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TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS

Engineering Physics (FYBTech)

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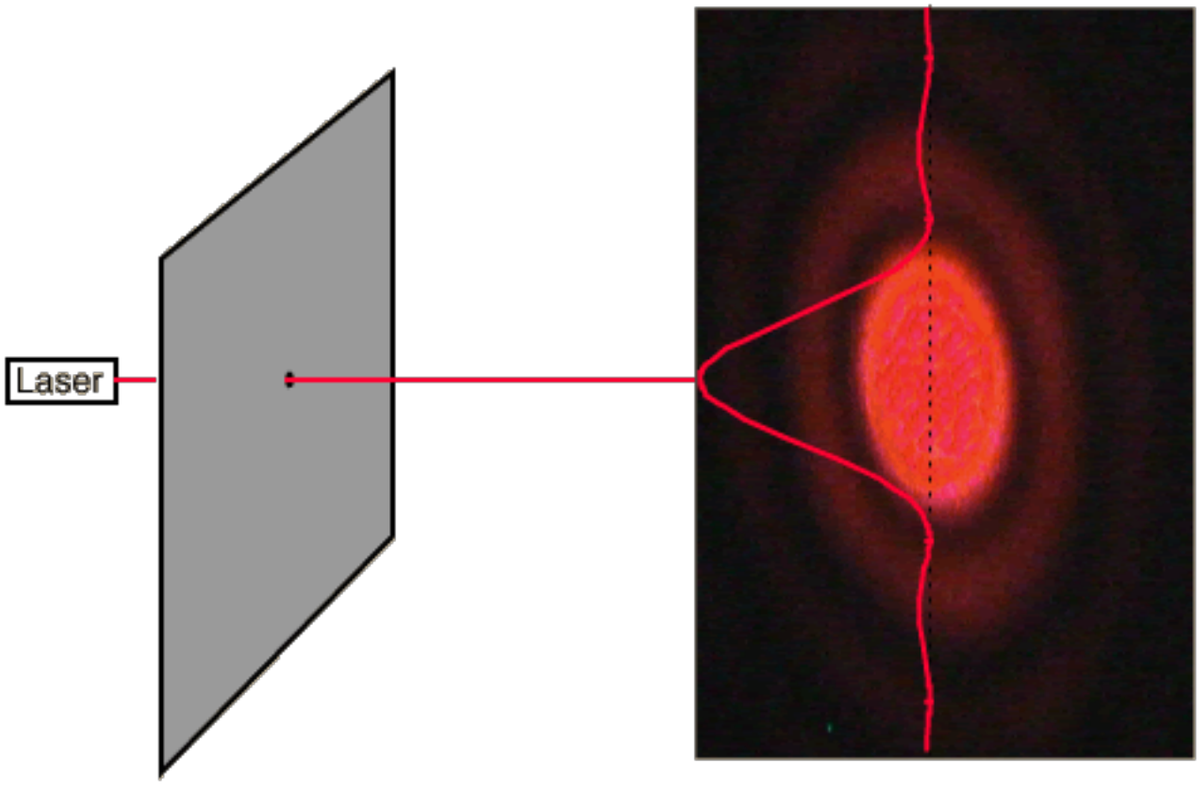
Polarisation

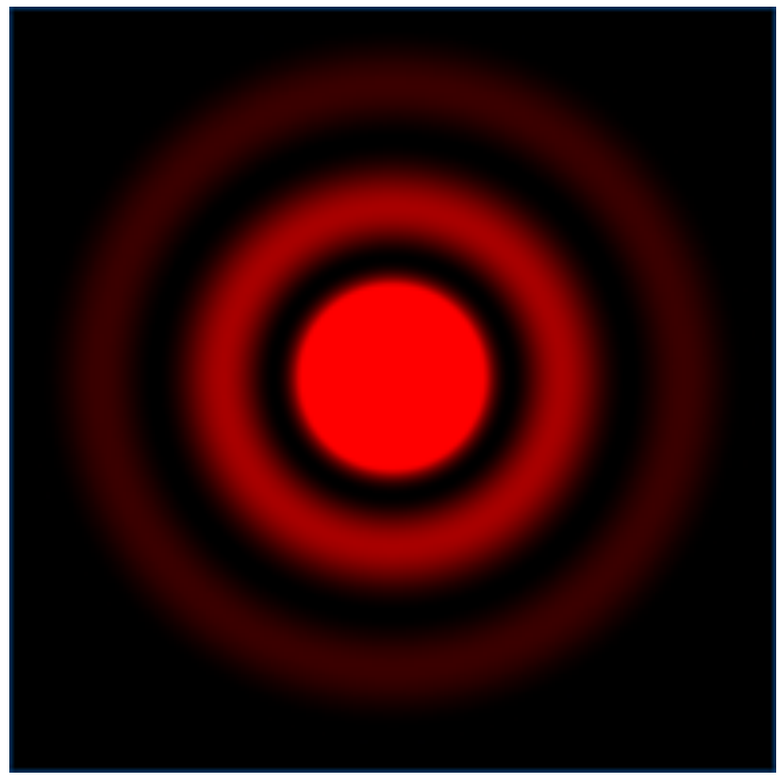
Content:

- Diffraction grating, its properties and uses
- Importance of polarisation in engineering and technology
- Representation
- Law of Malus (to be taught in the lab)
- Method of producing PPL
- Double refraction
- Huygens theory of double refraction
- Quarter Wave Plate
- Applications

