

Fresnel's theory of optical rotation

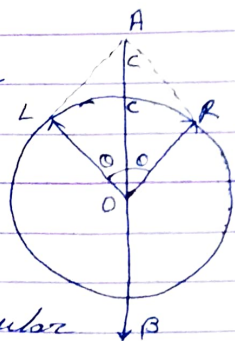
To explain phenomenon of optical rotation, Fresnel made following assumptions.

- (1) When a plane polarized beam enters into optically active substance, it splits up into two opposite directed circularly polarized beams, one clockwise and another anticlockwise.
- (2) These two circularly polarized beams travel with the same velocity in an optically inactive substances but they travel with different velocities in an optically active substance.
- (3) On emerging out of the optically active substance both circularly polarized beams recombine to form a plane polarized beam but its plane of vibration is rotated by certain angle direction of incident plane of vibration.

The amount of the angle of rotation depends on the phase difference between two circularly polarized beam in optical active substance.

(1) Optically inactive substance (calcite) \rightarrow

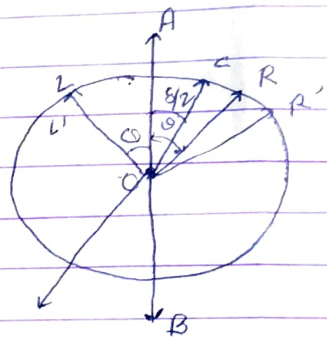
Let a plane polarized light be incident on calcite along optical axis OCA . It splits up into two circularly polarized light vibration rotating in opposite direction with the same angular velocity. Vibration rotating in clockwise direction are represented by OR and vibration rotating in anticlockwise direction are ~~represented~~



represented by OL . At any instant they have some angular displacement from OC therefore resultant of OR and OL at any time will be along OCA . Thus when light comes out of optically inactive substance they recombine forming plane polarized light whose vibration will be along OCA .

(ii) optically active substance (Quartz crystal) →

In case of Quartz a linearly polarized light on entering the crystal is resolved into two circularly polarized vibrations rotating in opposite direction with different angular velocity or frequency. Consider a right handed quartz crystal in which clockwise component travels faster than left handed component.



Suppose at any instant of time, right handed component rotated by an angle δ greater than left handed component as shown in figure. The new position of resultant of OL' and OR' will be along CO . i.e. plane of vibration of light has been rotated through angle $\delta/2$ towards right after passing through quartz crystal. The angle $\delta/2$ depends upon thickness of crystal.