INTERPRETATION AND DETERMINATION OF MUELLER MATRIX USING PARTIAL POLARIMETRY

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Mueller matrices relate Stokes parameters of the incident and the emerging light, after interaction with an object (or a medium), and carry information about diattenuation, retardance, and depolarization. Determining all $4 \times 4$ Mueller matrix elements requires the use of a polarization state generator and a polarization state analyzer with 16 (or more) measurements, which could be achieved by ellipsometry, also known as complete polarimetry. On the other hand, partial polarimetry uses a simpler generator and/or analyzer with a limitation to generate and/or analyze the states of polarizations; thus, it only measures a subset of the Mueller matrix directly. For example, regular spectrometry measures one of the 16 elements of the Mueller matrix; circular/linear dichroism spectrometry typically measures two elements; and a polarimeter with a single generator or analyzer measures four elements.

Partial polarimetry, however, may determine the full Mueller matrix under specific symmetry conditions. For example, the Mueller matrix for normal reflection upon an isotropic medium may be determined by measuring the reflectance at normal incidence. In other words, understanding the symmetries of Mueller matrices helps reduce the complexity of the required polarimetry measurements.

This work focuses on studying the applicability of using partial polarimetry to determine the full Mueller matrices. It will provide a basic interpretation and decomposition method of Mueller matrices, followed by discussions about the symmetries of Mueller matrices based on different types of materials, such as isotropic medium or anisotropic medium with or without electromagnetic reciprocity. The exploration of the simplest combinations of polarimetry measurements for determining the full Mueller matrix will also be discussed. This work will provide insightful understanding of Mueller matrices and guidance on easier ellipsometry measurements.

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