Diffraction by Circular Aperture



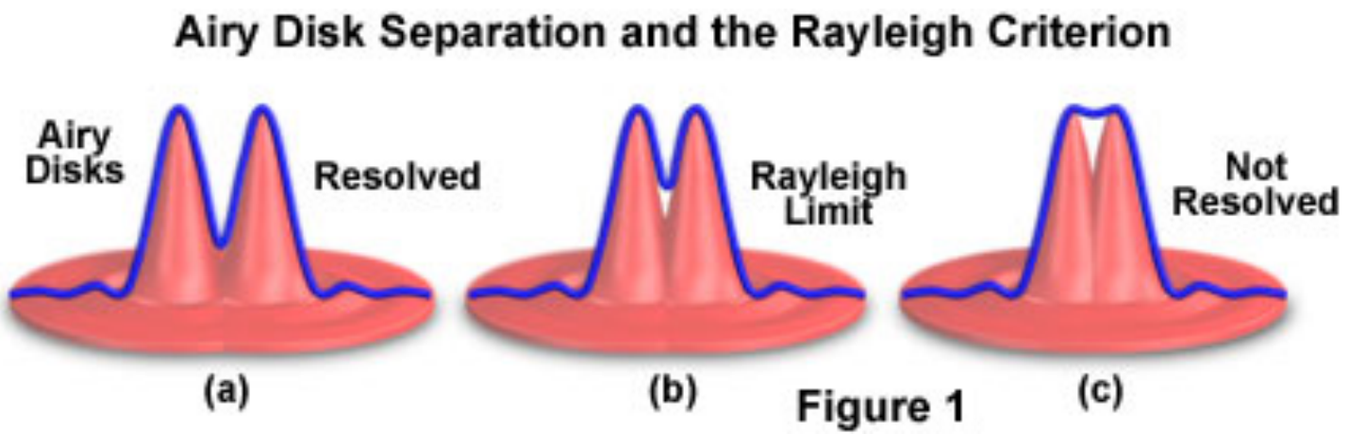
Circular Aperture Diffraction

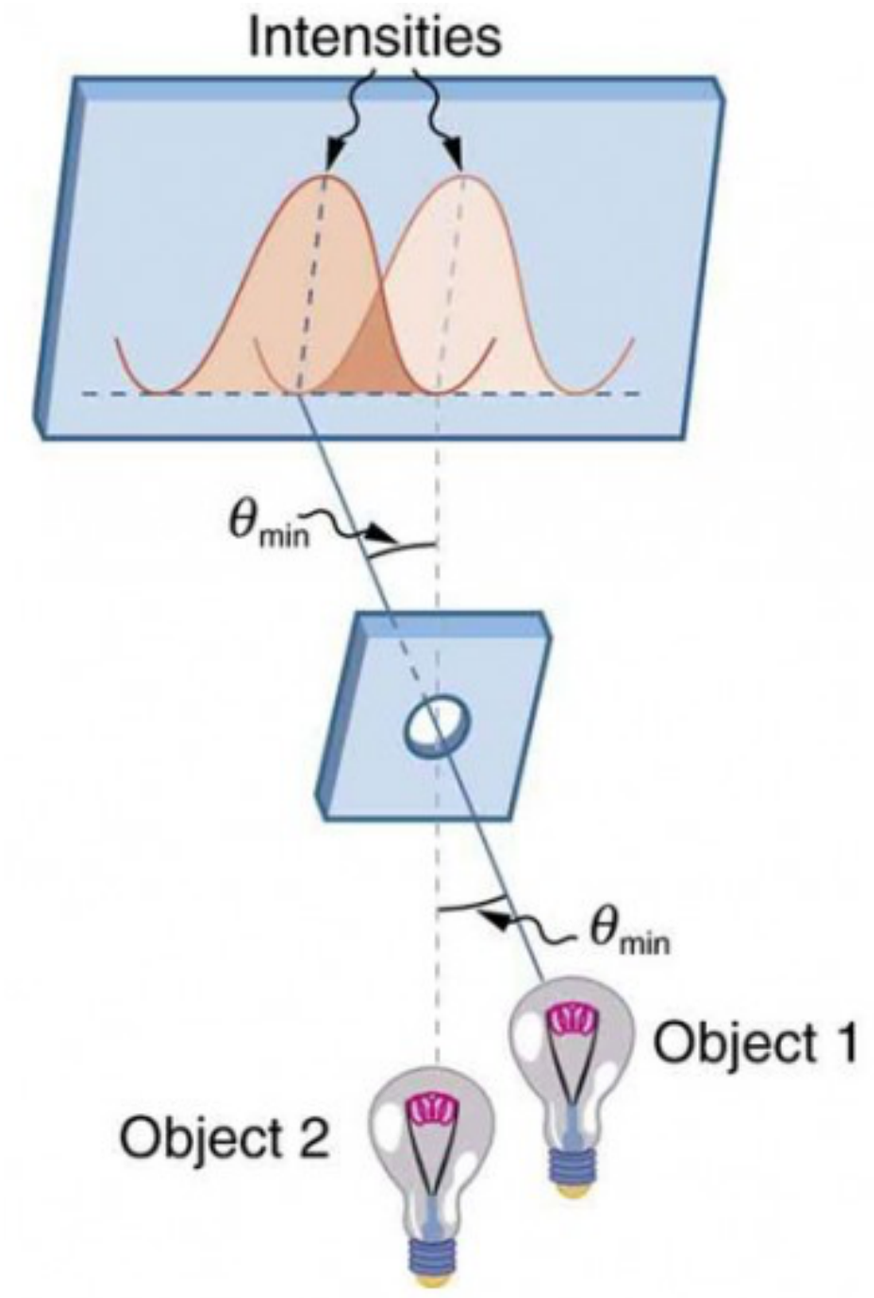


Airy's Discs

- This diffraction pattern is just like rotating the intensity distribution graph of single slit diffraction above central axis passing through P which traces the circular aperture perfectly symmetrical.
- This produces a diffraction pattern due to circular aperture produces central bright disc's (Airy's disc) surrounded by alternate dark and bright Airy rings.
- The diffraction pattern consisting of a central bright disc surrounded by bright and dark rings. The central bright disc is often called Airy's Disc.

Diffraction by Circular Aperture





Rayleigh's Criteria for Resolution

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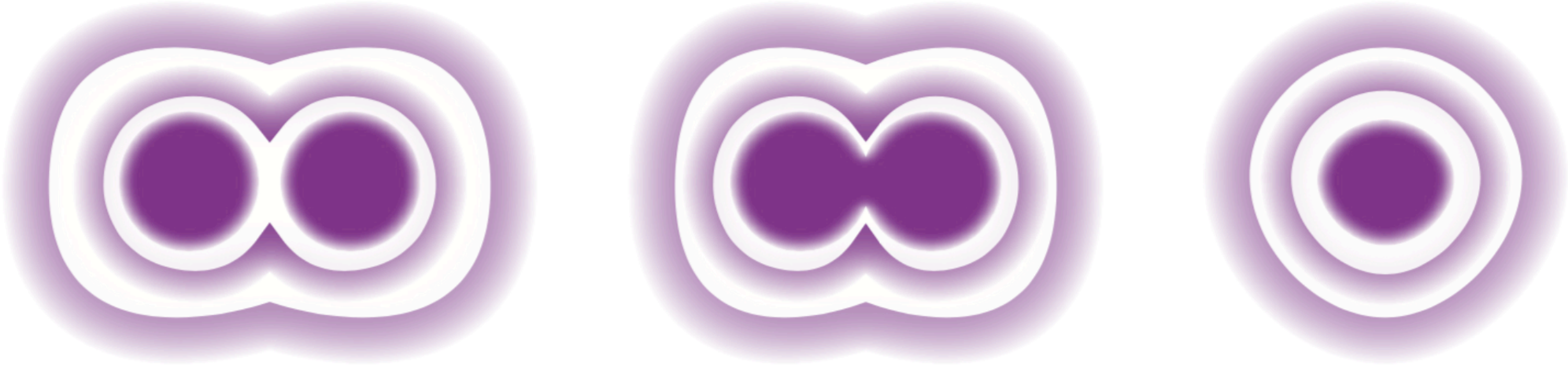
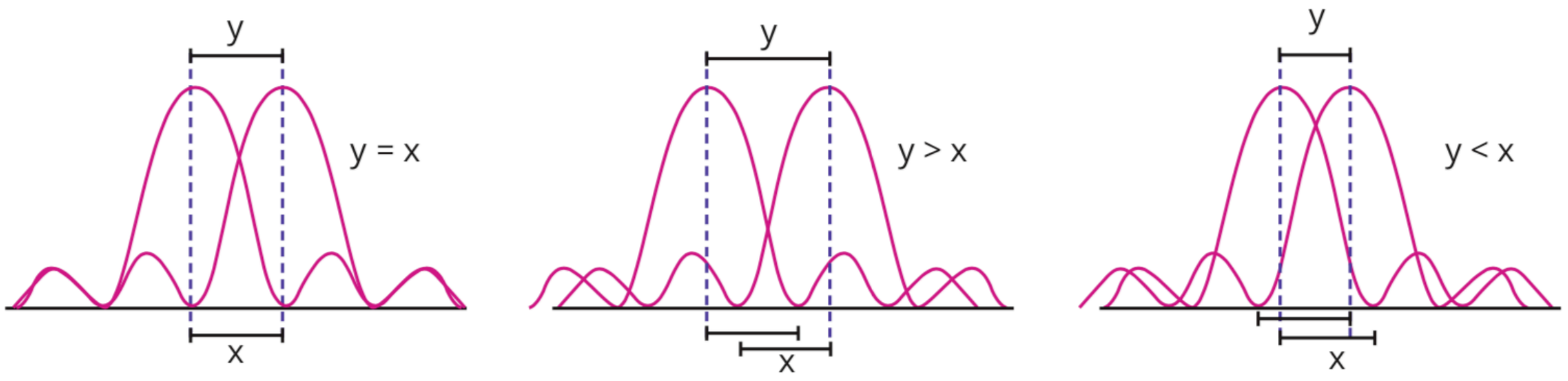


Just resolved | Well resolved | Un-resolved

- The Rayleigh criterion states that two closely spaced point sources are just resolved by an optical instrument only if central maximum in the diffraction pattern of one coincide the first minimum in the diffraction pattern of the other and vice-versa.



Just resolved | Well resolved | Un-resolved

Resolving Power of Grating

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- The ability of the instrument to produce just separate diffraction pattern of two close objects is known as its resolving power.

$$R.P = \frac{\lambda}{d\lambda} = nN$$

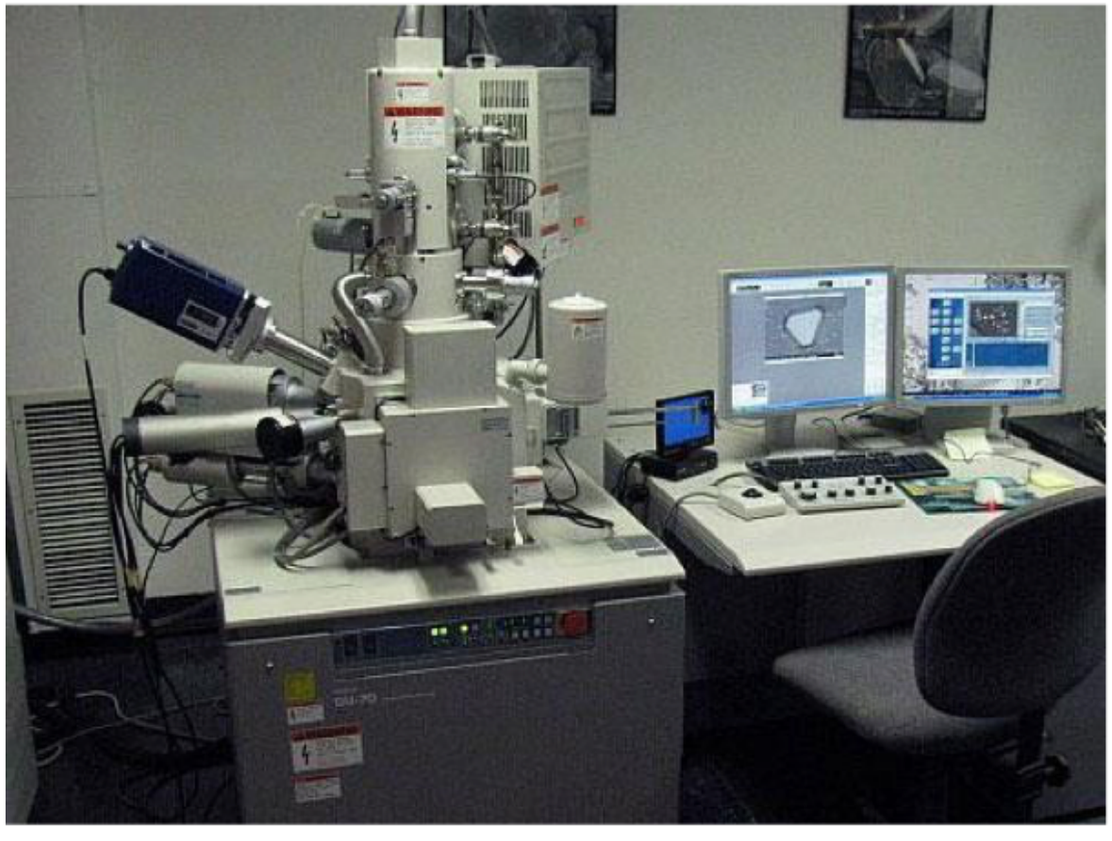
- It is the ability of the instrument to discriminate wavelength λ and λ+dλ
- If dλ tends to Zero, spectral lines overlap with each other.
- By increasing number of lines sharpness and resolution will be increased

