289(8): One Photon and Two Photon Wavelength Theory.

One Photon Theory, Air Water

In terms of angular frequency and in previous notation:

$$\hbar\omega = \hbar\omega_1 + \hbar\omega_2 \quad -(1)$$

and

$$\hbar\underline{\kappa} = \hbar\underline{\kappa}_1 + \hbar\underline{\kappa}_2 \quad -(2)$$

so:

$$\omega = \omega_1 + \omega_2 \quad -(3)$$

and

$$\kappa^2 = \kappa_1^2 + \kappa_2^2 + 2\kappa_1\kappa_2\cos\theta_3 \quad -(4)$$

where θ_3 is the angle between $\underline{\kappa}_1$ and $\underline{\kappa}_2$.

In terms of wavelength:

$$\lambda = \frac{f}{c}, \quad f = \lambda c, \quad \omega = 2\pi\lambda c \quad -(5)$$

and

$$\omega_1 = 2\pi\lambda_1 v, \quad \omega_2 = 2\pi\lambda_2 c \quad -(6)$$

so

$$\lambda = \lambda_1 \frac{v}{c} + \lambda_2 \quad -(7)$$

$$= \frac{\lambda_1}{n} + \lambda_2$$

where

$$n = \frac{c}{v} \quad -(8)$$

is the refractive index of water or a medium such as glass in which the refraction takes place.

Also:

$$\kappa = \frac{\omega}{c} = 2\pi\lambda \quad -(9)$$

$$\kappa_1 = \frac{\omega_1}{v} = 2\pi\lambda_1 \quad -(10)$$

) and

$$\kappa_2 = \frac{\omega_2}{c} = 2\pi \lambda_2 \quad -(11)$$

So

$$\lambda^2 = \lambda_1^2 + \lambda_2^2 + 2\lambda_1\lambda_2 \cos\theta_3 \quad -(12)$$

where

$$\lambda_2 = \lambda - \frac{\lambda_1}{n} \quad -(13)$$

Therefore:

$$\lambda^2 = \lambda_1^2 + \left(\lambda - \frac{\lambda_1}{n}\right)^2 + 2\left(\lambda - \frac{\lambda_1}{n}\right)\lambda_1 \cos\theta_3 \quad -(14)$$

where:

$$\theta_3 = \pi - (\theta + \theta_1) \quad -(15)$$

from Fig (1) of Note 289(6).

Therefore computer algebra may be used to solve eq. (14) for λ_1 in terms of λ, θ_3 and n.

<u>Two Photon Theory, Air Water</u>

In this case, eq. (7) is replaced by:

$$2\lambda = \frac{\lambda_1}{n} + \lambda_2 \quad -(16)$$

and eq. (12) by:

$$4\lambda^2 = \lambda_1^2 + \lambda_2^2 + 2\lambda_1\lambda_2 \cos\theta_3 \quad -(17)$$

From eqs. (16) and (17):

$$\lambda_2 = 2\lambda - \frac{\lambda_1}{n} \quad -(18)$$

so:

$$4\lambda^2 = \lambda_1^2 + \left(2\lambda - \frac{\lambda_1}{n}\right)^2 + 2\lambda_1\left(2\lambda - \frac{\lambda_1}{n}\right)\cos\theta_3 \quad -(19)$$

where

$$\theta_3 = \pi - (\theta + \theta_1) \quad -(20)$$

Therefore computer algebra may be used to solve eq. (19) for λ_1 in terms of λ, θ_3 and n.

These theories give the refracted wavelength λ_1. In order to find the reflected wavelength λ_2 use

$$\lambda_1 = n(\lambda - \lambda_2) \quad -(21)$$

for the one photon theory and

$$\lambda_1 = n(2\lambda - \lambda_2) \quad -(22)$$

for the two photon theory.

In the dogmatic and obsolete theory:

$$\omega = \omega_1 = \omega_2 \quad -(23)$$

i.e.

$$\frac{\lambda_1}{n} = \lambda_2 \quad -(24)$$

and

$$n = \frac{\lambda_1}{\lambda_2} = \frac{\kappa_1}{\kappa_2} = \frac{c}{v} \quad -(25)$$

4)

However, note 289(5) has shown that eq. (23) is incorrect.

The dogma leading to Eq. (23) was based on the boundary condition argument:

$$\omega t - \underline{\kappa} \cdot \underline{r} = \omega_1 t - \underline{\kappa}_1 \cdot \underline{r} = \omega_2 t - \underline{\kappa}_2 \cdot \underline{r} \quad -(26)$$

in which eq. (23) was just assumed. This led to

$$\underline{\kappa} \cdot \underline{r} = \underline{\kappa}_1 \cdot \underline{r} = \underline{\kappa}_2 \cdot \underline{r} \quad -(27)$$

where:

$$\underline{\kappa} = \kappa \left(\underline{i} \sin\theta + \underline{j} \cos\theta \right) \quad -(28)$$

$$\underline{\kappa}_1 = \kappa_1 \left(\underline{i} \sin\theta_1 + \underline{j} \cos\theta_1 \right) \quad -(29)$$

$$\underline{\kappa}_2 = \kappa_2 \left(\underline{i} \sin\theta_2 - \underline{j} \cos\theta_2 \right) \quad -(30)$$

$$\underline{r} = X \underline{i} + Y \underline{j} \quad -(31)$$

with reference to Fig. (1) of note 289(5).

So:

$$\begin{aligned} & X \kappa \sin\theta + Y \kappa \cos\theta \\ = \; & X \kappa_1 \sin\theta_1 + Y \kappa_1 \cos\theta_1 \\ = \; & X \kappa_2 \sin\theta_2 - Y \kappa_2 \cos\theta_2 \end{aligned} \quad -(32)$$

The dogma made the arbitrary assumption

$$\kappa \sin\theta = \kappa_1 \sin\theta_1 = \kappa_2 \sin\theta_2 \quad -(33)$$

and arbitrarily asserted that eq. (33)

5) gives Snell's law by using eq. (25).

The arbitrary assumption (33) means that:

$$\kappa \cos\theta = \kappa_1 \cos\theta_1 = -\kappa_2 \cos\theta_2 \quad -(34)$$

Experimentally:

$$\theta = \theta_2 \quad -(35)$$

i.e. the angle of incidence is observed to be the same as the angle of reflection. So from eqs. (34) and (35):

$$\kappa = -\kappa_2 \quad -(36)$$

<u>which is absurd</u>, because the magnitude of wavenumber must be positive valued.

Eq. (34) also gives:

$$\kappa \cos\theta = \kappa_1 \cos\theta_1 \quad -(37)$$

which <u>contradicts</u> eq. (33):

$$\kappa \sin\theta = \kappa_1 \sin\theta_1 \quad -(38)$$
