DYADIC GREEN'S FUNCTION FOR A GYRO-MAGNETIC MEDIUM

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In numerous electromagnetic applications such as remote sensing, wave propagation and scattering, monolithic integrated circuits and optics, it is necessary to compute the electromagnetic field inside the medium. When the dyadic Green's function (DGF) of the medium is known, it is relatively easy to find the electromagnetic field inside that environment. Because of this feature, the DGF method in electromagnetic applications still remains to be an attractive method for researchers over 50 years.

Many researchers have developed various techniques to obtain the DGFs for the isotropic and anisotropic multi-layered media. The most commonly used techniques include plane wave spectral representations of DGFs with vector wave functions, Fourier-transform domain representations with matrix analysis techniques, inverse operator technique, and characterizing each layer by an appropriate tensor and finding the Fourier transformed Green's function accordingly and the method of using transmission line network analog along the axis normal to the stratification.

The calculation of DGF for a magnetically gyrotropic or a gyro-magnetic medium such as a ferrite subject to a dc magnetic field requires special attention due to its Hermitian structured permitivity tensor. Y.A. Chow [*IEEE Trans. Antennas Propag*., **AP-10**, 464-469, 1962] derived the dyadic Green's function of the gyro-electric-magnetic medium by extending F.V. Bunkin's [*Sov. Phys. JETP*, Engl. Transl., **5**, 277-295, 1957] tensorial Green's function technique which was only applied to an electrically gyrotropic or a gyro-electric medium. W.S.Weiglhofer [*Int. J. Electronics*, 73(4), 763-771, 1992] represented the DGF for a gyro-magnetic medium in terms of a single scalar Green's function which is a solution of a fourth order partial differential equation using duality between gyro-electric and gyro-magnetic medium.

In this paper, we derive the dyadic Green's function of a gyro-magnetic medium using a new formulation technique, which consists of a matrix method with dyadic decomposition in the k-domain and application of the principle of duality. Our work consists of two parts. In the first part, the DGF for a gyro-electric medium is derived. The system is transformed into the k-domain by taking the Fourier transform of the vector wave equation for DGF. In this domain, the representation of the DGF is reduced to find the inverse of an electric wave matrix. The inverse operation is accomplished by using the dyadic decomposition. As a final step, the DGF is constructed by expressing the adjoint of the wave matrix in terms of its wave vectors using the matrix method. In the second part, we apply the principle of duality to derive the relationship between the magnetic DGF of a gyro-electric medium and the electric DGF of a gyro-magnetic medium. This duality relationship is used to obtain the dyadic Green's function for a gyro-magnetic medium. It is shown that the dyadic decomposition greatly facilitates the calculation of an inverse operation, which is crucial in derivation of Green's function and the principle of duality makes it possible to find Green's function of a "dual" medium. An explicit and simple formulation presented here is useful in problems involving new types of advanced composite materials and magnetized ferrites which are widely used in high frequency electromagnetic and optical applications.