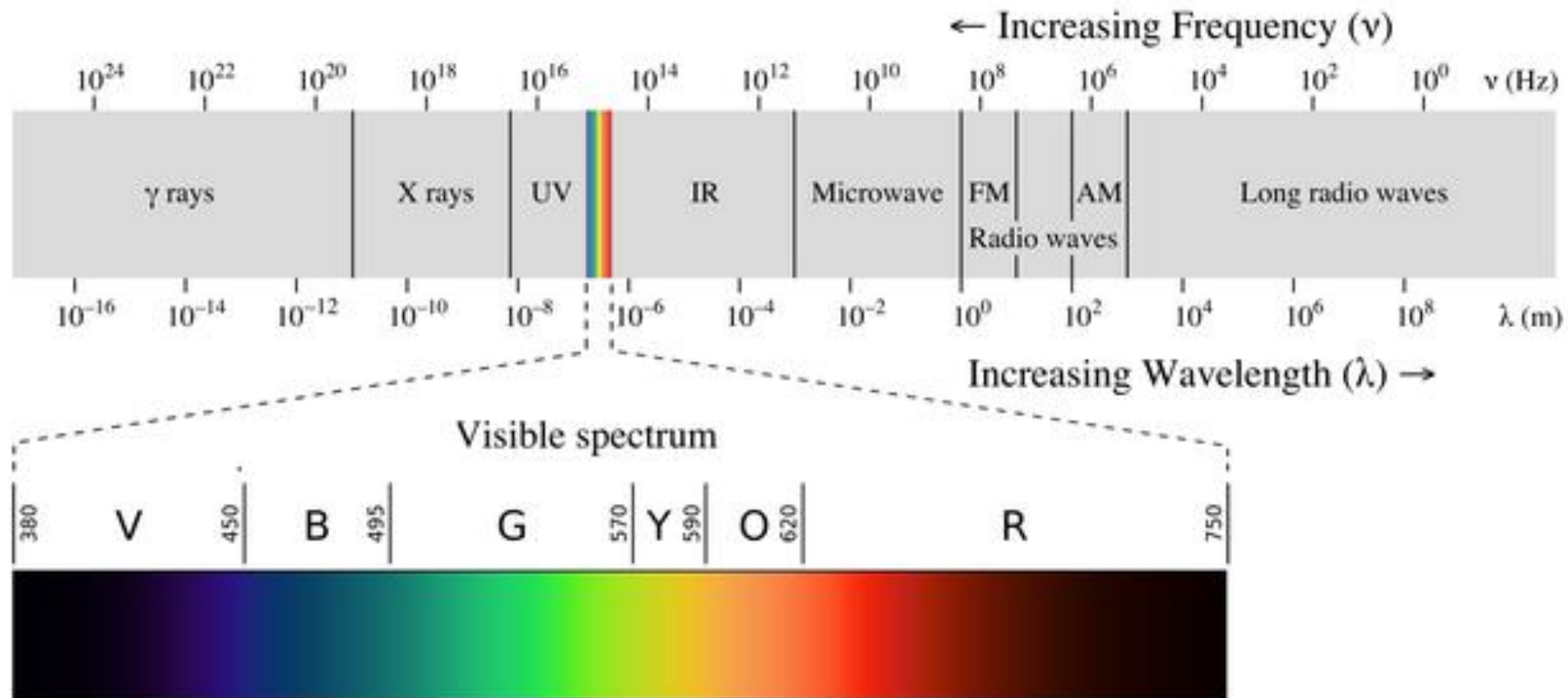


# Light and the Electromagnetic Spectrum

Lesson 22a

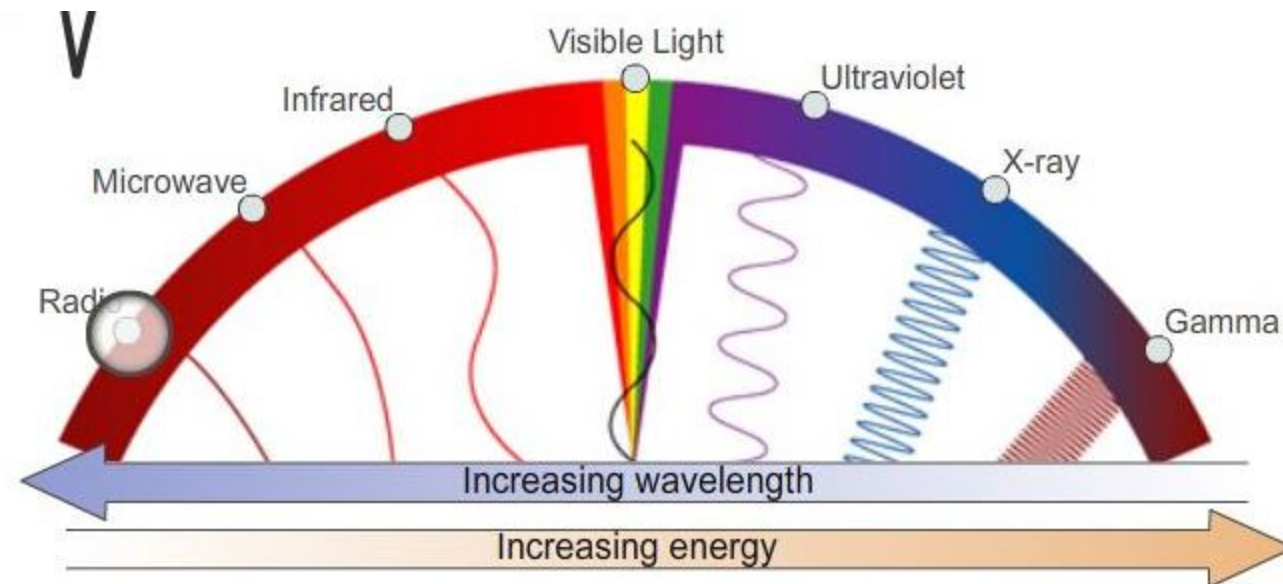
# Light at the Electromagnetic Spectrum

- A rainbow, or visible [light] spectrum, is a tiny portion of a much larger spectrum of radiation called the **electromagnetic spectrum**



