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LECTURE SERIES-04

(1) Production of plane polarised light. If the beam of monochromatic light is passed through a Nicol prism, it is split up into E-ray and O-ray. The O-ray is totally internally reflected at the Canada balsam layer and is absorbed, while the E-ray passes through the Nicol prism, which is plane polarised.

(2) Production of elliptically polarised light. An elliptically polarised light consists of two mutually perpendicular vibration of unequal amplitudes with a phase difference of $\pi/2$ or path difference of $\lambda/4$.

A parallel beam of monochromatic light is allowed to fall on a Nicol prism N_1. The outgoing plane polarised light is made to pass through the second Nicol N_2 which is gradually rotated till no light is seen through the system. The two Nicols are in crossed position.

A quarter wave plate P is mounted on a tube T_1 circumference of which is graduated in degrees. The tube T_1 is capable of rotation in another tube T_2 mounted on stand S. This arrangement is placed in between two Nicols, as shown in fig.(1).

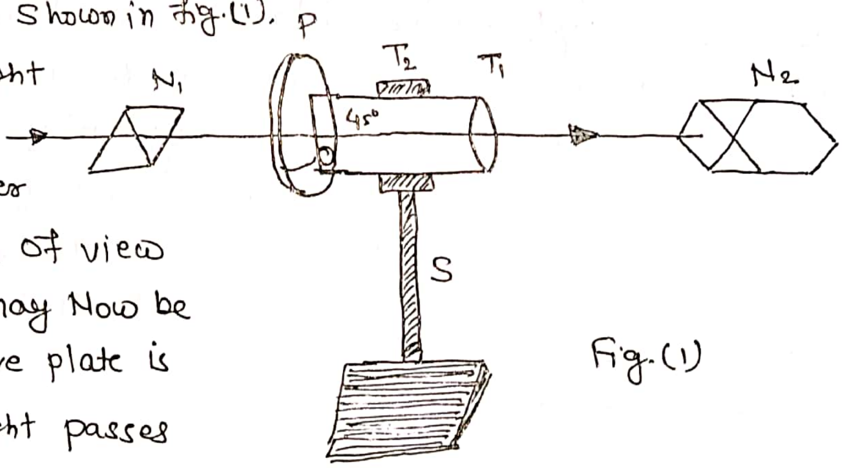

Fig.(1)

The plane polarised light from the Nicol N_1 falls normally on the quarter wave plate P. The field of view through the Nicol N_2 may now be bright. The quarter wave plate is rotated till again no light passes through the Nicol N_2. In this position the vibration of light incident on the quarter wave plate are parallel to the optic axis of the plate and both the E and O component travel in same direction but with the different velocities. These are refused transmission through the Nicol prism N_2 which is in a crossed position with respect to the Nicol N_1. The tube T_1 is rotated till the zero mark of the scale concides with the mark X on the Q plate. The quarter wave plate P, keeping the tube T_1 fixed is rotated till the mark X coincides with any mark other than 0, 45 and 180. The plane polarised beam consisting of O and E vibrations will have unequal amplitudes. These coming out of the quarter wave plate will result in an elliptically polarised light.

(3) Production of circularly polarised light. Circularly polarised light consists of two mutually perpendicular vibration of equal amplitudes with a phase difference of $\pi/2$ or path difference of $\lambda/4$. This is achieved with the a quarter wave plate.

The quarter wave plate P mounted on the stand is introduced between the two Nicols N_1 and N_2 in a crossed position. The plane polarised light from the Nicol N_1 falls normally on the quarter wave plate and the field of view through N_2 is illuminated as the light is elliptically polarised when the incident vibration makes an angle $45°$ with the optic axis of the quarter wave plate. To produce circularly polarised light, the quarter wave plate is rotated till again no light is seen through N_2. In this position, the incident vibration is parallel to the optic axis of the quarter wave plate. The light is split into E ray and O-ray having equal amplitude. The light is thus circular polarised.

