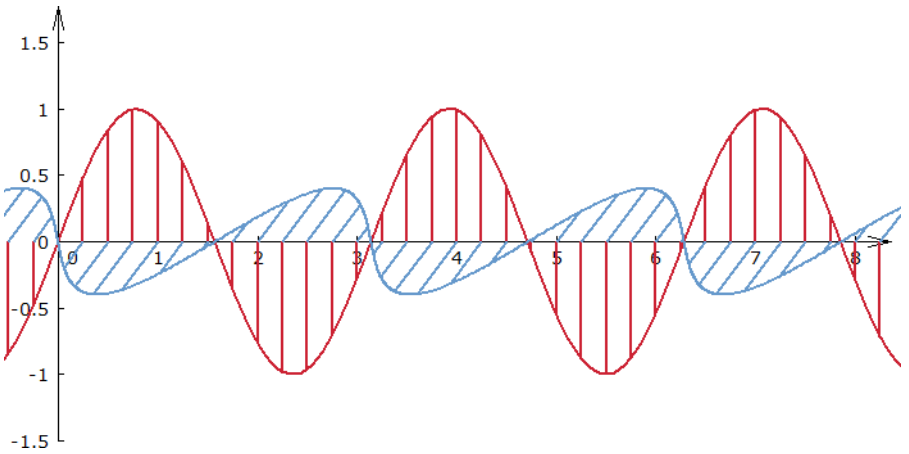


Polarization

Outline of PPT

- What polarization means
- Where Polarization is used in Technology
- Law of Malus
- Brewster’s law
- Introduction to Double Refraction

The wave nature of light clearly explained by

Interference and Difraction Phenomenon

But These Phenomenan failed to explain

Whether the light waves are longitudinal or Tansverse?
Whether the light waves linear, circular or elliptical?

Depending on direction of vibration waves are classified as

Transverse and longitudinal.

Phenomenon such as Reflection, Refraction, Interference, Difraction are common in both the types

But Polarisation is possible only in transverse waves

Polarisation is the charecteristics of the Transverse wave

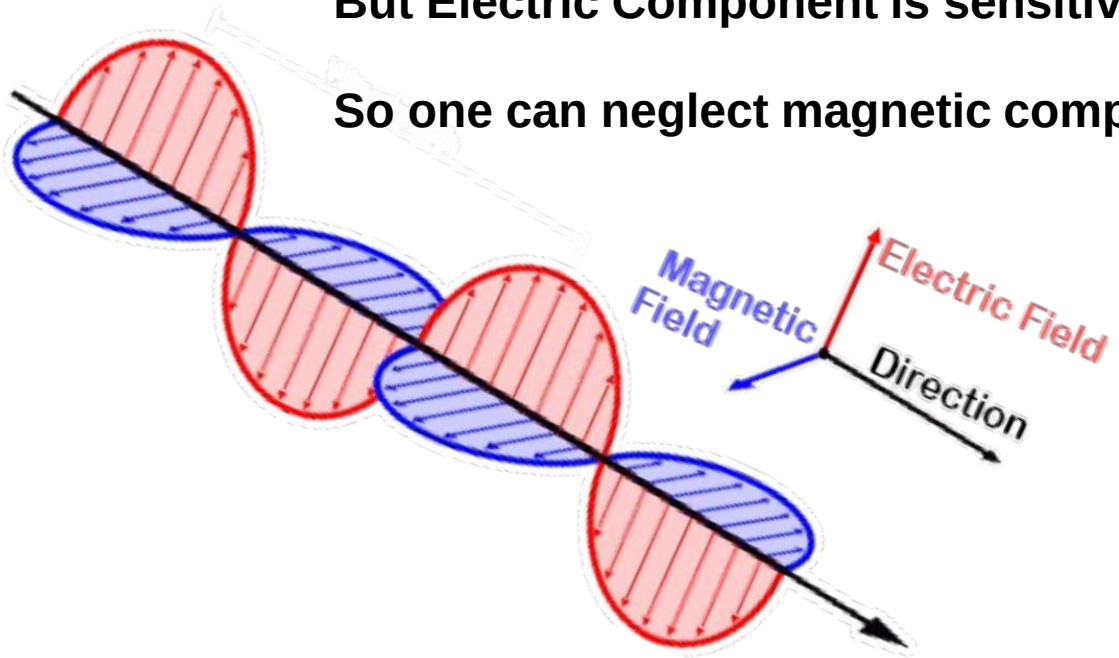
Light?

