Dielectric films

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Dielectric films are an ubiquitous form of amplitude-splitting interferometer.

Widely used in anti-reflection coatings, or to make highly reflective mirrors (over a limited range of wavelengths).

Equal-inclination fringes

Consider a dielectric sheet with parallel surfaces, of thickness d. Light enters, is refracted, reflects off back surface, and is refracted on exit. There is also another internal reflection, etc.

Consider just one internal reflection. Figure 9.17 shows the geometry of the two beams, where θ_t is the refraction angle inside the film. The equations on page 401–402 show that an optical path length difference of

$$\Lambda = 2 n_f d \cos\theta_t$$

occurs.

By referring to the Fresnel equations for reflection from a dielectric, an internally and an externally reflected beam will have a *relative phase shift of* π *rad.* So the OPD between the two beams will be

$$\begin{aligned} \delta &= k_0 \Lambda \pm \pi \\ &= \frac{4\pi d}{\lambda_0} d \cos\theta_t \pm \pi \end{aligned}$$

When these beams are brought together at a focus by a lens or on your retina, fringes result.

Note that the spacing of the fringes is given by both d and θ_t, maxima occur when $\delta = 2m\pi$:

$$d\cos\theta_t = (2m+1)\frac{\lambda_f}{4}, \quad m = 0, 1, 2\ldots$$

See figures 9.18–20 carefully.

Fringes of equal thickness

For small angles $\cos\theta \approx 1$, and the dominant contribution to the interference is the thickness of the film. These are sometimes called **Fizeau fringes.**

Oil and bubble films are good illustrations, as are Newton's rings (text).