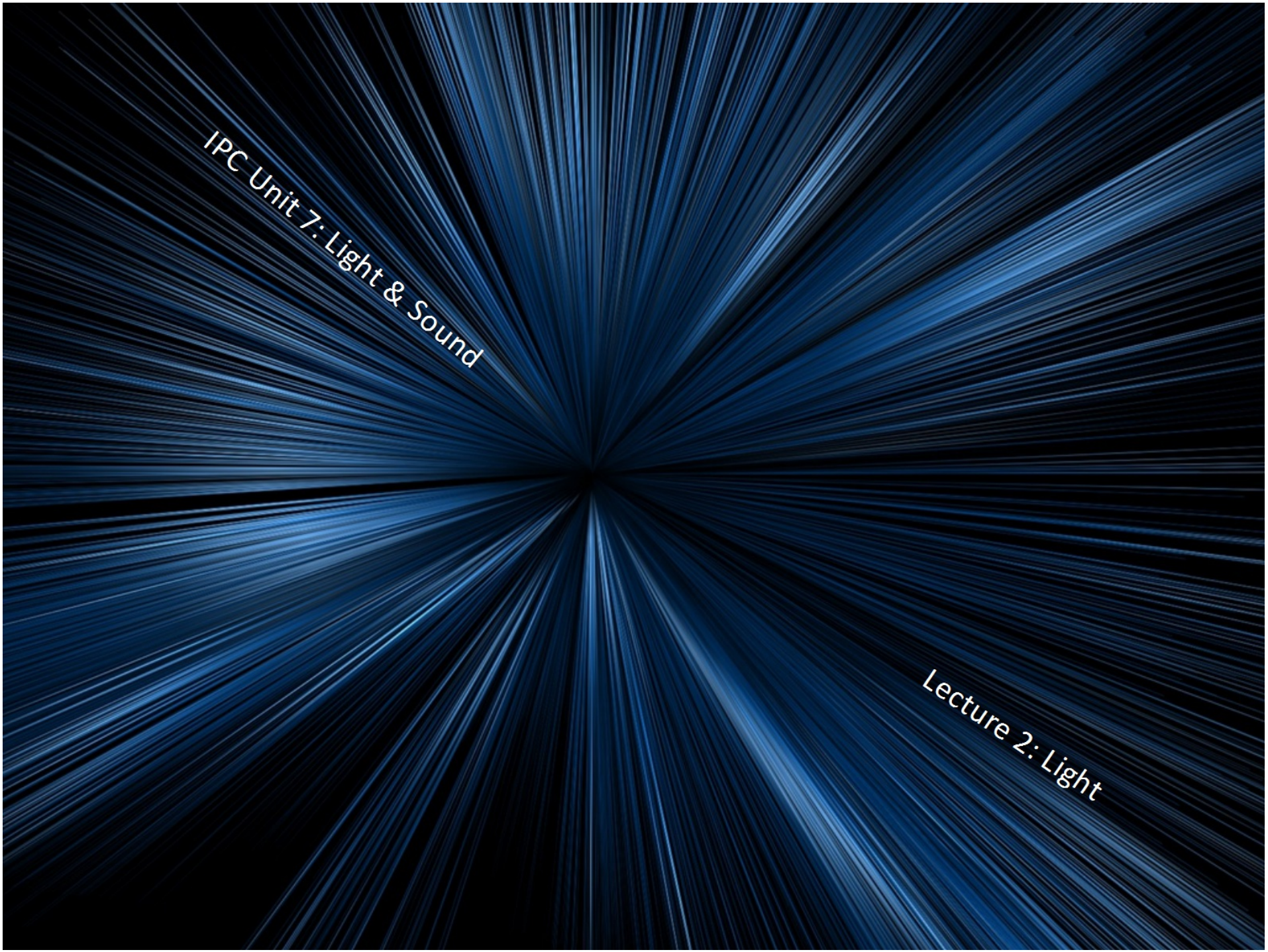
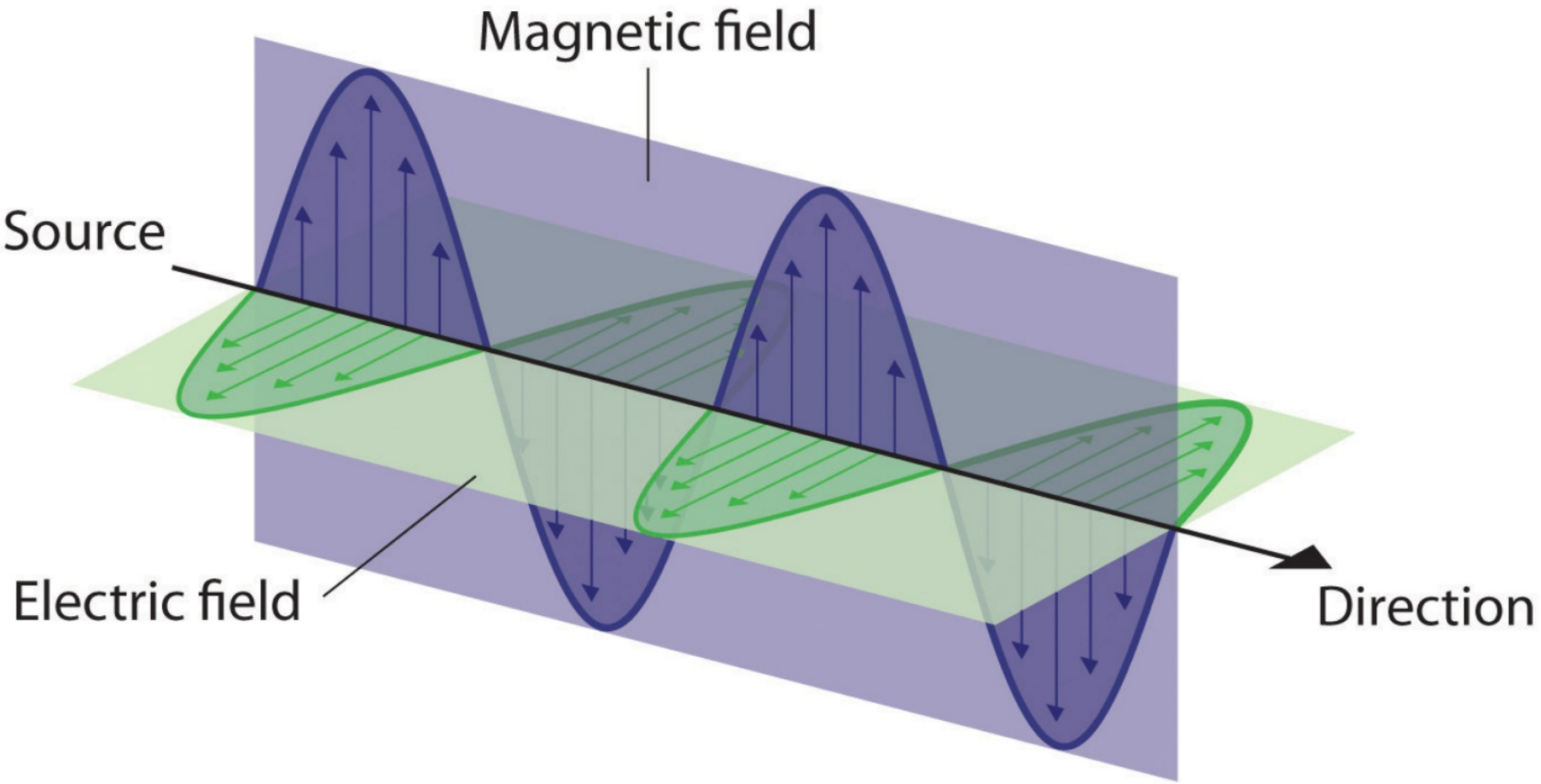

