Jones Calculus

Between 1941 and 1948, R. Clark Jones published a series of papers describing a new polarization calculus based upon optical fields rather than intensities. This approach, although more removed from direct observation than previous methods, allowed calculation of interference effects and in some cases provided a simpler description of optical physics. A completely polarized optical field can be represented by a two-element complex vector, each element specifying the magnitude and phase of the x and y components of the field at a particular point in space. The effect of transmission through an optical device is modeled by multiplying the input field vector by a complex two-by-two device matrix to obtain an output field vector.

The matrix representation of an unknown device can be found by measuring three output Jones vectors in response to three known stimulus polarizations. Calculation of the matrix is simplest when the stimuli are linear polarizations oriented at 0, 45, and 90 degrees (Fig. 1), but any three distinct stimuli may be used. The matrix calculated in this manner is related to the true Jones matrix by a multiplicative complex constant c. The magnitude of this constant can be calculated from intensities measured with the device removed from the optical path, but the phase is relatively difficult to calculate, requiring a stable interferometric measurement. Fortunately, measurements of many characteristics such as PMD do not require determination of this constant.

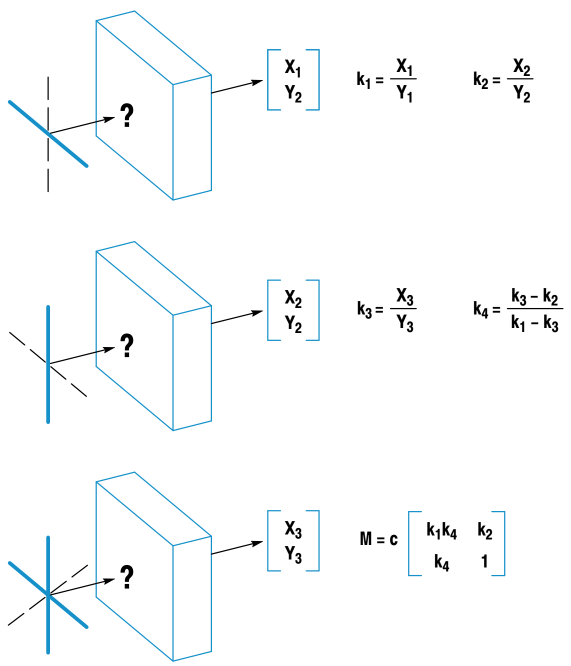

Fig. 1. Measurement of the Jones matrix requires application of three known states of polarization. Output electric field descriptions and ratios k_x are complex quantities. The Jones matrix **M** is found to within a complex constant c, whose phase represents the absolute propagation delay and is not required for PMD measurements.