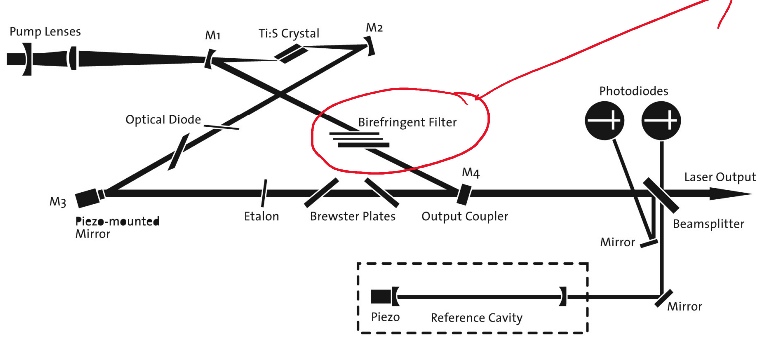
Lyot Filter

Dienstag, 16. Mai 2023 13:13

Optical Schematic of the MBR-110 Ti:Sapphire Laser

Verdi 532 nm input

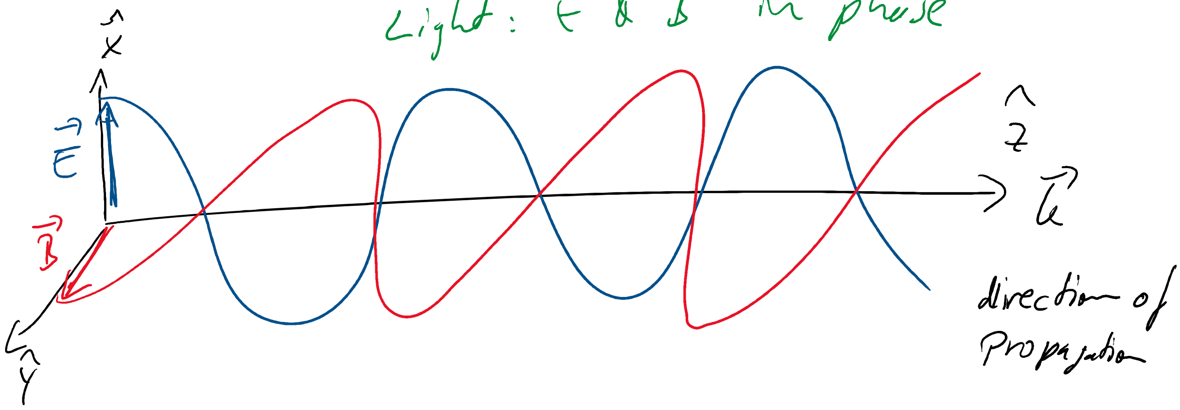


→ Lyot Filter
Birefringent Filter

Polarization states of light

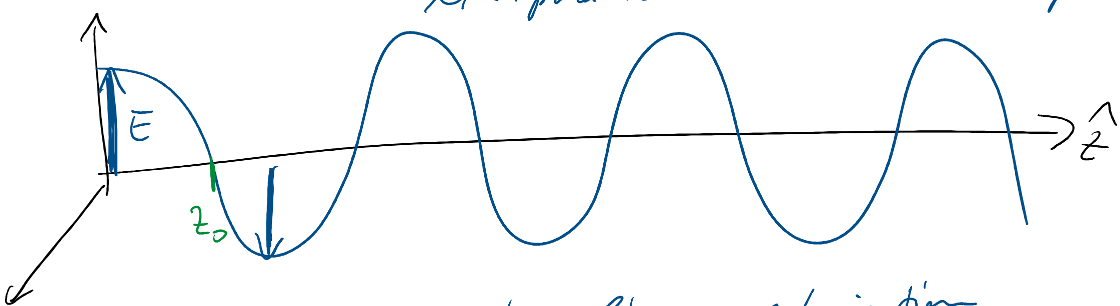
↳ E-field component

Light: $\vec{E}$ & $\vec{B}$ in phase

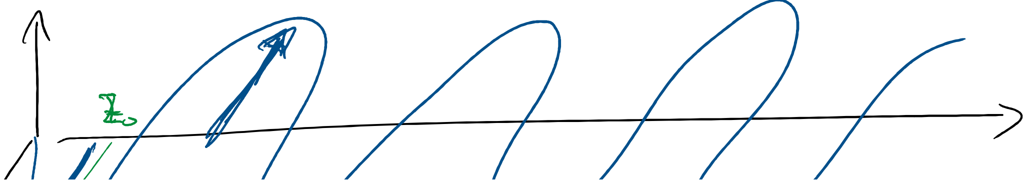


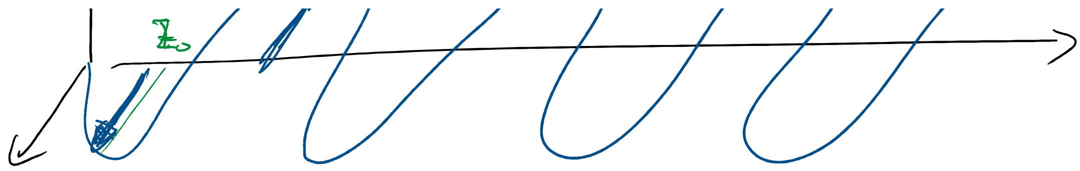
for polarization state: look only at $\vec{E}$ field