# Light at the Electromagnetic Spectrum

- Different waves of energy have different characteristics
- Radio waves and infrared radiation have longer wavelengths, lower frequencies, and less energy than visible light
- Ultraviolet light, X rays, and gamma rays all have shorter wavelengths, higher frequencies, and more energy than visible light



# Waves of energy are everywhere!



- No matter where you are, you are surrounded by invisible waves
  - Even though you cannot feel them, some of these waves are traveling through your body
- Imagine you are at the park on a summer day
  - You lather sunscreen on your skin to prevent a sunburn from the Sun's invisible wave
  - Someone plays music from a radio, while another person calls a friend on a cell phone
  - After you return home you use its wireless Internet connection, and then prepare popcorn in a microwave oven to eat while you watch TV



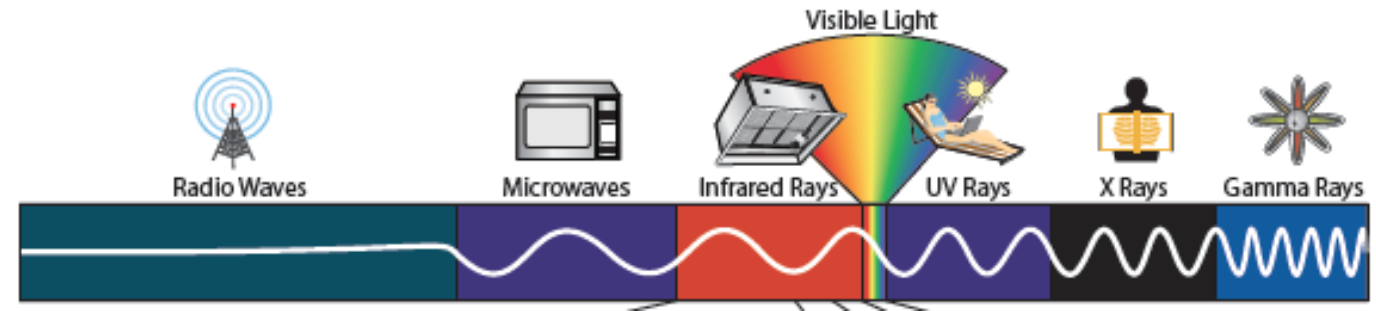
# Beyond Visible Light



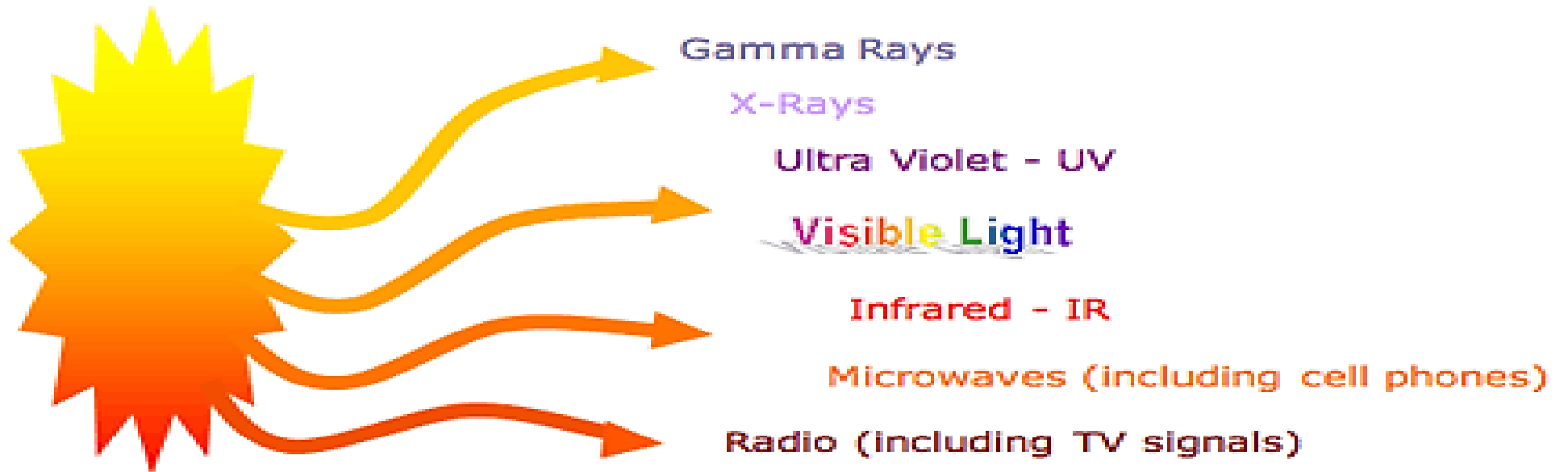
- The sun is the most important source of light on Earth
  - However, there is far more sunshine than meets the eye!
- Light spreads out, or radiates, from the Sun and other stars in all directions, like the spokes of a bicycle wheel
- Energy, such as light, that travels by radiation is often called **radiant energy**



