

Detection and Identification of Bio-medical Materials Possessing Chirality Using the Mueller Matrix

E. Bahar

University of Nebraska-Lincoln, USA

Since bio-medical materials possess some degree of chirality, the specific impact of chirality on the Mueller Matrix elements is analyzed. The canonical solutions for electromagnetic propagation in chiral media are the right and left circular polarized waves. Therefore, initially the effects of chirality on the circular like and cross polarized reflection coefficients are obtained.

It is shown that to within first order in the chirality parameters, only the circular, like polarized reflection coefficients (right to right, left to left) are modified. However since the Mueller Matrix elements are usually expressed in terms of linear like and cross polarized scattering coefficients, the corresponding expressions for the linear polarized reflection coefficients are determined. It is shown that only the linear, cross polarized reflection coefficient are modified. As a result (to within first order in the chirality parameter) only the eight quasi off diagonal elements of the Mueller Matrix are effected by the chiral property of the bio-medical materials. This reinforces the experimental observations from previous scattering experiments that the quasi off diagonal Mueller Matrix elements could provide a basis for detection and identification of bio-medical materials.

The analysis provides the explicit relationship between the quasi off diagonal elements and the degree of chirality of the bio-medical material. Thus it is possible to determine whether the chiral effects are sufficiently large to provide the accuracy necessary to conduct species-level discrimination in the present of spurious contributions due to surface roughness, etc. The explicit dependence of the Mueller Matrix elements (due to chirality) upon frequency and angles of incidence is also determined. Thus it is possible to optimize the impact of chirality on the Mueller Matrix in order to improve the feasibility of species level discrimination.