Chapter 1: Properties of LIGHT

SARAH LAMBART

Content chapter 1 (1 Lecture?)

- **Properties of light**

- **Interaction of light with matter:**
  - **Refraction**
  - **Reflection**
  - **Dispersion**
  - **Absorption**
  - **Polarization**

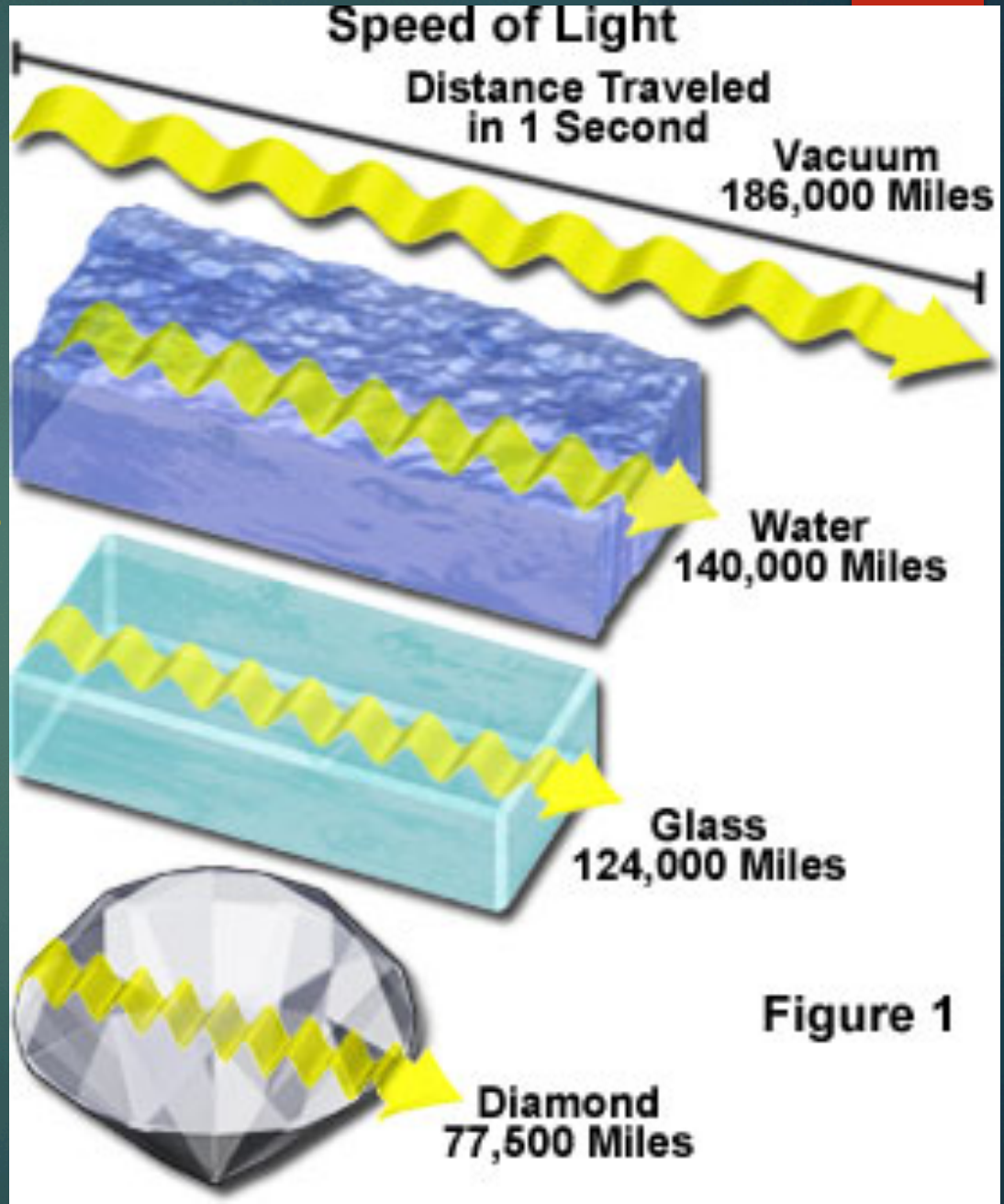
LIGHT

- Particles or quantas – photons
- Electromagnetic wave
- Particles-wave duality

LIGHT

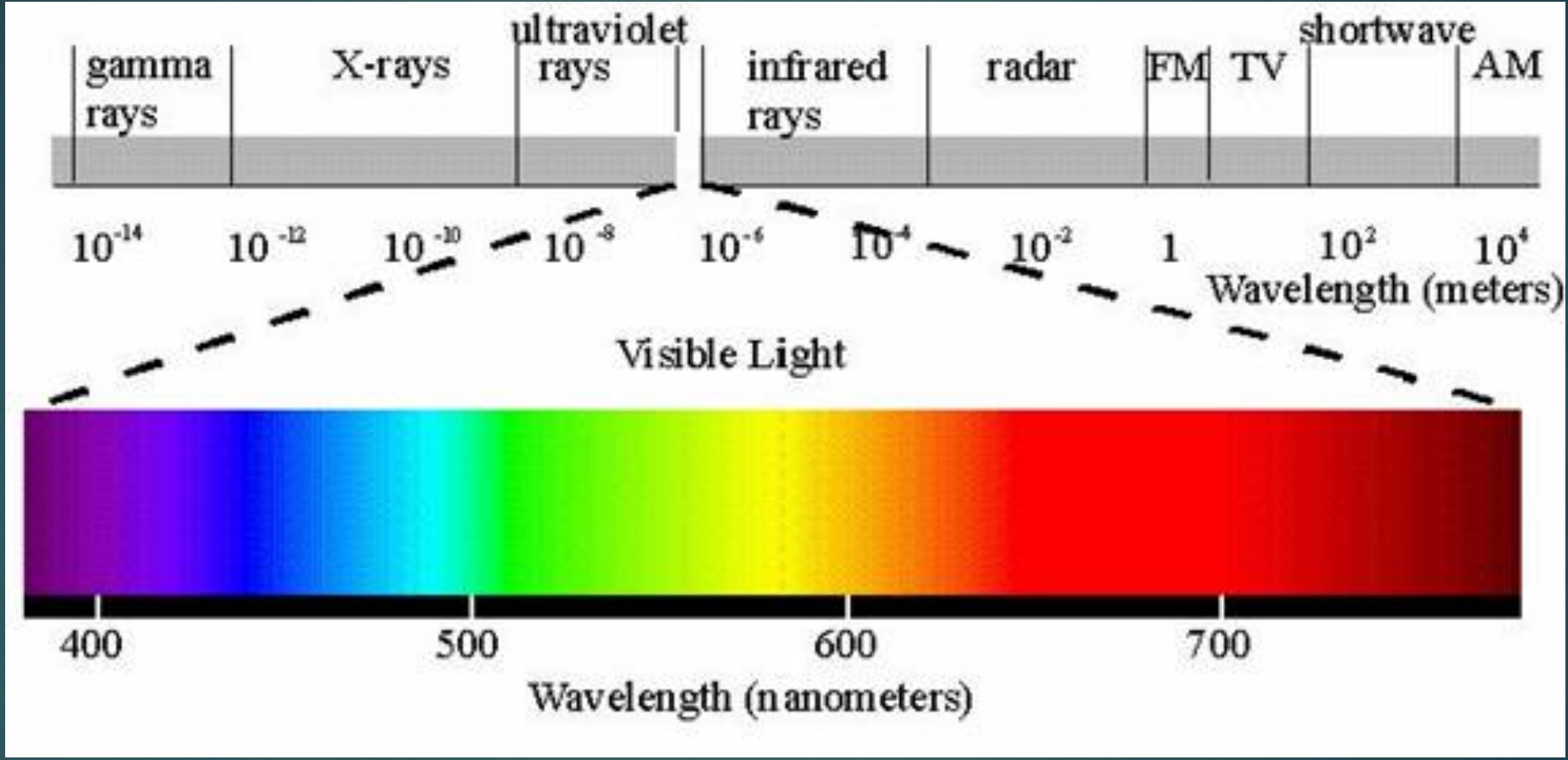
- **Propagating wave front that travel fast**