lin. polarization $\vec{E}$ is in 1 plane

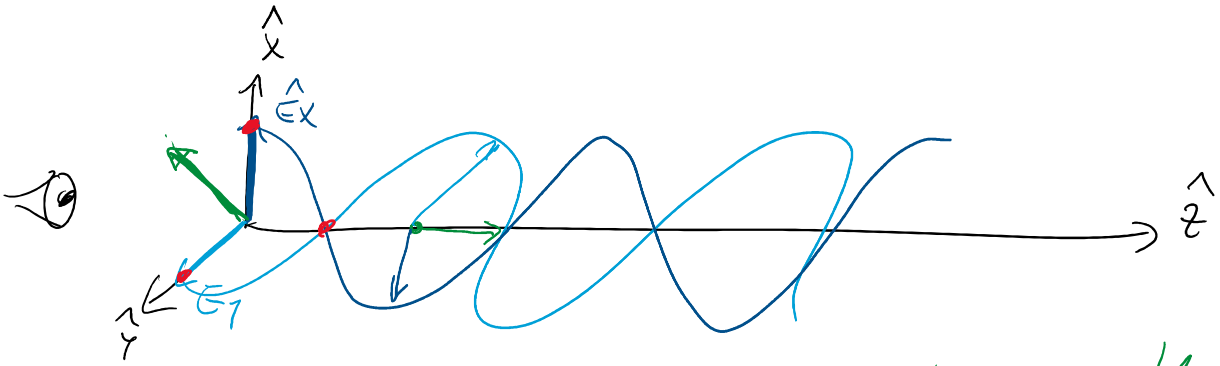


also linear polarization

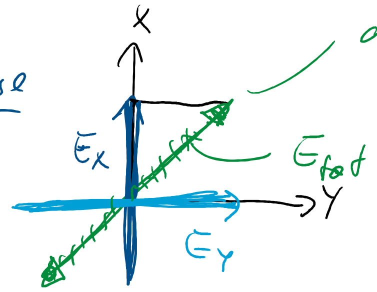




any lin polarization can be constructed / separated into (from)
2 perpendicular lin polarization states which are
in phase



45° case



in phase
→ sum is linear polarized

$$E_x(t) = E_x^0 \hat{x} \cos(\omega t - k \cdot z)$$

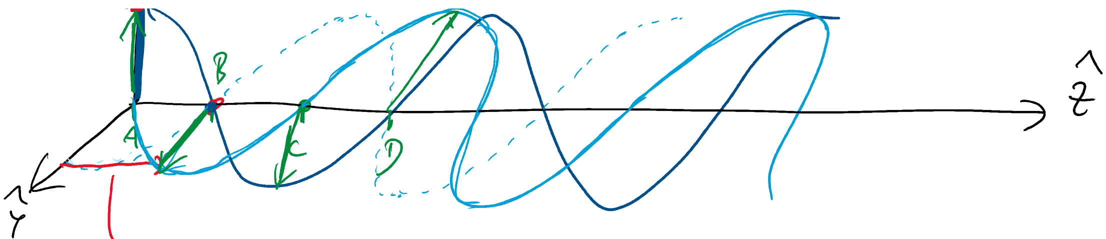
$$E_y(t) = E_y^0 \hat{y} \cos(\omega t - k z)$$

