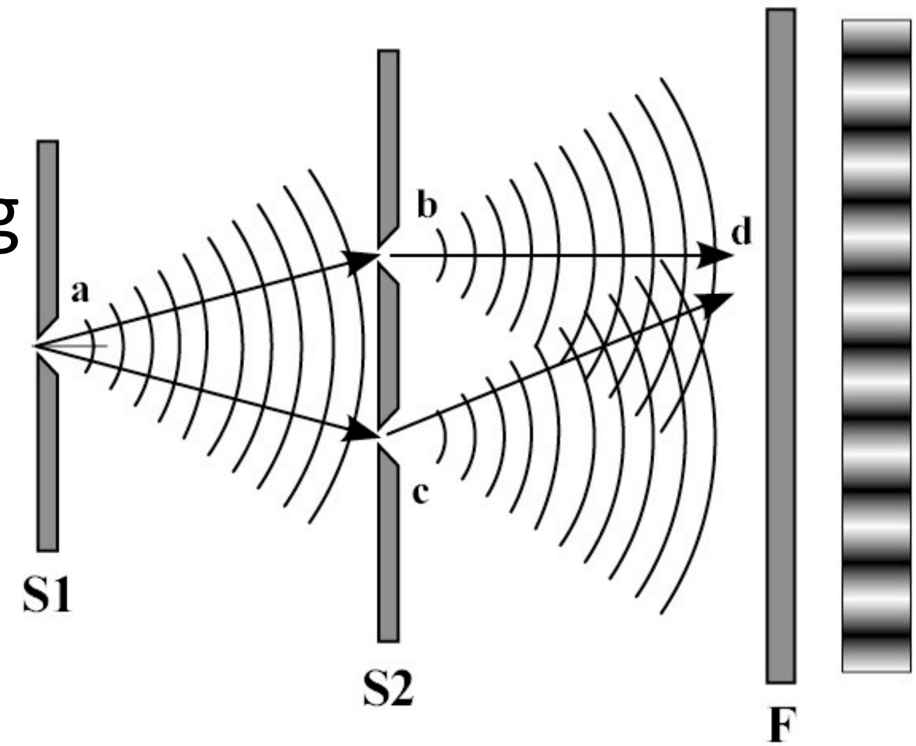
PHY385-H1F Introductory Optics

Class 19 – Outline: 9.1 to 9.3

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



In-Class Task from Last time.. I asked:

1. If $E_0 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, which direction does $\vec{B}_0$ point?

This Jones vector simply means E_0 points along $+y$. In this case, B_0 points along $+x$.

2. Write the normalized Jones vector for the plane wave with: $$\vec{E} = \hat{i}E_0 e^{i(kz-\omega t)} - \hat{j}E_0 e^{i(kz-\omega t)}$$

$$\frac{1}{\sqrt{2}}\begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

3. What kind of polarization state is the wave of question 2?

$\mathscr{P}$– state, at $\theta = -45°$

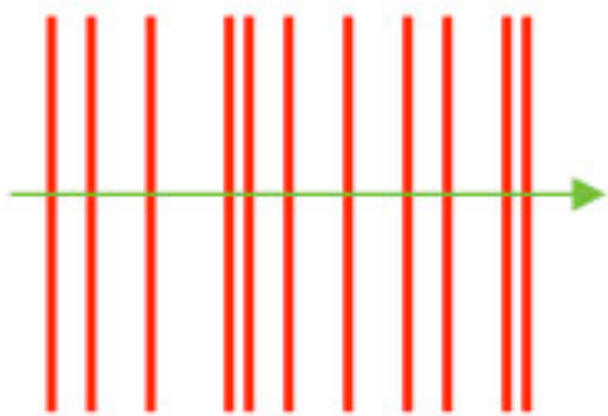
Notes from Table 8.5 on pg. 375:

- $\mathscr{P}$- 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:

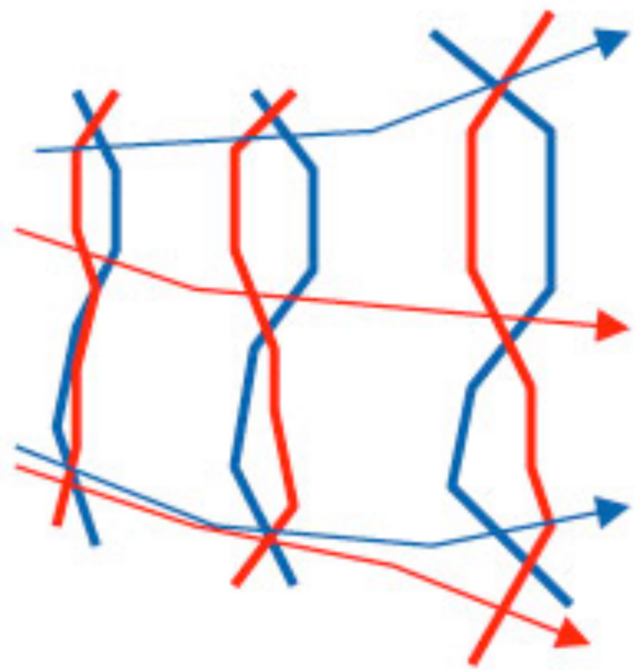
- Linear Polarizer at –45° $\frac{1}{2}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$
- QWP, fast axis along y $e^{i\pi/4}\begin{bmatrix} 1 & 0 \\ 0 & -i \end{bmatrix}$
- QWP, fast axis along x $e^{i\pi/4}\begin{bmatrix} 1 & 0 \\ 0 & i \end{bmatrix}$

Two types of “coherence”