IPC Unit 7: Light & Sound
Lecture 2: Light

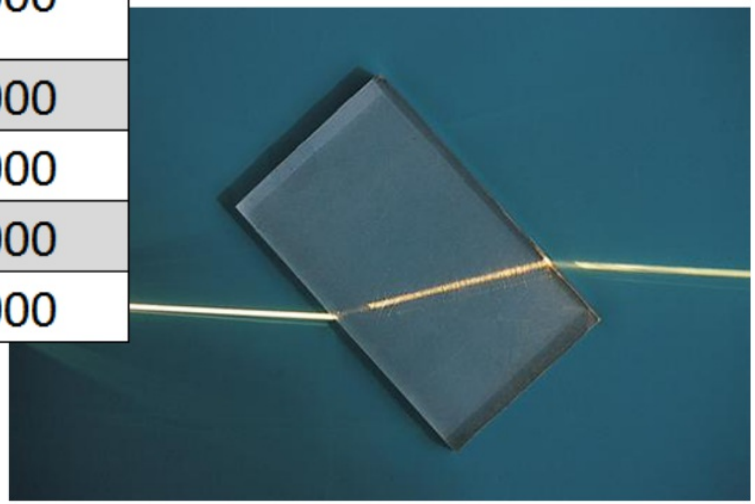
Electromagnetic Waves

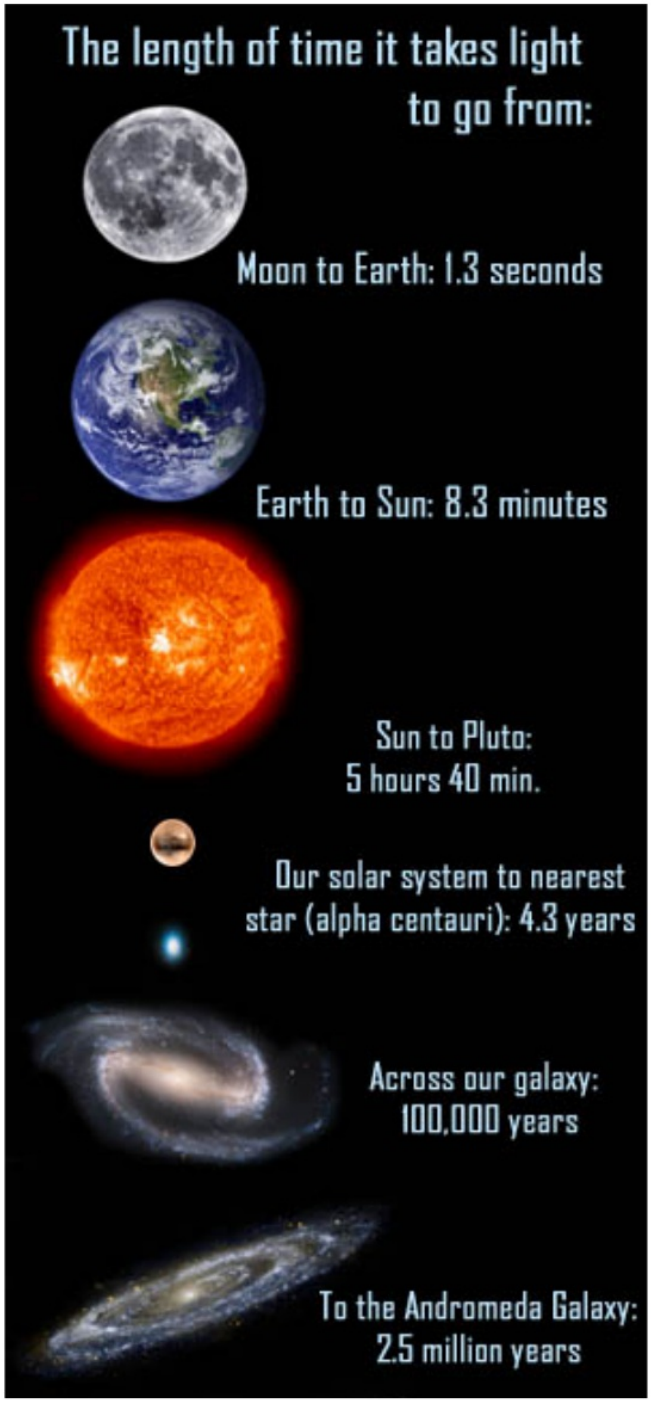


The Speed of Light

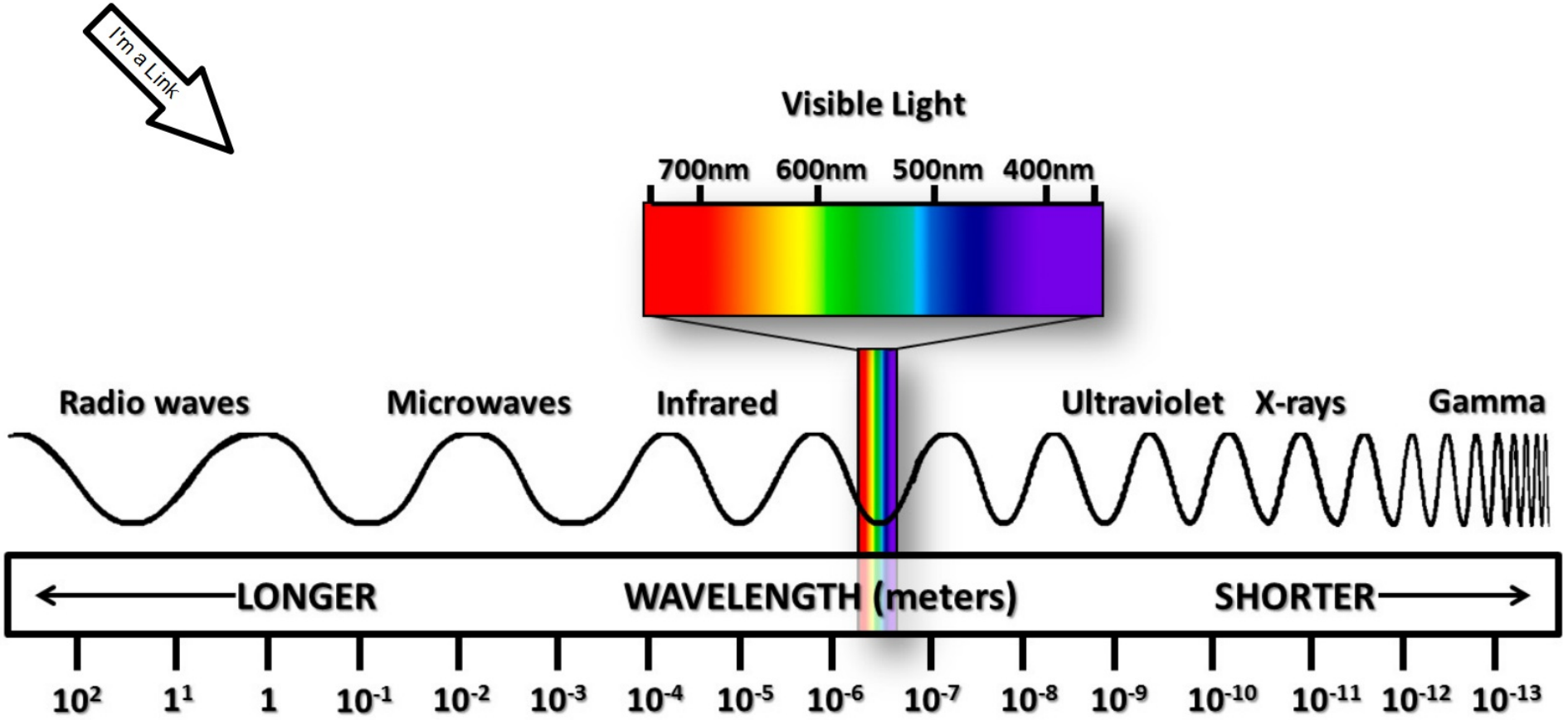
- The speed of light in a vacuum = 3.0 x 10^8 m/s (300-million m/s)
- The speed of light is dependent upon the medium it travels through

Speed of Electromagnetic Waves	
Matrial	**Speed (km/s)**
