Wavefront-splitting interferometers

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Double slit

For Young's experiment (see fig. 9.8) the path length difference for slits of spacing a, screen distance s, lateral screen position y is

$$r_1 - r_2 = \frac{a}{s} y$$

Constructive interference will occur for $r_1 - r_2 = m\lambda$, and so the *m*th bright fringe will be at:

$$y_m \approx \frac{s}{a} m\lambda.$$

The fringe spacing will be

$$\Delta y \approx \frac{s}{a}\lambda$$

Note that longer wavelengths produce broader fringes. This idea leads to the development of multiple slit **gratings**.

We can use the expression (9.17) for the irradiance distribution due to phase differences to write the screen pattern as

$$\begin{aligned} I &= 4I_0 \cos^2 \frac{k(r_1 - r_2)}{2} \\ &= 4I_0 \cos^2 \frac{ya\pi}{s\lambda} \end{aligned}$$

So the brightness of the fringes is a sinusoidal pattern.

Other similar interferometers

Fresnel double mirror has same spacing *using distances to virtual images in mirrors.* Same basic irradiance pattern. See fig. 9.12.

Fresnel biprism virtual images of slit separate due to prism. Same irradiance pattern as single slit. (Prism must have optically flat surfaces, so as not to induce random phase changes.)

Lloyd's mirror see fig 9.14. One reflection at grazing incidence puts in a phase shift of π, so

$$\delta = k(r_1 - r_2) \pm \pi$$

and the irradiance is the **complement** of the double slit: a $\sin^2$ form. (p. 399)