# Beyond Visible Light



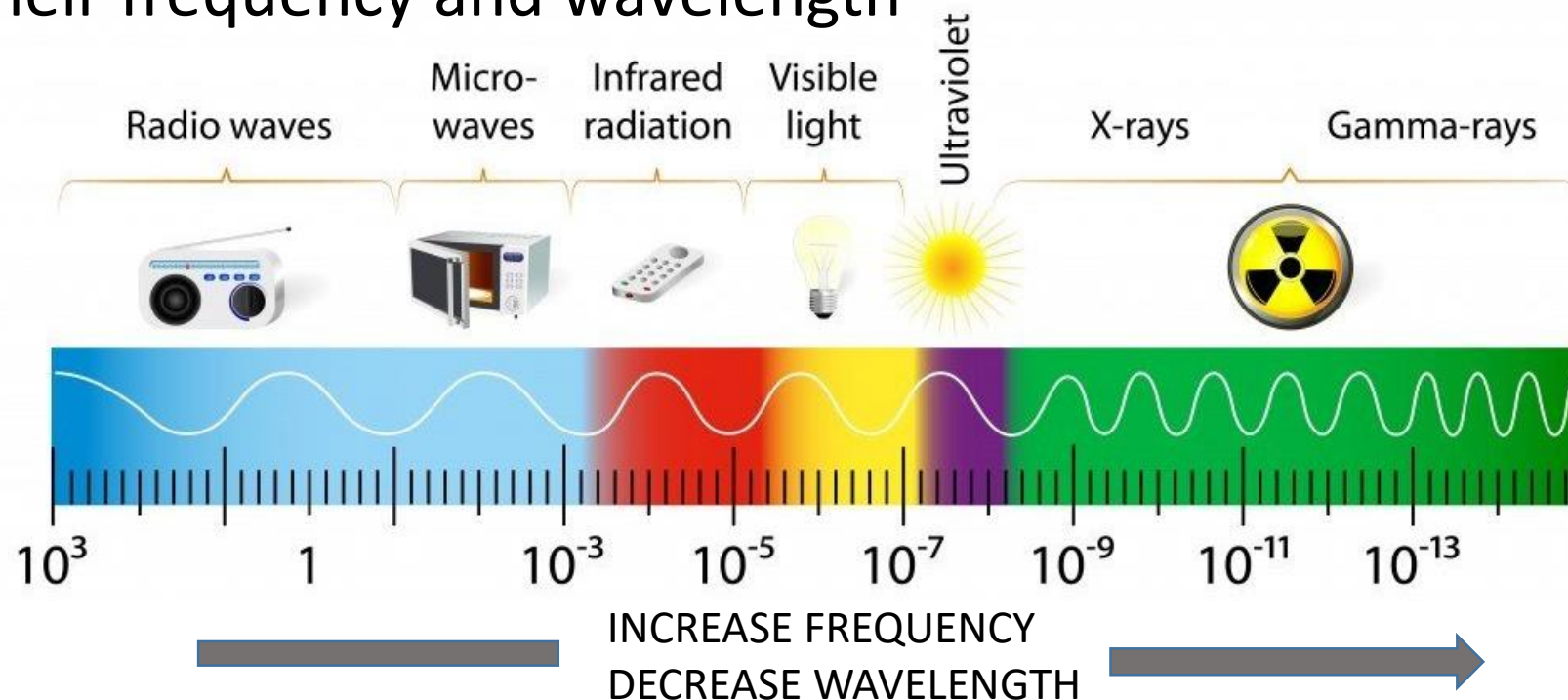
- The Sun radiates visible energy that we call light AND it also radiates invisible energy
  - The light we see is just a tiny band of a much broader spectrum of energy





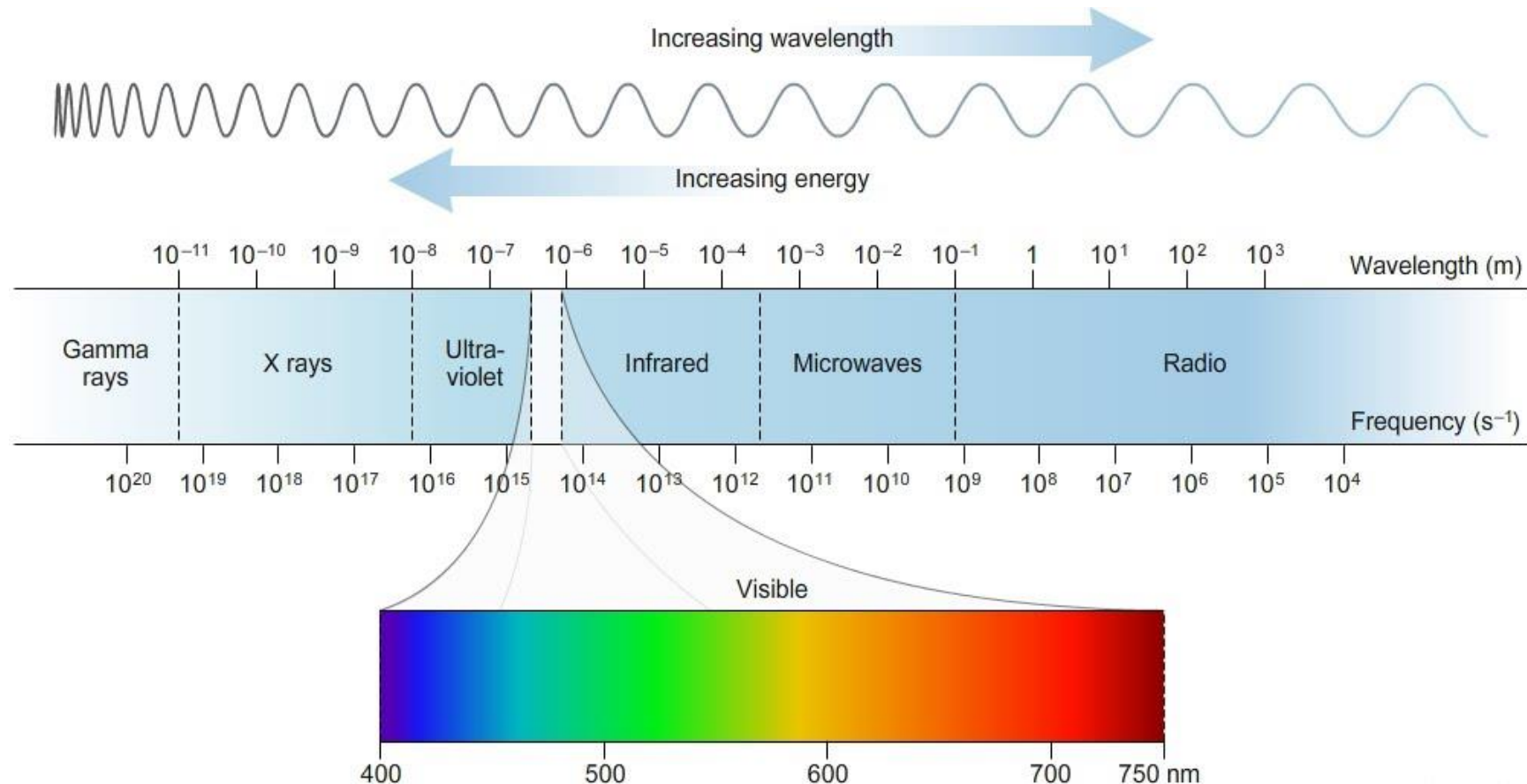
# Electromagnetic Radiation

- **Electromagnetic radiation** is the transmission of energy in the form of waves that extend from the longest radio waves to the shortest gamma rays
- Electromagnetic waves are described by different names depending on their frequency and wavelength