Temporal Coherence

Random fluctuations in the *spacing* of the wavefronts

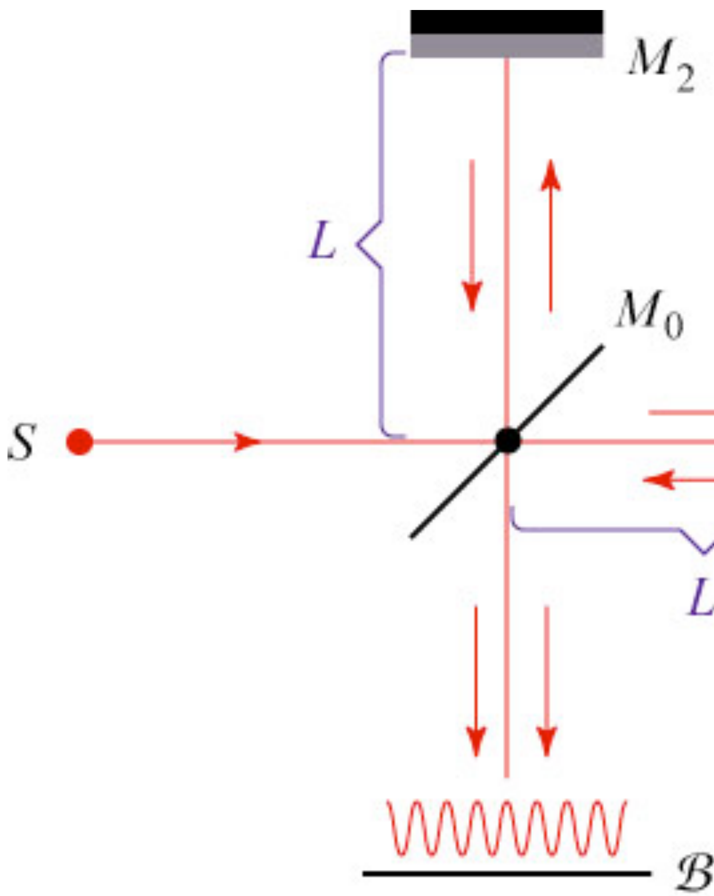


Spatial Coherence

Random fluctuations in the *shape* of the wavefronts

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

A Michelson interferometer



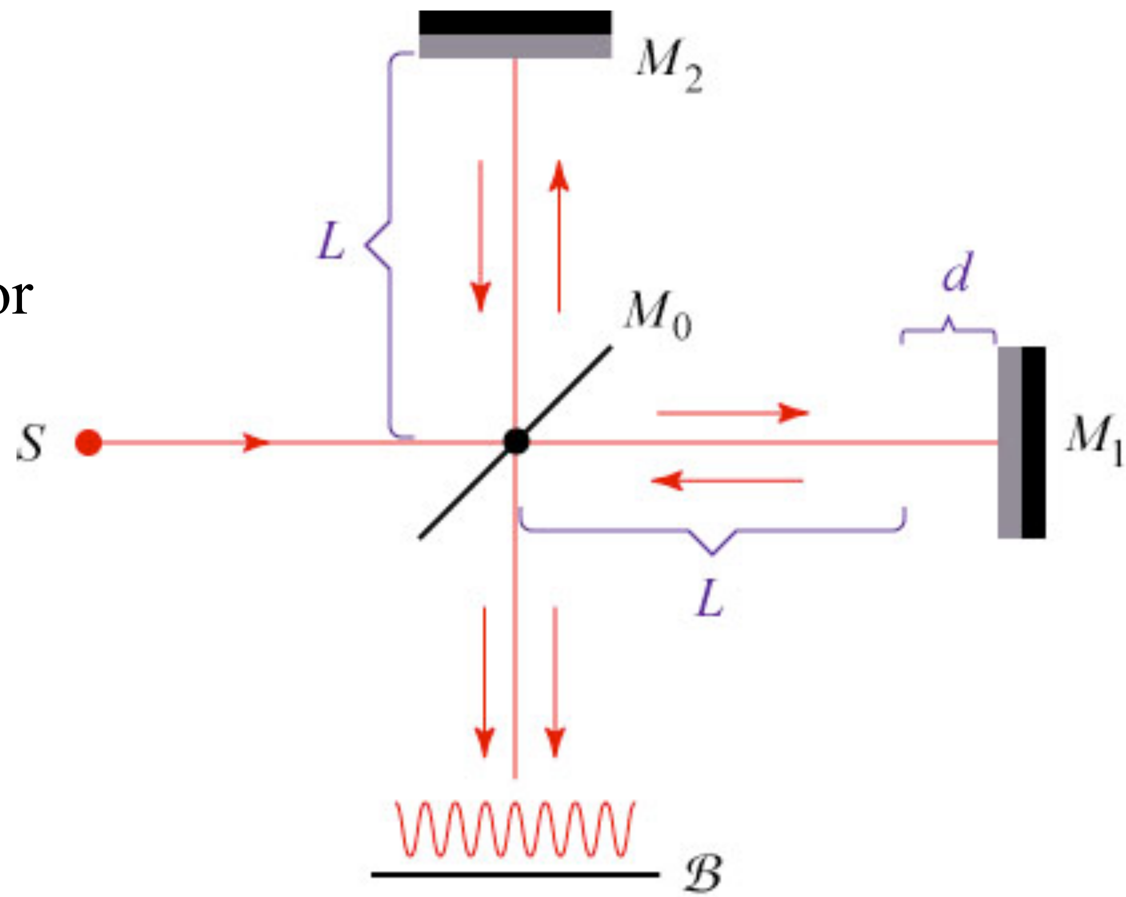
Measures Temporal Coherence

$d = 0$ | d larger | d very large

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

