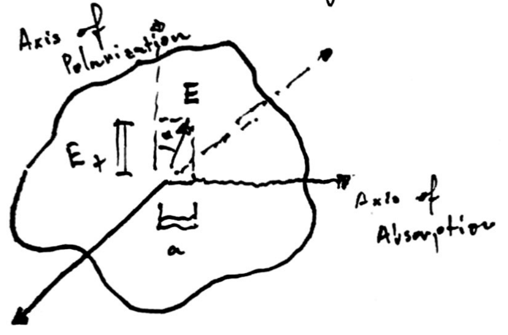
Experimental Mechanics: 1 Oct 2017

Notes on Birefringence

- Polariscope: use linear polarizers through a transparent model material
- Plane polarizer for plane wave; circularly with wave plane
- Linear or Plane Polarizer

  → Thin material between light source and continues



$\vec{E}$: light vector

E_t : transmitted light

E_a : absorbed light

α : angle b/w $\vec{E}$ & axis of polarization

  → Equation for Light Vector: $\vec{E} = a \cos \frac{2\pi}{\lambda}(z_0 - ct) \rightarrow a \cos(\omega t)$

  + initial phase (δ) of light can be neglected

  + $f = c/\lambda$; $\omega = 2\pi f$

  → Break into E_t and E_a

  + $E_a = a \cos(\omega t) \sin \alpha$

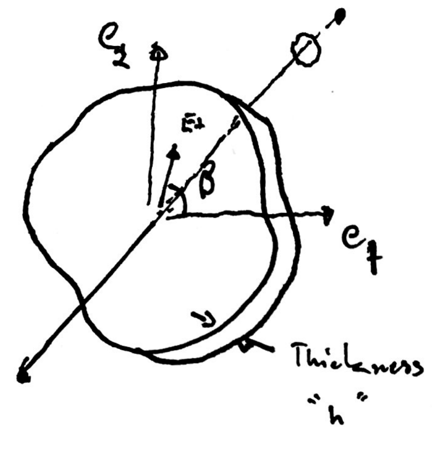
  + $E_t = a \cos(\omega t) \cos \alpha$

- Polaroid Filters

Iodoquinine crystals in nitrocellulose } J sheet: older & replaced w/ H Sheets

- Wave Plate: transmits 2 orthogonal light vectors with different velocities

→ Wave plate after linear polarizer



- β : angle
- e_1 : index of refraction axis (± 1) / fast axis
  - → n_1 : index of refraction
  - → c_1 : velocity of propagation
- Labeled so that $c_1 > c_2$

+ $E_{t_1} = E_1 \cos\beta = a\cos(\omega t)\cos\alpha\cos\beta = k\cos\omega t\cos\beta$ } $k = a\cos\alpha$
+ $E_{t_2} = E_2 \sin\beta = k\cos\omega t \sin\beta$
+ δ : phase shift de to $c_1 \neq c_2$; n w.r.t. air

$$\left.\begin{aligned} \delta_1 &= hn_1 - hn \\ \delta_2 &= hn_2 - hn \end{aligned}\right\} \delta = h(n_2 - n_1);\ \text{relative linear phase difference}$$

$$\Delta = \frac{2\pi}{\lambda}\delta = \frac{2\pi}{\lambda}h(n_2 - n_1) : \text{Angular } \cancel{\text{A}} \text{ phase shift}$$

→ Classification

+ Quarter wave : $\Delta = \pi/2$
+ Half wave : $\Delta = \pi, 2\pi, \ldots$

→ Results in

$$\left.\begin{aligned} &+ E_{t,1}' : k\cos\beta\cos\omega t \\ &+ E_{t,2}' : k\sin\beta\cos(\omega t - \Delta) \end{aligned}\right\} E_t' = \sqrt{E_{t_1}^2 + E_{t_2}^2} \Rightarrow \cancel{|E_T| = k\cos}$$