None (Vacuum)	300,000
Air	299,000
Water	226,000
Glass	200,000
Diamond	124,000





The Electromagnetic Spectrum



Radio Waves

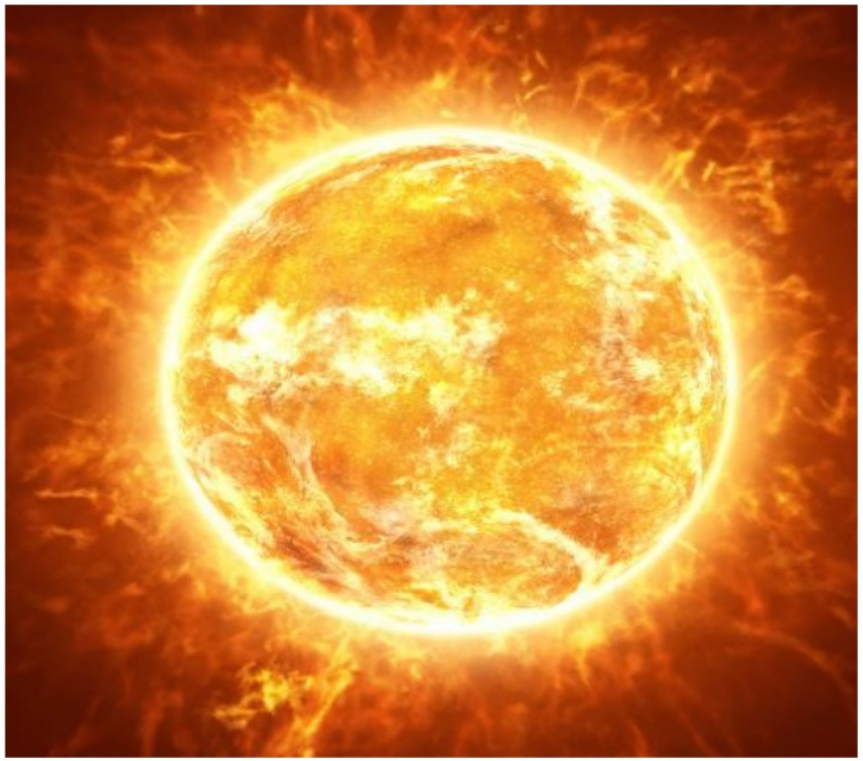
- **<u>Radio Waves</u>:** are electromagnetic waves with wavelengths longer than 10 cm.
- Radio waves have long wavelengths and low frequencies
- Examples: Audio Transmission (AM & FM), Radar, & Magnetic Resonance Imaging (MRI)