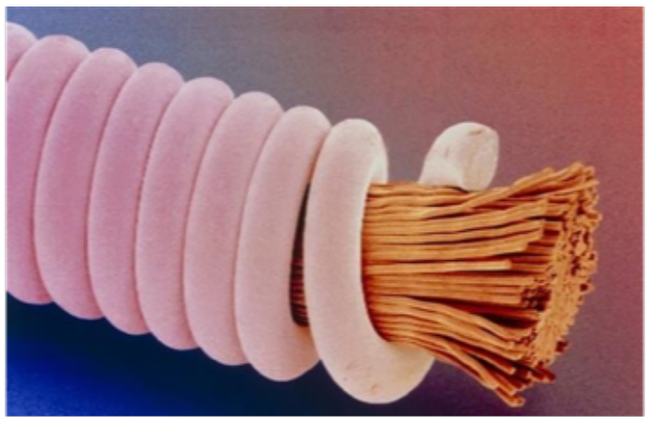
The wavelengths λ and λ+dλ can be resolved, if the principal maximum corresponding to wavelength λ+dλ falls on the first minimum of the wavelength λ.

Applications of Diffraction

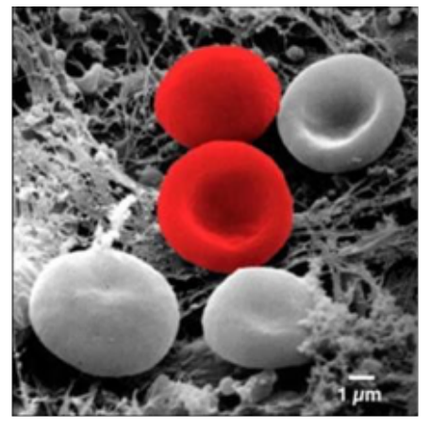
Why electron microscope is incredibly superior to Optical microscope?

In electron microscope, electrons are used for imaging instead of light. the wavelength of electrons is extremely small (100000 times) as compared to light. Therefore they are incredible superior to optical microscope

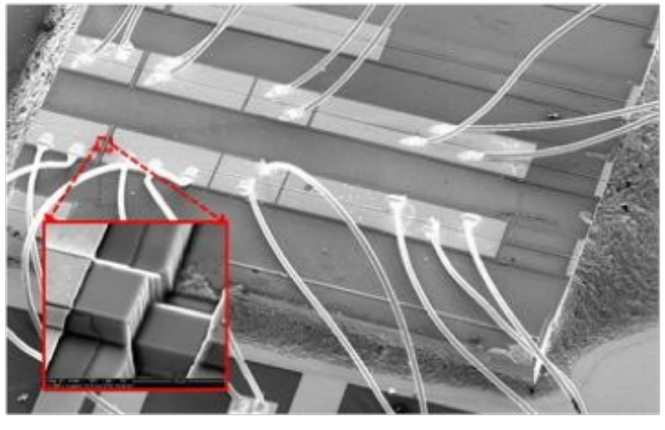




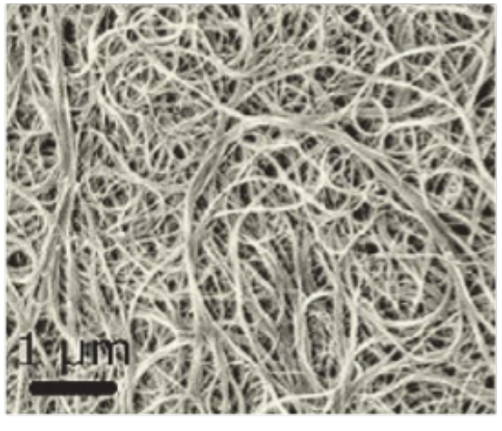
String of a guitar



Blood cells



Integrated circuit



Carbon Nanotubes

Applications of Diffraction

Why multi-array telescopes and radars have enhanced resolving power?

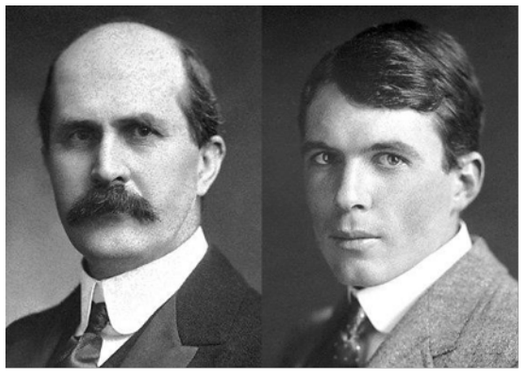
26 huge antennas at in GMRT

VLA at New Mexico. The images from the telescopes interfere constructively when the condition $dsin\theta = m\lambda$ is satisfied

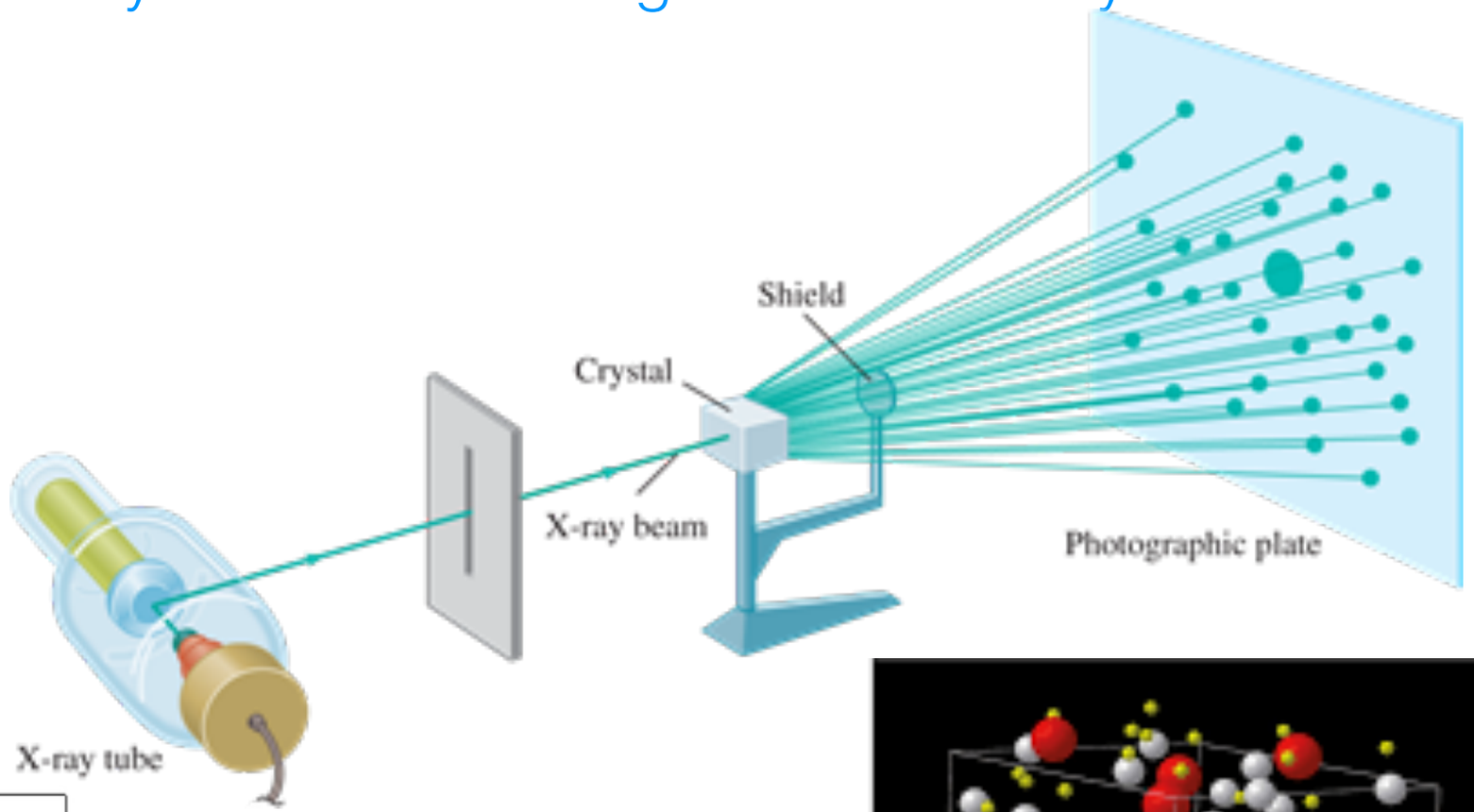
Why a multi-slit diffraction grating has better resolving power than a single slit? Images become sharp. Same is the reason here