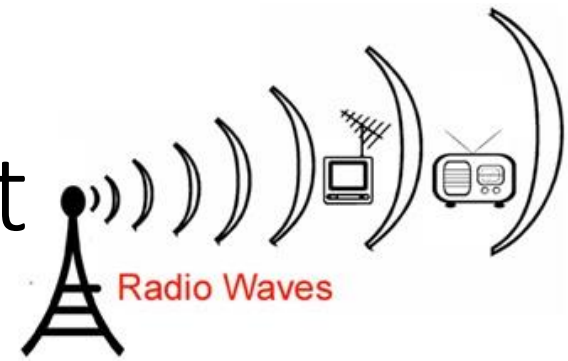
# Wavelengths Longer than Visible Light

- The electromagnetic waves that we can detect with our eyes are a small portion of the entire electromagnetic spectrum

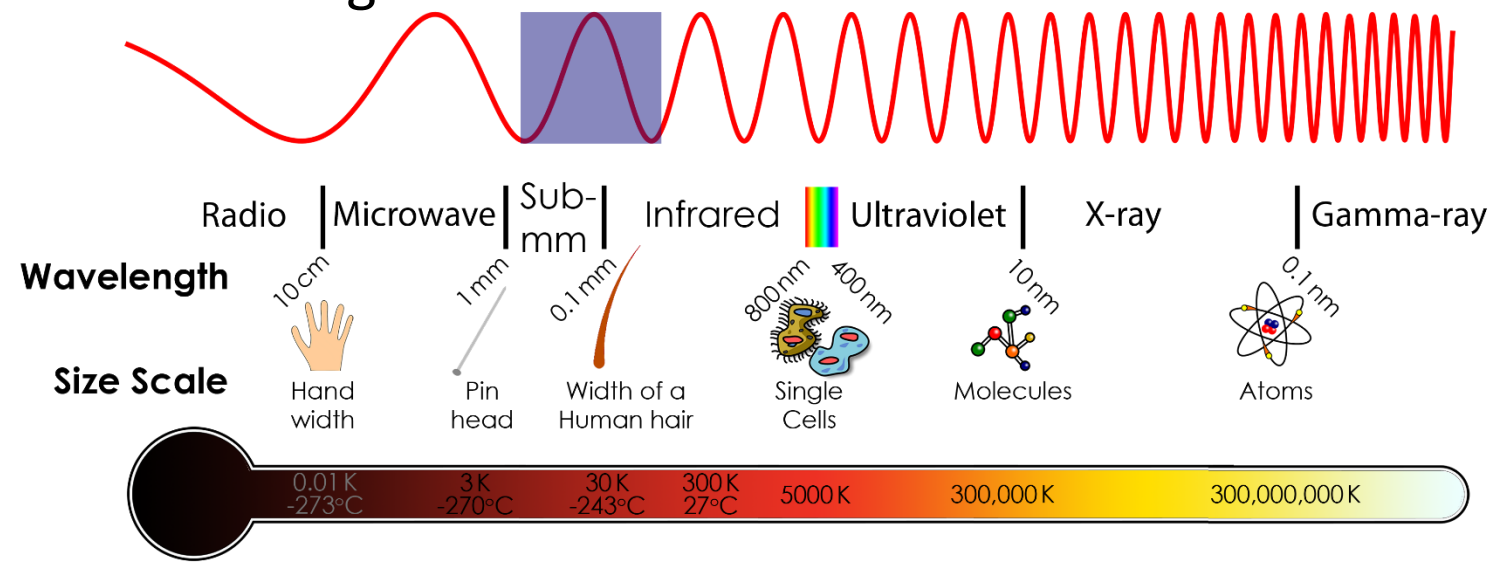




# Wavelengths Longer than Visible Light

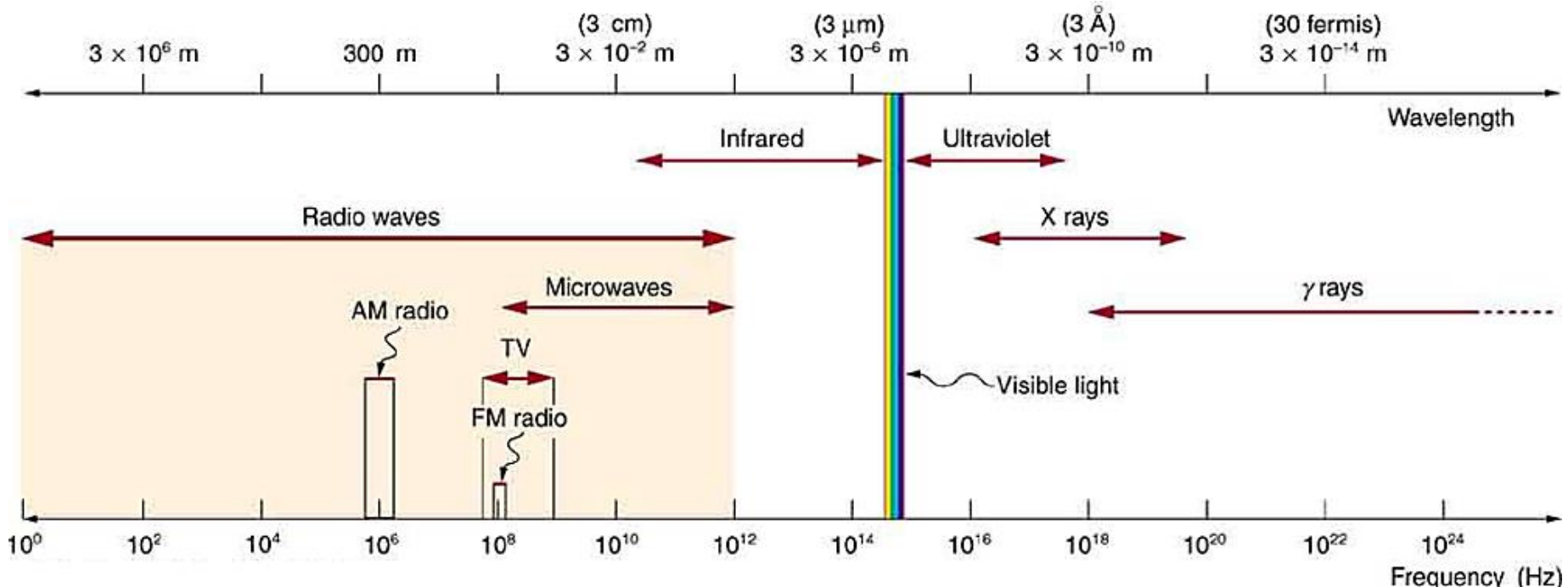


- Even though our eyes can only detect a small portion of the entire electromagnetic spectrum, various devices have been developed to detect other frequencies
- For example, the antenna of a radio detects radio waves
  - Radio waves and infrared waves have longer wavelengths and are lower frequency than visible light

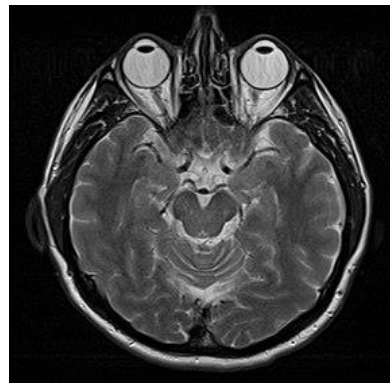


# Radio Waves

- **Radio waves** are a type of electromagnetic radiation that have the longest wavelength and lowest energy and frequency compared to all other types
- Different wavelengths of radio waves have different uses, such as radio and television broadcasting