Microwaves

- **<u>Microwaves</u>:** are electromagnetic waves with wavelengths between 0.1 mm to 30 cm
- Satellite signals and cellular telephones use microwaves with wavelengths between 1 cm to 20 cm.
- Examples: cellular telephones, satellite signals, & microwave ovens

Infrared Waves

- **<u>Infrared waves</u>:** are electromagnetic waves with wavelengths between about one-thousandth of a meter and about 700-billionths of a meter
- Warmth from objects like the Sun are felt as thermal energy transmitted by infrared waves.
- Infrared detectors can form images of objects from the infrared waves they emit.



Visible Light

- **<u>Visible light</u>:** is the range of electromagnetic waves that you detect with your eyes.
- Range: 700-billionths of a meter to 400-billionths of a meter
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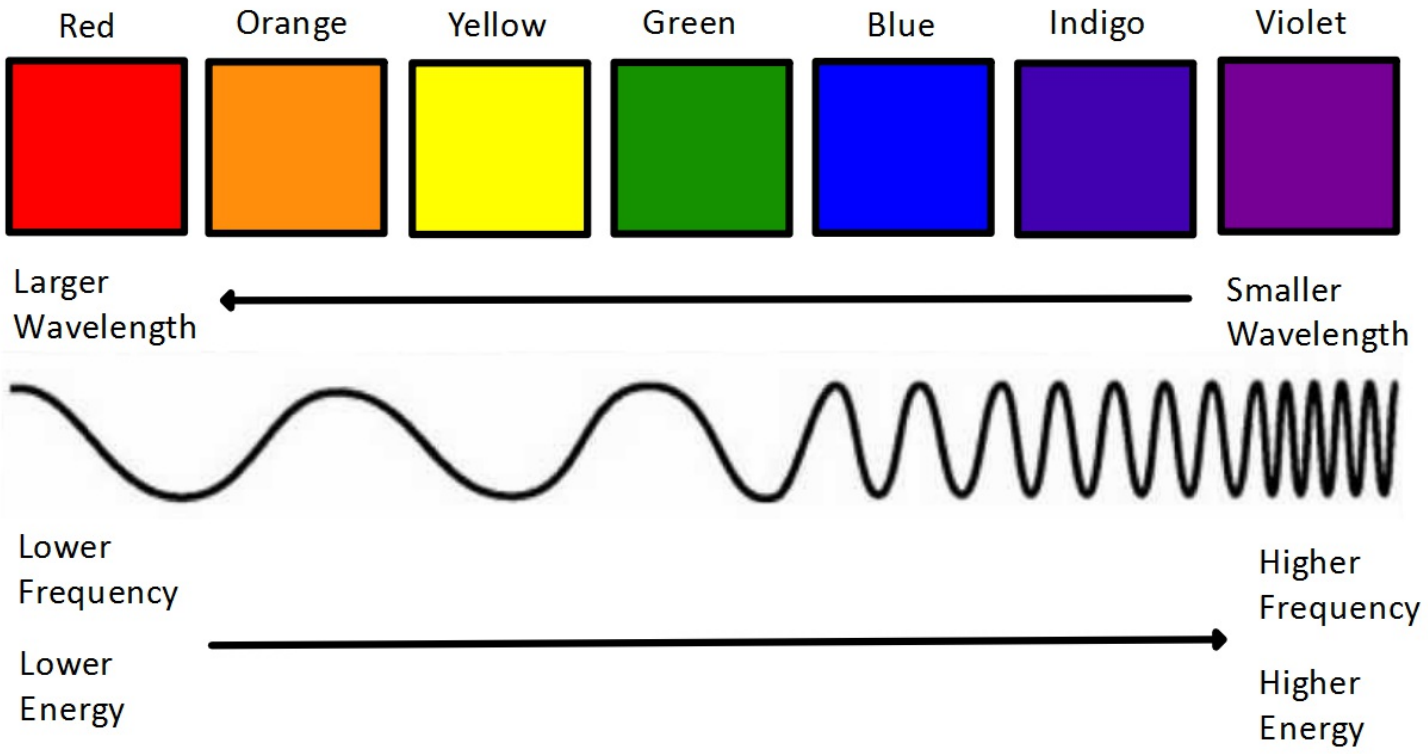
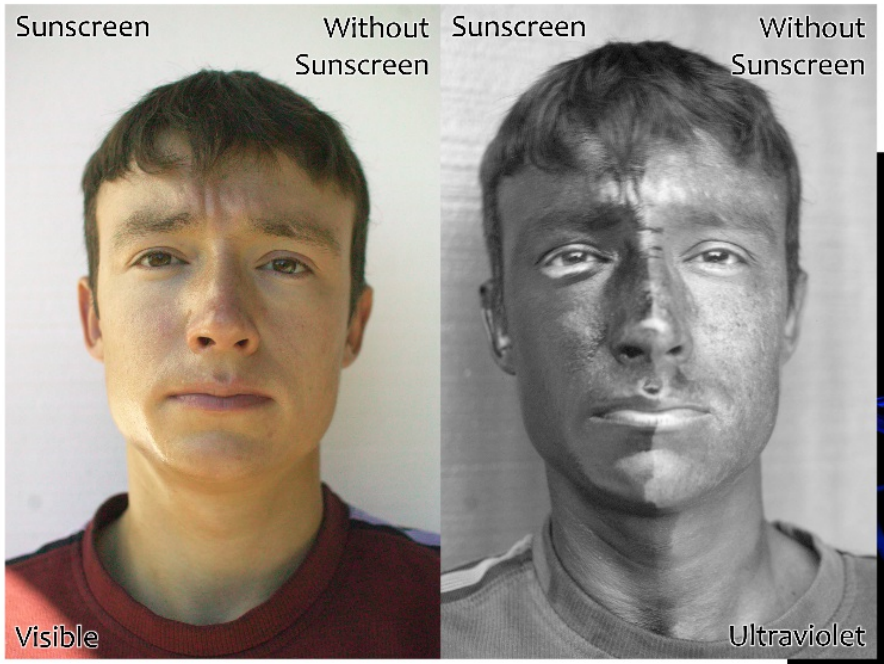