Velocity of light into vacuum:
c (for celerity) = 2.988 * 10^8 m/s



LIGHT

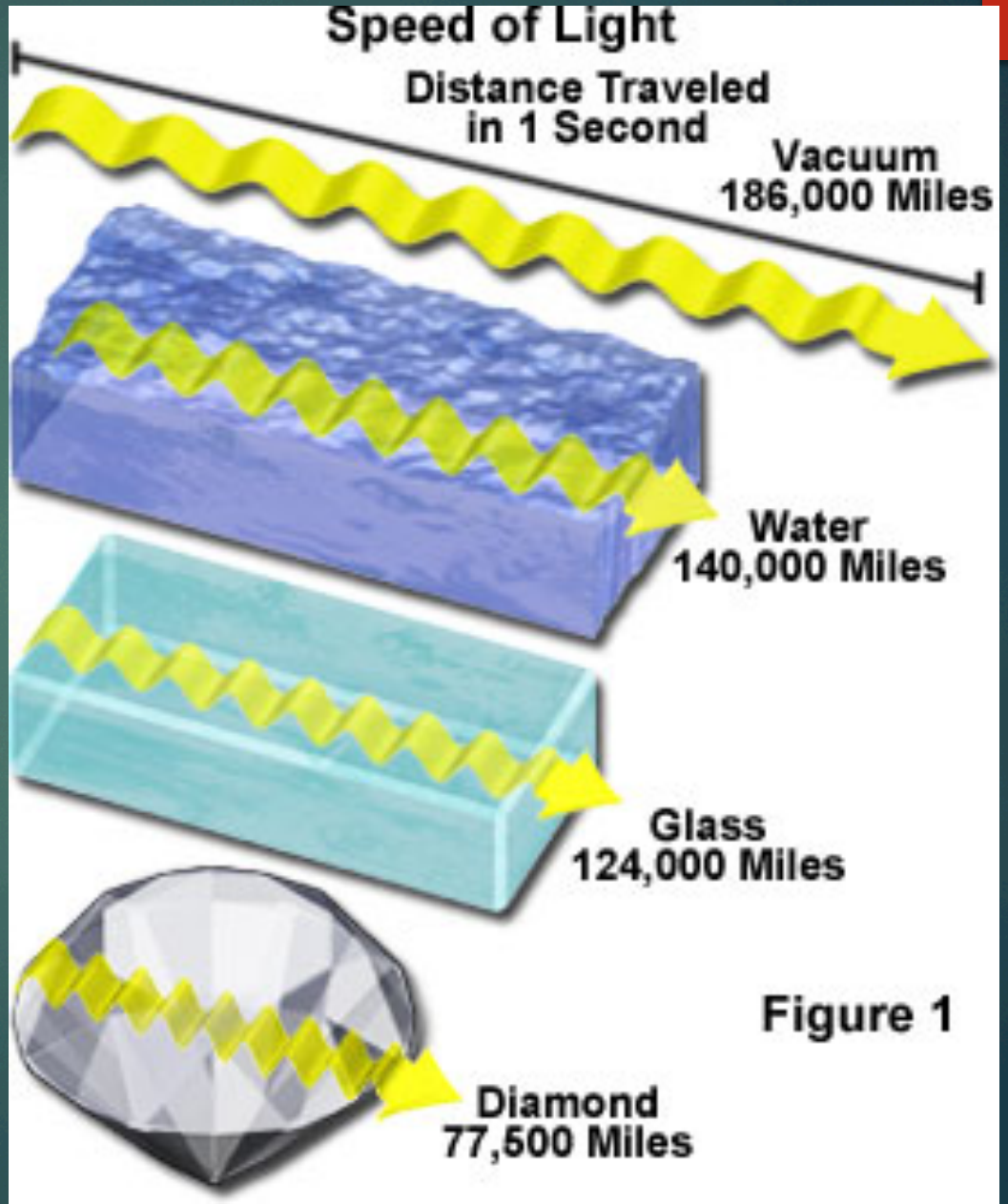
= electromagnetic radiation



Visible: 380-730 nm

INTERACTION OF LIGHT WITH MATTER

- **Index of refraction: n=c/v**



n = 1

n = 1.33

n = 1.5

n = 2.4

INTERACTION OF LIGHT WITH MATTER

- **Index of refraction: n=c/v**

Material	n
Air	1.000027
Water (20°C)	1.333
Glass	1.5
Minerals	1.4-3.22

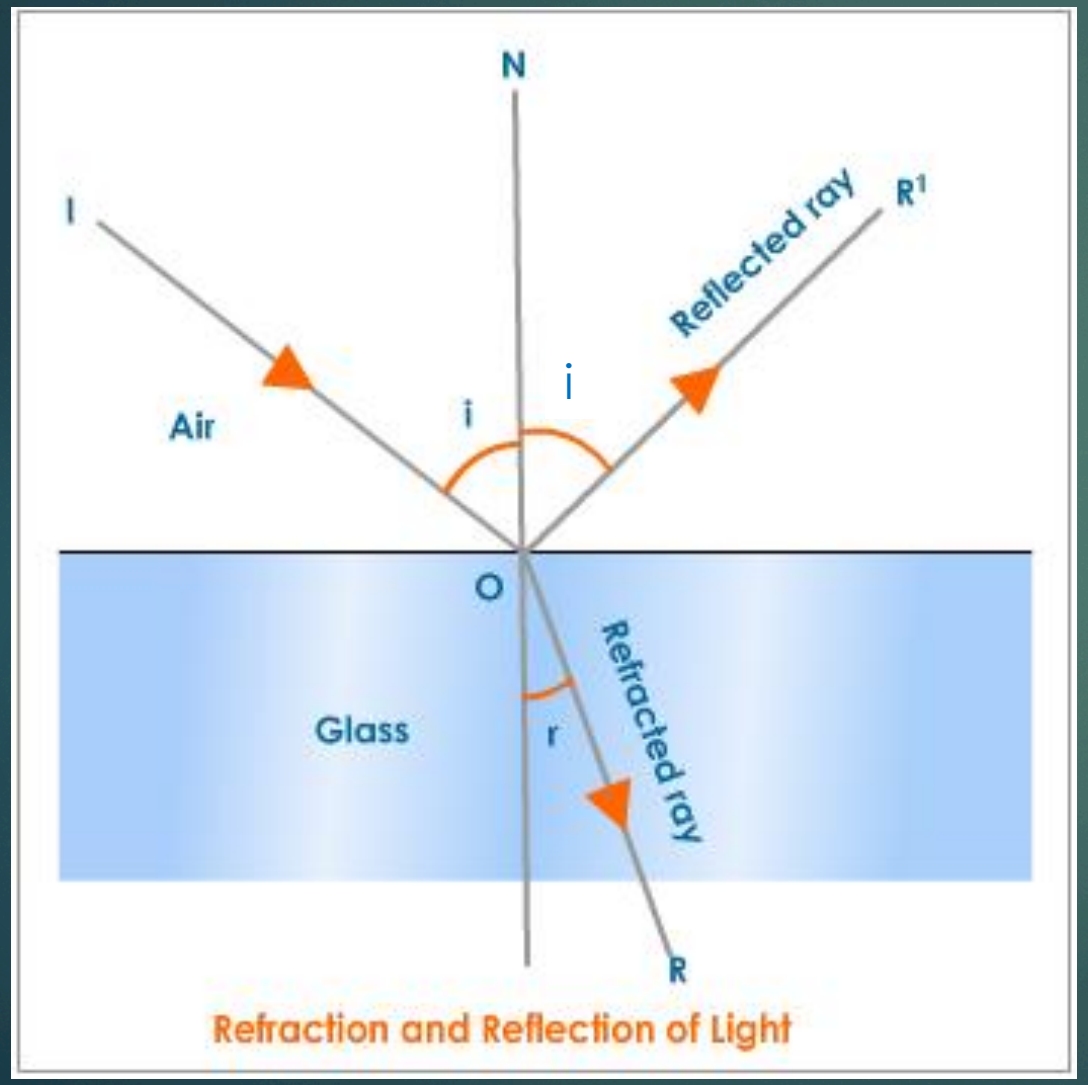
Mineral	n
Fluorite	~1.435
Leucite	~1.510
Quartz	~1.545
Apatite	~1.635 (n_0)
Augite	~1.71 (n_β)
Zircon	~1.95 (n_0)
Rutile	~2.6 (n_0)

