

Astronomical Telescopes and Instruments 2014:
Exercises on Polarization
(Due on 8 October 2014 at 13:45)

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1 Rotating Retarder Polarimeter

A rotating retarder (or waveplate) polarimeter consists of a rotating retarder with retardance δ and position angle $\theta(t)$, a fixed linear polarizer, and a detector.

1.1 Modulation Signal

Show that the intensity I' measured by the detector as a function of time for an incoming Stokes vector $(I, Q, U, V)^T$ is given by

$$I' = \frac{1}{2} \left(I + \frac{Q}{2} ((1 + \cos \delta) + (1 - \cos \delta) \cos 4\theta) + \frac{U}{2} (1 - \cos \delta) \sin 4\theta - V \sin \delta \sin 2\theta \right)$$

1.2 Uniform Modulation Amplitude

Show that the modulation amplitudes in Q , U , and V are identical for $\delta=127^\circ$.

1.3 Measurement Intervals

Assume that the detector measures the intensity signal in n equally long time intervals for every full rotation of the retarder. How large does n need to be to detect all components of the Stokes vector.

2 Mueller Matrix

The most general Jones matrix describing the interaction of monochromatic light with matter has eight independent parameters (four complex numbers). How many independent parameters does a Mueller matrix have that describes the same interaction of a polarized beam with matter?

3 Rotating Mirror Problem

The Mueller matrix for an ideal mirror at normal incidence is given by

$$M = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix}.$$

Calculate the Mueller matrix of a mirror as a function of the rotation angle α around its normal. What is wrong and why?