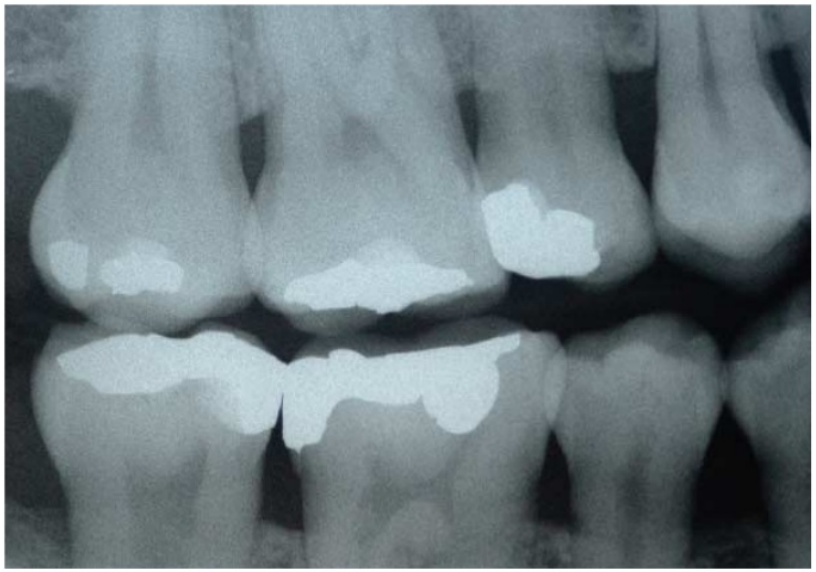
Ultraviolet Waves

- **<u>Ultraviolet waves</u>:** are electromagnetic waves with wavelengths from about 400-billionths to 10-billionths of a meter
- UV light striking your skin causes your body to produce vitamin D
- UV light can be used to kill bacteria and other single celled organisms
- UV light can cause sunburns and skin cancers



X-rays

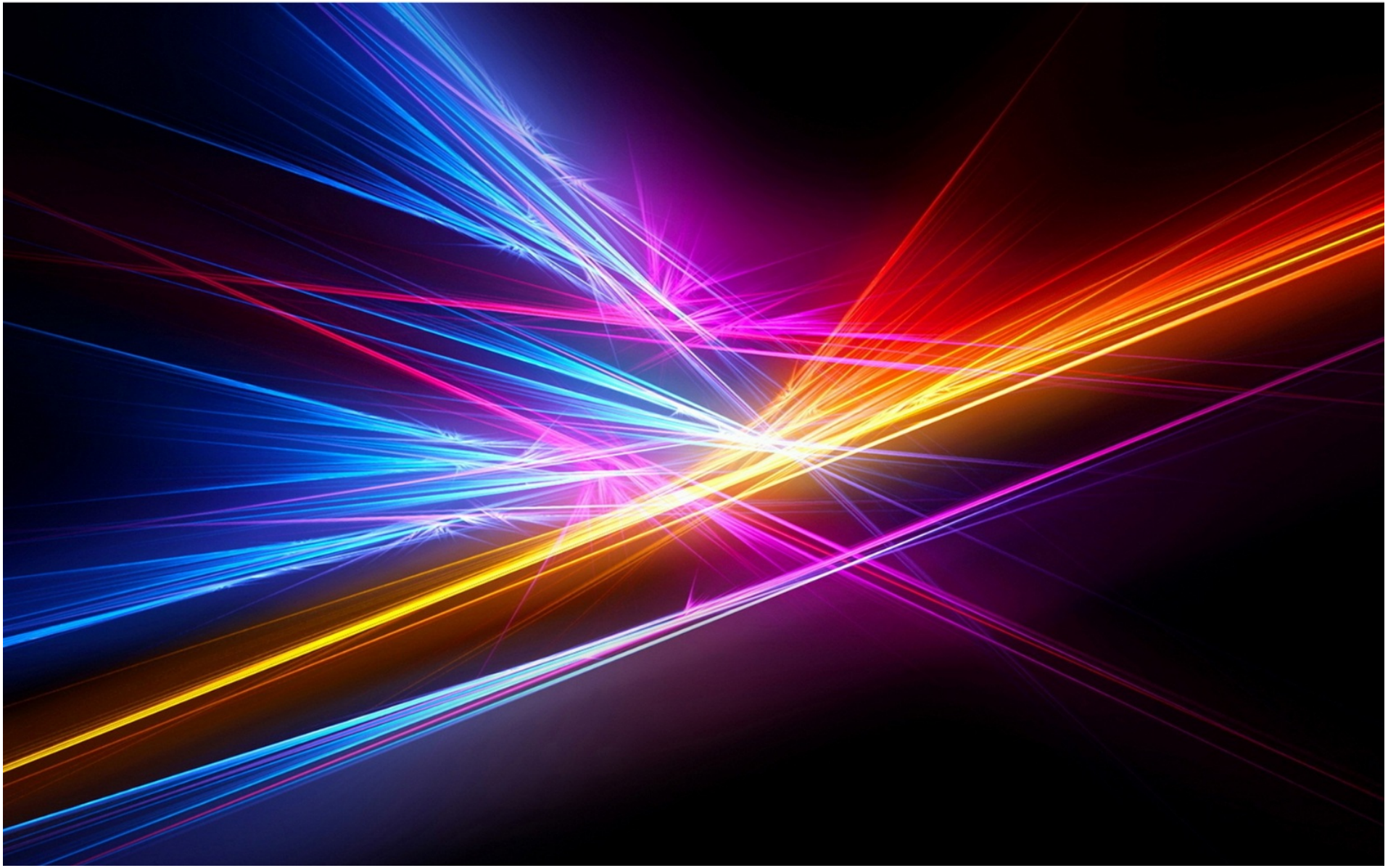
- **<u>X-rays</u>:** are electromagnetic waves with wavelengths between about ten-billionths of a meter to ten-trillionths of a meter.
- X-rays can penetrate skin and soft tissue but not denser materials, such as teeth and bones
- Doctors and dentists used X-rays to form images of bones and teeth
- X-rays are also used in airports to screen luggage