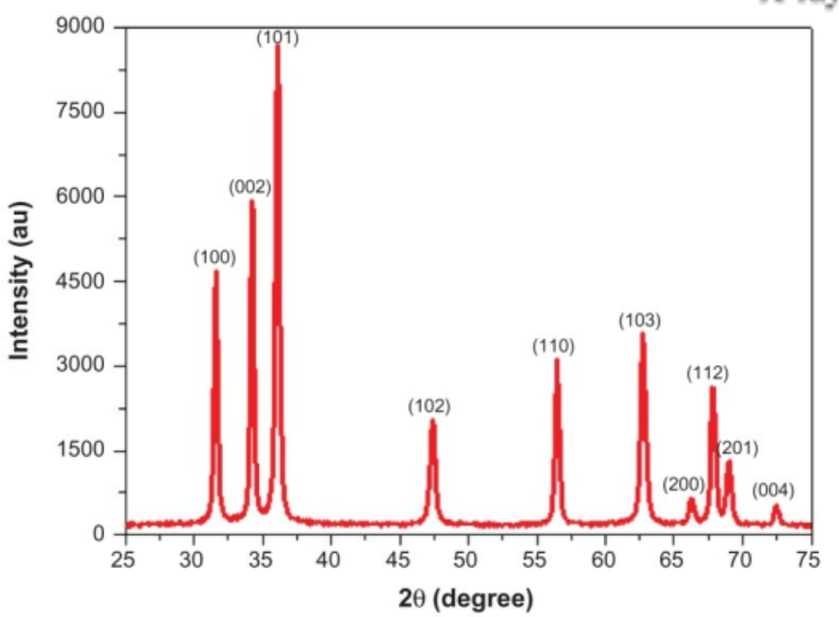
X-ray Diffraction

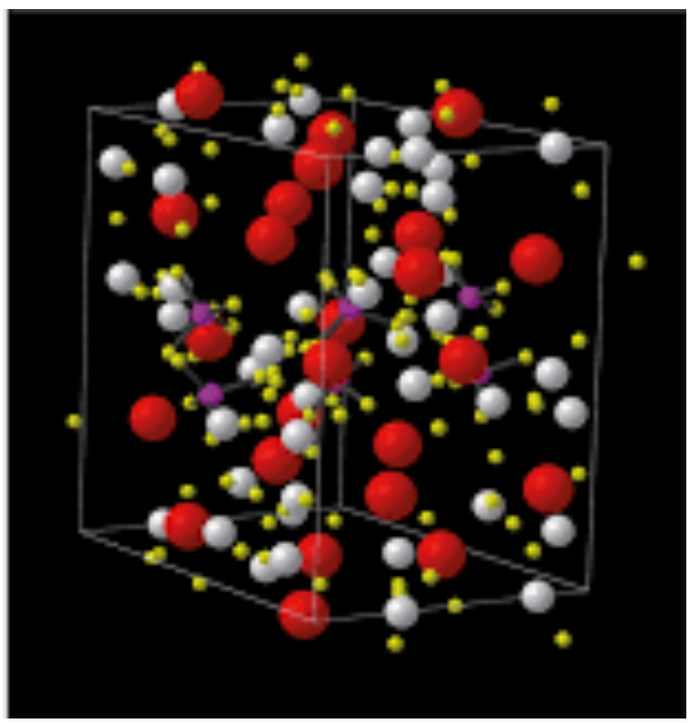
X-ray diffraction can able to study the atomic arrangement in the crystalline structure



