The Impact of Random Rough Surfaces on the Identification of Chiral Materials

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Chiral media are characterized by either right or left circularly polarized waves that propagate with a phase velocity larger than the velocity of light in the medium. Many biological materials are optically active and this leads to a variety of possible applications for the remote sensing of chiral media. Electromagnetic scattering from random rough surfaces above chiral media is investigated to determine its impact on the identification of chiral media.

Using the Drude-Born-Fedorov constitutive relations for chiral media, initially a Fourier harmonic solution is found for scattering from a planar interface between an achiral (free space) and a chiral media. To allow for imposition of the exact boundary conditions at a rough interface this harmonic solution is used to derive modal solutions expressed as sets of basis and reciprocal basis functions. The various modes of the solution (radiation, lateral, and surface waves for right and left circularly polarized waves) can be identified using asymptotics. The basis and reciprocal basis functions are used to define a generalized Fourier transform that is used to convert Maxwell's equations into sets of coupled first order ordinary differential equations (generalized telegraphist's equations) for the forward and backward traveling wave amplitudes. Iterative solutions of these equations are found. Each iteration corresponds to an additional multiple reflection from the surface.

Depolarization occurs as a result of both the chirality and the surface roughness. These two mechanisms are separated through the use of a two-term Maclaurin series expansion of the scattering matrix with respect to the chirality parameter. Furthermore this expansion is used to show that the depolarization due to chirality only occurs at specular points, while depolarization due to surface roughness only occurs away from the specular points.