- Microwaves and radar are types of radio waves



# Radio Waves



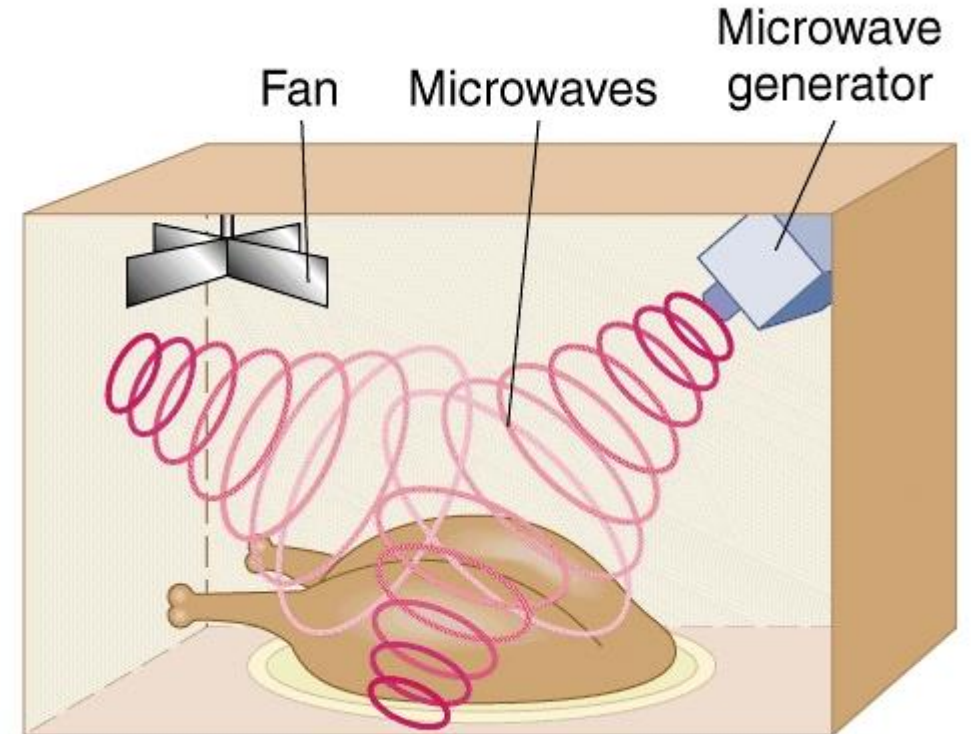
- Some of the longest radio waves can help us see inside our bodies and diagnose illnesses without having to do surgery
- In magnetic resonance imaging (MRI), a patient lies in a large cylinder that is equipped with a powerful magnet, a radio wave emitter, and a radio wave detector.
  - MRI technology uses radio waves as an alternative to imaging with X rays



# Microwaves

## Radio Waves

- **Microwaves** have the shortest wavelength and the highest frequency of all radio waves
- Microwave ovens use a specific wavelength (or frequency) of microwave that is strongly absorbed by water particles
  - When the water particles in the food absorb microwaves, they begin to vibrate quickly and become hot
  - Only food that contains water particles can be heated using microwaves



