21.4 PRODUCTION OF POLARIZED LIGHTS

21.4.1 Production of Elliptically Polarized Light

We have seen that *the elliptically polarized light results from compounding together two mutually perpendicular plane-polarized coherent light waves of unequal amplitudes but differing in phase by* $\pi/2$, [*see* Sec. 21.2].

To obtain elliptically polarized light a beam of parallel monochromatic light, say from a sodium flame, is passed through two nicols which are arranged in the crossed position. For the sake of convenience the shorter diagonals of the end faces of the nicols are set mutually perpendicular to each other, that of the first, say, vertical and that of the other horizontal. A quarter-wave plate is inserted between them. It is held normal to the incident beam in a suitable frame so that it can be rotated about a horizontal axis through any desired angle. Let its optic axis lie inclined at about 30° to the plane of vibration of the incident light. The plate introduces a phase difference of $\pi/2$ between the two components *O* and *E* into which the plane-polarized light from the first nicol is split up. These components are of unequal amplitudes and on emergence from the quarter-wave plate give rise to an elliptical wave so that emergent light is elliptically polarized and in general on examination through the second nicol the field of view will be illuminated. On rotating the analysing nicol, the intensity of the emergent beam will vary between a *maximum* and a *minimum*.

21.4.2 Production of Circularly Polarized Light

We have seen in Sec. 21.2, Case II (*ii*) that *circularly polarised light arises from compounding together two mutually perpendicular coherent vibrations of equal amplitudes and periods but differing in phase by* $\pi/2$. To get circularly polarised light the nicols are placed in the crossed position and the quarter-wave plate is rotated until the field of view is dark. This will happen when the optic axis of the quarter-wave plate is parallel to the principal plane of the polarizing nicol. Then the frame holding the plate is rotated through 45°. The quarter-wave plate is now in the desired position and the incident light is resolved into two equal components, the E and O vibrations respectively along and perpendicular to optic axis. Initially both the components are in the same phase but on emergence the O wave lags behind the E wave by one-quarter of a wavelength if the quarter-wave plate is of calcite. This is equivalent to a phase difference of $\pi/2$ between the O and E waves. On emergence from the quarter-wave plate they compound into a circular wave and hence the light is circularly polarized. If at this stage the analysing nicol is rotated the field of view shows no change in the intensity of the emergent beam, apparently the field is identical with that obtained when ordinary light passes through a nicol prism.