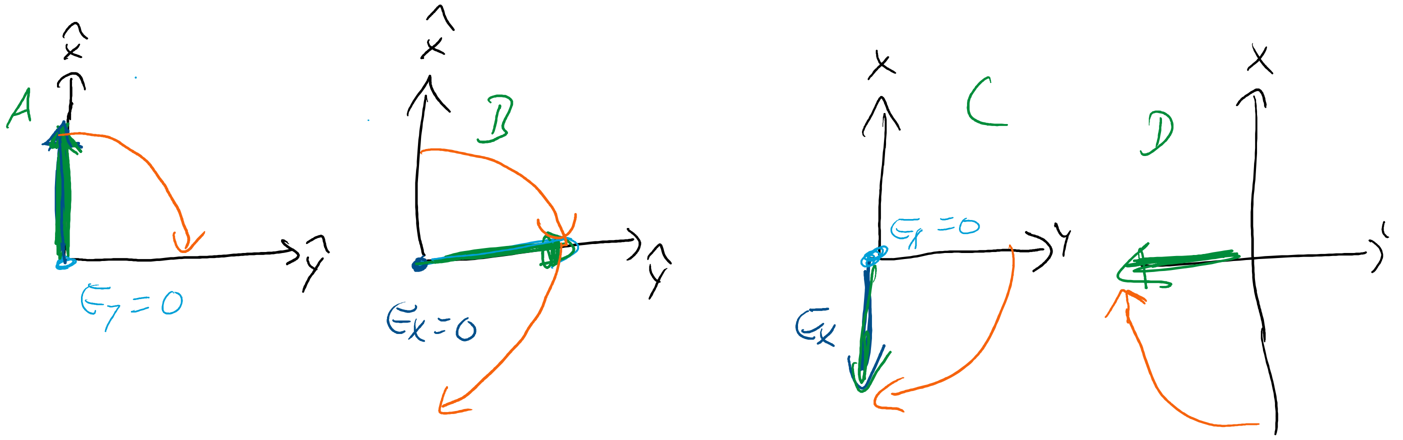
↑ wave traveling in pos. z dir.

$$E_{tot} = (E_x^0 \hat{x} + E_y^0 y) \cdot \cos(\omega t - k z)$$

$E_x^0 = E_y^0 \rightarrow$ 45° lin polarized light

circular polarization: 90° phase shift





$$E_x(t) = E_x^0 \hat{x} \cos(\omega t - k \cdot z)$$
$$E_y(t) = E_y^0 \hat{y} \cos(\omega t - kz \pm \frac{\pi}{2})$$

90° phase shift

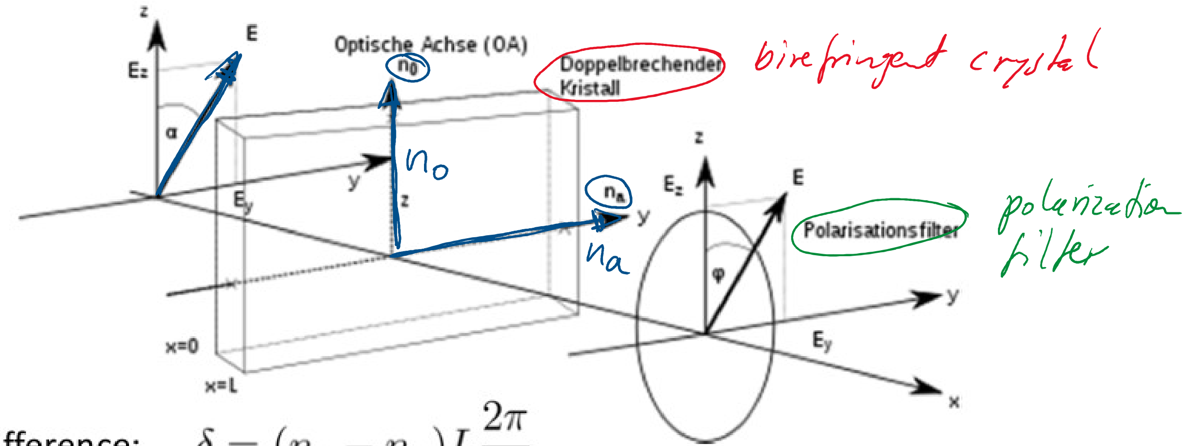
⇒ summed E field is rotating around the $\hat{z}$ axis

E_{tot} = const because $\cos(\omega t - kz \pm \frac{\pi}{2}) = \sin(\omega t - kz)$

$$E_{tot} = \sqrt{E_x^2 + E_y^2} \qquad \cos^2 + \sin^2 = 1$$

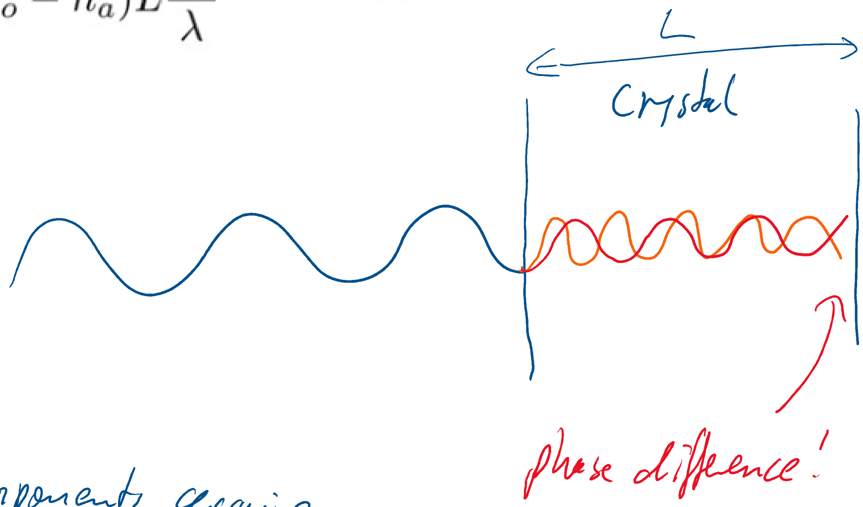
phase $\pm \frac{\pi}{2}$ defines direction of rotation