Gamma Rays

- **Gamma rays:** are electromagnetic waves with wavelengths shorter than about 100-trillionths of a meter
- Gamma rays have high frequencies and have the highest-energy photons
- Gamma rays have enough energy to penetrate several centimeters of lead
- Both gamma rays and X-rays can be used in radiation therapy to kill diseased cells in the human body (like cancer)

The Behavior of Light

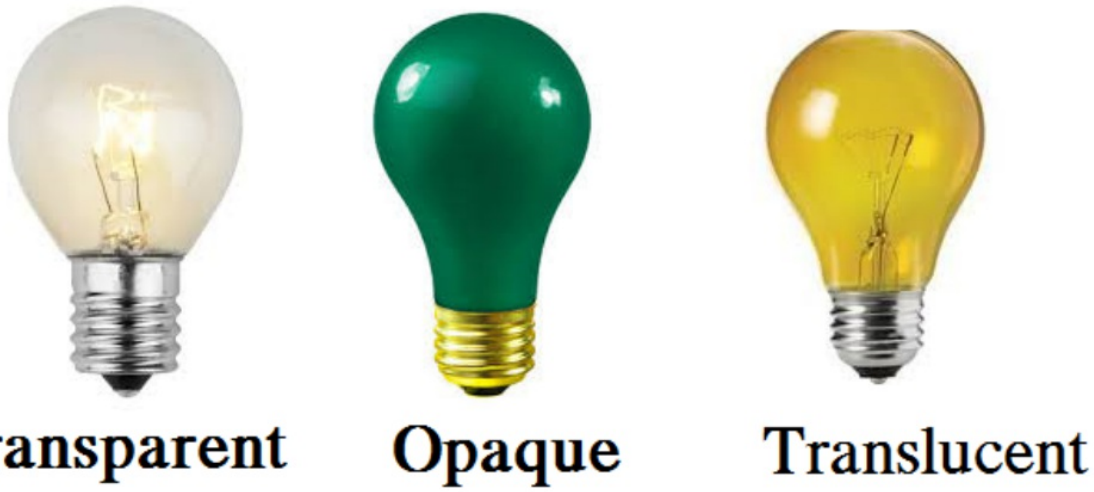


Light and Matter

Opaque: is used to describe materials that only absorb and reflect light; no light passes through them

Translucent: is used to describe materials that transmit light but also scatter it

Transparent: is used to describe materials that transmit light without scattering it, so you can see objects clearly through them

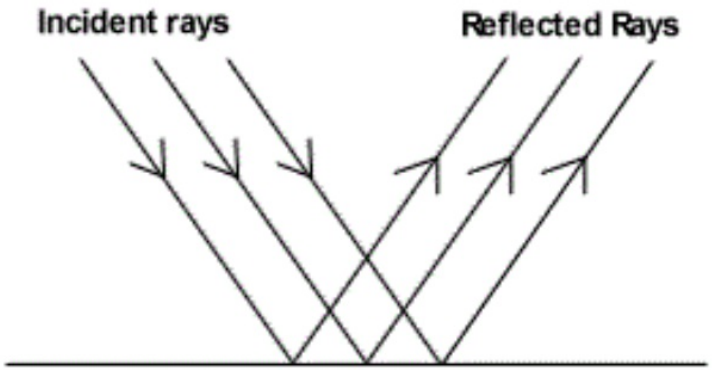


Reflection of Light

Regular reflection is light that bounces off a smooth surface (i.e. a pane of glass) and produces a sharp image by reflecting parallel light waves in only one direction.

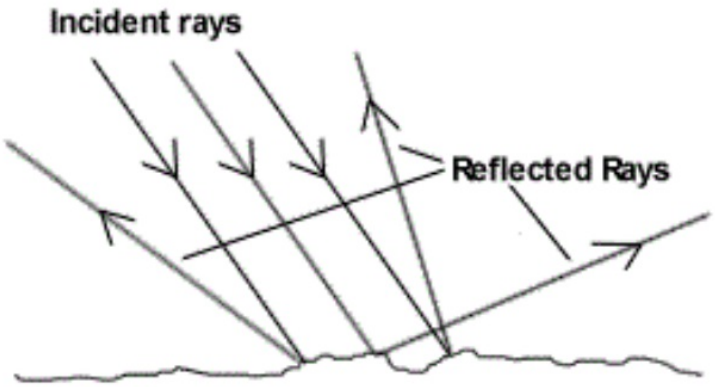
Diffuse reflection is light that bounces off a rough or uneven surface (i.e. a brick wall) in which the parallel light rays coming in bounce off the surface in many directions (diffuse reflections do not produce an image)

Regular Reflection



plane mirror or any other surface that produces a reflected image.

