PHY385-H1F Introductory Optics

Class 18 – Outline: Sections 8.10 to 8.13

- Phase Retarders
- Optical Activity
- Faraday Effect
- Pockels Effect
- Jones Matrices and Jones Algebra
- [Stokes Vectors and Mueller Matrices will not be on the final exam.]

What kind of polarization state is the following wave?

$$\vec{E} = \hat{\imath}E_0 e^{i(kz-\omega t)} - \hat{\jmath}E_0 e^{i(kz-\omega t)}$$

1. Linear polarized; P-state
2. Circular polarized; R-state
3. Circular polarized; L-state
4. Elliptical polarized; E-state

What kind of polarization state is the following wave?

$$\vec{E} = \hat{\imath}E_0 e^{i(kz-\omega t)} + \hat{\jmath}E_0 e^{i(kz-\omega t+\frac{\pi}{2})}$$

1. Linear polarized; P-state
2. Circular polarized; R-state
3. Circular polarized; L-state
4. Elliptical polarized; E-state

What kind of polarization state is the following wave?

$$\vec{E} = \hat{\imath}E_0 e^{i(kz-\omega t)} + \hat{\jmath}E_0 e^{i(kz-\omega t-\frac{\pi}{2})}$$

1. Linear polarized; P-state
2. Circular polarized; R-state
3. Circular polarized; L-state
4. Elliptical polarized; E-state

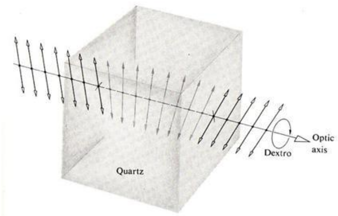
What kind of polarization state is the following wave?

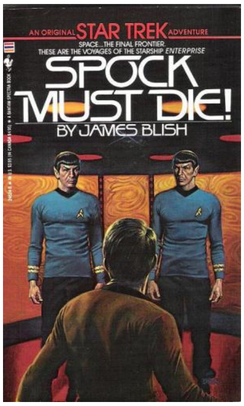
$$\vec{E} = \hat{\imath}E_0 e^{i(kz-\omega t)} + \hat{\jmath}\frac{E_0}{2} e^{i(kz-\omega t+\frac{\pi}{2})}$$

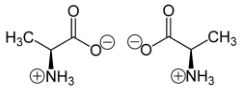
1. Linear polarized; P-state
2. Circular polarized; R-state
3. Circular polarized; L-state
4. Elliptical polarized; E-state

Optical Activity

"The property, possessed by certain substances, of rotating the plane of polarization of polarized light passing through them. Optical activity is shown by asymmetric crystals which have two mirror-image forms – the rotation being to the left (laevorotatory, l-) or right (dextrorotatory, d-) respectively."
[http://www.daviddarling.info/encyclopedia/O/optical_activity.html]







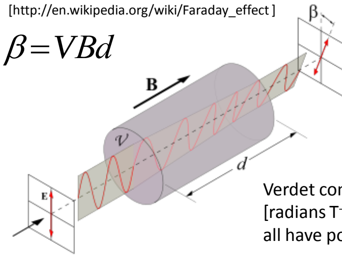
L-Alanine is levorotatory. It is an essential part of the genetic code in every strand of your DNA

D-Alanine is dextrorotatory. It is rare, bactericidal, and used in some antibiotics

Faraday Effect

- "Faraday effect or Faraday rotation is a Magneto-optical phenomenon-- that is, an interaction between light and a magnetic field in a medium. The rotation of the plane of polarization is proportional to the intensity of the component of the applied magnetic field in the direction of the beam of light."
- [http://en.wikipedia.org/wiki/Faraday_effect]

$$\beta = VBd$$



Verdet constant, V, is measured in [radians T^{-1} m^{-1}]. Water, glass, air all have positive Verdet constants

Pockels Effect

- "An electro-optical effect in which the application of an electric field produces a birefringence which is proportional to the field. The Pockels cell is used in ultrafast shutters."
- [http://scienceworld.wolfram.com/physics/PockelsEffect.html]

The phase shift between the fast and slow axis linear polarization states is:

$$\Delta\phi = \frac{2\pi n_o^3 r_{63} V}{\lambda_0}$$

The crystal's electro-optic tensor element r_{63}, has units of m/V. Only piezoelectric crystals which lack a centre of symmetry may show this effect.

If $E_0 = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, which direction does $\vec{B}_0$ point?

1. x
2. y
3. z

What is the normalized Jones vector for the plane wave with:

$$\vec{E} = \hat{\imath}E_0 e^{i(kz-\omega t)} - \hat{\jmath}E_0 e^{i(kz-\omega t)}$$

1. $E_0 = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$
2. $E_0 = \begin{bmatrix} -1 \\ 1 \end{bmatrix}$
3. $E_0 = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 \\ -1 \end{bmatrix}$
4. $E_0 = \frac{1}{\sqrt{2}}\begin{bmatrix} -1 \\ 1 \end{bmatrix}$

What is the normalized Jones vector for the plane wave with:

$$\vec{E} = \hat{\imath}E_0 e^{i(kz-\omega t)} + \hat{\jmath}E_0 e^{i(kz-\omega t+\frac{\pi}{2})}$$

1. $E_0 = \begin{bmatrix} 1 \\ -i \end{bmatrix}$
2. $E_0 = \begin{bmatrix} 1 \\ i \end{bmatrix}$
3. $E_0 = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 \\ -i \end{bmatrix}$
4. $E_0 = \frac{1}{\sqrt{2}}\begin{bmatrix} 1 \\ i \end{bmatrix}$