William Bragg and
Lawrence Bragg,
NobelPrize 1915

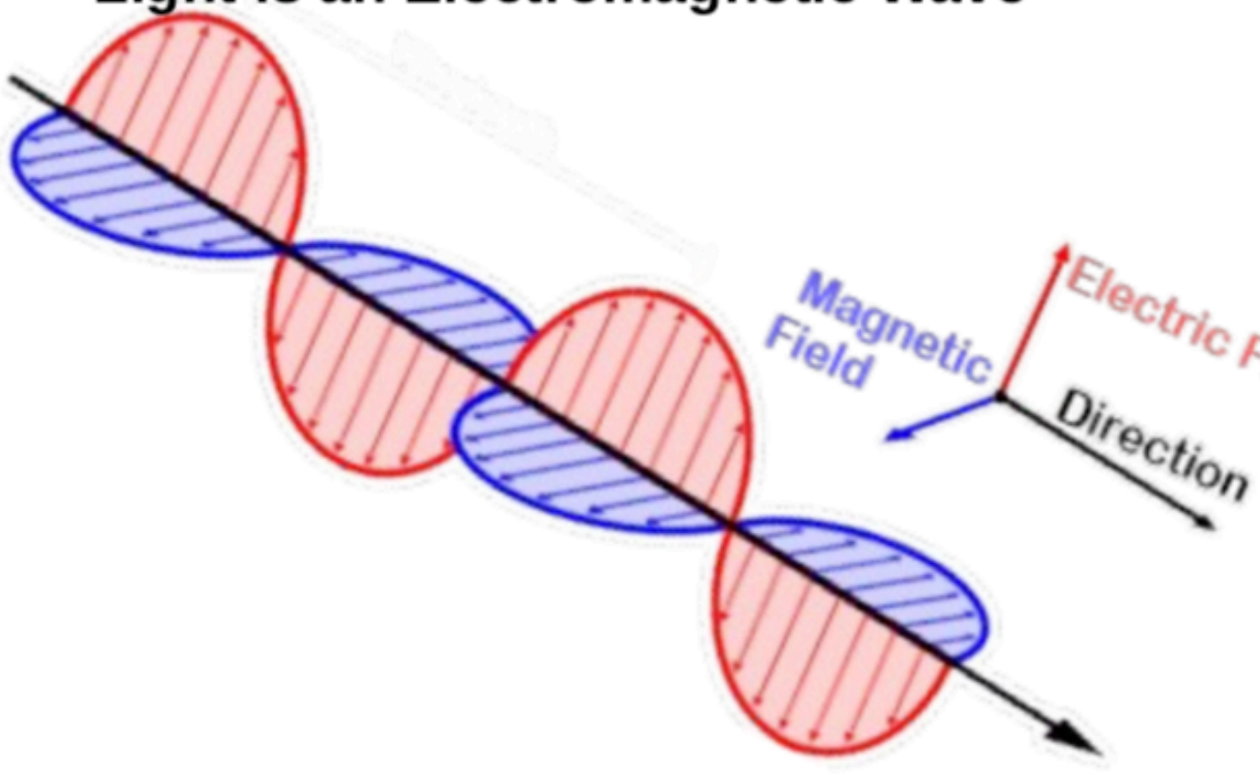






Polarisation: Light

Light is an Electromagnetic Wave



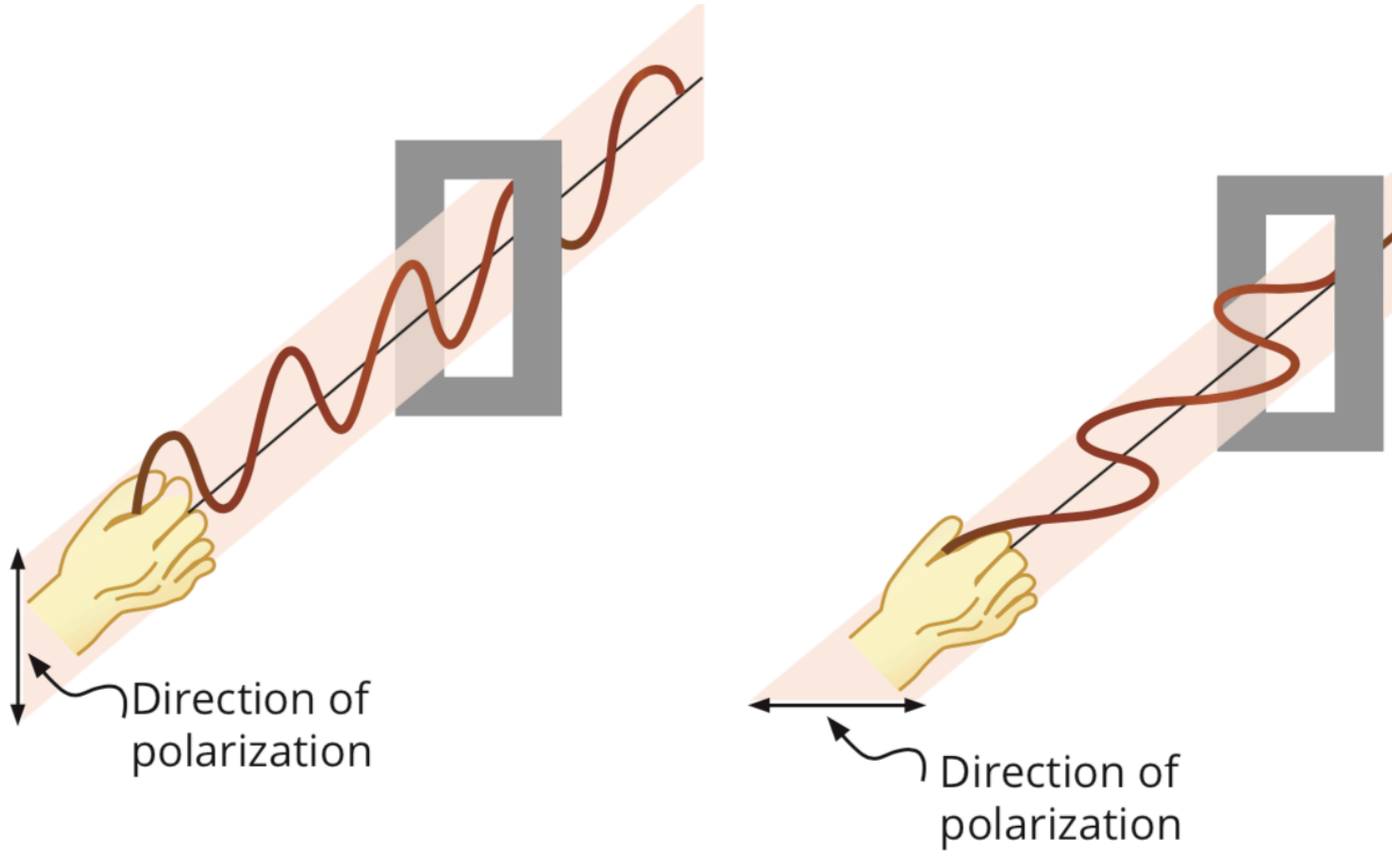
It contains:
- **Electric Component**
- **Magnetic Component**
- **Both are perpendicular to each other**
- **Both are perpendicular to direction of Propogation**

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

So one can neglect magnetic component

Light polarisation: Vertical/Horizontal

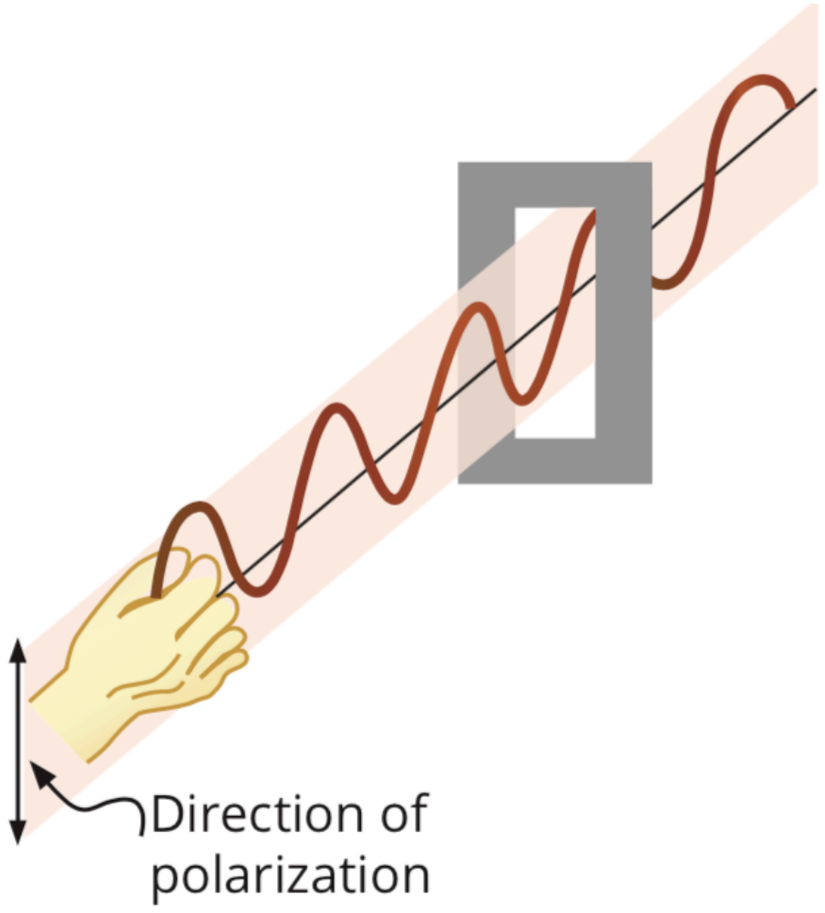
- This dependence of certain properties on directions or this property of asymmetry or one-sidedness is called polarity.
- A wave having such characteristics said to be polarized and the phenomenon is called polarization.
- The phenomenon in which light restrict to vibrate in a single direction is called polarization.

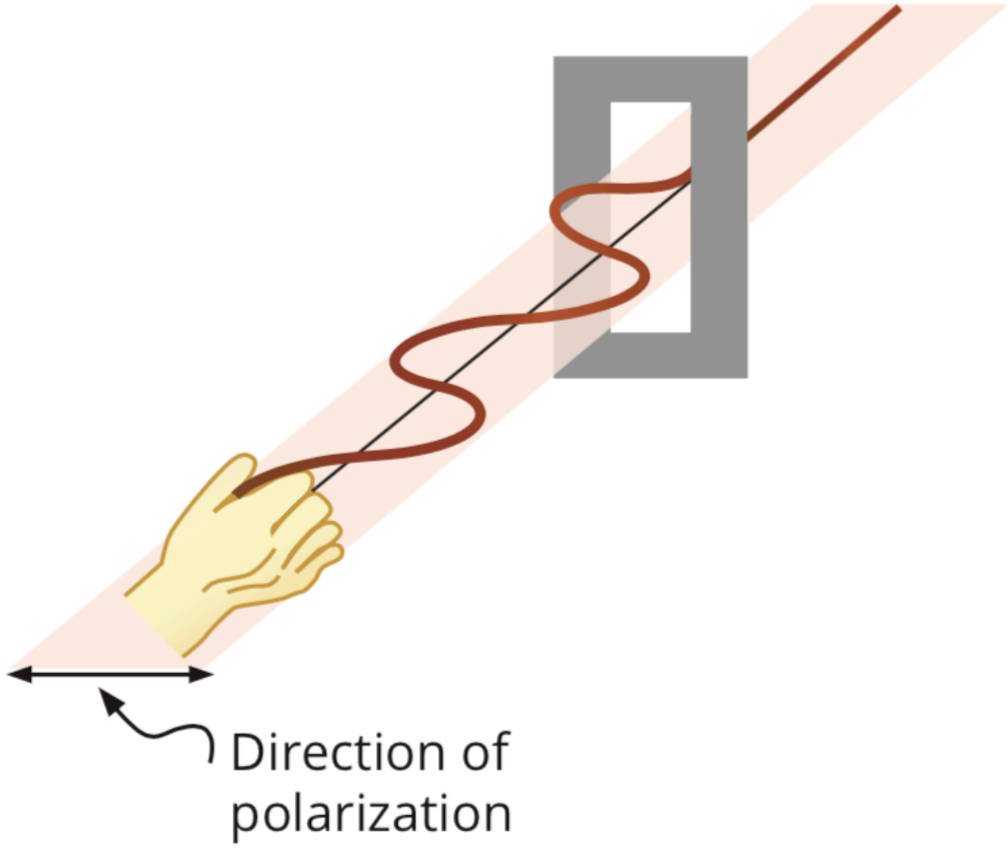


- The first is said to be vertically polarized, and the other is said to be horizontally polarized. Vertical slits pass vertically polarized waves and block horizontally polarized waves and vice versa.

Polarisation

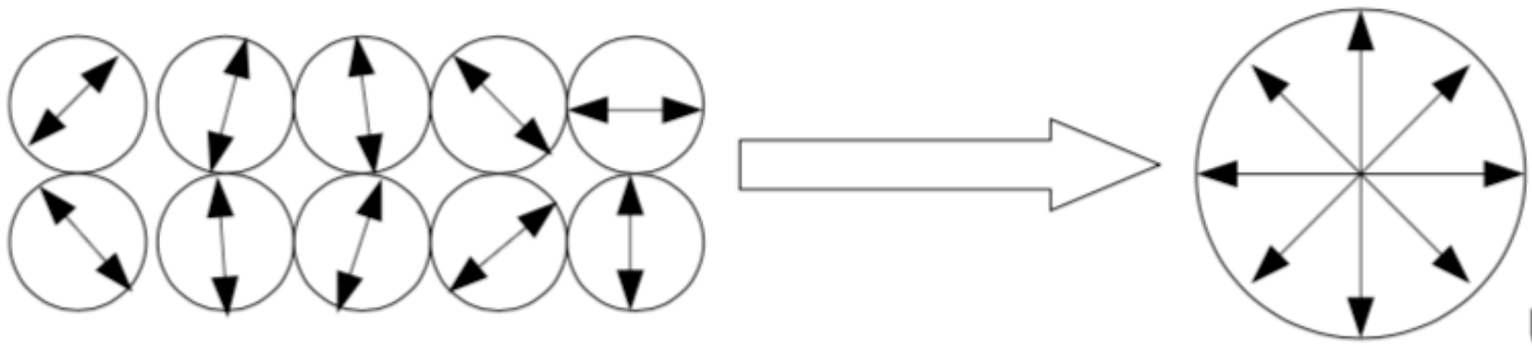
"Restricting vibrations or oscillations of a wave in a plane perpe



