Primary Optical Instruments
Used by the UST
Physics Department

\[
\begin{pmatrix}
    S'_0 \\
    S'_1 \\
    S'_2 \\
    S'_3
\end{pmatrix} =
\begin{pmatrix}
    m_{00} & m_{01} & m_{02} & m_{03} \\
    m_{10} & m_{11} & m_{12} & m_{13} \\
    m_{20} & m_{21} & m_{22} & m_{23} \\
    m_{30} & m_{31} & m_{32} & m_{33}
\end{pmatrix}
\begin{pmatrix}
    S_0 \\
    S_1 \\
    S_2 \\
    S_3
\end{pmatrix}
\]

Output Stokes Vector
 Mueller matrix of target
Input Stokes Vector

Linear Polarization
Circular Polarization
Axometrics Mueller Matrix Polarimeter

• measures complete 16-element Mueller matrix of target; spectral range of 400-800 nm

• Mueller matrix contains all polarization information about target. These quantities can be measured simultaneously:

  --Linear and circular retardance
  --Linear and circular dichroism
  --Depolarization; polarization-dependent loss
  --Percent transmittance or reflection

• measures 10 Mueller matrices per second
J.A. Woollam M-2000 Spectroscopic Ellipsometer

• measures changes of polarization when light reflects from a solid or liquid surface; works in transmission mode, too

• calculates thickness of thin films as well as optical constants such as real and imaginary refractive indices

• characterizes anisotropy and depolarization; measures 11 Mueller matrix elements

• near-UV to near IR bandwidth

• manual angle adjustment from 45° to 90°
**Meadowlark Liquid Crystal Polarimeter LCPM-3000**

- measures full Stokes vector of input light
- Computes degree of polarization, ellipticity, and orientation
- Displays polarization ellipse and Poincare sphere
- temperature controlled optical head
- 450-1100 nm optical bandwidth
- Can measure complete Mueller matrix if used with well-calibrated polarization state generator such as Meadowlark’s Eigenstate Generator Set
Hinds Photoelastic Modulators

- variable retarders that modulate light between orthogonal polarization states at 50 kHz (fixed frequency)
- near UV to near IR bandwidth
- can be used to measure linear and circular dichroism and birefringence as well as degree of polarization
- very high sensitivity and accuracy
- large aperture and acceptance angle
Meadowlark and Thorlabs Liquid Crystal Variable Retarders

- variable zero-order waveplates for visible to near IR spectrum
- various diameters
- some are temperature stabilized
- produce any polarization state
- response times on the order of tens of ms
- some can be used for imaging polarimetry
Homemade Ultraviolet to Visible Imaging Polarimeter

- created by undergraduate student Jimmy Feeks
- fully automated and operates with wavelengths between 200-800 nm
- provides Stokes parameters as processed images rather than single numbers
- LabVIEW software calculates degree of polarization, ellipticity, and orientation angle of light
Homemade Optical Tweezers

- Created by undergraduate students Eric Brost and Vy Tran
- Laser system to trap and manipulate micron-sized objects
- Can be used with polarized light to rotate birefringent targets
- Has option of creating a multi-trap array using diffraction gratings