Light is an Electromagnetic Wave

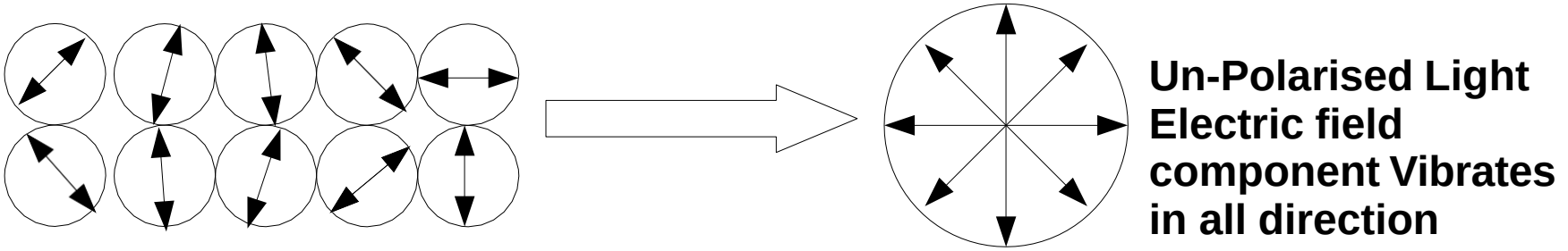
It contains:
- **Electric Component**
- **Magnetic Component**
- **Both are perpendicular to each other**
- **Both are perpendicular to direction of Propogation**

But Electric Component is sensitive to eye, so it is called as light vector

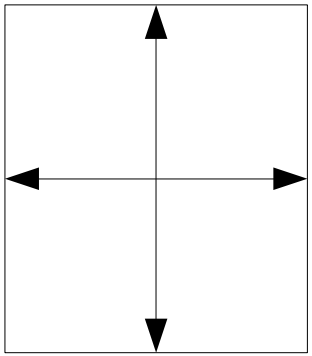
So one can neglect magnetic component



Source of light contains large number of atoms/molecules
Each atom produces its own wave independently
Each emission has its own electric component, orientation may be diffrent
What we se is resultant of each emission