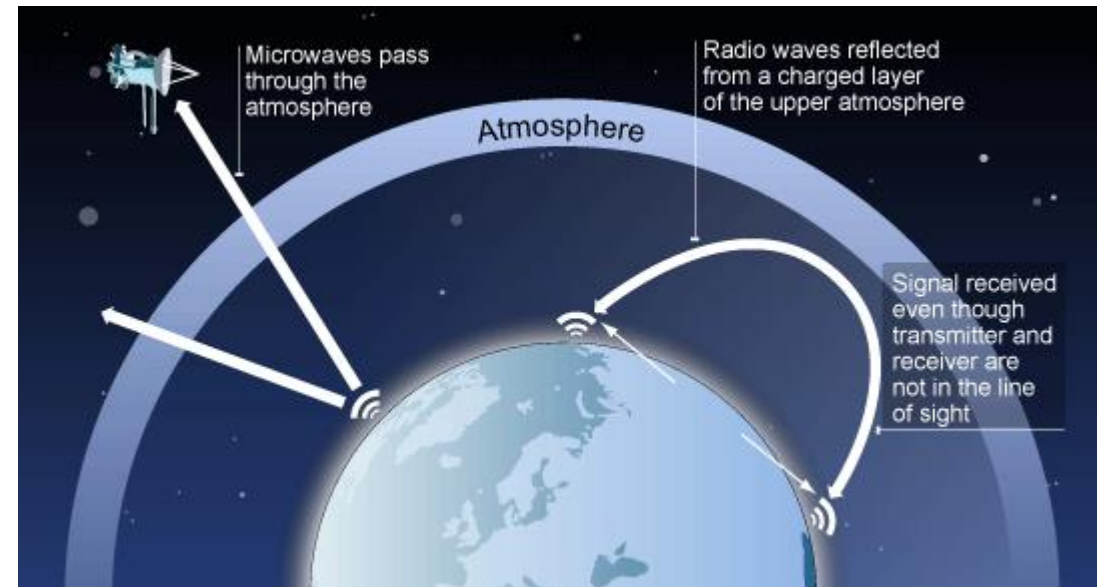
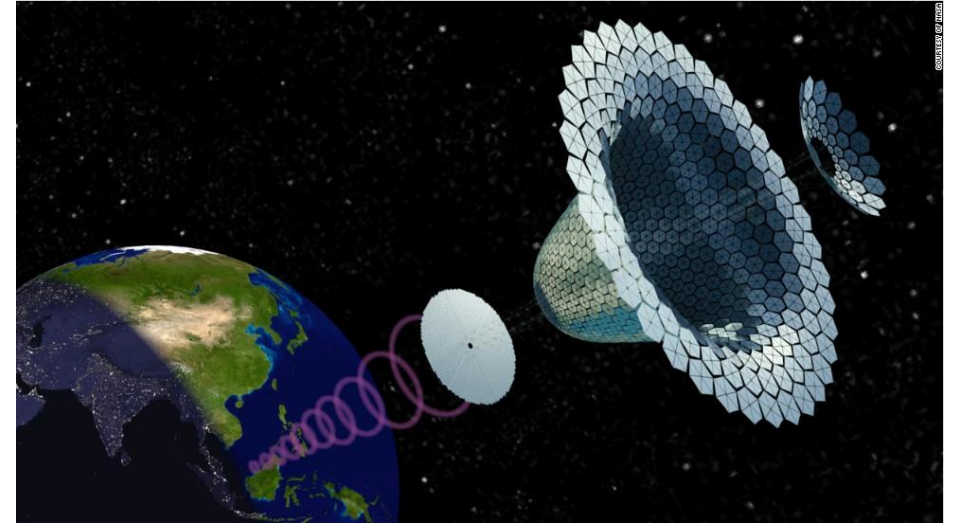
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# Microwaves

## Radio Waves

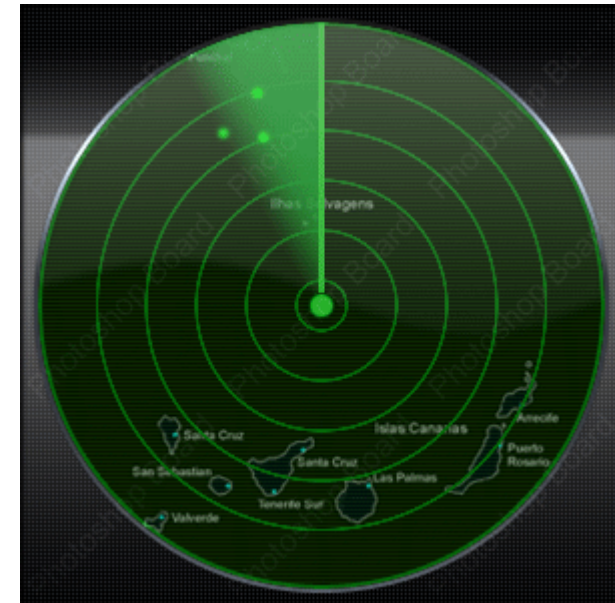
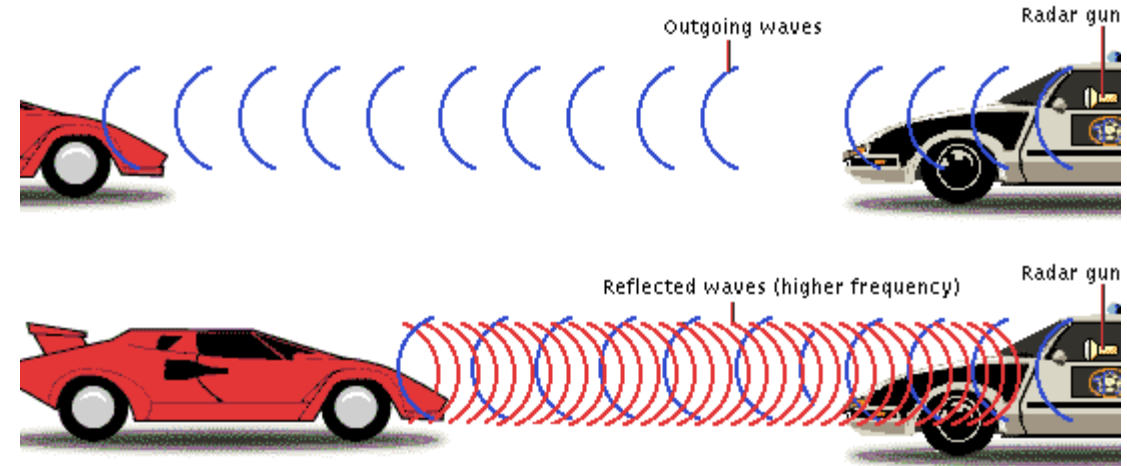
- Microwave frequencies are also used in telecommunications
- Microwaves can be transmitted to telecommunications satellites that orbit Earth
  - The satellites receive microwave signals, strengthen them, and retransmit them to a new location
- Some radio telescopes are directed not at Earth, but toward distant planets and galaxies
  - Scientists study radio waves to learn more about the composition, motion, and structure of these distant objects



# Radar

## Radio Waves

- Microwaves with shorter wavelengths are used in remote sensing, such as radar
  - Microwaves are beamed out through the air and the waves that are reflected from an object can show the location and speed of the object
- Radar is used for tracking the movement of automobiles, aircrafts, watercrafts, and spacecrafts etc.