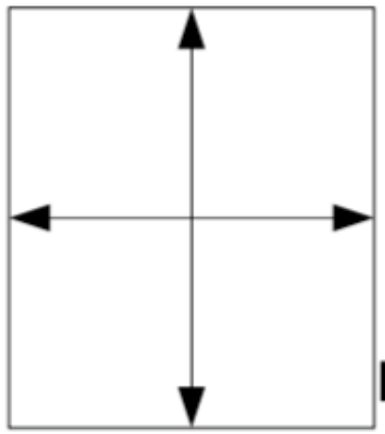


Polarisation

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

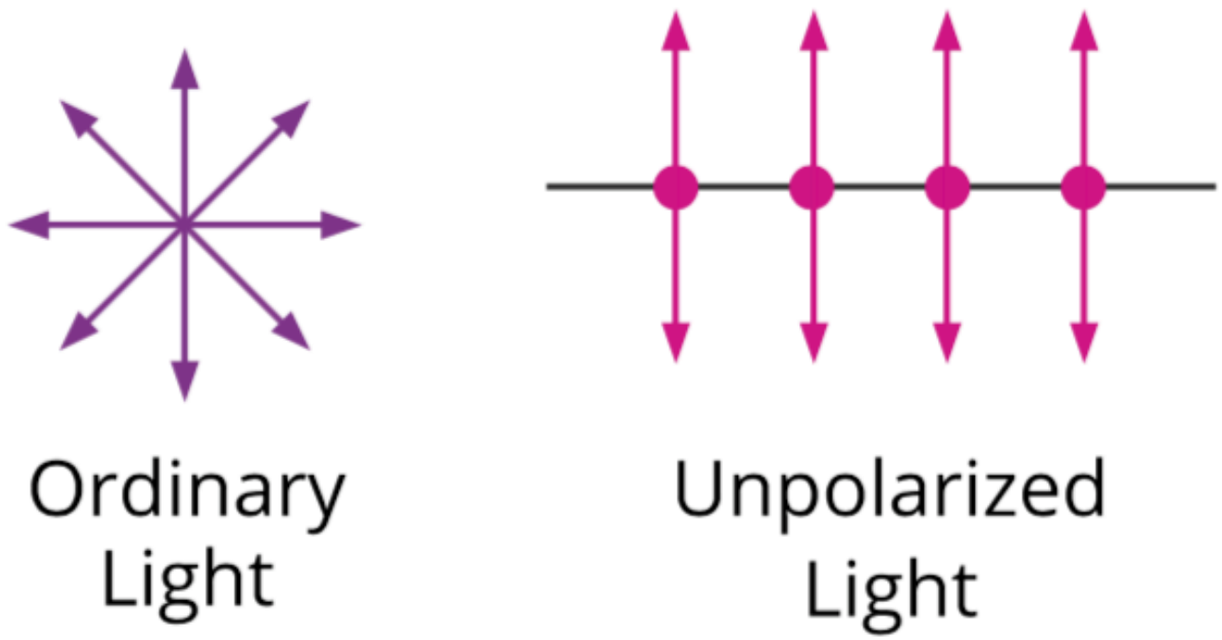


Electric field is a vector quantity, So one can resolve the vector

Terms Related to Polarisation

Unpolarised Light:

- The ordinary light beam having vibrations along all possible plane perpendicular to the direction of propagation is said to be unpolarized light.



Terms Related to Polarisation

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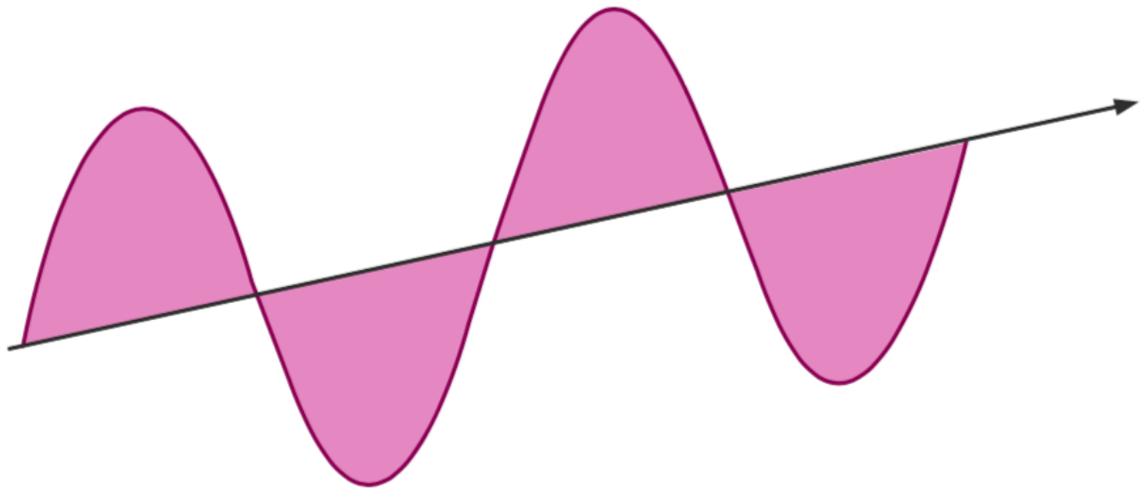
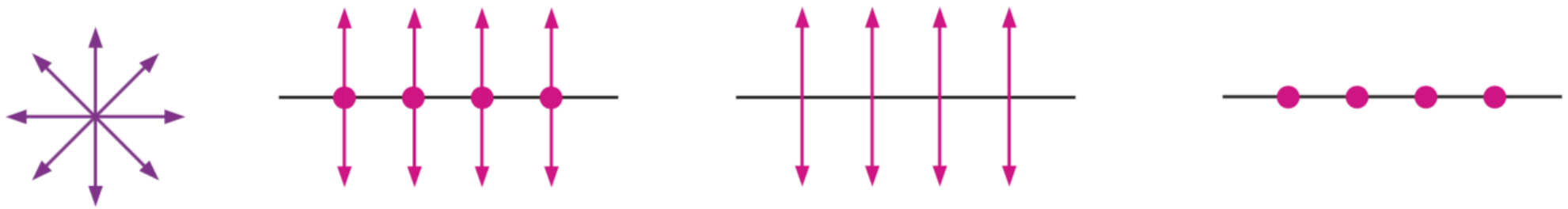
- The light beam having vibrations along the single direction perpendicular to the direction of propagation of light is called plane polarized light.



Polarised Light:

- When plane polarized light has vibrations in plane of paper they are denoted by a straight arrow and when vibration present in perpendicular to plane of paper represented by dots.



Ordinary Light

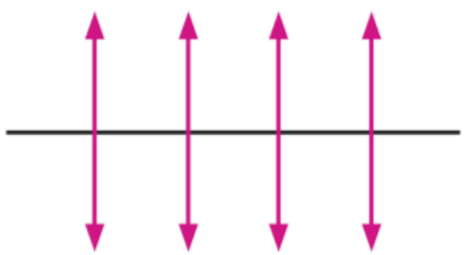
Unpolarized Light

PPL with Vibration parallel to plane of paper

PPL with Vibration perpendicular to plane of paper

Polarised Vs Unpolarised

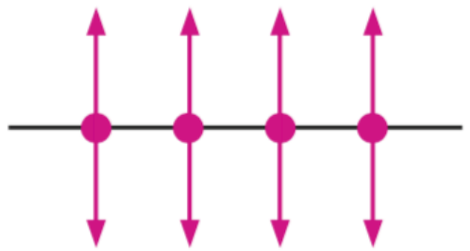
Polarized Light	Unpolarized Light
The oscillation is confined to only one plane.	The oscillation occurs in many planes.
It is coherent in nature.	It is incoherent in nature.
Its intensity depends on the nature of polaroid used.	Its intensity depends on the nature of source.
In polarized light electric vector is confined to a plane and magnetic vector H is normal to the plane.	In unpolarized light plane of vibration of electric vector continuously and C random change.