→ Angle Relative to e_1 : $\tan\gamma = \dfrac{E_{t_2}'}{E_{t_1}'} = \dfrac{\cos(\omega t - \Delta)}{\cos(\omega t)}\tan\beta$

· Conditioned Light using wave plates and linear polarizers

→ 3 defined cases

→ Plane Polarized Light : $\beta = 0$; Δ has no restriction

$$E_t' = k\cos(\omega t)$$

$$\gamma = 0$$

→ Circularly Polarized Light : $\Delta = \pi/2$; $\beta = \pi/4$ for left ; $\beta = 3\pi/4$ for right

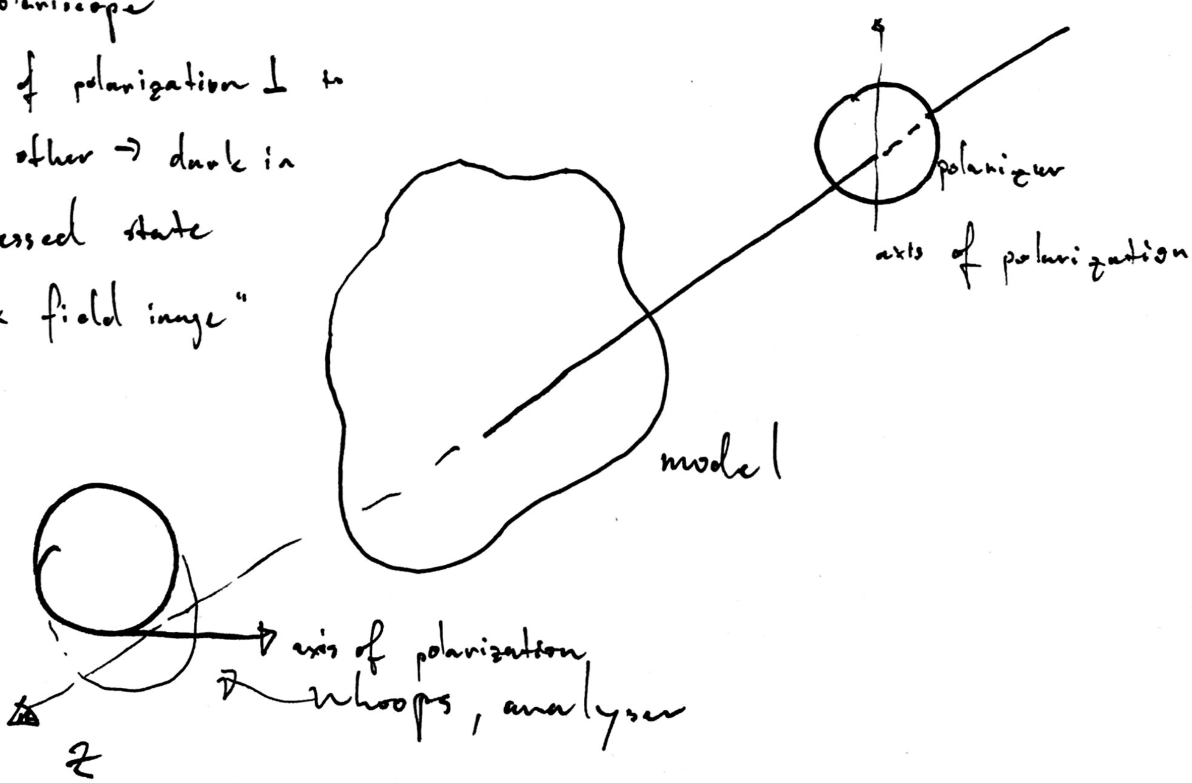
$$\left. \begin{aligned} E_t' &= \frac{\sqrt{2}}{2} k \\ \gamma &= \omega t \end{aligned} \right\} \text{Constant Magnitude, helical shape}$$

→ Elliptically Polarized : quarter wave plate ($\Delta = \pi/2$)

