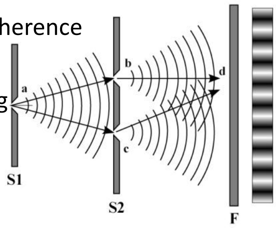
PHY385-H1F Introductory Optics

Class 19 – Outline: 9.1 to 9.3

- Jones Matrices
- Two-slit interference
- Young's 2-slit Experiment
- Temporal and Spatial Coherence
- Fresnel-Arago Laws
- Other wavefront splitting interfometers



Notes from Table 8.5 on pg. 375:

- $\mathscr{P}$- state at –45° $\frac{1}{\sqrt{2}}\begin{bmatrix} 1 \\ -1 \end{bmatrix}$
- $\mathscr{R}$- state $\frac{1}{\sqrt{2}}\begin{bmatrix} 1 \\ -i \end{bmatrix}$
- $\mathscr{L}$- state $\frac{1}{\sqrt{2}}\begin{bmatrix} 1 \\ i \end{bmatrix}$

Notes from Table 8.6 on pg. 378:

- Linear Polarizer at –45° $\frac{1}{2}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$
- QWP, fast axis along y $e^{i\pi/4}\begin{bmatrix} 1 & 0 \\ 0 & -i \end{bmatrix}$
- QWP, fast axis along x $e^{i\pi/4}\begin{bmatrix} 1 & 0 \\ 0 & i \end{bmatrix}$

Horizontally polarized light with Jones Vector E0 = $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ first passes through a linear polarizer at 45°, M1, then through a vertical polarizer M2.

$$M1 = \begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0.5 \end{bmatrix} \qquad M2 = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}$$

After passing through M1, the unnormalized Jones vector of the light is

1. $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$
2. $\begin{bmatrix} 0 \\ 0.5 \end{bmatrix}$
3. $\begin{bmatrix} 0.5 \\ 0 \end{bmatrix}$
4. $\begin{bmatrix} 0.5 \\ 0.5 \end{bmatrix}$

Horizontally polarized light with Jones Vector E0 = $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ first passes through a linear polarizer at 45°, M1, then through a vertical polarizer M2.

$$M1 = \begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0.5 \end{bmatrix} \qquad M2 = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}$$

If M1 is removed and the light E0 passes only through M2, the Jones vector of the resulting light is

1. $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$
2. $\begin{bmatrix} 0 \\ 0.5 \end{bmatrix}$
3. $\begin{bmatrix} 0.5 \\ 0 \end{bmatrix}$
4. $\begin{bmatrix} 0.5 \\ 0.5 \end{bmatrix}$

Horizontally polarized light with Jones Vector E0 = $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ first passes through a linear polarizer at 45°, M1, then through a vertical polarizer M2.

$$M1 = \begin{bmatrix} 0.5 & 0.5 \\ 0.5 & 0.5 \end{bmatrix} \qquad M2 = \begin{bmatrix} 0 & 0 \\ 0 & 1 \end{bmatrix}$$

What is the correct Jones Matrix for the system?

1. $\begin{bmatrix} 0 & 0.5 \\ 0 & 0.5 \end{bmatrix}$
2. $\begin{bmatrix} 0 & 0 \\ 0.5 & 0.5 \end{bmatrix}$
3. $\begin{bmatrix} 0.5 & 0 \\ 0.5 & 0 \end{bmatrix}$
4. $\begin{bmatrix} 0.5 & 0.5 \\ 0 & 0 \end{bmatrix}$

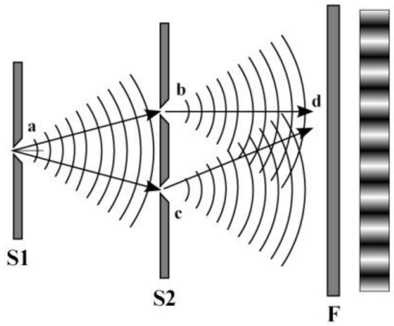
Horizontally polarized light with Jones Vector E0 = $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$ first passes through a linear polarizer at 45°, M1, then through a vertical polarizer M2. The system matrix is

$$M2 \times M1 = \begin{bmatrix} 0 & 0 \\ 0.5 & 0.5 \end{bmatrix}$$

After passing through the system, the unnormalized Jones vector of the light is

1. $\begin{bmatrix} 0 \\ 0 \end{bmatrix}$
2. $\begin{bmatrix} 0 \\ 0.5 \end{bmatrix}$
3. $\begin{bmatrix} 0.5 \\ 0 \end{bmatrix}$
4. $\begin{bmatrix} 0.5 \\ 0.5 \end{bmatrix}$

