THE IMPACT OF CHIRALITY ON THE MUELLER MATRIX ELEMENTS

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Electromagnetic waves propagating in free space over a half space with media possessing chiral properties satisfying the Drude-Born-Fedorov constitutive relations, are expressed in canonical form in terms of right and left circular polarized waves. However the elements of the Mueller Matrix are expressed in terms of scattering coefficients for linear vertical (parallel) and horizontal (perpendicular) polarized waves. Thus in order to explore the impact of chirality on the elements of the Mueller Matrix, it is initially necessary to determine the impact of chirality upon the reflection and transmission coefficient for right and left circular polarized waves that are incident from free space, upon a chiral half space. Since the degree of chirality in biological materials is much smaller than one, it is necessary to retain only first order terms in the chiral parameter in the expressions for the circularly polarized reflection and transmission coefficients. It is shown that while the circular like polarized reflection coefficients are proportional to the chiral parameters, the circular cross polarized terms depend on higher order terms in the chiral parameters. Through a series of transformations (that relate circular to linear polarized waves), the corresponding reflection coefficients for linear polarized waves are obtained. Consequently it is shown that the explicit expressions for the linear, like polarized reflection coefficients are insensitive to charality and the linear cross polarized reflection coefficients are proportional to the chiral parameters. The explicit expressions for the reflection coefficients also depend upon the angle of incidence, frequency, and polarization (through the transmission coefficients associated with the permeability and the permittivity of the host medium). Thus chirality impacts only upon the eight off diagonal elements of the Mueller Matrix. The results satisfy the duality and reciprocity relations in electromagnetic theory. It is also shown that the results satisfy energy conservation for non-dissipative media.

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