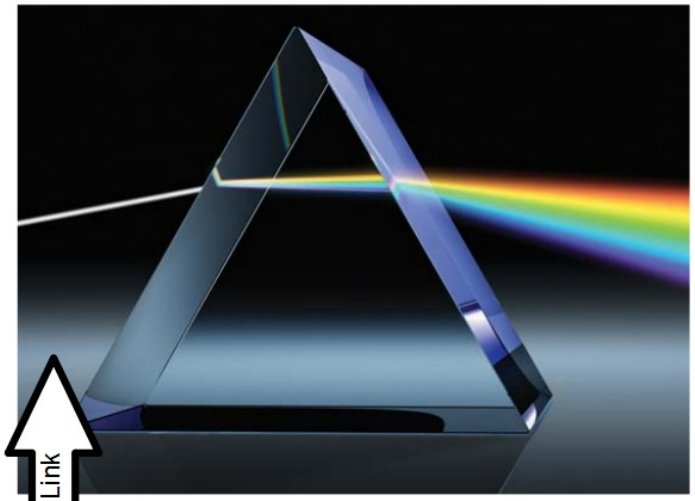
Diffuse Reflection



This is like any surface that we can see but does not reflect an image

Refraction of Light

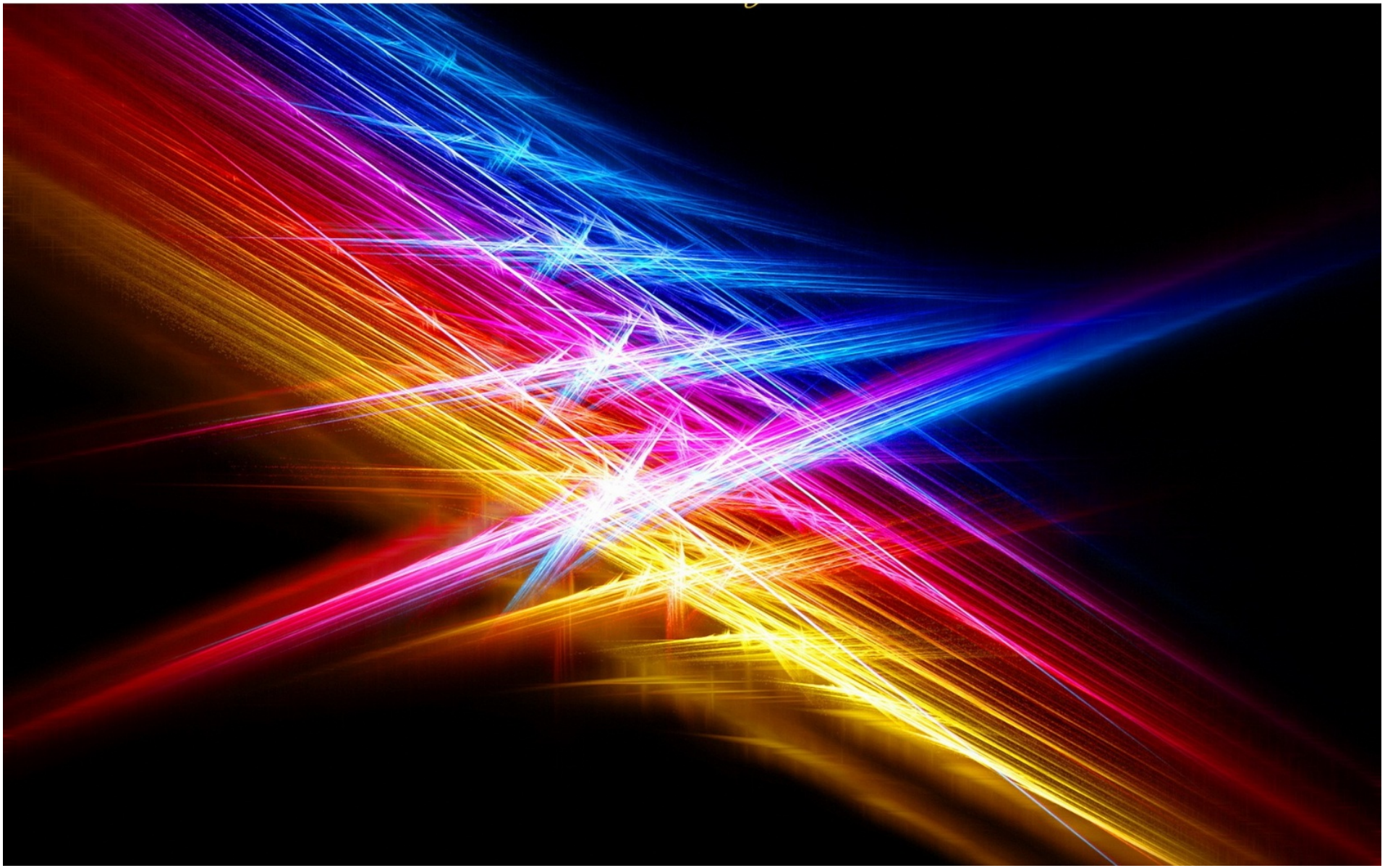
- **Index of refraction:** is a property of a material that indicates how much the speed of light in the material is reduced compared to the speed of light in a vacuum.
- In most materials, the index of refraction also depends on the light's wavelength
- The larger the index of refraction, the slower the speed of light will be in a material
- Examples: prisms, rainbows, mirages, eyeglasses, binoculars, cameras, microscopes, and telescopes



