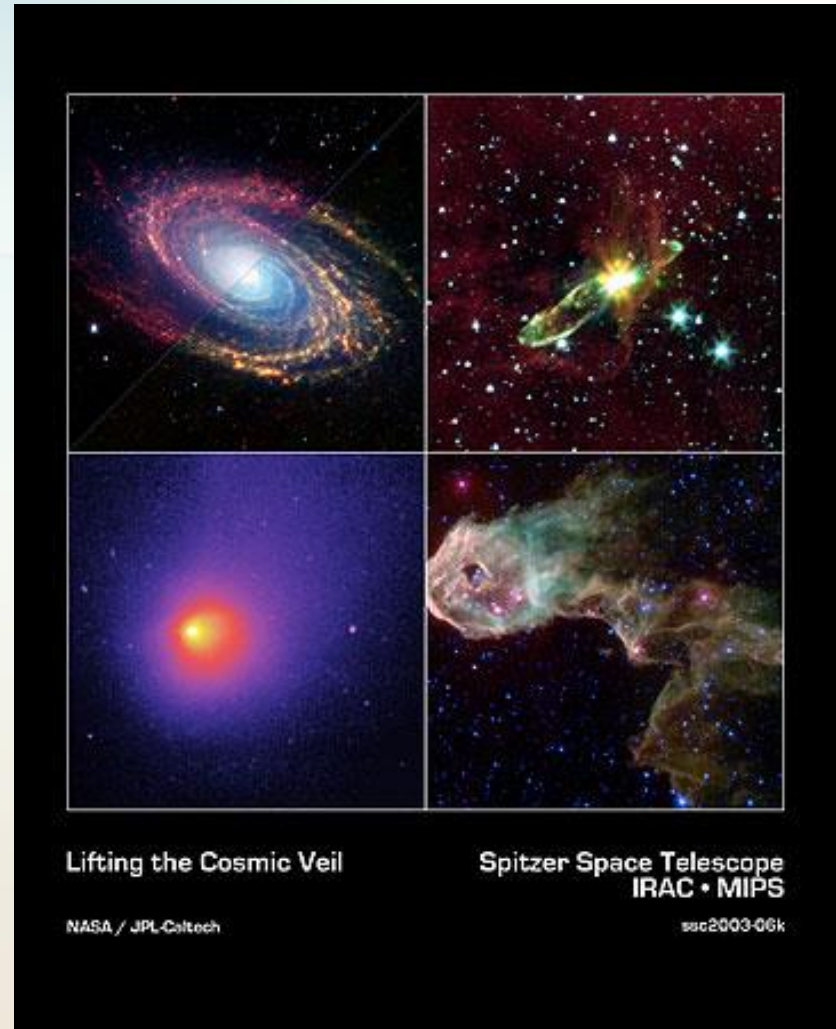


# Electromagnetic Spectrum

# Astronomy

- The study of the universe
- The universe is the totality of all space, time, matter, and energy



# Astronomy Tools

- Astronomers use a wide variety of tools in order to observe and collect data
- The earliest people studied the stars with just their naked eyes
- Today we can study the universe with everything from binoculars to telescopes to satellites

# Andromeda Galaxy

- 2.5 million light years away
- At such a distance it is inaccessible
- Even if a space probe could miraculously travel at the speed of light, it would need 2.5 million years to reach this galaxy and 2.5 million more to return with its findings



