

Lect. 15, March 25, 2010

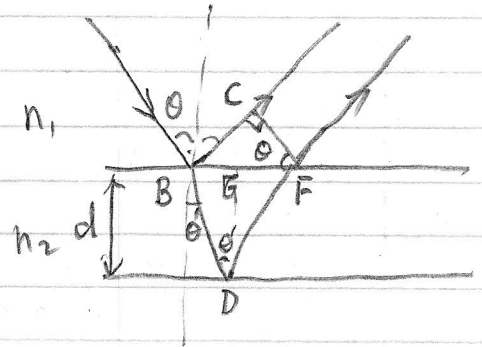
①

Oblique Incidence on a film — the Cosine Law (CH 15-3)

The difference of the optical paths

$$\Delta = 2n_2 d \cos \theta'$$

θ' : angle of refraction



$$\Delta = n_2 (BD + DF) - n_1 BC$$

Consider $\triangle BGD$. $BD = DF = \frac{DG}{\cos \theta'} = \frac{d}{\cos \theta'}$

$$BF = 2BG = 2 \cdot DG \cdot \tan \theta' = 2d \tan \theta'$$

Consider $\triangle BFC$. $BC = BF \cdot \sin \theta = BF \cdot \sin \theta' \frac{n_2}{n_1}$

$$BC = 2d \frac{\sin^2 \theta'}{\cos \theta'}$$

$$\Delta = 2n_2 d \left(\frac{1}{\cos \theta'} - \frac{\sin^2 \theta'}{\cos \theta'} \right)$$

$$\Delta = 2n_2 d \frac{\cos^2 \theta'}{\cos \theta'} = 2n_2 d \cos \theta'$$

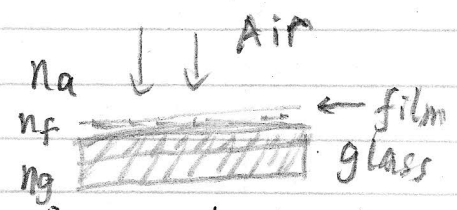
Δ : depends on θ , and also depend on λ_0 ($S = \frac{2\pi}{\lambda_0} \Delta$)

\Rightarrow Explain the colors on soap bubbles

* Non reflecting Films (CH 15.4)

Example: anti reflective coating of eye class

Thickness of the film d



Looking for destructive interference

Since $n_g > n_f > n_a$, phase changes of π for both reflection

$$\Delta = \frac{1}{2} \lambda_0 = 2n_f d$$

$$\Rightarrow d = \frac{\lambda_0}{4n_f}$$

Exp: $\lambda_0 = 5 \times 10^{-5} \text{ nm}$, $n_f = 1.38$ (MgF₂ film)

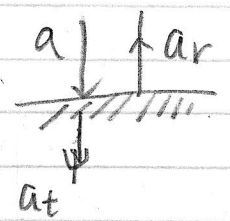
$$d = 0.9 \times 10^{-5} \text{ cm}$$

* Reflectivity R . reflection coefficient r

transmission coefficient t

$$a_r = ar$$

$$a_t = at$$



a, a_r, a_t are amplitudes of incident, reflected, transmitted light beams

From electromagnetic theory (CH 24.2, Eq. 67-72)

$$\left. \begin{aligned} r &= \frac{n_1 - n_2}{n_1 + n_2} \\ t &= \frac{2n_1}{n_1 + n_2} \end{aligned} \right\} \text{from medium } n_1 \text{ to } n_2$$

$$\text{Reflectivity } R = r^2 = \left(\frac{n_1 - n_2}{n_1 + n_2} \right)^2$$

For eyeglass without coating.

$$n_1 = 1, \quad n_2 = 1.5$$

$$R = 0.04, \quad \text{or } 4\% \text{ reflection of light}$$

