Symmetrical Property of Dyadic Green's Functions for Layered Non-reciprocal Medium

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When solving for the radiation problem of a source in the presence of layered anisotropic medium, dyadic Green's function for the region above the source point is often required. In the case when anisotropic medium involved is reciprocal, symmetry (or reciprocity) relations of the DGFs [J.W. Graham, G. F. Pettis, J. K. Lee, "Symmetrical Property of Dyadic Green's Functions for Layered Anisotropic Medium", IEEE APS /URSI, Toronto, Ontario, Canada, July 11-17, 2010], are utilized to transform a known Green's function into the Green's function needed. However, if the anisotropic medium involved is non-reciprocal, e.g., gyrotropic, then the above symmetry relations are no longer appropriate.

In this paper, modified symmetry relations of the DGFs are derived for the two-layer non-reciprocal anisotropic geometry shown in Fig.1. It is important to note here that the anisotropic region (Region 1) is assumed to be a non-reciprocal medium. Furthermore, two different cases are considered here as shown in Fig.1 (a) and Fig.1 (b). The first case is when the source and field points are both in the isotropic region (Region 0), and the second case is when the source and field points are in different regions (Region 0 and Region 1). We show that the interchange of the field point and the source point of the DGF for both cases is possible with the help of complimentary medium, when the anisotropic region is filled with non-reciprocal medium.

The derivations for the symmetry relations of both cases share the similar procedures and follow the same method used by C. T. Tai [*Dyadic Green's Functions in Electromagnetic Theory*, 1994] for the half-space isotropic problem. Specifically, wave equations for DGFs of different regions with or without source are first presented. It then follows the application of the vector Green's theorem of the second kind to DGF of each region. DGFs of different regions are then correlated through the boundary conditions at the interfaces. Finally, the resulting integrals are simplified using appropriate vector identities in order to derive the desired symmetry relation.

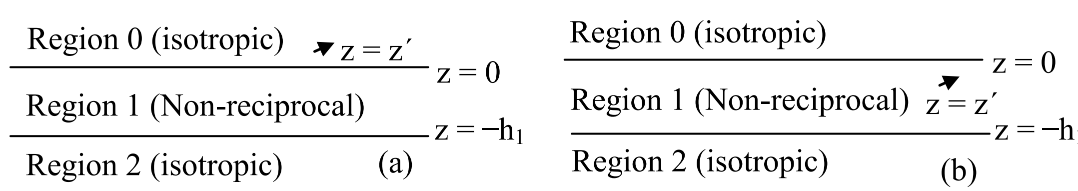

Figure 1. Geometry of the two-layer non-reciprocal problem (a) with source in Region 0 and (b) with source in Region 1.