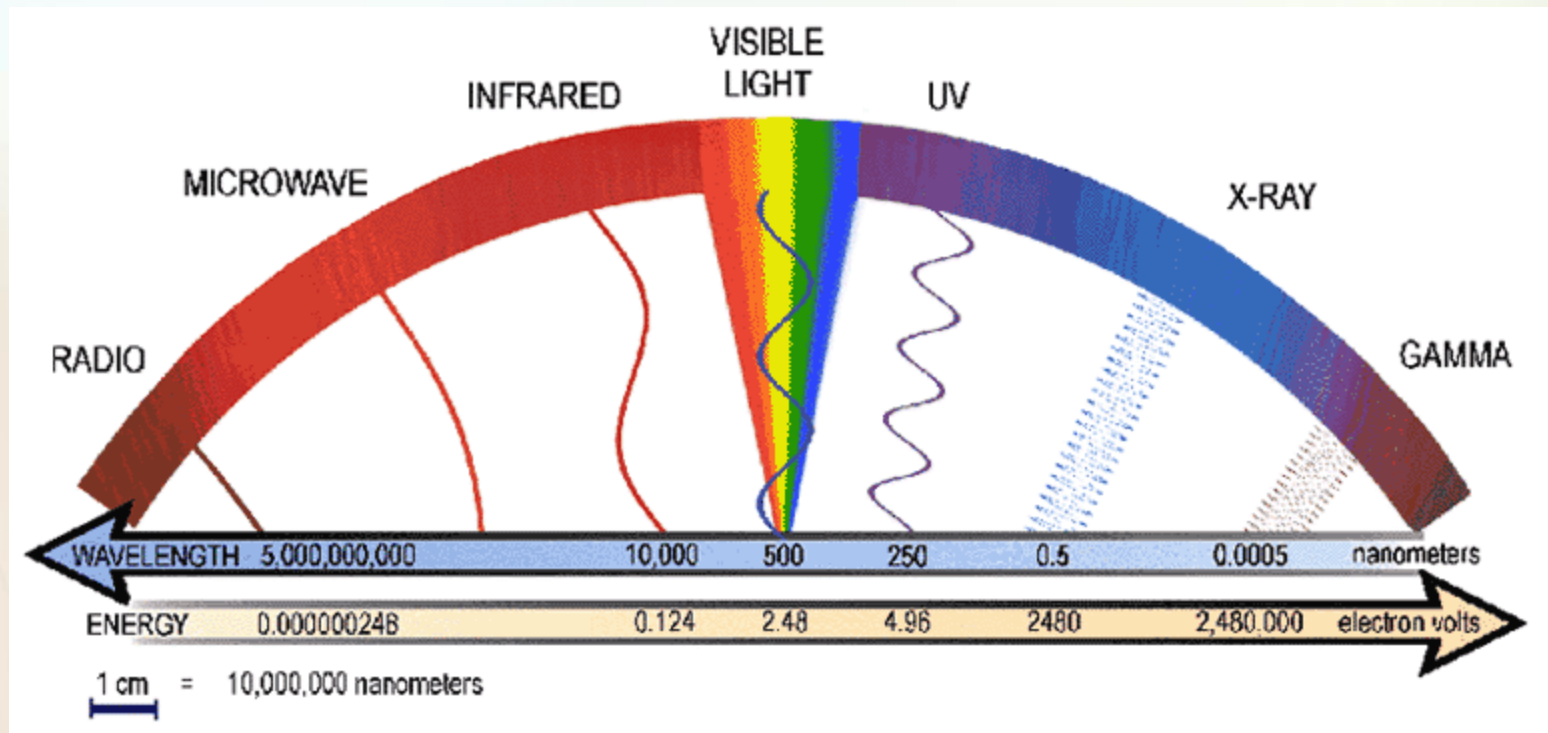
How do we obtain detailed information about any planet, star, or galaxy too distant for a personal visit or any kind of controlled experiment?

# Electromagnetic Radiation

- The answer is that we use the laws of physics, as we know them here on Earth, to interpret the electromagnetic radiation emitted by these objects
- Electromagnetic radiation is another term for light
  - Electromagnetic radiation transfers energy and information from one place to another, even through the vacuum of empty space
- Almost all we know about the universe beyond Earth's atmosphere has been determined from electromagnetic radiation analysis