Un-Polarised Light
Electric field component Vibrates in all direction

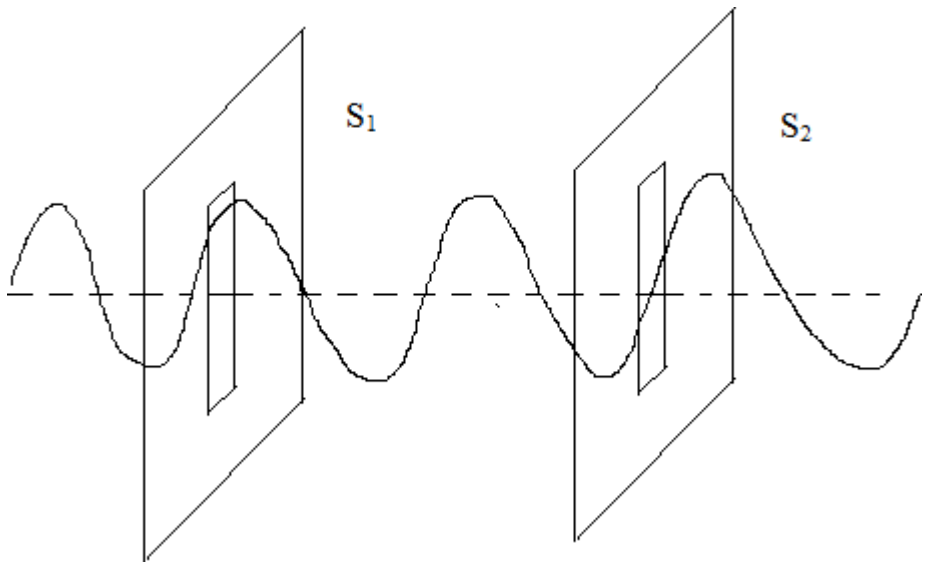


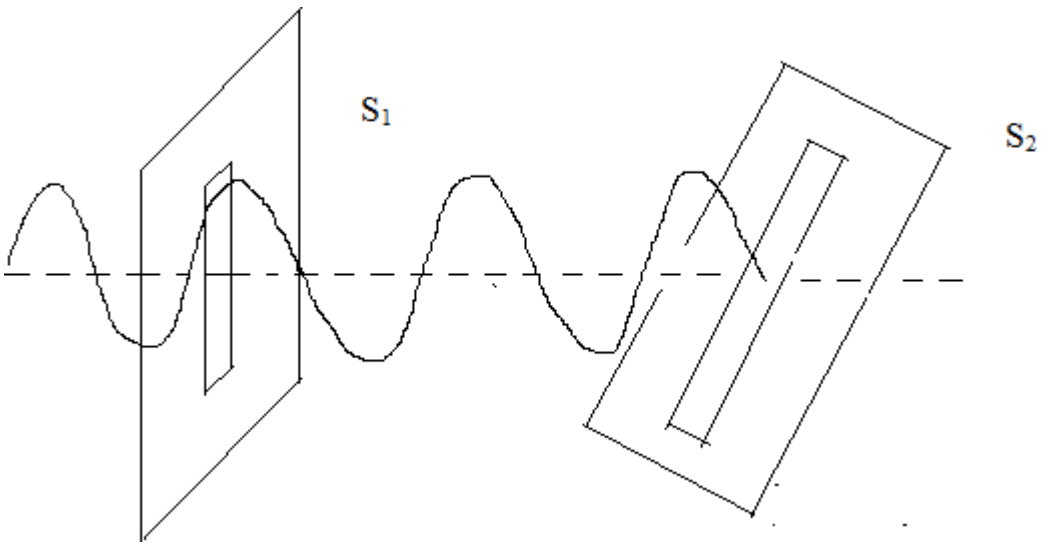
Electric field is a vector quantity, So one can resolve the vector

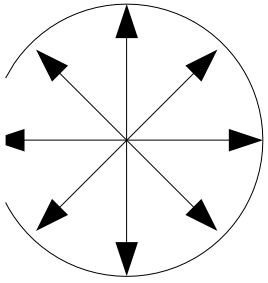
Polarisation

“Restricting vibrations or oscillations of a wave in a plane perpendicular to the wave propogation in only one direction”

Mechanical Analogy







No Vibrations

Optical Analogy

Consider an ordinary light instead of a string
a Polaroid (or a tourmaline crystal) instead of a slit.
If the Polaroid S_1 is rotated then the intensity of the light will not vary proving that it is unpolarized.

However, the case will be different if light is passed through two Polaroids instead of one.

If the second Polaroid S_2 is rotated across the first one,

Intensity of the light Varies
at **90^o** and **270^o** intensity is **minimum**

At **0^o**, **180^o** and **360^o** intensity is **maximum**
Ordinary light contains vibrations in all possible directions perpendicular to the direction of propagation.

When such light passes through a polarizer, it contains vibrations only in a particular direction decided by polarizing direction (optic axis) of the polarizer.

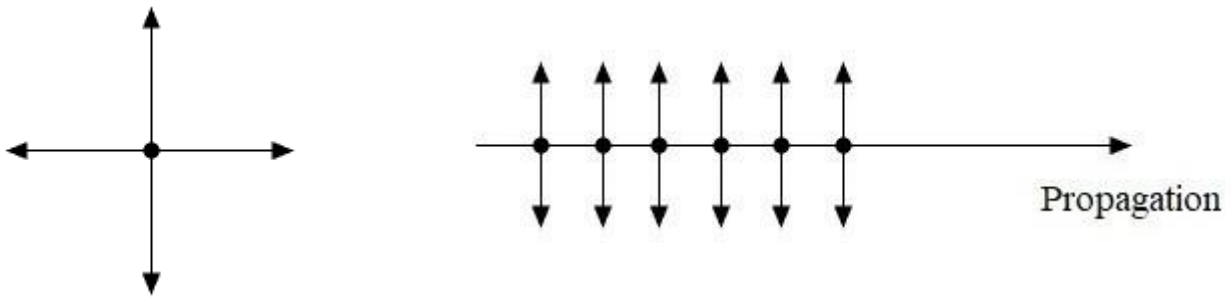
This experiment conclusively proves that light is a transverse wave