Lyot-filter uses Birefringence
↑
different refractive indices for different optical axes



Phase difference: $\delta = (n_o - n_a) L \frac{2\pi}{\lambda}$

$\lambda(n) = \frac{\lambda}{n}$



Both E-field components acquire a different phase

Phase difference $\delta = n_o k \cdot L - n_a k L = (n_o - n_a) L \frac{2\pi}{\lambda}$

→ rotates the polarization vector
(elliptical polarization)

Pol. filter gets rid of 1 polarization

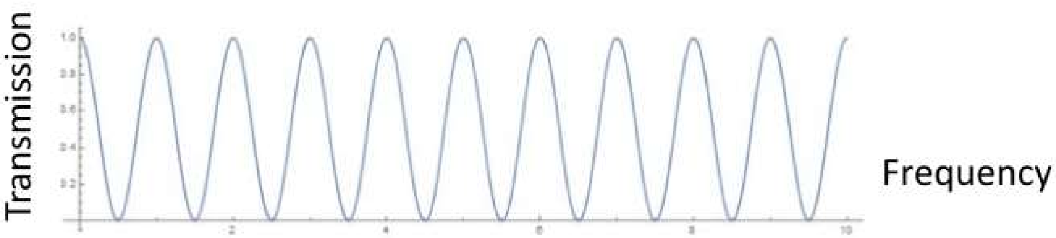
⇒ transmits only input polarization

⇒ transmits only input polarization

max. transmission $\delta = 2\pi \cdot m$, $m \in 1, 2, 3, \ldots$

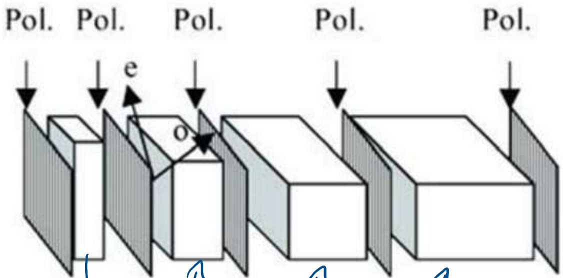
$$\Rightarrow \lambda = \frac{(n_o - n_a)L}{m}$$ gets 100% transmission

phase $= 0, 2\pi, 4\pi, \ldots$



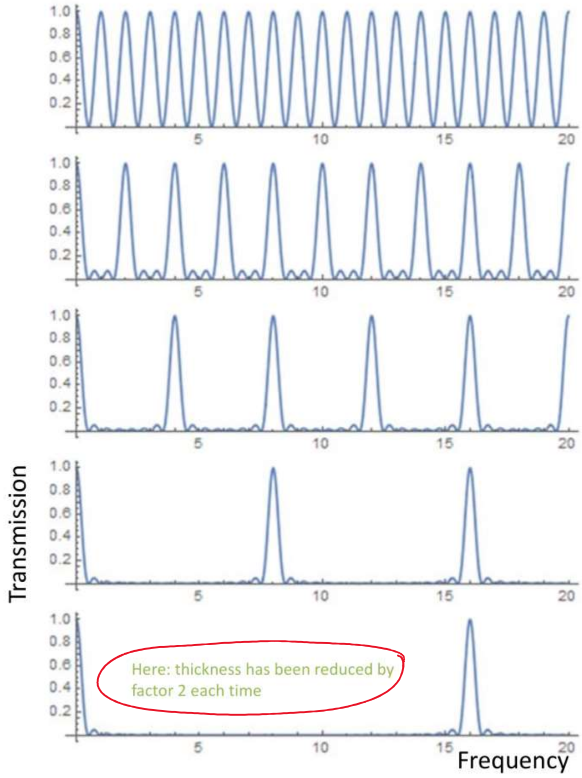
Lyot filter

light in →



birefringent mat.

different thickness!



1st layer transmission

2nd

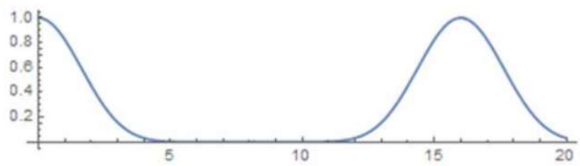
4th

8th

16th peak transmitted

→ nicely frequency selective device

5x same thickness



5 layers, each L = doubled