

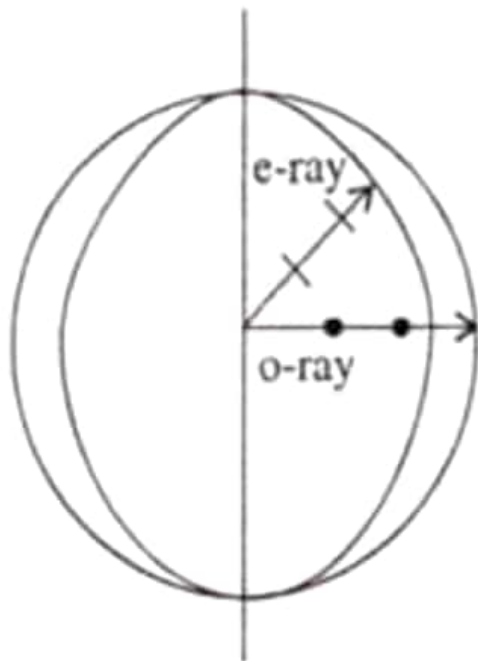
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physics B.Sc. part-2 physics (Hons)
paper-iii lecture no -67

Topic: Uniaxial and Biaxial Crystals

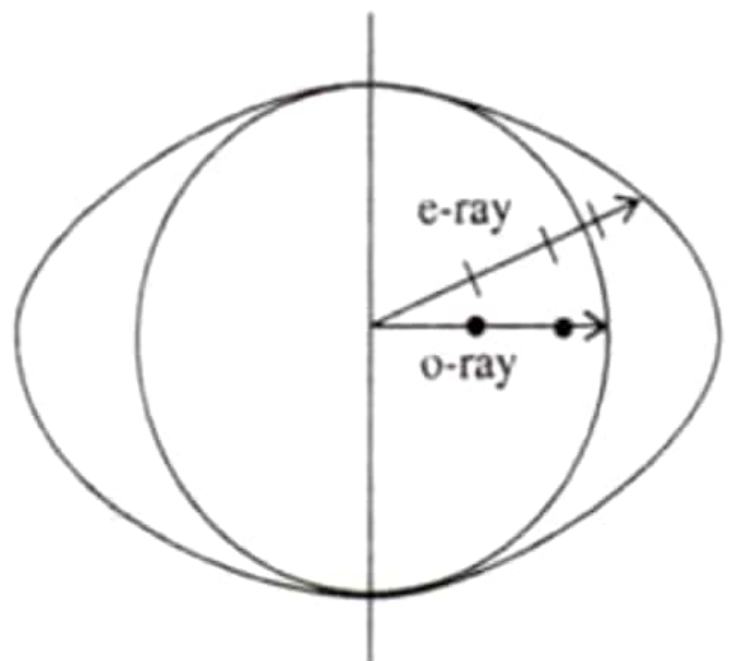
(1) Uniaxial Crystal

- This crystal is described by one optical axis and two principal refractive indices.
- Examples of uniaxial Crystals are calcite, KDP, quartz, rutile etc.
- When light beam passes through such crystal, it splits into **O-ray and e-ray**
Here o-ray passes through it without any deviation where as e-ray deviates at air to crystal interface.
- There are two forms of uniaxial crystals viz. positive uniaxial crystal and negative uniaxial crystal.

: Positive and negative Uniaxial Crystal



Positive uniaxial crystal



Negative uniaxial crystal

- When light is propagated through uniaxial crystal the wavefronts (i.e. Huygen's wave surfaces) due to o-ray and e-ray are depicted as shown in the figure-1. Based on relative velocities of o-ray and e-ray following two cases may arise.

- Case-1: If $V_o > V_e$ (i.e. $n_o < n_e$) in all the directions except along optical axis. In this case, spherical wavefront due to o-ray would be outside of elliptical wavefront due to e-ray. In this condition, two wavefronts from o-ray and e-ray touch only at two diametrically opposite points on the optical axis. Such crystals are known as positive uniaxial crystals. Examples of such crystals are quartz, rutile etc.

• Case-2: If $V_o < V_e$ (i.e. $n_o > n_e$), the elliptical wavefront due to e-ray is outside of the spherical wavefront due to o-ray. Such crystals are known as negative uniaxial crystals. Examples of such crystals are calcite, KDP etc.

Double refraction properties in such birefringent crystals depend on following three factors.

-Polarization state of incoming light ray

-Incidence angle of light ray

-Orientation of crystal's optical axis with respect to its surface plane etc.

(2) Biaxial Crystal

- This crystal is described by two optical axis and three principal refractive indices.
- Examples of biaxial Crystals are mica, lead oxide, topaz etc.
- These crystals are also known as birefringent crystals.
- When light beam passed through this crystal, it splits into two parts. Both the fractions are e-rays. These waves or rays have different directions and speeds.
- Examples: Crystalline structures e.g. orthorhombic or monoclinic or triclinic etc.