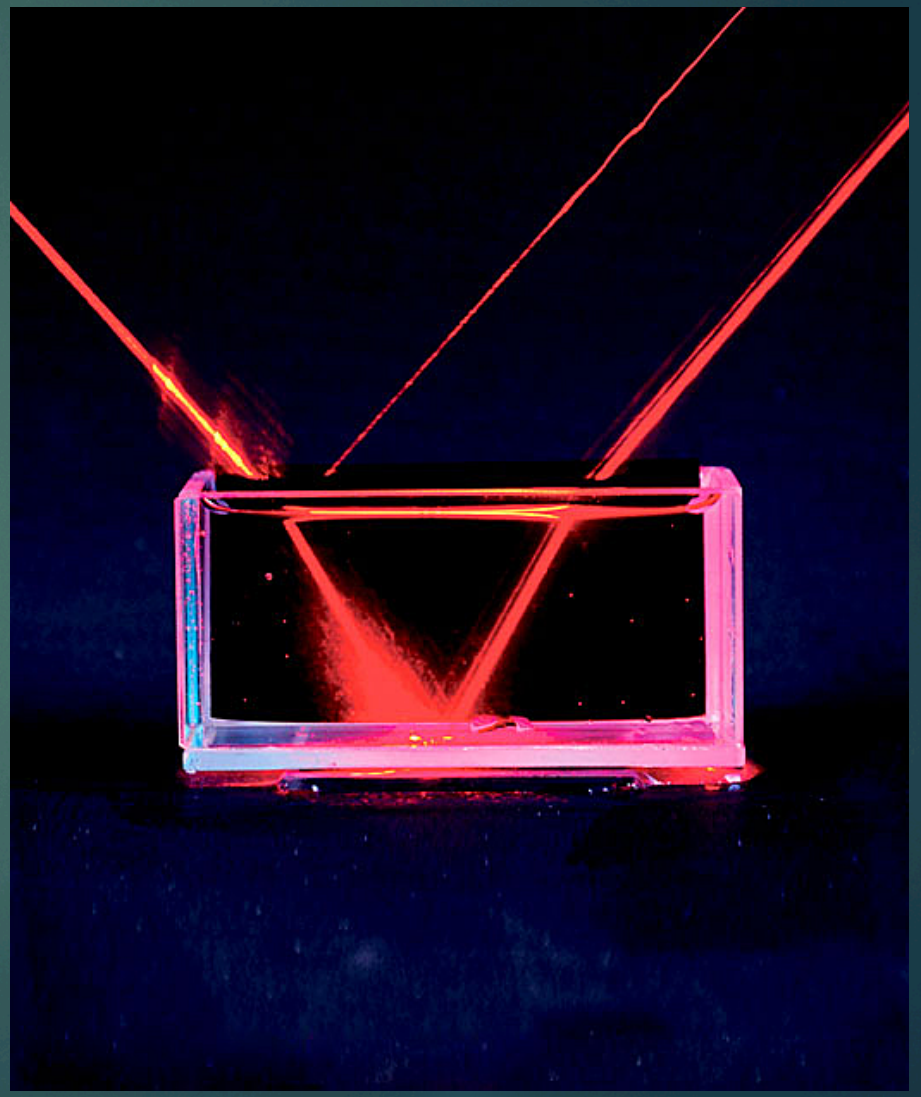
INTERACTION OF LIGHT WITH MATTER

- **Isotropic mineral:** velocity of light is the same in all the directions. n = constant – mineral in the isometric (= cubic) system. (Ex. Diamond)
- **Anisotropic minerals:** velocity of light is **not** the same in all the directions:
  - **Uniaxial:** tetragonal and hexagonal crystal systems: 2 extreme (or end-member) values of refractive indices (Ex. Quartz, Calcite)
  - **Biaxial**: triclinic, monoclinic, orthorhombic systems: 3 refractive indices. (Ex. Feldspars, pyroxenes, amphiboles)

INTERACTION OF LIGHT WITH MATTER

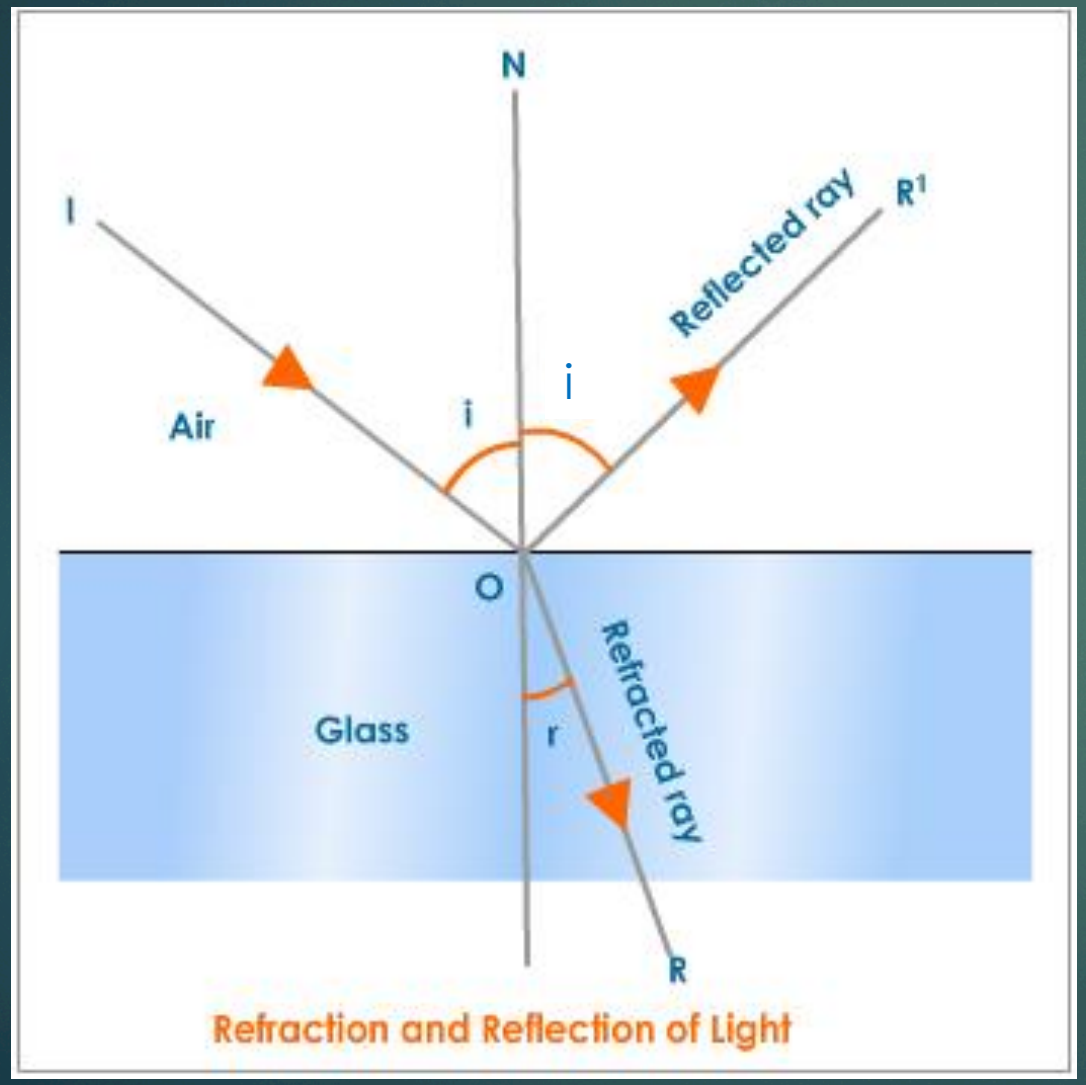
- **Refraction & Reflection**





INTERACTION OF LIGHT WITH MATTER

- **Refraction and Snell's law**



- $n_i \sin(i) = n_r \sin(r)$
  - If i =0°, r = 0°
  - If r=90°, $\sin(i_c) = n_r/n_i$