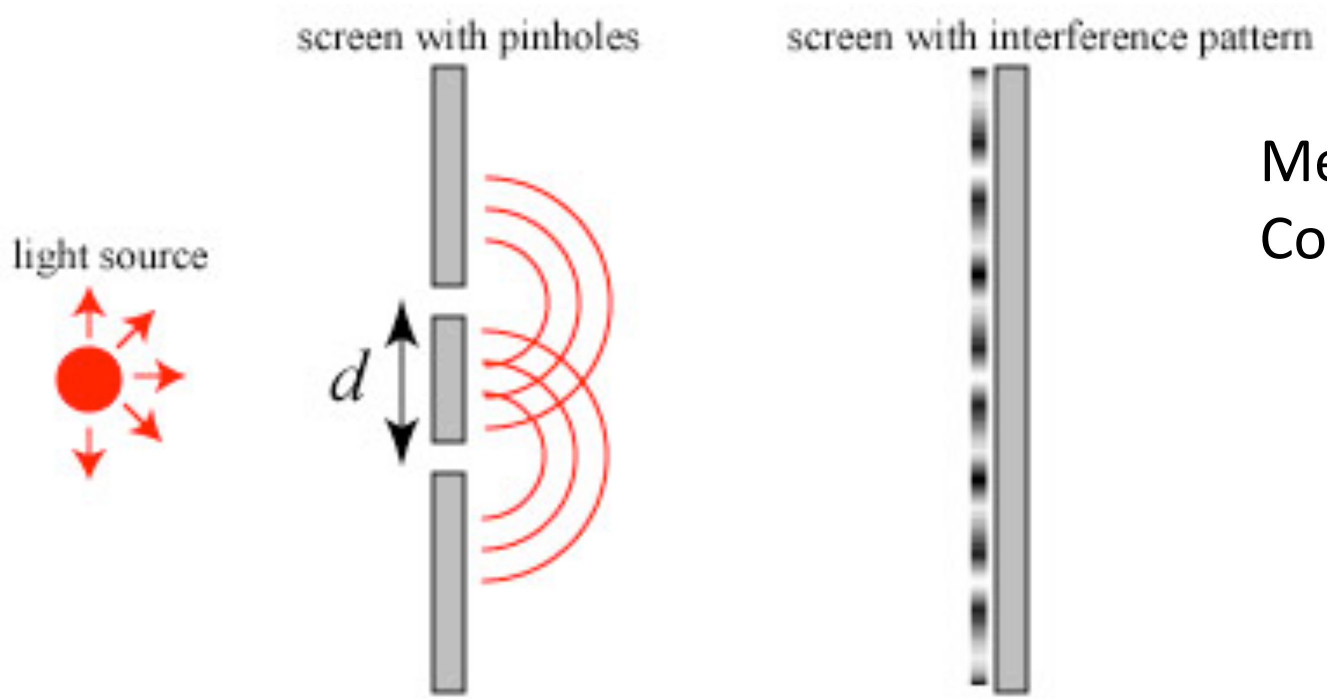
A Michelson interferometer

- 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/

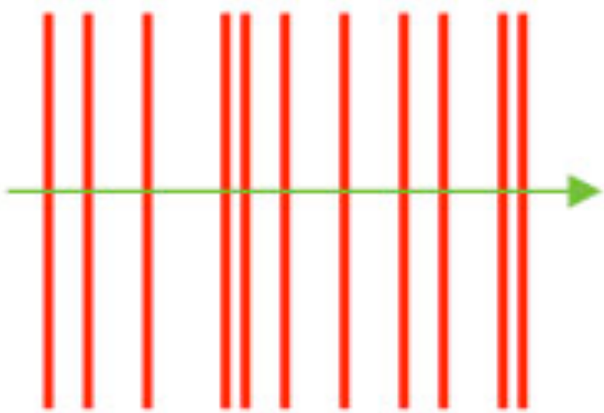
A Young Double Slit Experiment



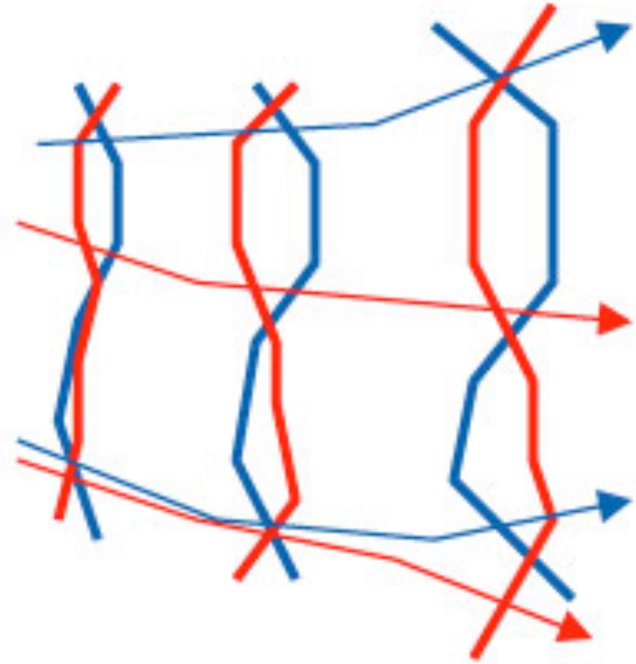
Measures Spatial Coherence

- 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/

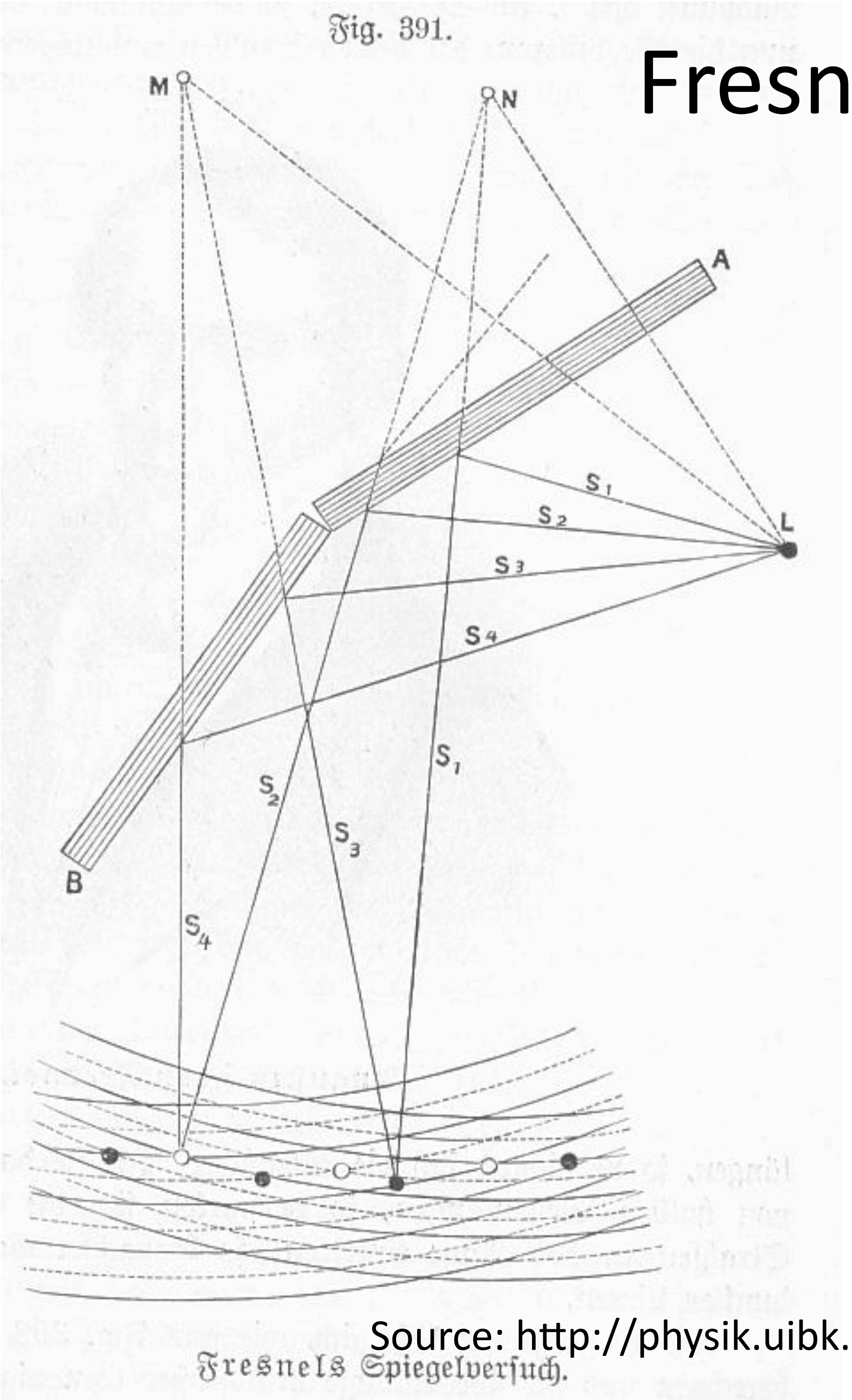
Fresnel's Double Mirror

