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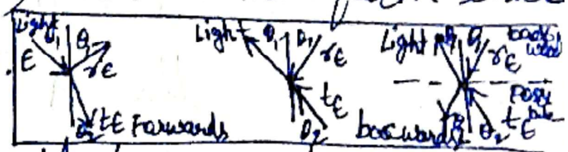
Sem-IV MJC-Physics
Unit-1 Paper07

Stakes treatment

Stoke treatment in interference, often reffered to as stoke 'Relation', is a fundamental concept in wave optics. The phase change experienced by light upon reflection at the boundary of an optically denser medium. It provides the theory for the λ/2 path difference (or π phase shift) used in thin film interference calculations.



→ Phase change on reflection → When a light wave is reflected at the surface of an optically denser medium, It suffers a phase change of π (180°) which carresponts to an addional path difference of λ/2.

→ It Reversibility principle – It there no absorption at the interface, a light ray that is reflected or refracted will ref retrace it's original path if its direction is reversed.

→ Stocks relation – Let r and t be the reflection and transmission cofficients from a rarer to a denser medium and r' and t' be the cofficient from a denser to a rarer medium.

Stokes treatment shows—

(a) $r^2 + tt' = 1$ (Conservation of energy)

(b) $r = -r'$ (The amplitude reflection cofficient changs sign when the direction of light is reversed, signifying the π phase change)

Derivation →

(a) Direct process — consider a light wave of amplitude A incident on the boundary between medium rarer and medium denser.

(i) Reflected wave amplitude Ar →

(ii) Transmitted wave amplitude At

(b) Reversed process — Consider the reflected and transmitted waves now reversing their paths.

(i) The reflected wave Ar strikes the boundary again, Reflecting with amplitude

$(Ar)r = Ar^2$ and reflecting with

$(Ar)t' = Art'$

(ii) The transmitted wave At strikes the boundary from the other side reflecting with amplitude

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transmitted with $(At)t = Att$

(iii) Resultant — to satisfy the principle of reversibility, the combined amplitudes must satisfy:

(a) $r^2 + tt' = 1$ (Total intensity is conserved)

(b) $r = -r'$ (The negative sign indicates that a wave reflected from a denser medium experiences a phase shift of π compared to one reflected from a rarer medium).

Stokes treatment is critical for determining the condition for interference in thin films.

✓ Reflected system → $\Delta = 2\mu t \cos r \pm \lambda/2$ (The total effective path difference)

(When ray reflects from rarer to denser and the denser to rarer)

✓ Transmitted system → Both interfering rays undergo similar reflections, resulting in no relative π phase shift.

✓ Complementary fringes → Because of this π phase shift in reflection, the reflected (bright) and transmitted (dark) interference patterns are complimentary.

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