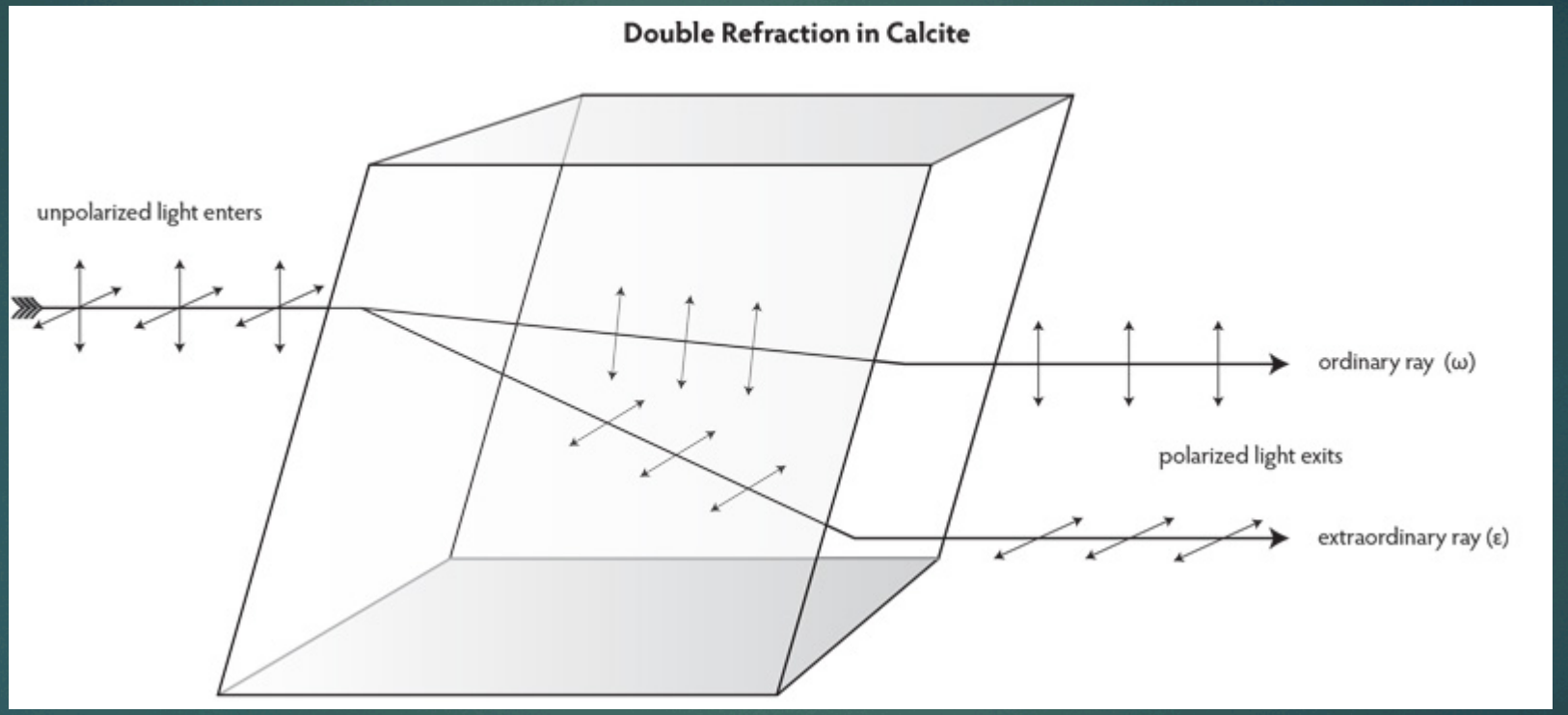
INTERACTION OF LIGHT WITH MATTER

- **Birefringence (or double refraction)**

- **Birefringence**, or **double refraction**, is the decomposition of a ray of light into two rays when it passes through anisotropic materials

INTERACTION OF LIGHT WITH MATTER

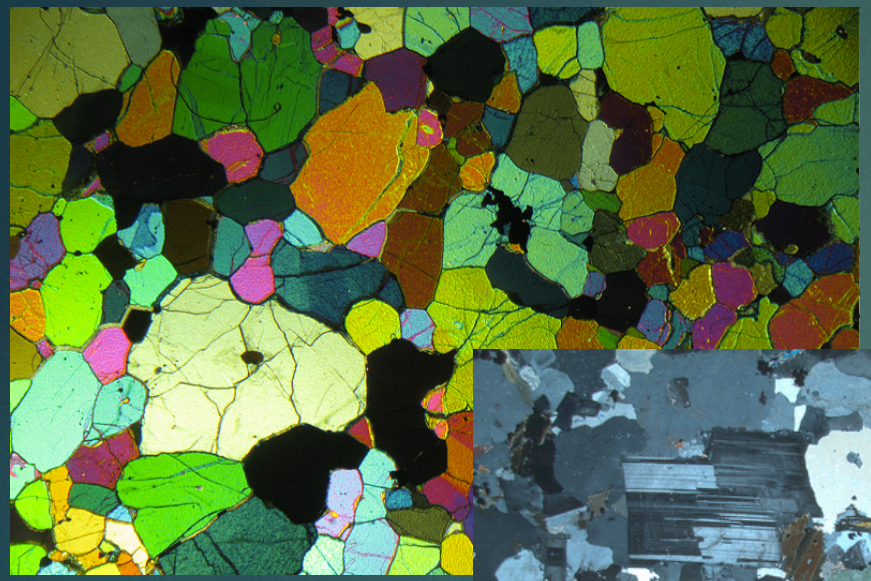
- **Birefringence (or double refraction)**

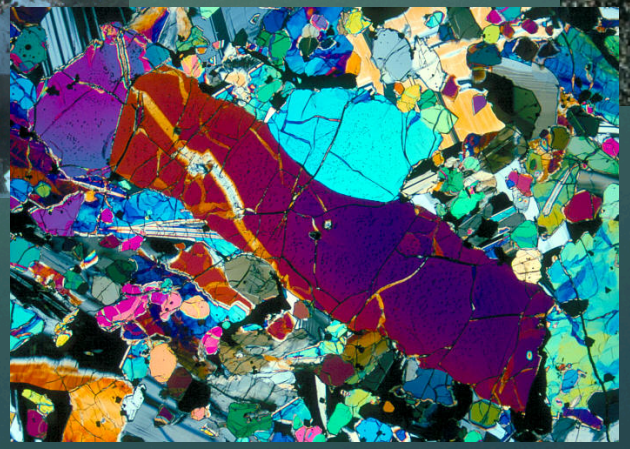


ALL anisotropic minerals

INTERACTION OF LIGHT WITH MATTER

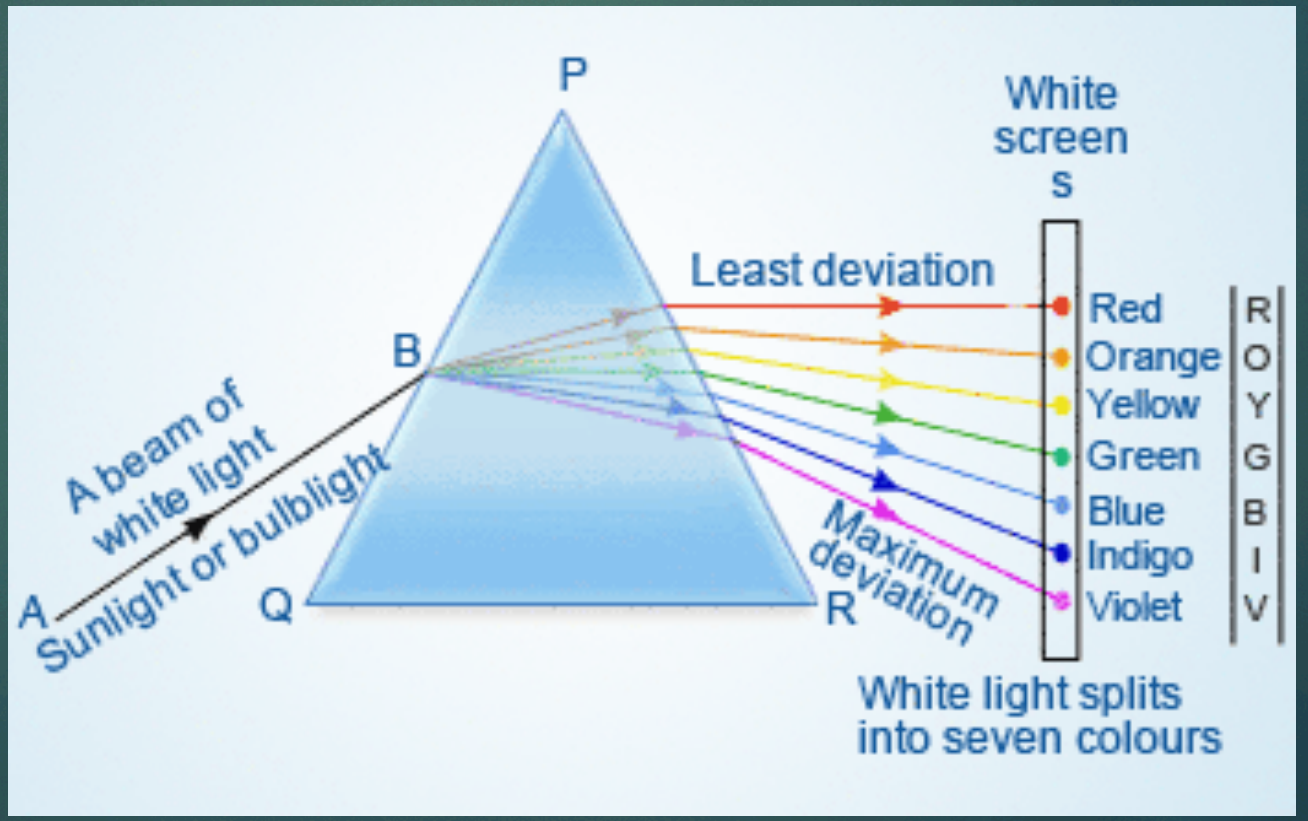
- **Birefringence (or double refraction)**