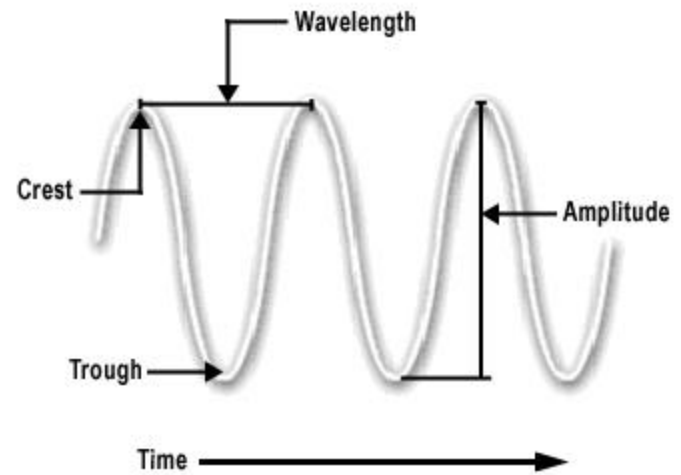
# Electromagnetic Spectrum

- The electromagnetic spectrum contains gamma rays, radio waves, and everything in between



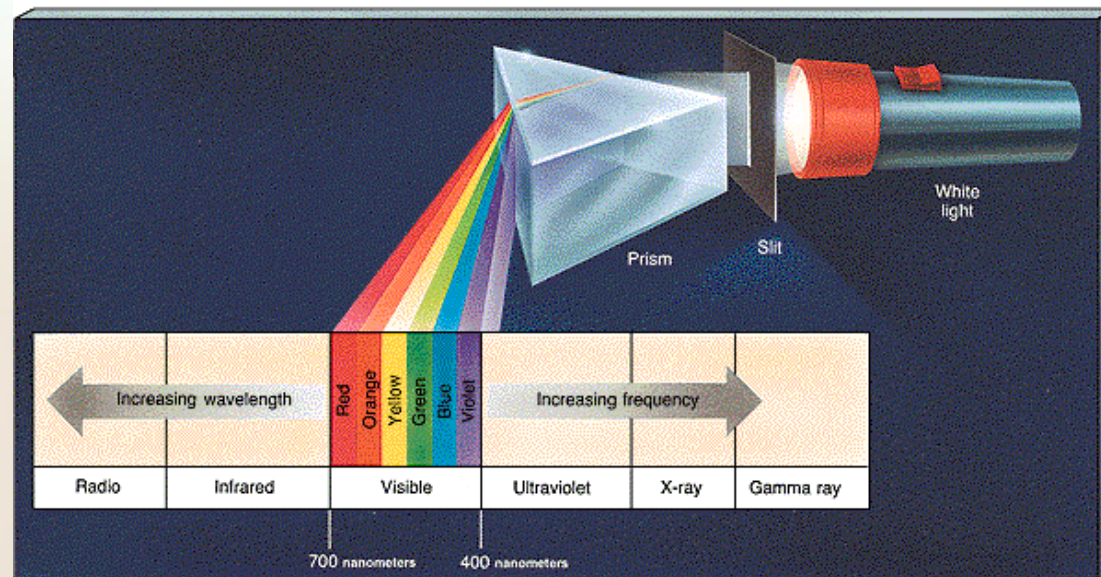
# Waves

- All types of electromagnetic radiation travel through space in the form of waves
- The way in which energy is transferred from place to place without physical movement of material from location to another



# Visible Light

- The small range of the electromagnetic spectrum that human eyes perceive as light
- The visible spectrum ranges from about 400 to 700 nm corresponding to violet through red light





# What determines the color of a beam of light?

- Its frequency or wavelength
- We see different colors because our eyes react differently to electromagnetic waves of different frequencies
- A prism splits a beam of light up into separate colors because light rays of different frequencies are bent as they pass through the prism
  - Red light the least, violet light the most
- Radiation outside this range is invisible to human eyes

# Invisible Electromagnetic Radiation

- Radio, infrared, ultraviolet, X-rays, and gamma rays are completely undetected by our eyes
- Most objects in the universe emit large amounts of invisible radiation
- Many emit only a tiny fraction of their total energy in the visible range
- Knowledge can be gained by studying the invisible region of the electromagnetic spectrum

# Opacity

- Only a small fraction of the radiation produced by astronomical objects actually reaches the Earth's surface because of the opacity of our planet's atmosphere
- Opacity is the extent to which radiation is blocked by the material through which it is passing-ex. Air
- Opacity is the opposite of transparency
- The more opaque an object is, the less radiation gets through it