Interference
Chapter 9, Sections 9.1 to 9.3



Two flashlight beams, each of irradiance I_0, pass through the same small window of area A. The total irradiance passing through this window at any moment is

1. 0
2. I_0
3. $2I_0$
4. $4I_0$

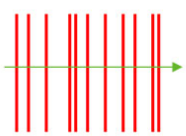
Two monochromatic beams of light, each of irradiance I_0, pass through the same small window of area A. The maximum possible irradiance passing through this window at any moment is

1. 0
2. I_0
3. $2I_0$
4. $4I_0$

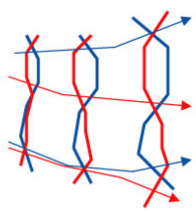
Two monochromatic beams of light, each of irradiance I_0, pass through the same small window of area A. The minimum possible irradiance passing through this window at any moment is

1. 0
2. I_0
3. $2I_0$
4. $4I_0$

Two types of "coherence"



Temporal Coherence
Random fluctuations in the *spacing* of the wavefronts

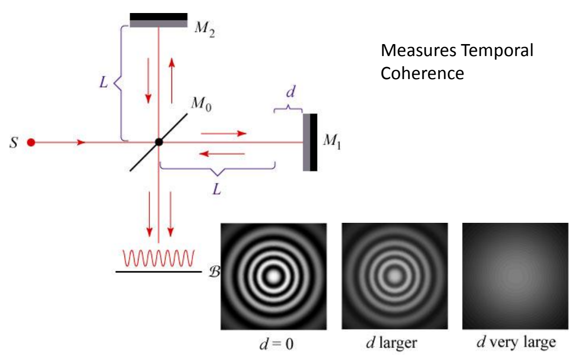


Spatial Coherence
Random fluctuations in the *shape* of the wavefronts

Source: http://skullsinthestars.com/2008/09/03/optics-basics-coherence/

A Michelson interferometer

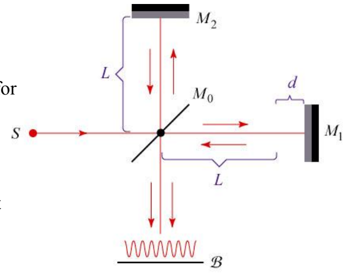
Measures Temporal Coherence



Source: http://skullsinthestars.com/2008/09/03/optics-basics-coherence/

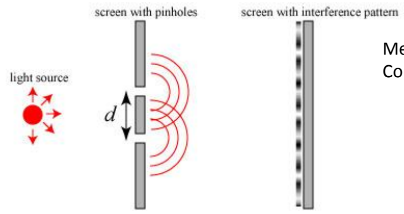
A Michelson interferometer

• When d exceeds a critical value, D, the fringes disappear
• D = "Coherence Length" for this particular kind of light
• D corresponds to a "Coherence time"
• $T = D/c$
• Coherence times are about 10 – 15 ns for typical lasers (about 5 m)



Source: http://skullsinthestars.com/2008/09/03/optics-basics-coherence/

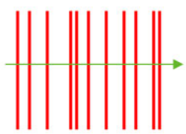
A Young Double Slit Experiment



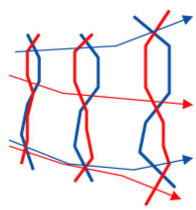
Measures Spatial Coherence

• When d exceeds a critical value, D, the fringes disappear
• D = "Transverse Coherence Length" for this particular light source
• πD^2 is the "Coherence Area"
• Coherence area for filtered sunlight: A ~ 10^{-2} mm^2
• Coherence area for filtered starlight: A ~ 6 m^2

Source: http://skullsinthestars.com/2008/09/03/optics-basics-coherence/



temporal coherence: random fluctuations in the *spacing* of the wavefronts



spatial coherence: random fluctuations in the *shape* of the wavefronts

• Very monochromatic sources tend to have longer values of coherence time. These are "temporally coherent".
• Light from point-sources tends to have larger values of coherence area. These are "spatially coherent". The larger the angular size of the source, the less spatially coherent it will be.

Source: http://skullsinthestars.com/2008/09/03/optics-basics-coherence/