INTERACTION OF LIGHT WITH MATTER

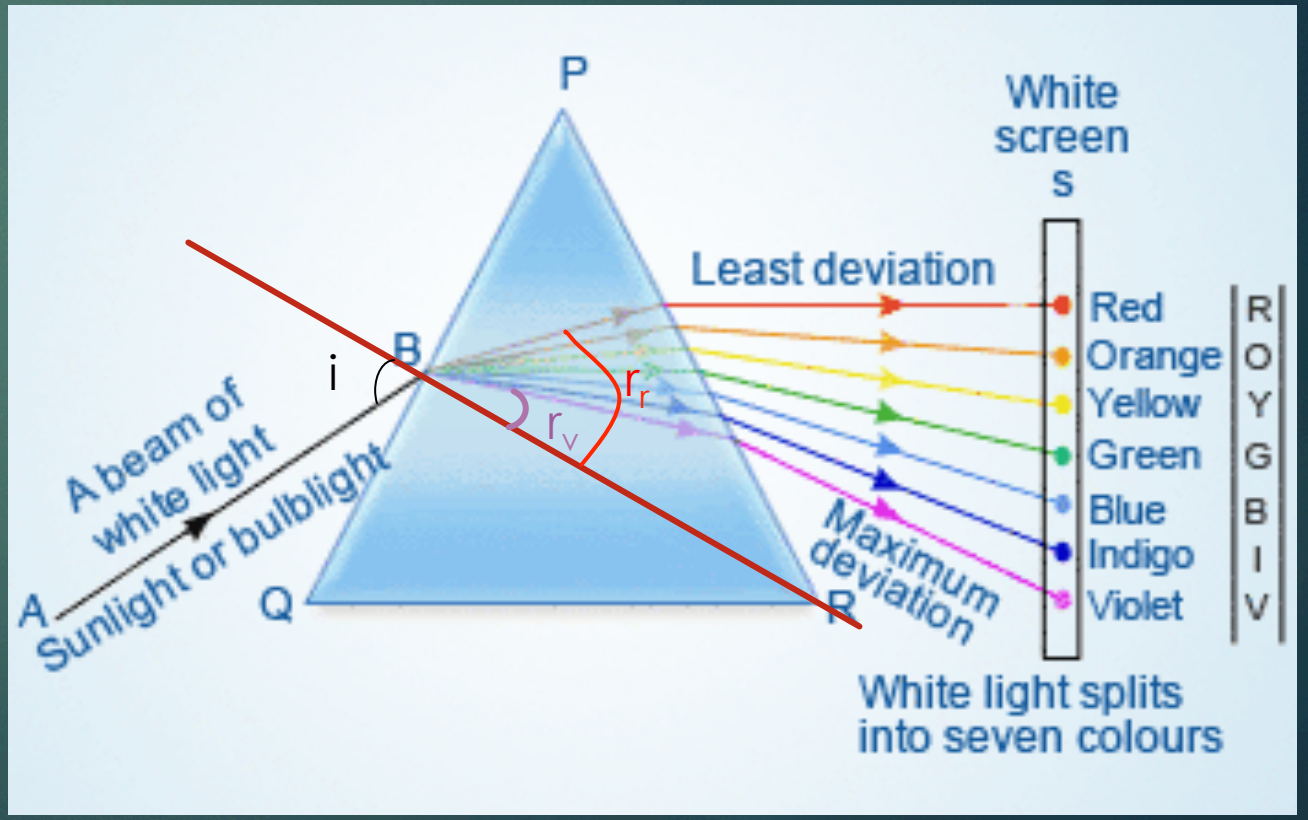
- **Dispersion** is the prism effect that occurs when the white light is split into its component colors (i.e., different wavelengths travel at different speeds).



INTERACTION OF LIGHT WITH MATTER

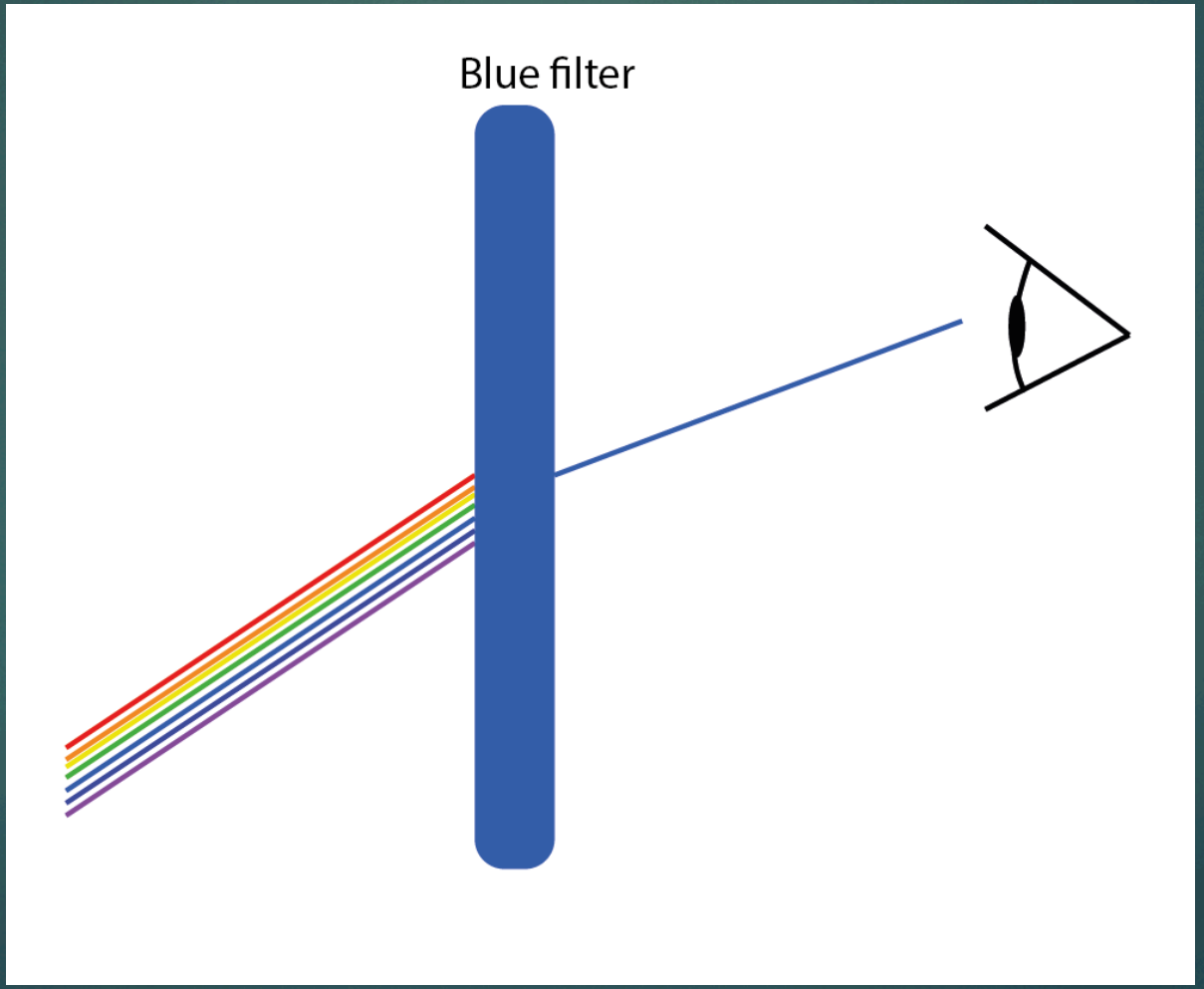
- **Dispersion** is the prism effect that occurs when the white light is split into its component colors (i.e., different wavelengths travel at different speeds).