Types of Polarisation and Representations

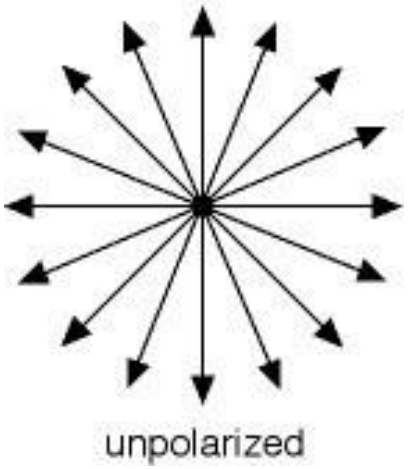
1. Un Polarised Light (UPL)
2. Linearly/Plane Polarised Light (PPL)
3. Circularly Polarised Light (CPL)
4. Elliptically Polarised Light (EPL)
5. Partially Polarised Light (PRPL)

Unpolarized light:

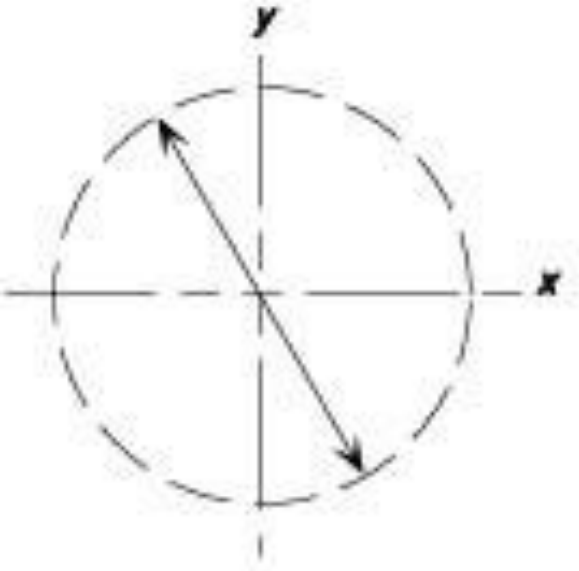
The vibrations are symmetrically distributed in all the directions perpendicular to the direction of propagation



UPL to PPL is Polarization



Polarization



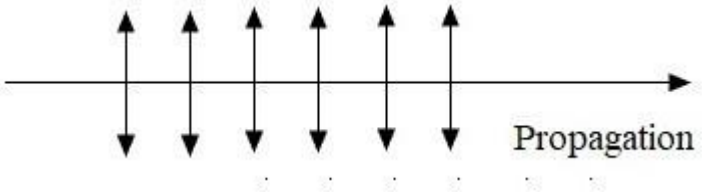
UPL PPL

i. Polarizer polarizes the light
ii. Only vibrations parallel to optic axis are passed
iii. Thus either X or Y, only one is transmitted
iv.iv. One axis parallel to optic axis another perpendicular
v. Thus when light is polarized once, its intensity always falls by 50%: **Polarizing sunglasses**

Plane Polarized Light (PPL)

UPL is allowed to pass through a polarizer, then it vibrates only in one direction parallel to its optic axis. Such light which vibrates only in a particular plane.