Detection of plane polarised light. The light beam is allowed to fall on a Nicol prism capable of rotation about the incident beam as an axis. If the beam is completely extinguished for one setting of the Nicol prism (analyser) then in this position

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the direction of vibration of the incident light is perpendicular to the principal section of the analyser of the end face. For each complete rotation of the analyser there are two position 180° apart where the incoming beam is completely extinguished. There will be two maximum intensity position 90° from each zero intensity position. In this case the vibrations of incident beam are parallel to the principal section of the Nicol prism and thus these will pass out. In such a case the beam is plane polarised.

Detection of circular polarised light. A circular vibration consists of two linear vibration of equal amplitude mutually perpendicular to each other. When circularly polarised light is examined through a Nicol prism the intensity of the transmitted beam is not altered as the Nicol is rotated. The behaviour is similar to that of unpolarised beam of light.

To distinguish between the two, allow the light to fall normally on a quarter wave plate and then examin it through the Nicol prism. If the intensity varies between maximum and zero. It is circularly polarised light. It is because the circular vibration on enterning the quarter wave plate is broken up into to linear vibration of the same amplitude mutually perpendicular to each other. The quarter wave plate further introduces a phase change of $\pi/2$ between two. The resultant phase difference becomes 0 or π and the outgoing light is plane polarised. On examination through the rotating Nicol, maximum intensity is observed when the principal section of the Nicol is parallel to the vibration of the plane polarised light. Light will be cut off completely when the principal section of the Nicol is perpendicular to the direction of the resultant plane polarised vibration.

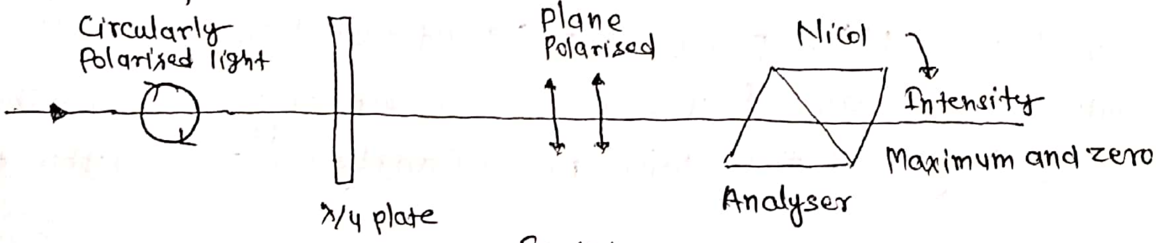

Fig. (2)

The unpolarised light after passing through a quarter wave plate remains unpolarised and hence no change in intensity will be observed when passed through a Nicol prism which is rotated gradually.

Thus we conclude that if the beam after passing through the quarter wave plate is extinguished twice in each rotation of the Nicol prism, it is circularly polarised.

Detection of elliptically polarised light. When a beam of elliptically polarised light is examined through a Nicol prism rotating about the ray as an axis, its intensity varies in magnitude, but is never zero. It is because an elliptic vibration consists of a combination of two unequal rectilinear vibration in two direction perpendicular to each other along the major and minor axis of the ellipse. When the principal plane of the Nicol is parallel to the vibration along the major axis, the transmitted light has a maximum intensity and when the principal plane is parallel to vibration along the minor axis it has a minimum intensity. The ellipic vibration is resolved into two rectangular vibration of unequal amplitude with a phase difference of $\pi/2$ between them. By passage through the quarter wave plate a further phase difference of $\pi/2$ is introduced between the two rectangular components along the two axes of the ellipse, So that the resultant phase difference becomes π or 0. This light on emergence becomes plane polarised. If the light is now examined through the Nicol prism, the intensity is reduced to zero twice in one rotation of the Nicol Prism when the principal section of the Nicol is perpendicular to the plane of vibration of the emergent light. The incident light is thus elliptically polarised.

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