Paper - III

19

Group - A

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Que: What do you mean by "polarisation of light"? Explain the production and detection of plane polarised circularly polarised and elliptically polarised light.

Ans: Polarisation of light → The phenomenon of interference and diffraction show that light travels in the form of waves. But they do not tell us about the type of light waves. i.e wheather the light waves are longitudinal or transverse or, wheather the vibrations are linear circular elliptical or torsional. Such important enquiries constitute the subject matter of polarised light. The phenomenon of polarisation can be explained only by assuming transverse character of waves of light

⊗ Production and detection of plane circularly and elliptically polarised light :→

Notations

(i) plane polarised light :→ In order to produce plane polarised light a beam of unpolarised monochromatic light is passed through a Nicol prism. It is split up in to ordinary and extraordinary components. The ordinary components is totally internally reflected at the canada 'balsam' layer and is absorbed. while the extraordinary component passed through the Nicol prism. The emergent light

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is plane polarised having its vibrations parallel to the Shorter diagonel of end face of the Nicol.

Detection :→ To detect plane polarised light it is passed through another Nicol prism, which is rotated gradually about

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the direction of the propagation of light emerging from the rotating Nicol varies with zero minimum. the light is plane polarised.

(ii) Circularly polarised light :→ This type of light may be produced by following plane polarised light obtained from a Nicol prism to fall normally on a quater wave plate. such that the direction of vibration in the incident plane polarised light make an angle of 45° with the optic axis of the plate.

In the inner of plate the incident wave of amplitude A (say) is broken in to an E component $A \cos 45°$ parallel to the optic axis and an O component $A \sin 45°$ ⊥r to the optic axis. These components emerges from the plate with a phase difference of $\pi/2$

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Notations

Let us take $A\cos 45° = A\sin 45° = a$

If the axis of x and y be taken along and normal to the optic axis, then the emerging components may be written as —

$$x = a\sin(\omega t + \pi/2) = a\cos\omega t \quad \text{—(i)}$$

$$y = a\sin\omega t \quad \text{—(ii)}$$

on eliminating t from (i) and (ii) the resultant vibration is

$$\boxed{x^2 + y^2 = a^2}$$

This represents a circle. so the light emerging from the quarter

Detection :→ The circularly polarised light when seen through a rotating Nicol show no vibration in intensity it so resembles unpolarised light. so to confirms that the given light is circularly polarised. It is first passed through a 1/4 plate and then through the

Notations

rotating Nicol.

The light now shows a vibration in intensity with zero minimum.

(iii) Elliptically polarised light :-

This type of light may be produced by allowing plane polarised light received from a Nicol prism to fall normally on a quarter wave plate such that the direction of vibration in incident plane polarised light makes an angle other than 0 45° and 90° with the optic axis of the plate. An appropriate angle is 30°.

Inside the plate incident wave is divided in to E and O components of unequal amplitudes A cos 30° and A Sin 30° respectively which emerges from the plate with a phase difference of $\pi/2$.

Let us take $A \cdot \cos 30° = a$
$A \sin 30° = b$

So the emerging components may be expressed as.

$x = a \sin(\omega t + \pi/2) = a \cos \omega t$

$y = b \sin \omega t$

eliminating t, we get

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

This represents an ellipse. Hence the light emerging from the $\lambda/4$ plate is elliptically polarised.

Detection :→ When this light seen through a rotating Nicol indicates variation in intensity but the minimum intensity is not zero. It resembles partly plane polarised light so to confirms that the given light is elliptically polarised. It is first examined through a rotating Nicol and the Nicol is adjusted for minimum intensity. The principle section of the Nicol is now parallel to the major axis of the elliptic vibration.

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Another 1/4 plate is now produced between the first plate (which produced the elliptically polarised light) and the Nicol. Such that the optic axis of the second plate is parallel to the principle section of the Nicol (which has been adjusted for maxima intensity) The optic axis of the plate thus becomes parallel to the major axis of the elliptic vibration. The light after passing through the second 1/4 plate becomes plane polarised. If the Nicol be now rotated the intensity will vary with zero minimum.

The End