• Light (preferably monochromatic) is reflected by 2 mirrors with a very small but adjustable angle between the normals to the mirror planes.

• The superposition of the light waves produces a interference, which is observed with a magnifying glass.

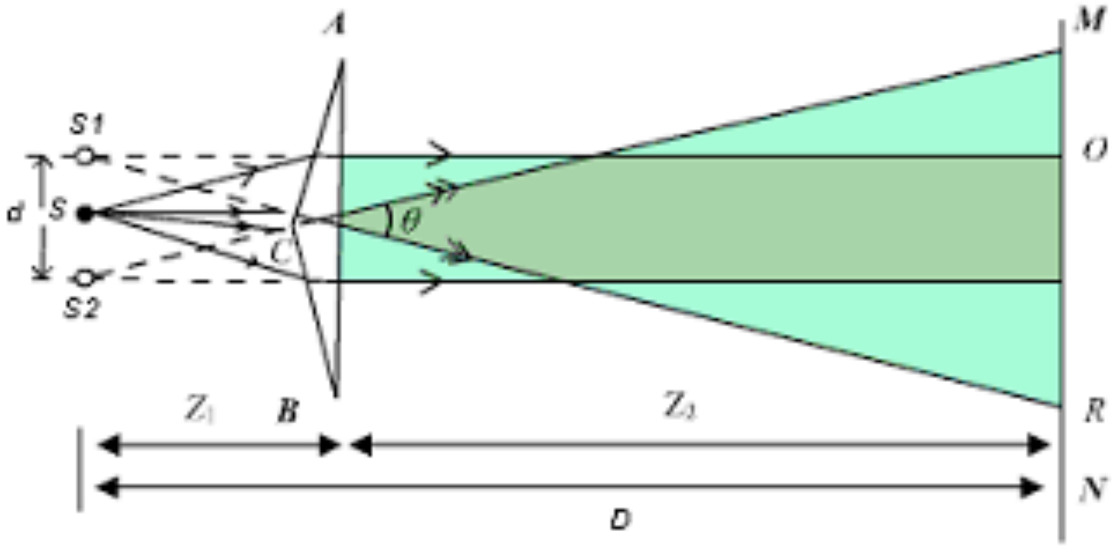
Source: http://physik.uibk.ac.at/museum/en/details/optics/fresnel.html

Fresnel’s Double Mirror



Source: http://physik.uibk.ac.at/museum/en/details/optics/fresnel.html

Fresnel Biprism



- The Fresnel biprism experiment was one of the early experiments which demonstrated the phenomenon of interference between two coherent light beams.
- A thin biprism is used to derive two coherent sources from a single monochromatic source of light.
- Virtual slit-sources *S1* and *S2* are formed by the biprism.
- Interference fringes can be observed in the region where the two beams overlap.

Source: http://easyengineering.net/index1.php?id=402