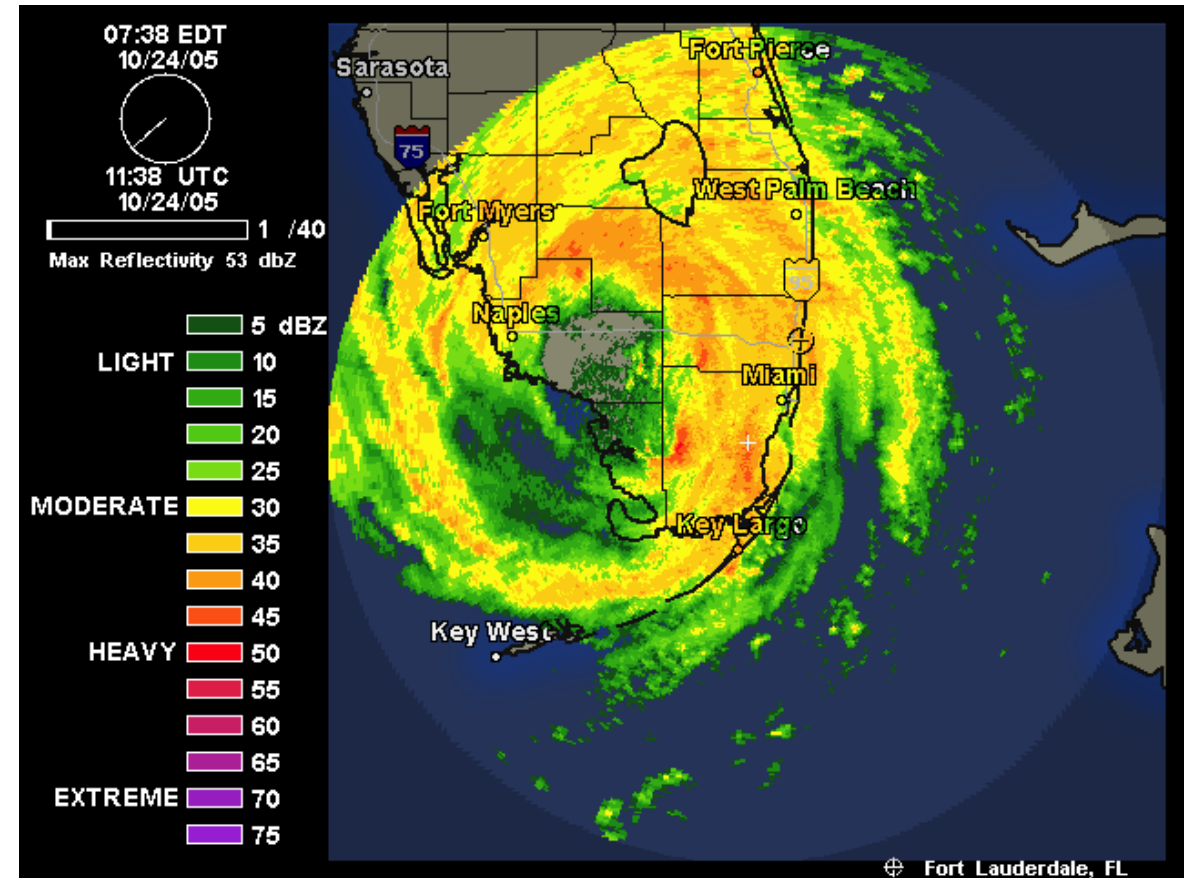




# Radar

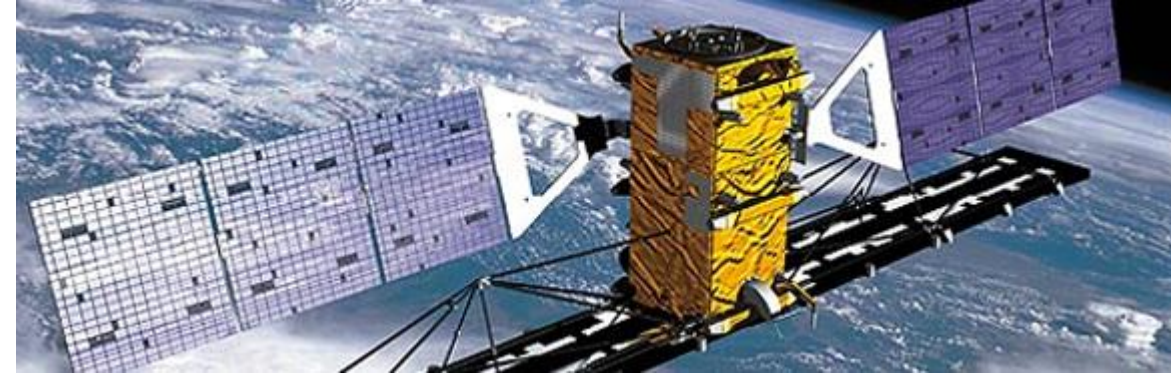
## Radio Waves

- Radar is also used for weather forecasting
  - Raindrops, snow crystals, and other objects in the air reflect radio waves
  - Doppler radar (weather radar device), electronically converts the reflected radio waves in pictures that show the location and intensity of precipitation and wind speed



