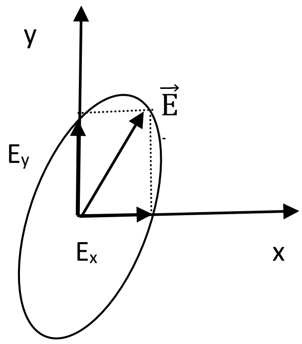
Answer on Question #65282, Physics / Optics

Obtain an expression for elliptically polarised light resulting due to superposition of two orthogonal linearly polarised light waves.

Solution:

Consider two coherent and plane polarised light waves. The plane of oscillation of first wave is perpendicular to the plane of oscillation of the second wave. Fluctuations in first wave are located along the axis x. Fluctuations in second wave are located along the axis y. Light vector $\vec{E}$ is a result of the addition of these two oscillations.



Projections of light vectors of these waves:

$E_x = A_1 \cos \omega t$ (1)

$E_y = A_2 \cos(\omega t - \varphi)$ (2),

where A_1 and A_2 are amplitudes, ω is cyclic frequency, φ is phase difference.

Of (1) $\Rightarrow$ $\cos \omega t = \frac{E_x}{A_1}$ (3)

Of (2) $\Rightarrow$ $E_y = A_2(\cos \omega t \cos \varphi + \sin \omega t \sin \varphi)$ (4)

Of (4) $\Rightarrow$ $\sin \omega t \sin \varphi = \frac{E_y}{A_2} - \cos \omega t \cos \varphi$ (5)

(3) in (5): $\sin \omega t \sin \varphi = \frac{E_y}{A_2} - \frac{E_x}{A_1} \cos \varphi$ (6)

Of (6) $\Rightarrow$ $(\sin \omega t \sin \varphi)^2 = \left(\frac{E_y}{A_2} - \frac{E_x}{A_1} \cos \varphi\right)^2$ (7)

Of (7) $\Rightarrow$ $(\sin \omega t \sin \varphi)^2 = \left(\frac{E_y}{A_2}\right)^2 - 2 \times \frac{E_y}{A_2} \times \frac{E_x}{A_1} \cos \varphi + \left(\frac{E_x}{A_1} \cos \varphi\right)^2$ (8)

Of (3) $\Rightarrow$ $\cos \omega t \sin \varphi = \frac{E_x}{A_1} \sin \varphi$ (9)

Of (9) $\Rightarrow$ $(\cos \omega t \sin \varphi)^2 = \left(\frac{E_x}{A_1} \sin \varphi\right)^2$ (10)

(8) + (10): $\sin^2 \varphi = \left(\frac{E_x}{A_1}\right)^2 + \left(\frac{E_y}{A_2}\right)^2 - 2 \times \frac{E_y}{A_2} \times \frac{E_x}{A_1} \cos \varphi$ (11)

Expression (11) is a equation of ellipse.