prof. Vidya Sagar
Department of physics
Raja Singh College, Siwan

production of plane and Elliptically polarised light.

production of plane-palarised Light:— To produce plane polarised light, a beam of ordinary light is sent through a Nical prism. Inside the prism is broken up in to components, O and E. The O-component is totally reflected at the Canada Balsam layer and is absorbed. The E-Components emerges out. It is plane-polarised with its vibration parallel to the shorter diagonal of the end face of the Nical.

Detection!— To detect plane-palarised light, it is examined through another Nical prism rotating about the direction of propagation of light. If the intensity of light varies with zero minimum, the light is plane-polarised.

production of Elliptically-palarised Light:— The elliptically polarised light can be produced by sending plane-polarised light normally through a quarter-wave plate such that the direction of vibration in the incident light makes an angle θ with the optic axis of the plate. Let A be amplitude of vibration of the incident light. Inside the plate the light is devided in to two plane-polarised waves the one with vibration parallel to the optic axis. The amplitude of the E and O components will be $A\cos\theta$ and $A\sin\theta$ respectively. The phase difference between the two components at the entrance is zero and on emergence is $\pi/2$.

Let $A\cos\theta = a$ and $A\sin\theta = b$. If the axes of x and y be taken along and perpendicular to the optic axis respectively, then the equation of E and O waves may be written as

$$x = a\sin(\omega t + \frac{\pi}{2}) = a\cos\omega t \quad \text{(I)}$$

and $$y = b\sin\omega t \quad \text{(II)}$$

Eliminating t between (i) and (ii), we get the equation of the resultant vibration as

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1.$$

The equation represents an elliptic vibration. Hence the emergent light is in general elliptically polarised.

However when $\theta = 0$, $b = 0$ and emergent light is plane polarised with vibration parallel to the optic axis. When $\theta = 90°$, $a = 0$ and the emergent light is plane polarised with vibration perpendicular to the optic axis. When $\theta = 45°$, $a = b$ and the resultant vibration is circular so that the emergent light is circularly-polarised.

Hence to produce elliptically-polarised light, θ must be different from 0, 45°, and 90°. An appropriate value for θ is about 30°.

Detection:— The elliptically polarised light, when observed through a rotating Nicol prism, shows vibration in intensity but is never completely cut off. It thus resembles partially plane-polarised light. Hence to confirm that the given light is elliptically-polarised, it is passed through a $\lambda/4$ plate and then through the rotating the Nicol prism. The light is now completely cut off for a particular position of the Nicol.

If the given light were partially plane-polarised it would have remained unchanged by the $\lambda/4$ plate. Hence on passing through Nicol the light would have shown a vibration in intensity but never completely cut off.