Visualizing Interference: Young's Double Slit
Why three slits? Coherence!

Natural light randomly skips in phase at a characteristic time scale:

Coherence time (about 2 nanoseconds for sunlight)

Since interference depends on phase differences, random jumps in phase will move the interference pattern. If it occurs every 2 nanoseconds the interference pattern will be "washed out".
Three slits because light has *spatial coherence*: over small region of the wavefront it randomly skips in phase together.

Randomly skipping in phase here....

...results in *same* random skips in phase at these two slits.

The spatial coherence of sunlight is about 0.1 mm
Visualizing Interference: Young’s Double Slit

Two sources have the same field amplitude and irradiance:

\[ I_1 = I_2 = I_o \]
Irradiance at P is described by interference of the light from each slit:

\[ I_p = 2I_o + \varepsilon_o c \bar{E}_o^2 \cos(\delta) \]

\[ I_p = 2I_o + 2I_o \cos(\delta) \]

It is usually written in a more compact form:

Use: \( 1 + \cos(\delta) = 2 \cos^2 \left( \frac{\delta}{2} \right) \)

\[ I_p = 4I_o \cos^2 \left( \frac{\delta}{2} \right) \]

The average value is what you get if you ignore interference.
What is $\delta$?

$$\delta = \frac{\Delta_{\text{path}} + \Delta_{\text{phase}}}{\lambda_o} 2\pi$$

$$\delta_{YDS} = \frac{a\sin(\theta) + 0}{\lambda} 2\pi$$

$I_p = ?$
$I_p = 4I_0 \cos^2 \left( \frac{\pi a \sin(\theta)}{\lambda} \right)$

if \( y \ll s, \sin(\theta) = y/s \)

\[ I_p = 4I_0 \cos^2 \left( \frac{\pi a}{s \lambda} y \right) \]

\[ \frac{\pi a}{s \lambda} y_1 = \pi \]

\[ \frac{\pi a}{s \lambda} y = \frac{\pi}{2} \]

\[ \frac{\pi a}{s \lambda} y_0 = 0 \]

Maxima at: \[ y = \frac{m \lambda s}{a} \quad m = 0, 1, 2, 3, \ldots \]