I'm a Link

I'm a Link

Light and Color



Seeing Color

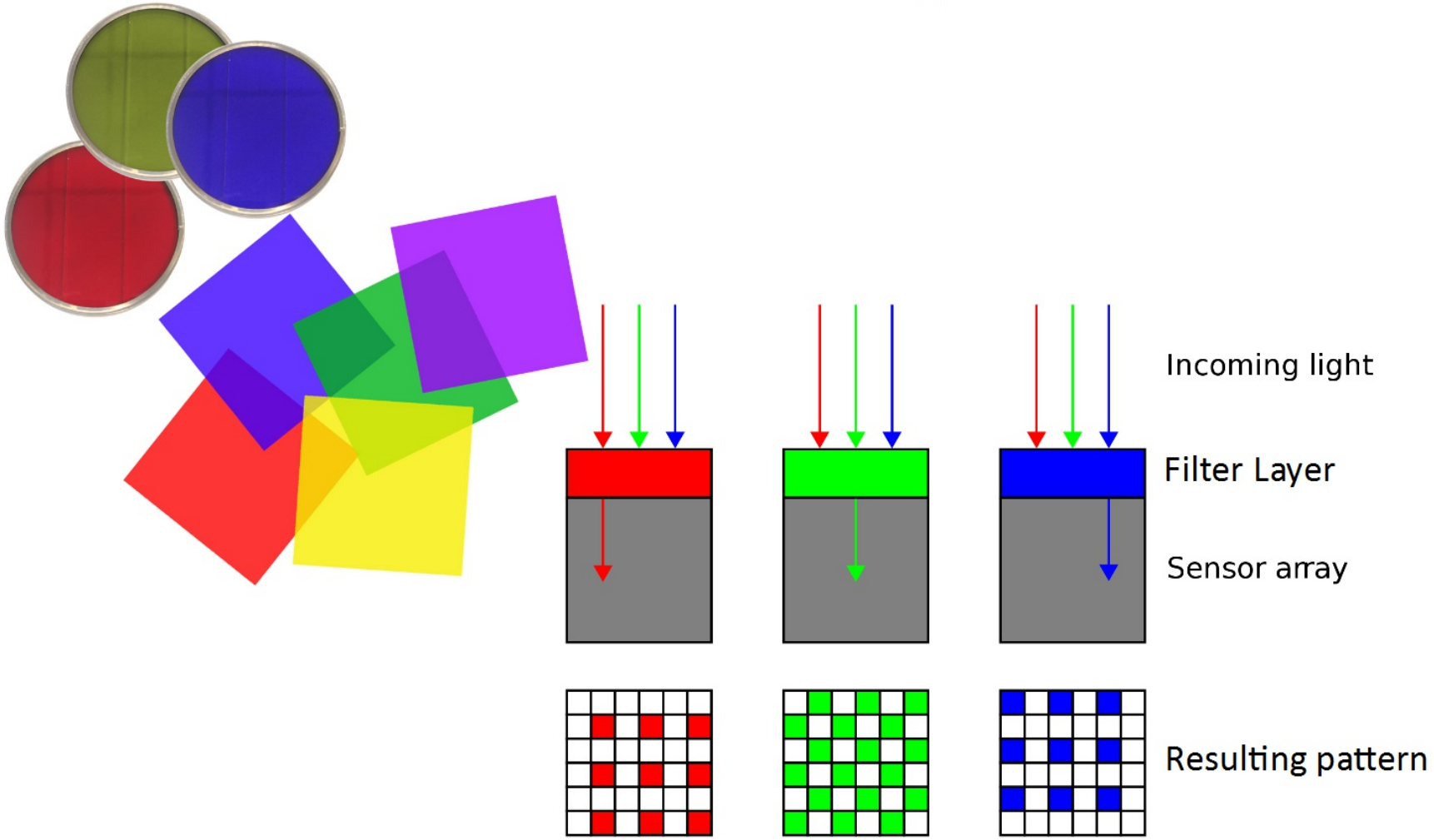
- An object's color depends on the wavelengths of light that it reflects and that our eyes detect

I'm a Link

I'm a Link

Filtering Colors

- **Filter:** is a transparent material that selectively transmits light
- Color filters transmit one or more colors of light but absorb all others



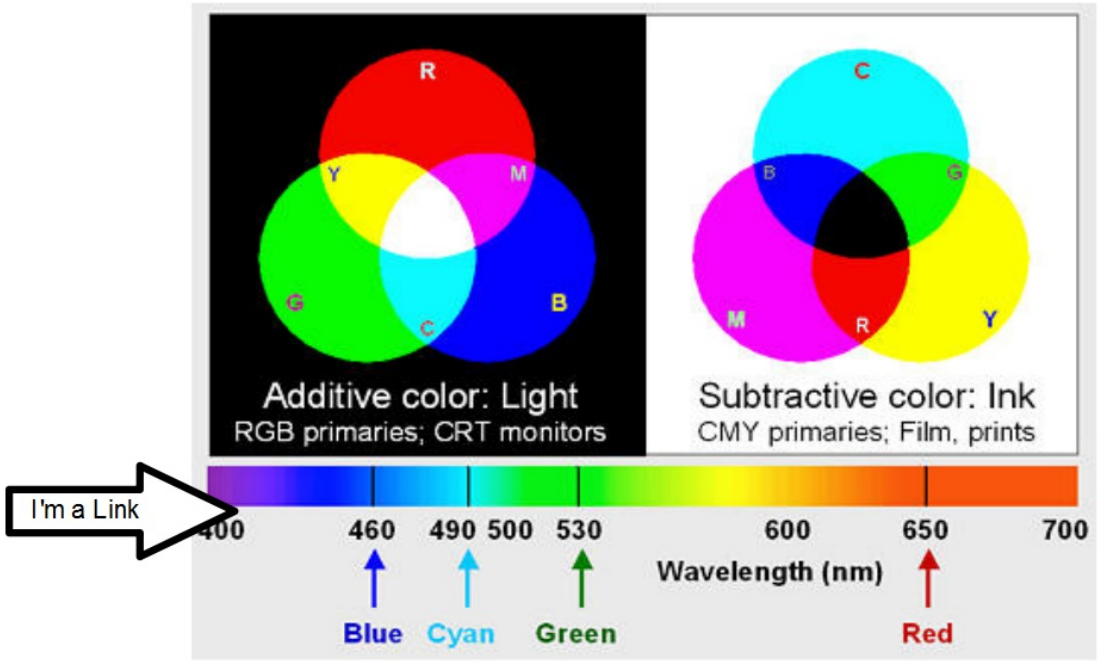
Mixing Colors

Additive Color

- Primary colors of light: red, green, & blue
- These colors correspond to the types of receptors in your eye
- Mixing all three colors of light evenly, creates white light

Subtractive Color

- **Pigment:** is a colored material that is used to change the color of other substances
- Primary colors of pigments: magenta, yellow, & cyan
- Mixing all three colors of pigments evenly, creates a black pigment



Using Light

Polarized Light

- **<u>Linearly polarized light</u>:** is light with a magnetic field that vibrates in only one direction
- Polarizing filters have lines of crystals that act like a group of parallel slits; only waves that have magnetic fields that vibrate in the same direction as the crystal lines can pass through
- Example: polarized lenses

with

I'm a Link

without