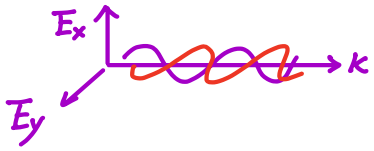
Polarization

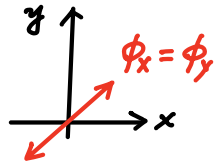


$$\vec{E} \equiv \mathrm{Re}\begin{pmatrix} E_x e^{i(kz-\omega t+\phi_x)} \\ E_y e^{i(kz-\omega t+\phi_y)} \end{pmatrix} \equiv \mathrm{Re}\begin{pmatrix} E_x e^{i\phi_x} \\ E_y e^{i\phi_y} \end{pmatrix} e^{i(kz-\omega t)}$$

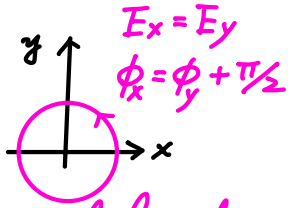
$$\Downarrow$$

Jones vector $\equiv \vec{P}$

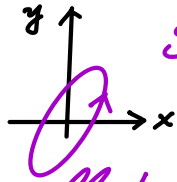
face the light beam → eye



Linear polorized π light



circularly polarized $\sigma^{+/-}$ light



elliptically polorized mixture

Any vector $\vec{P} = \begin{pmatrix} \hat{E}_x \\ \hat{E}_y \end{pmatrix} = \hat{E}_x \begin{pmatrix} 1 \\ 0 \end{pmatrix} + \hat{E}_y \begin{pmatrix} 0 \\ 1 \end{pmatrix} \equiv \tilde{E}_x |H\rangle + \tilde{E}_y |V\rangle$ can be written in diff basis.

↑ horizontal ↖ vertical

$$= \hat{E}_x^* \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ 1 \end{pmatrix} + \hat{E}_y^* \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ -1 \end{pmatrix} = \tilde{E}_x^* |D\rangle + \tilde{E}_y^* |A\rangle$$

↑ diagonal ↖ antidiagonal

$$= \hat{E}_x^\circ \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ -i \end{pmatrix} + \hat{E}_y^\circ \frac{1}{\sqrt{2}} \begin{pmatrix} 1 \\ +i \end{pmatrix} = \tilde{E}_x^\circ |R\rangle + \tilde{E}_y^\circ |L\rangle$$

↑ right-hand circular σ^+, $\hbar$ per photon

↖ left-hand circular σ^-, $-\hbar$ per photon

Polarization control:

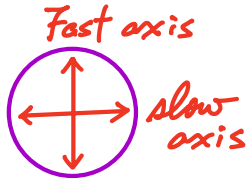
Polarizer that blocks Ey $P_{out} = \begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix} P_{in}$

Phase retarder $P_{out} = \begin{pmatrix} e^{ik_x l} & 0 \\ 0 & e^{ik_y l} \end{pmatrix} P_{in}$ $\quad k_x = \frac{\omega}{v_x} = n_x \frac{\omega}{c}$

Birefringence glass

Half-waveplate (HWP): $k_x l = k_y l \pm \pi$.

Quarter-waveplate (QWP): $k_x l = k_y l \pm \pi/2$



Fast means smaller n and less phase shift $k_{fast} l < k_{slow} l$

Slow means larger n and thus more phase shift