Transmission of Light through a Polariser

Assume light to be a polarised vector arriving at a slit and that the proportion of light transmitted through the polariser is the resolved vector parallel to the polariser and the light absorbed is the vector perpendicular to the polariser.

Assume the angle between the polarised light and the polariser itself is θ.

We want an expression where

$n \times [\, f(\theta) + f(\theta - \tfrac{1}{2}\pi)\,] = n$

Clearly the function must be

$\cos^2\theta + \sin^2\theta = 1$

for all θ 0 to $\tfrac{1}{2}\theta$.

So the proportion transmitted at any angle is given by $\cos^2\theta$.

So at $\theta = 0°$

transmission is complete,

at $\theta = 90°$ transmission is blocked

and at $\theta = 45°$

then half is transmitted.

These are the expected results.

Now if we consider individual photons the value $\cos^2\theta$ becomes a probability.

ie P(transmission at angle θ) = $\cos^2\theta$.

Now for photons arriving at random orientations, the proportion that will be transmitted is given by

$\{ \int_0^{\pi} \cos^2\theta \, d\theta \} / \tfrac{1}{2}\pi$

$= \{ \int_0^{\frac{1}{2}\pi} \tfrac{1}{2} (1 + \cos 2\theta) \, d\theta \} / \tfrac{1}{2}\pi$

$= [\, \tfrac{1}{2}\theta + \tfrac{1}{4}\sin 2\theta \,]_0^{\frac{1}{2}\pi} \} / \tfrac{1}{2}\pi$

$= \{ \tfrac{1}{2}\tfrac{1}{2}\pi + \tfrac{1}{4}\sin\pi - 0 - 0 \} / \tfrac{1}{2}\pi$

$= \tfrac{1}{2}$

That is a polariser transmits half and absorbs half of the unpolarised light falling on it.

Polarised sunglasses "work" because the polariser is perpendicular to the reflected light from say water which tends to polarise.

XO *rg*

Transmission of Light through a Polariser

Assume light to be a polarised vector arriving at a slit and that the proportion of light transmitted through the polariser is the resolved vector parallel to the polariser and the light absorbed is the vector perpendicular to the polariser.

Assume the angle between the polarised light and the polariser itself is θ.

We want an expression where

$n \times [\, f(\theta) + f(\theta - \tfrac{1}{2}\pi)\,] = n$

Clearly the function must be

$\cos^2\theta + \sin^2\theta = 1$

for all θ 0 to $\tfrac{1}{2}\theta$.

So the proportion transmitted at any angle is given by $\cos^2\theta$.

So at $\theta = 0°$

transmission is complete,

at $\theta = 90°$ transmission is blocked

and at $\theta = 45°$

then half is transmitted.

These are the expected results.

Now if we consider individual photons the value $\cos^2\theta$ becomes a probability.

ie P(transmission at angle θ) =

$\cos^2\theta$.

Now for photons arriving at random orientations, the proportion that will be transmitted is given by

$\{ \int_0^{\pi} \cos^2\theta \, d\theta \} / \tfrac{1}{2}\pi$

$= \{ \int_0^{\frac{1}{2}\pi} \tfrac{1}{2}(1 + \cos 2\theta)\, d\theta \} / \tfrac{1}{2}\pi$

$= [\, \tfrac{1}{2}\theta + \tfrac{1}{4}\sin 2\theta \,]_0^{\frac{1}{2}\pi} \} / \tfrac{1}{2}\pi$

$= \{ \tfrac{1}{2}\tfrac{1}{2}\pi + \tfrac{1}{4}\sin\pi - 0 - 0 \} / \tfrac{1}{2}\pi$

$= \tfrac{1}{2}$

That is a polariser transmits half and absorbs half of the unpolarised light falling on it.

Polarised sunglasses "work" because the polariser is perpendicular to the reflected light from say water which tends to polarise.

XO *rg*