- This is a problem when we try to measure *n* ⇒ use of **monochromatic light** (1λ)



INTERACTION OF LIGHT WITH MATTER

- **Absorption:** lost of light intensity



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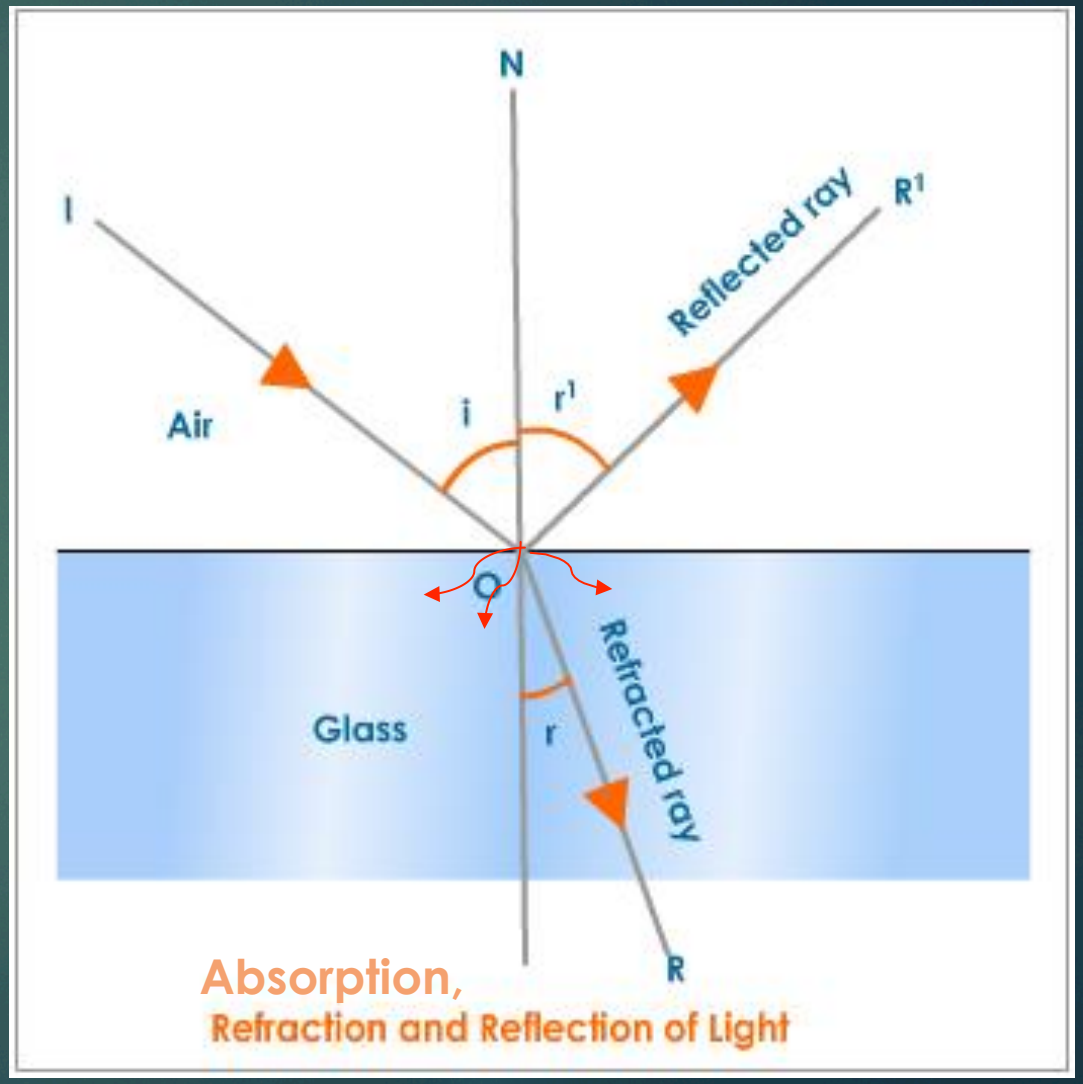

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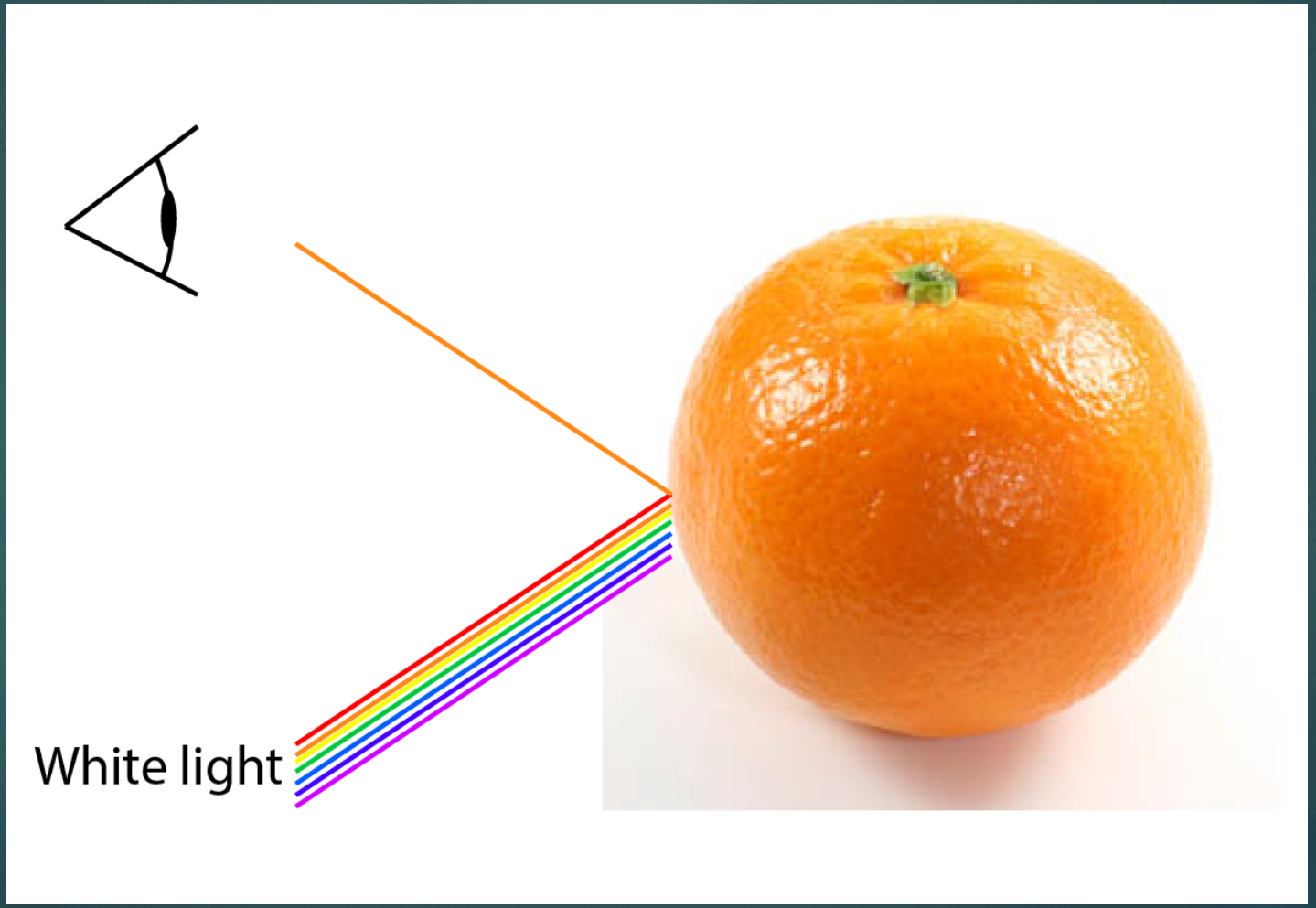