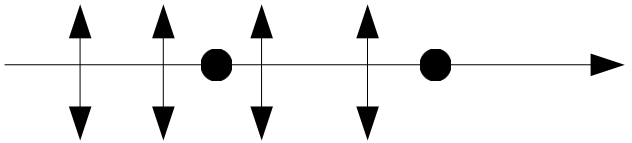
PPL (Vertically polarized)



PPL (Horizontally polarized)

Partially Polarised Light (PRPL)

Neither fully polarized nor fully unpolarized

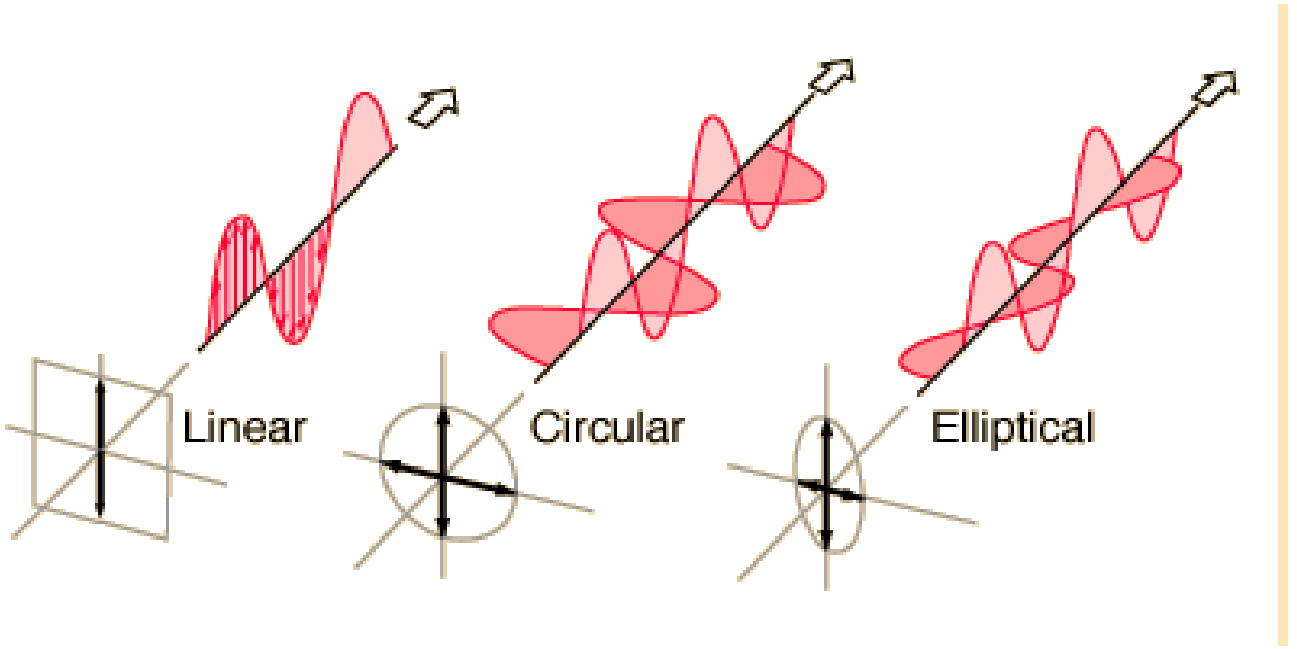


Circularly Polarised Light

Two plane polarised light of Equal amplitude are superimposed with a path difference λ/4 polarized electric vector in CPL rotates in a circle during its propagation