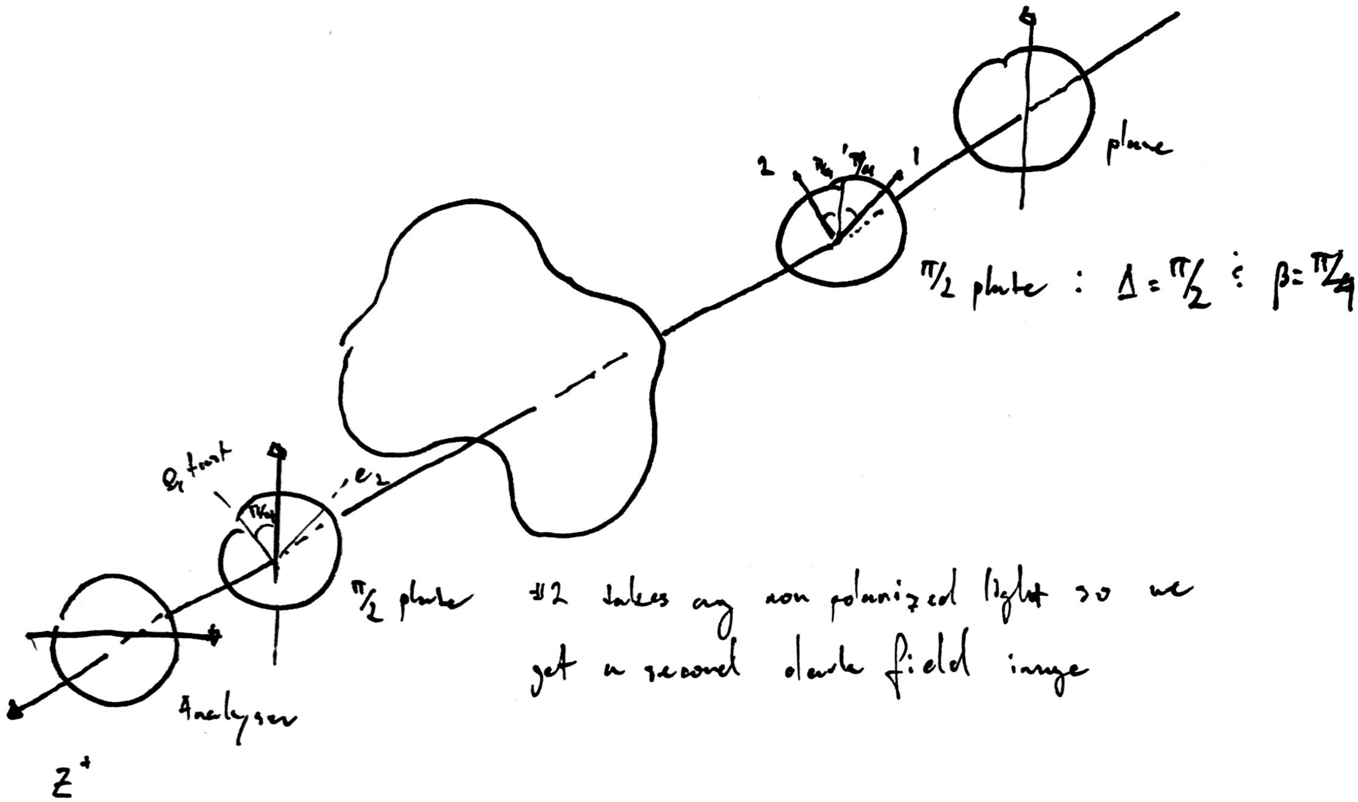
$$\left\{ \beta \neq \frac{n\pi}{2} , n \in \mathbb{I} \right\}$$

· Plane Polariscope

→ Axis of polarization ⊥ to each other → dark in unstressed state "dark field image"



Circular Polarizer



#2 takes any non polarized light so we get a second dark field image