PPL with Vibration parallel to plane of paper

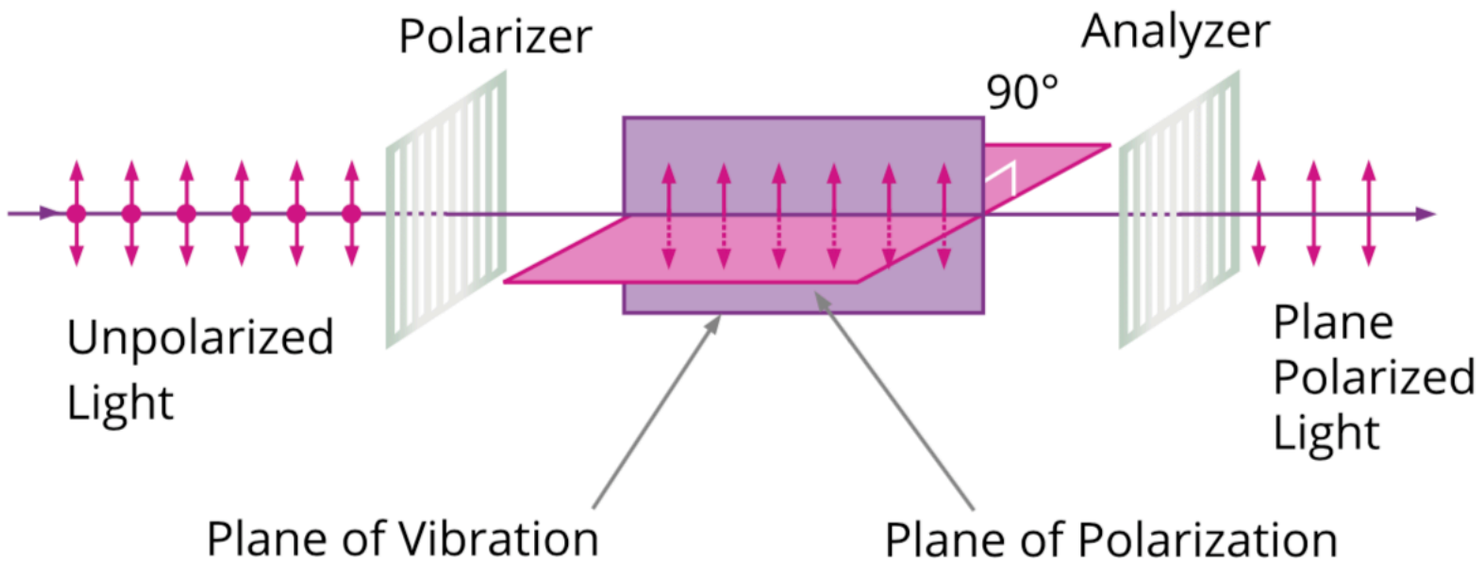
PPL with Vibration perpendicular to plane of paper

Ordinary Light



Unpolarized Light

Plane of Vibration and Polarisation



Plane of Vibration

- The plane containing the crystallographic axis, the direction of vibration and direction of propagation of light is known as the plane of vibration.
- The plane of polarization is always perpendicular to the plane of vibration.

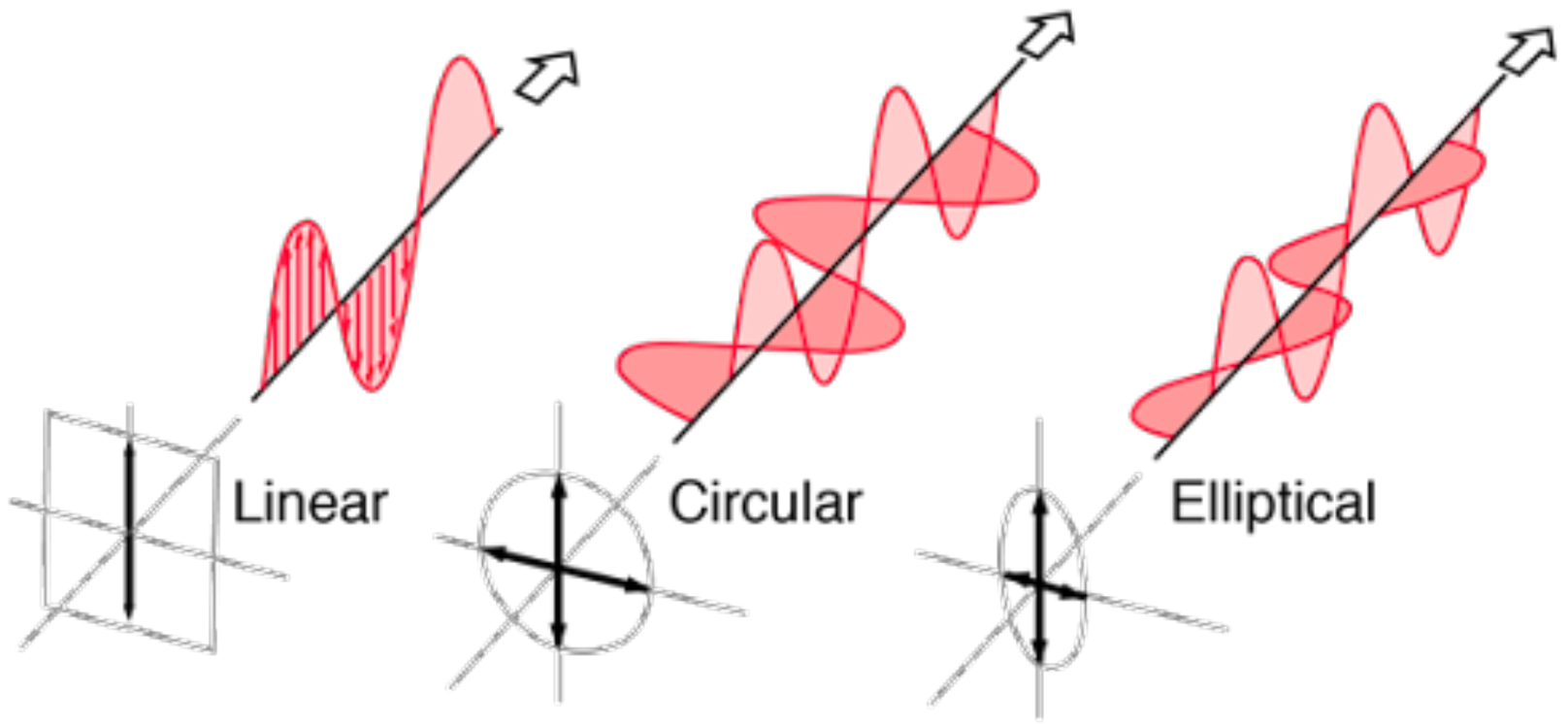
Plane of Polarization

- The plane containing the direction of propagation of light, but containing no vibrations is known as the plane of polarization.

Types of Polarisation

Linear polarised Light: The electric field of light is confined to a single plane along the d

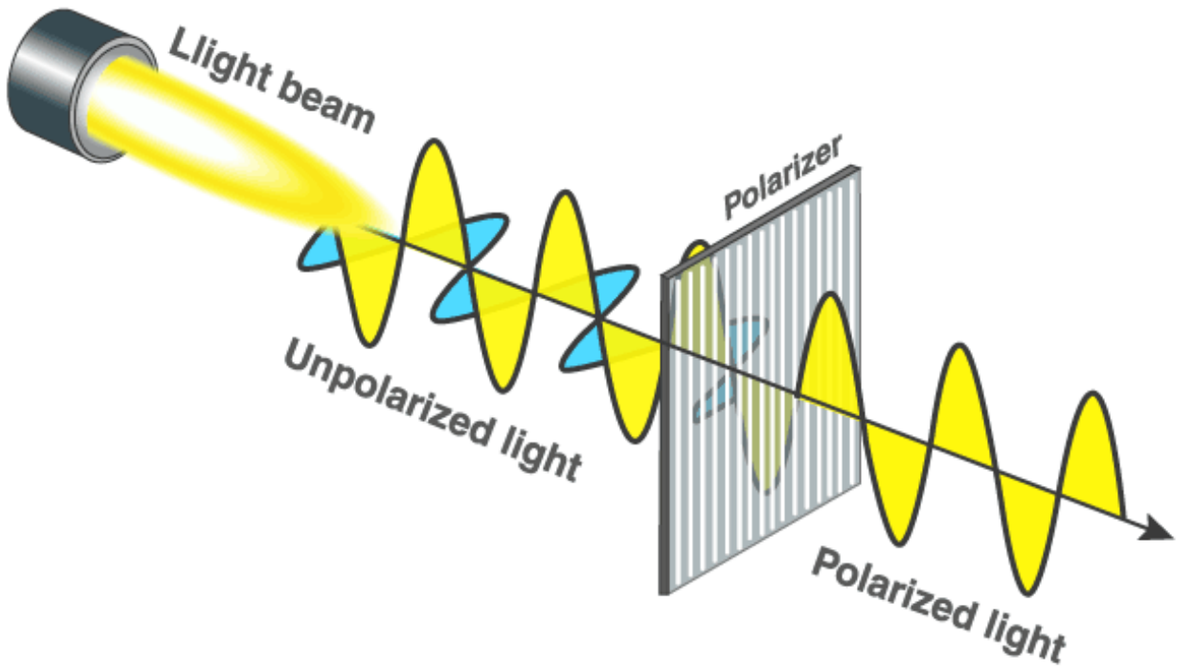
Circular polarised Light: The the electric field of the light consists of two linear compone



Elliptical polarised Light: The electric field of the light consists of two linear components

