

## Chromatic Aberration

656 nm (red): C line

589 nm (orange-yellow): D line

489 nm (aqua-blue): F line

$$v = \frac{n_D - 1}{n_F - n_C}$$

$$CA_{\text{surface}} = \frac{F_D}{v} \quad CA_{\text{thinlens}} = \frac{F_D}{v}$$

for a pair of thin prisms:

$$CA_{\text{prism}} = \frac{Z_1}{v_1} + \frac{Z_2}{v_2}$$

## Monochromatic Aberration

$$\sin \theta = \theta - \frac{\theta^3}{3!}$$

$$LSA[D] = F'_{\text{marginal}} - F'_{\text{paraxial}}$$

$$LSA[m] = f'_{\text{paraxial}} - f'_{\text{marginal}}$$

$$\left. \begin{aligned} P_t &= P \left[ 1 + \frac{4\phi^2}{3} \right] \\ P_s &= P \left[ 1 + \frac{\phi^2}{3} \right] \\ RA &= P_t - P_s = P\phi^2 \end{aligned} \right\} \begin{array}{l} \text{when} \\ \theta < 20 \text{ deg} \\ \text{and} \\ n = 1.5 \end{array}$$

$$K = P/n$$

$$K = \sum_j \frac{P_j}{n_j}$$

## Wave Model for Light

$$f = \frac{1}{T} \quad \lambda = v \cdot T$$

$$\lambda f = v \quad I \propto A^2$$

$$\lambda_m = \frac{\lambda}{n}$$

$$E = A \cdot \sin(kx - \omega t + \varepsilon)$$

$$k = \frac{2\pi}{\lambda} \equiv \text{propagation number}$$

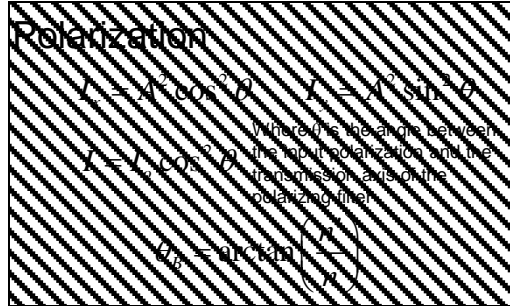
$$\omega = 2\pi f \equiv \text{angular frequency}$$

$$\varepsilon \equiv \text{initial phase [in radians]}$$

$$\frac{\omega}{k} = f\lambda = v$$

speed of light in vacuum =  $3 \times 10^8$  m/s

### Polarization



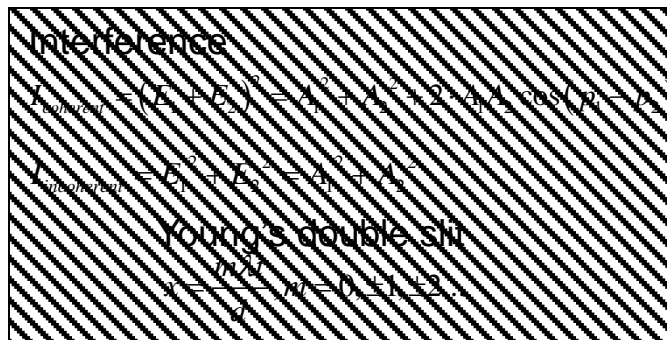
$$I_t = A^2 \cos^2 \theta \quad I_s = A^2 \sin^2 \theta$$

where  $\theta$  is the angle between the input polarization and the transmission axis of the polarizing filter.

$$I = I_t \cos^2 \theta$$

$$\theta_p = \arctan \left( \frac{n_y}{n_x} \right)$$

### Interference



$$I_{\text{coherent}} = (E_1 + E_2)^2 = A_1^2 + A_2^2 + 2 \cdot A_1 A_2 \cos(\phi_1 - \phi_2)$$

$$I_{\text{incoherent}} = E_1^2 + E_2^2 = A_1^2 + A_2^2$$

### Young's double slit

$$x = \frac{m\lambda}{\theta} \quad m = 0, \pm 1, \pm 2, \dots$$

## Thin film coatings:

$$t_{\text{dest}} = \frac{(m + 1/2) \lambda}{2 n_2}, \quad m = 0, 1, 2, \dots$$

$$t_{\text{const}} = \frac{m \lambda}{2 n_2}, \quad m = 0, 1, 2, \dots$$

These rules apply whenever the phase change by reflection is the same for both waves (ie both 180 deg or both 0. When only one wave undergoes a phase change by reflection but the other does not, then the equations are reversed.

amplitude condition for an ARC:  $n_c = \sqrt{n_g}$

$$r = \left| \frac{n' - n}{n' + n} \right| \quad \text{for intensity: } R = (r)^2 = \left[ \frac{n' - n}{n' + n} \right]^2$$

## Diffraction

### Slit Aperture

minima occur when  $\theta = \frac{m\lambda}{a}$  or  $x = \frac{m\lambda t}{a}$   $m = \pm 1, \pm 2, \dots$

### Circular Aperture

1st minimum occurs when  $\theta = \frac{1.22 \cdot \lambda}{a}$  or  $x = \frac{1.22 \cdot \lambda t}{a}$

## Phase

$$\frac{(\text{angles in degrees}) \times \pi}{180} = (\text{angles in radians})$$

$$\frac{(\text{angles in radians}) \times 180}{\pi} = (\text{angles in degrees})$$

$$\frac{(\text{phase difference in distance})}{\lambda / (\text{index through which light is passing})} = (\text{phase difference in waves})$$

$$(\text{phase difference in waves}) \times 2 \times \pi = (\text{phase difference in radians})$$