineering Department, P.O. Box 210104, 1230 E. Speedway Boulevard, 85721 Tucson, Arizona, USA

²Technical University of Denmark, Oersted-DTU, Electromagnetic Systems, Build. 348, Oersteds Plads, DK-2800 Kgs. Lyngby, Denmark

Double-negative (DNG) materials, first considered by V.G. Veselago in the late 1960s, have a negative real part of their permittivity as well as permeability, and these materials thus possess several unfamiliar electromagnetic properties (V. G. Veselago, *Sov. Phys. Usp.*, **10**, 509-514, 1968). In recent years, a great interest in exploring and exploiting the electromagnetic characteristics and properties of DNG materials has emerged, and a considerable amount of work, of theoretical as well as practical importance, has already been performed; e.g., see (N. Engheta *et al.*, *IEEE Trans. Microw. Theory Tech.*, **53**, 1535-1556, 2005) and the works referenced therein. Specifically, the sign and branch of certain parameters - such as wave number, intrinsic impedance, and refractive index - in DNG materials have been subjects of some discussion and disagreement (D.R. Smith *et al.*, *Phys. Rev. Lett.*, **85**, 2933-2936, 2000), (R. W. Ziolkowski *et al.*, *Phys. Rev. E.*, **64**, Paper 056625, 2001), (C. Caloz *et al.*, *J. Appl. Phys.*, **90**, 5483-5486, 2001), (R. A. Shelby *et al.*, *Science*, **292**, 77-79, 2001), (I. V. Lindell *et al.*, *Microwave Opt. Tech. Lett.*, **31**, 129-133, 2001), (A. L. Pokrovsky *et al.*, *Solid State Commun.*, **124**, 283-287, 2002). There is thus a need to re-examine these parameters.

In this work we investigate the sign and branch of wave number, intrinsic impedance, and refractive index for simple, lossy DNG materials. The investigation takes into account at the outset the obvious yet important fact that Maxwell's equations include only permittivity and permeability, but not wave number, intrinsic impedance, and refractive index. These parameters are introduced for convenience, and their introduction requires, of course, a consistent and proper choice of definitions. Each involves a square root quantity and, hence, requires a choice of the sign and branch of these parameters. One definition may be more convenient, or perhaps even more advantageous, than another but the correct solution to a given problem can be obtained with either definition as long as it is used stringently and the resulting physical quantities are consistent with expectations. Starting with lossless DPS materials (double-positive materials with positive real parts of the permittivity and permeability) the investigation extends to include lossy DNG materials. As an example illustrating the present findings, the problem of scattering by a circular DPS or DNG cylinder illuminated by an exterior, nearby electric line source is considered, and the exact eigenfunction solution is obtained with different choices of the sign of the wave number.

Abstract Submission Form

2006 National Radio Science Meeting

Abstract: arslanagic21967

Date Received: September 19, 2005

1. (a)

Samel Arslanagic
The University of Arizona
Electrical and Computer Engineering
P.O. Box 210104
1230 E. Speedway Boulevard
Tucson, AZ
85721 USA
samela@ece.arizona.edu

(b) (520)621-2434

(c) (520)621-8076

2. B - Fields and Waves

3. (a) S-B1

4. C - Contributed Paper

5. No special instructions