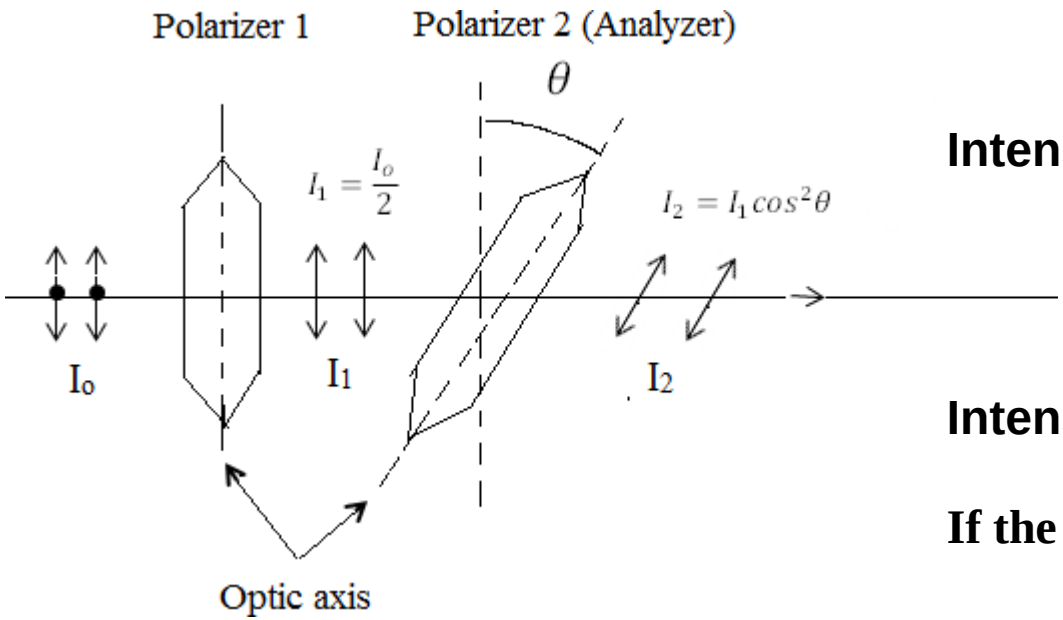
Elliptically Polarised Light

Two plane polarised light of unequal amplitude are superimposed with a path difference λ/4 polarized electric vector in EPL traces in a ellipse during its propagation



LAW OF MALUS

If the light is passed through two polarizers then the **intensity of light** passing through second polarizer **is a cosine square function** of the **angle** between their optic axis**.**



$$I_\theta = I_m cos^2\theta$$

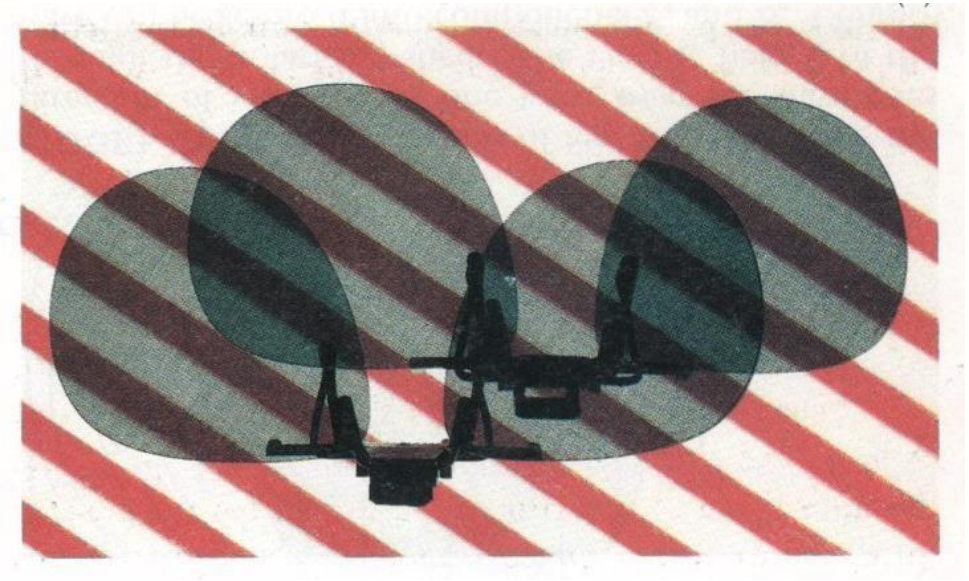
Intensity is Maximum at 0^o, 180^o, 360^o

$$I_1 = I_o \overline{cos^2\theta} = \frac{I_o}{2}$$

Intensity is Minimum at 90^o, 270^o

If the light is polarized once, its intensity falls by 50%

Demonstration of Law of Malus-I
Polarizing sunglasses



Parallel Sunglasses

Crossed Sunglasses

Demonstration of Law of Malus-II
LCD through Polarizers

Demonstration of Law of Malus-III