1.9 REFERENCES

1. A text Book of Optics – Brijlal, S.Chand Publishing, N.Delhi
2. Optics-Satya Prakash, Pragati Prakashan, Meerut
3. Introductory University Optics, PHI Learning, New Delhi, 1998.

11.5 HUYGEN'S EXPLANATION OF DOUBLE REFRACTION IN UNIAXIAL CRYSTAL

In order to explain the double refraction exhibited by uniaxial crystal Huygen's extended his wave theory of secondary wavelets. Huygen's postulated that

1. When light is incident on a doubly refracting crystal, every point of it becomes source of secondary wavelets and excites two separate wavelets within the crystals; one spherical wavelet associated with O-ray and other elliptical with E-ray. For O-ray, the crystal is isotropic and homogeneous, hence O-ray travels with the same velocity in all directions and therefore, the wavefront corresponding to it is spherical. For E-ray the crystal is anisotropic (different properties in different directions) hence its velocities varies with the directions i.e. wavefront can't be spherical it is ellipsoid.

2. The two wave fronts corresponding to E-ray and O-ray touch each other at the two points. The direction of the line joining these two points is called optic axis. As light advances through the crystal the two wave surfaces travel in different direction in the crystal therefore two refracted rays corresponding to E–ray and O-ray respectively emerges out of crystal.

11.5.1 Positive and Negative Crystals

Because of the two different types of wavefronts, two possibilities are there

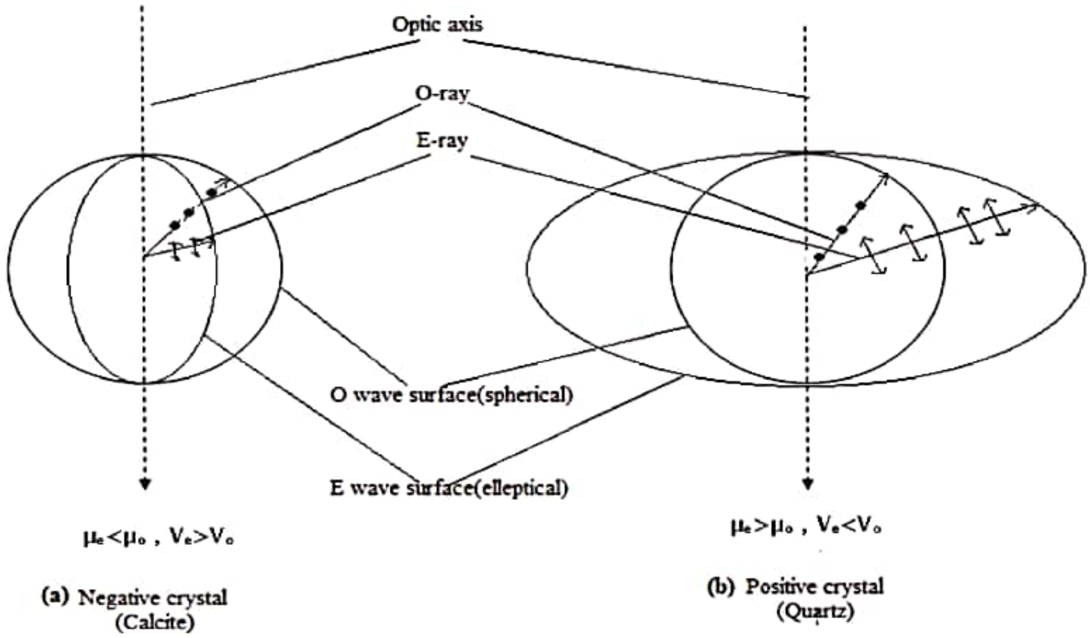

Figure 11.3

Case 1: The spherical wavefront of O-ray is enclosed by the ellipsoidal wavefront of E-ray. Such crystals are called negative crystals e.g. calcite. Obviously the diameter of the sphere is equal to the minor axis of the ellipsoid (figure 11.3(a)). For such crystals the velocity of ordinary ray is constant in all directions while velocity of extraordinary ray varies as the radius vector of ellipsoid. The velocity of E-ray is minimum and equal to O-ray along optic axis and a maximum in a direction perpendicular to direction of optic axis.

i.e., $v_e = v_o$ parallel to optic axis

$v_e > v_o$ in other direction

In this case, the refractive index for O-ray is greater than the refractive index for the E-ray

i.e., $\mu_e < \mu_o$

We can see that in negative crystals, extra ordinary wave surface behaves as if it were repelled away from the optic axis.

Case 2: The ellipsoidal wavefront of E-ray is enclosed by the spherical wavefront of O-ray. Such crystals are called positive crystals e.g., quartz. Obviously the diameter of the sphere is equal to the major axis of the ellipsoid (figure 11.3 (b)). For such crystals the velocity of ordinary ray is constant in all directions while velocity of extraordinary ray varies as the radius vector of ellipsoid. The velocity of E-ray is maximum and equal to O-ray along optic axis and a minimum in a direction perpendicular to direction of optic axis.

i.e., $v_e = v_o$ parallel to optic axis

$v_e < v_o$ in other direction

In this case, the refractive index for the E-ray is greater than the refractive index for the O-ray

i.e., $\mu_e > \mu_o$

In contrast to negative crystals we can see that in positive crystals extra ordinary wave surface behaves as if it were attracted towards the optic axis.

EG-45

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