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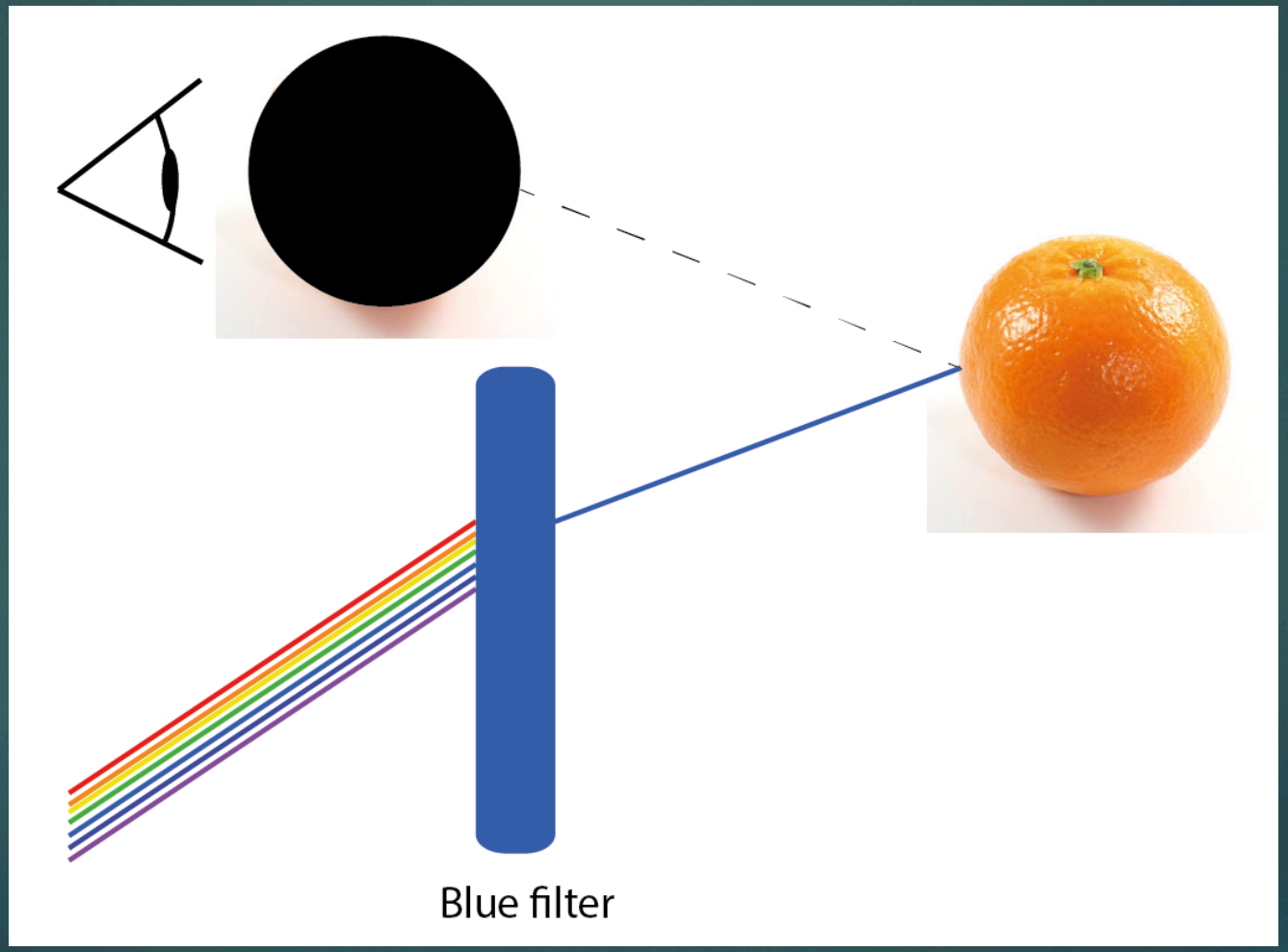
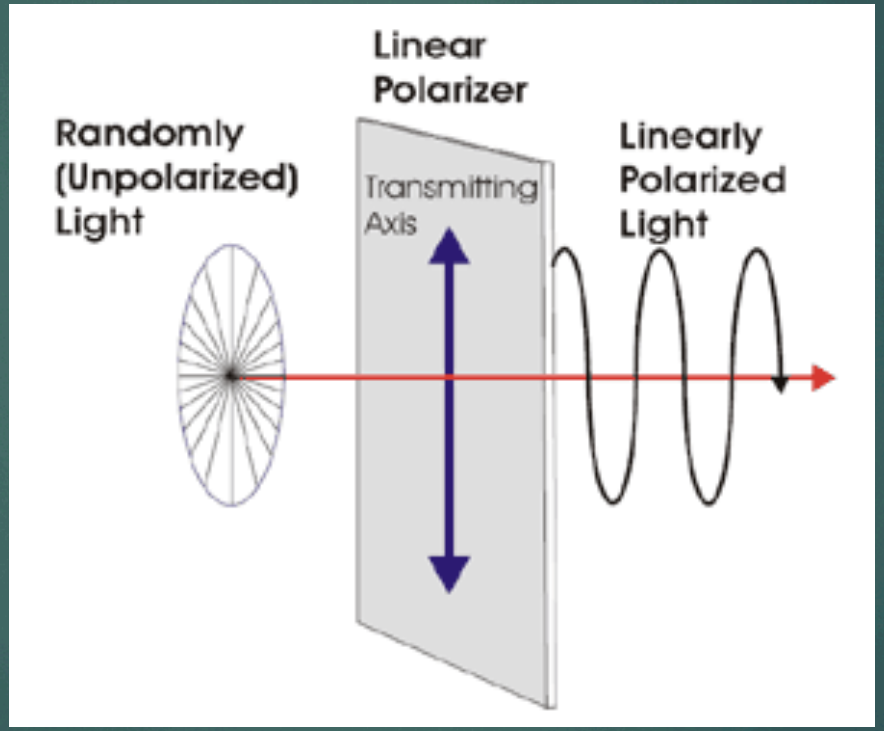