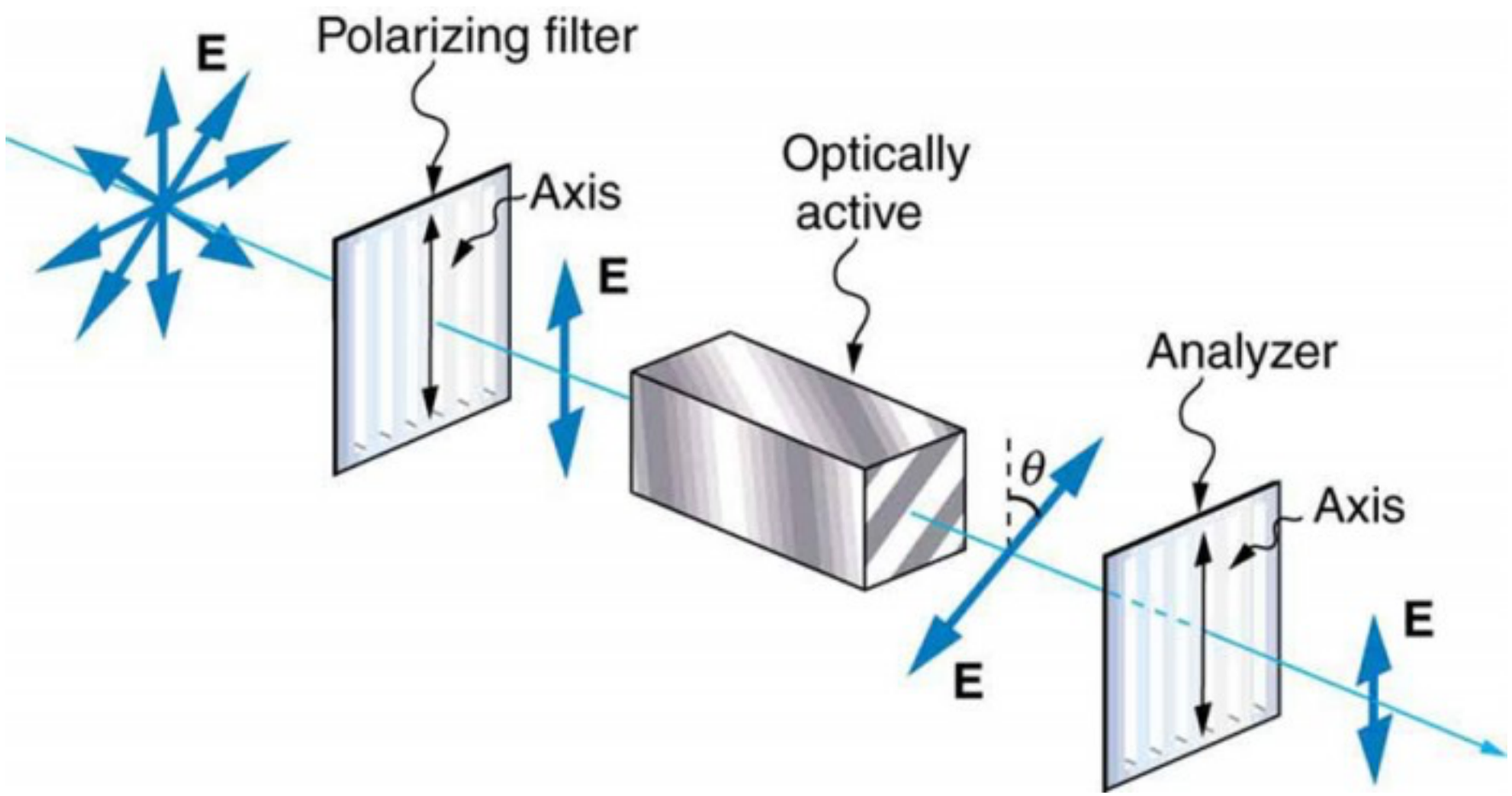
Polarizer and Analyzer

A **polarizer** or polariser is an optical filter that lets light waves of a specific polarizati



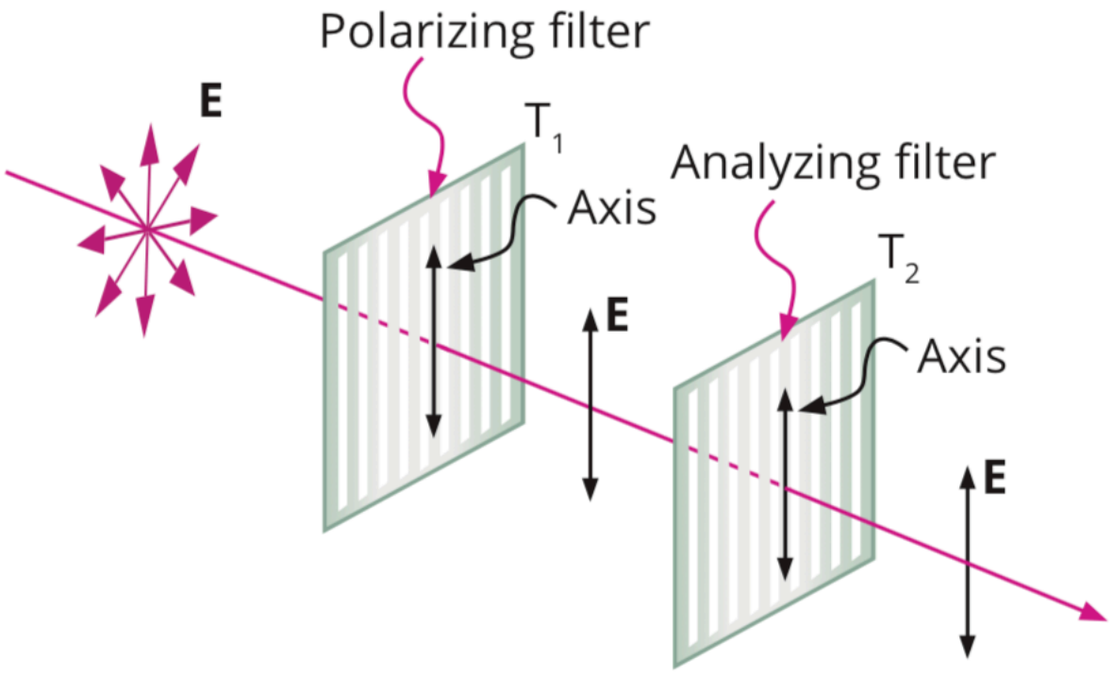
Polarizer and Analyzer

A analyser is the same optical instrument as polariser. The main difference between

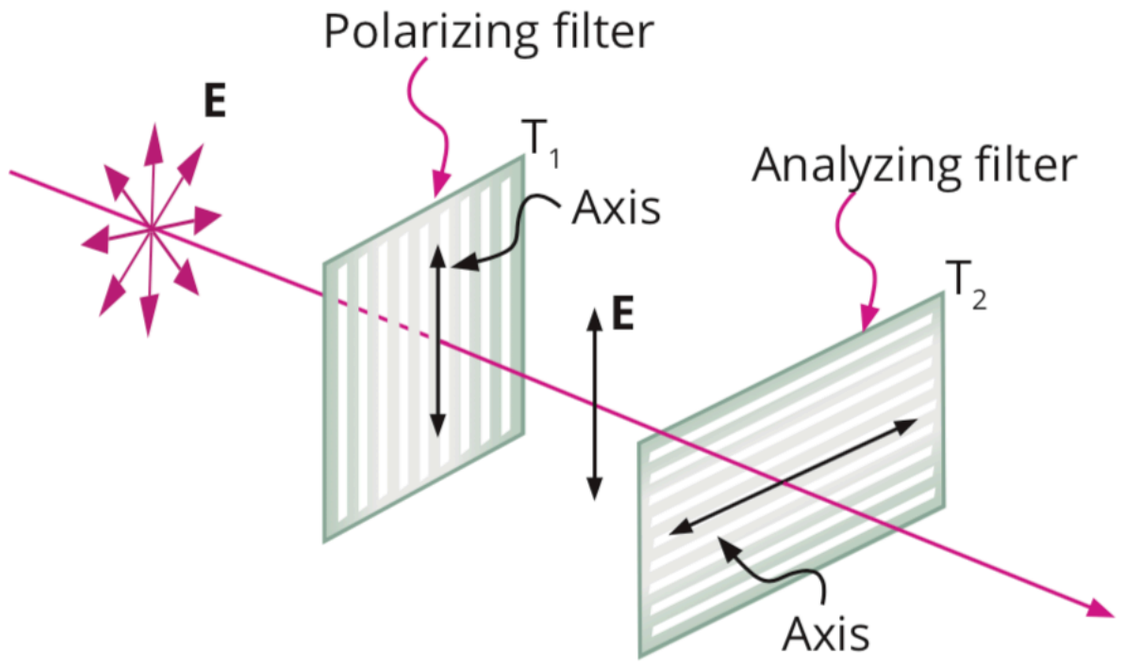


Transverse Nature of Light

- This is an optical experiment used to demonstrate transverse characteristics of light waves.
- In this experiment, ordinary light incident normally on a crystal plate (T_1) i.e. on a thin plate of tourmaline of calcite crystal, cut with faces parallel to its vertical axis.



Output light with Intensity I ≠ 0



Output light with Intensity I = 0

Thank You