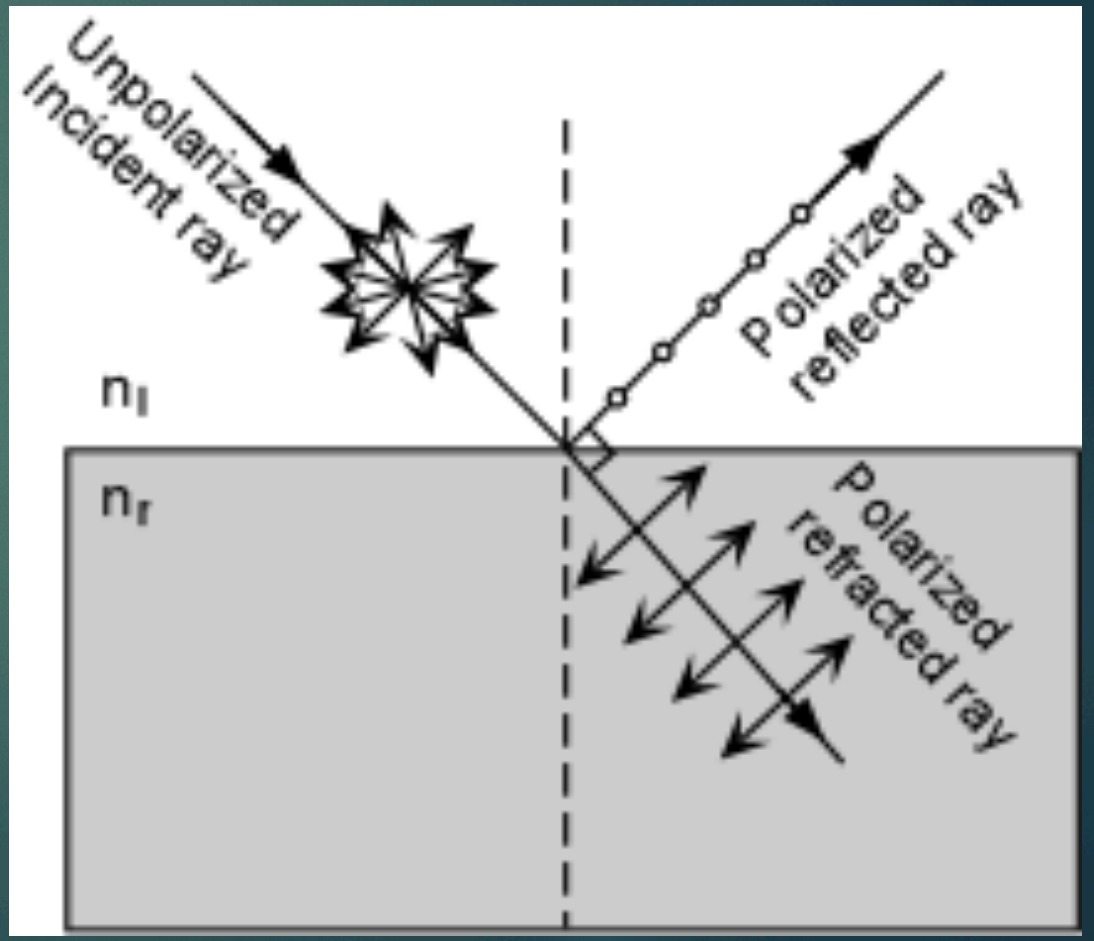
INTERACTION OF LIGHT WITH MATTER

- **Polarization**



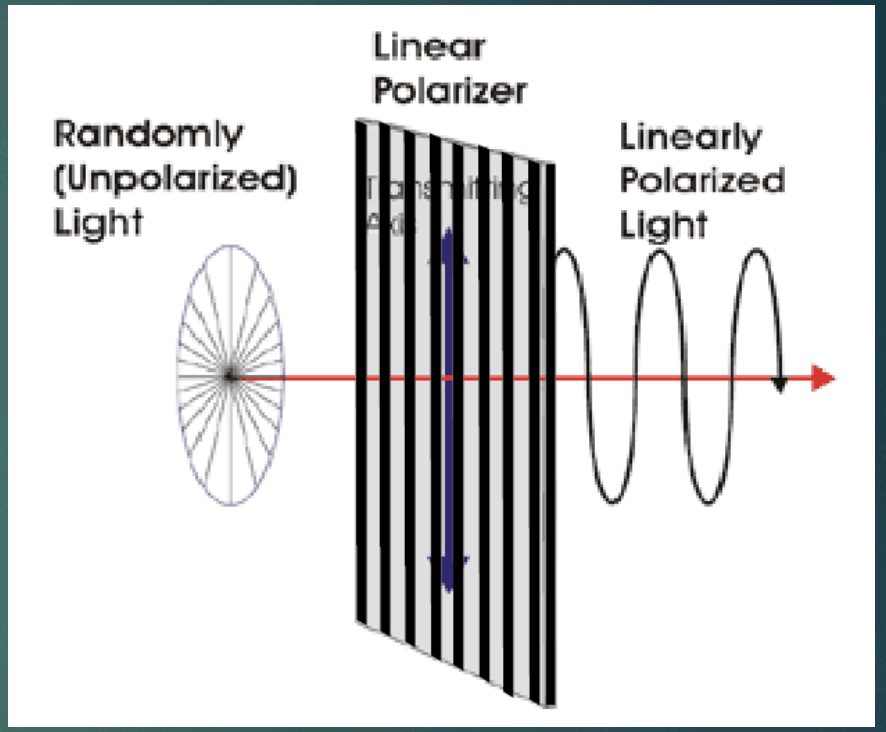
INTERACTION OF LIGHT WITH MATTER

- **Polarization**
  - Due to refraction of reflection
    - The reflected beam: polarized with vibration directions parallel to the reflecting surface (perpendicular to the screen)
    - The reflected beam: only if you have a 90° angle between the refracted & the reflected ray: vibration directions perpendicular to the path of the refracted ray AND to the direction of vibration in the reflected ray



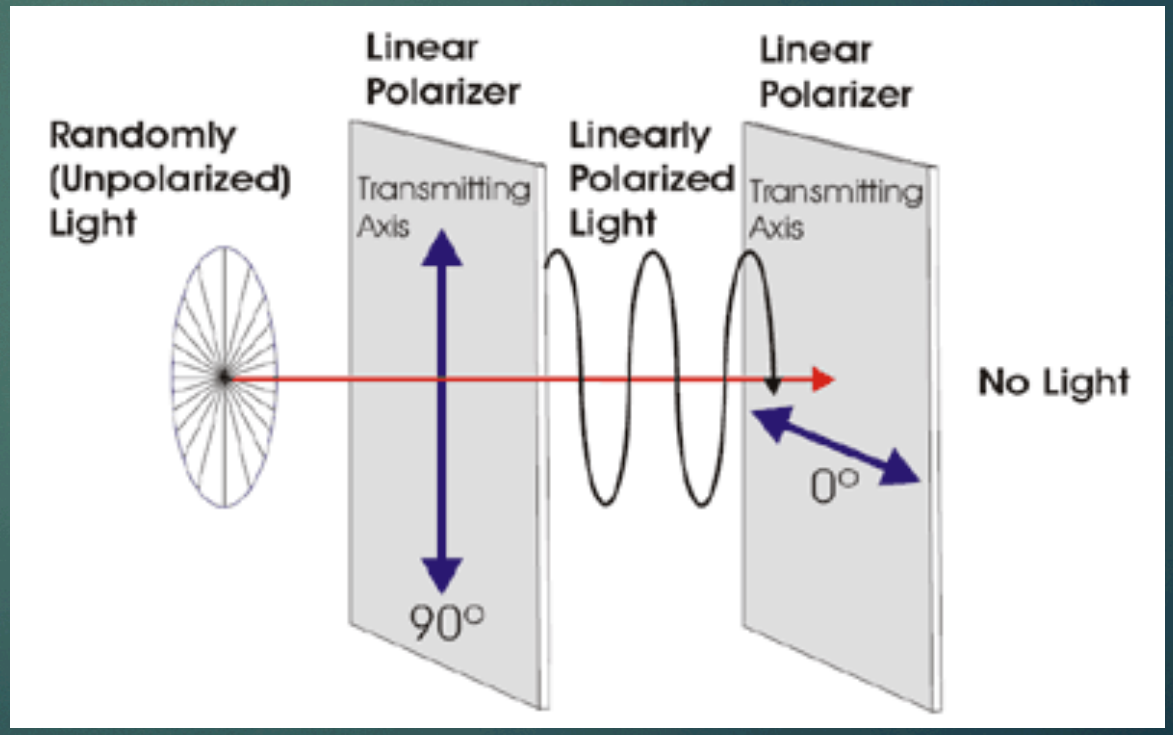
INTERACTION OF LIGHT WITH MATTER

- **Polarization**
  - **A polarizer** (or polaroid) consists of long-chain organic molecules placed close enough to form a closely spaced linear grid, that allows the passage of light vibrating only in the same direction as the grid.



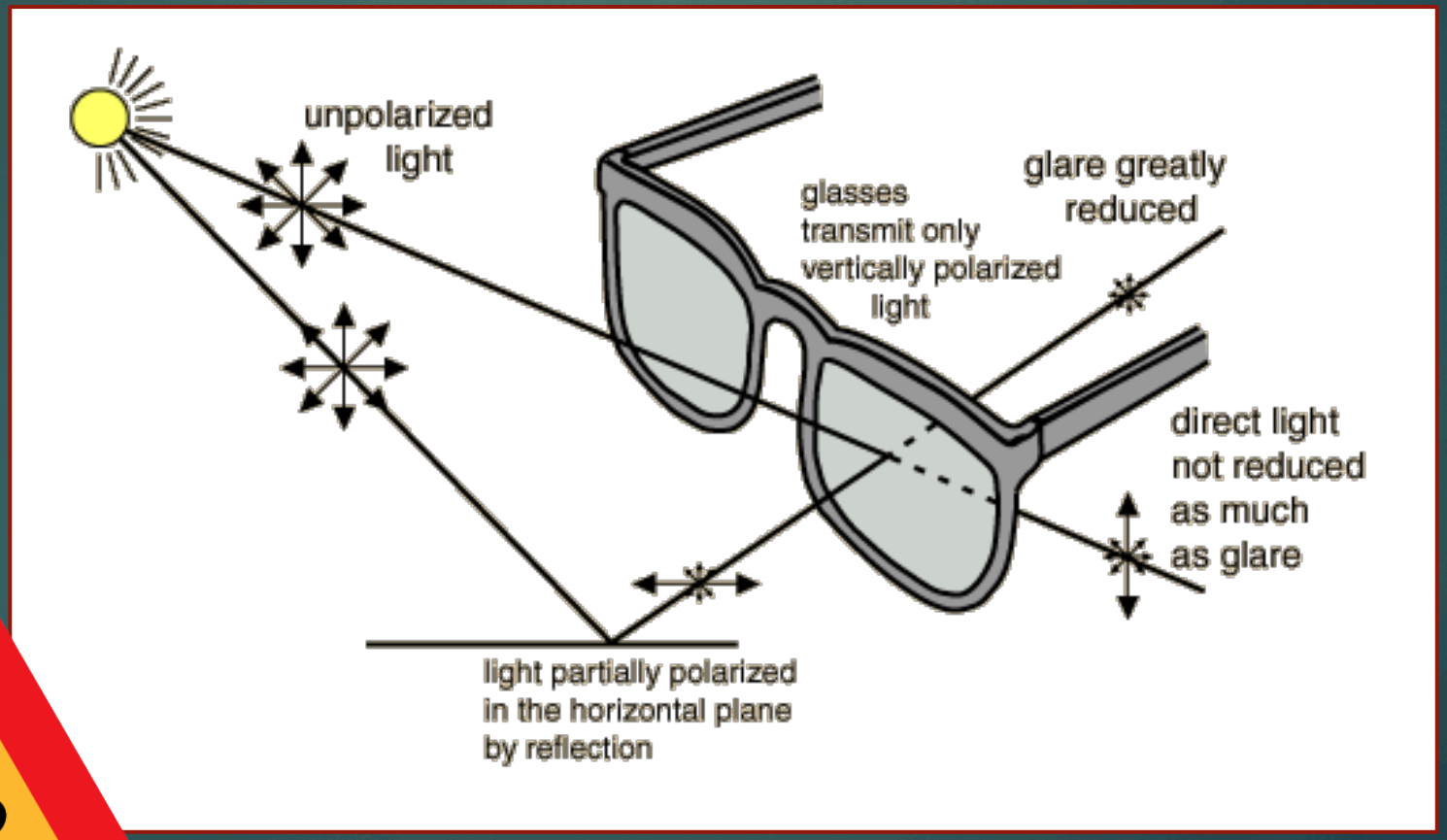
INTERACTION OF LIGHT WITH MATTER

- **Polarization**
  - Two perpendicular polarizers: the light has been **extinguished**.



INTERACTION OF LIGHT WITH MATTER

- **Polarization**
  - Case of sunglasses



For next week:

- **Reading: Chap 1-4 in Introduction to Optical Mineralogy**

Lab:

- **Introduction to the microscope: Chap.2**