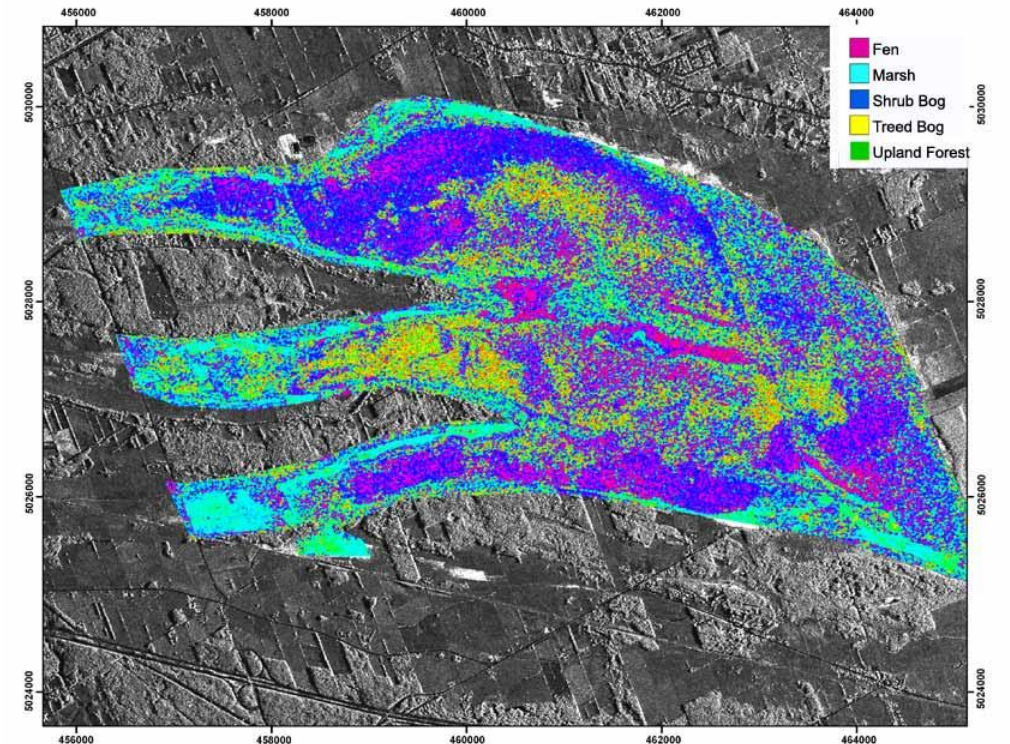
# RADARSAT

- RADARSAT is a Canadian satellite that sweeps the ground below with radio waves that can penetrate haze, fog, clouds, and rain



## RADARSAT Uses:

- Over the ocean, reflects info about ice floats that can endanger ships
- Monitor oil spills so that workers can identify where environmental damage might occur
- Gather data about geographical features of Earth's surface to locate sites for oil, natural gas, and minerals
- Images of floods help to protect lives and save property



Monitoring Canadian wetlands

# Infrared Waves

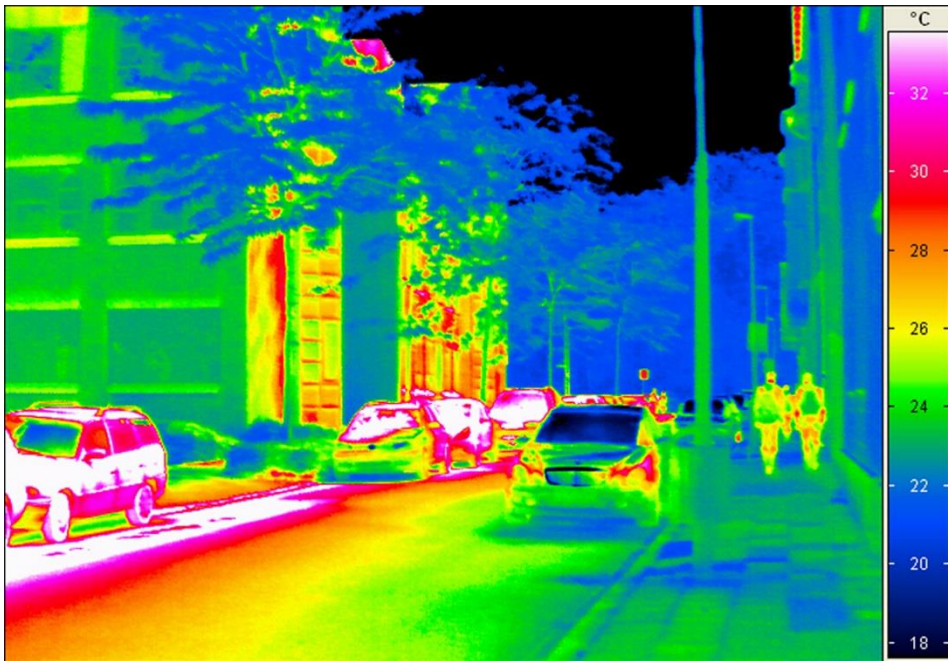
- **Infrared waves** are a type of electromagnetic radiation that, when compared to light, has a longer wavelength and lower energy and frequency
- We use infrared waves everyday
  - TV remote emits infrared waves to control a TV set
  - A computer uses infrared waves to read CDs/DVDs





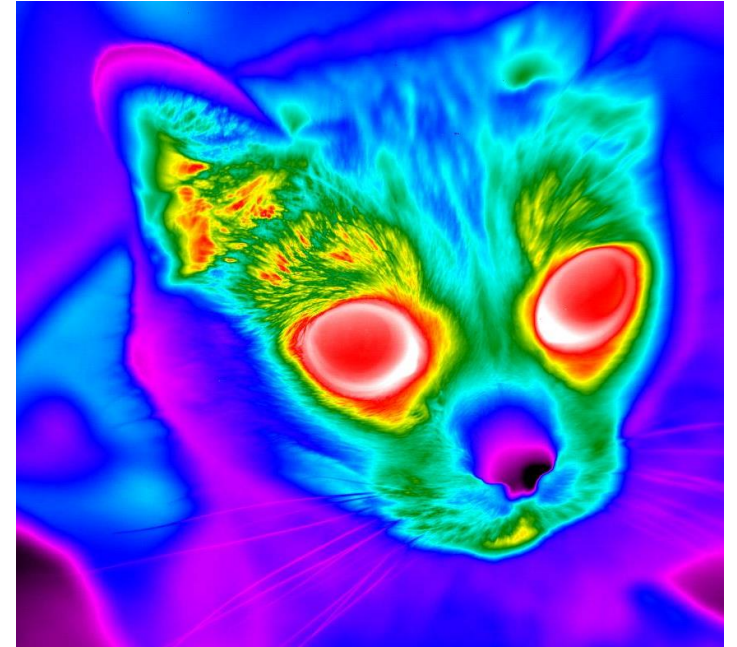
# Infrared Waves

- **Infrared radiation** is also referred to as **heat radiation**
- Every object emits some infrared waves because all objects contain some heat energy
  - Warmer objects emit more infrared waves than cooler objects



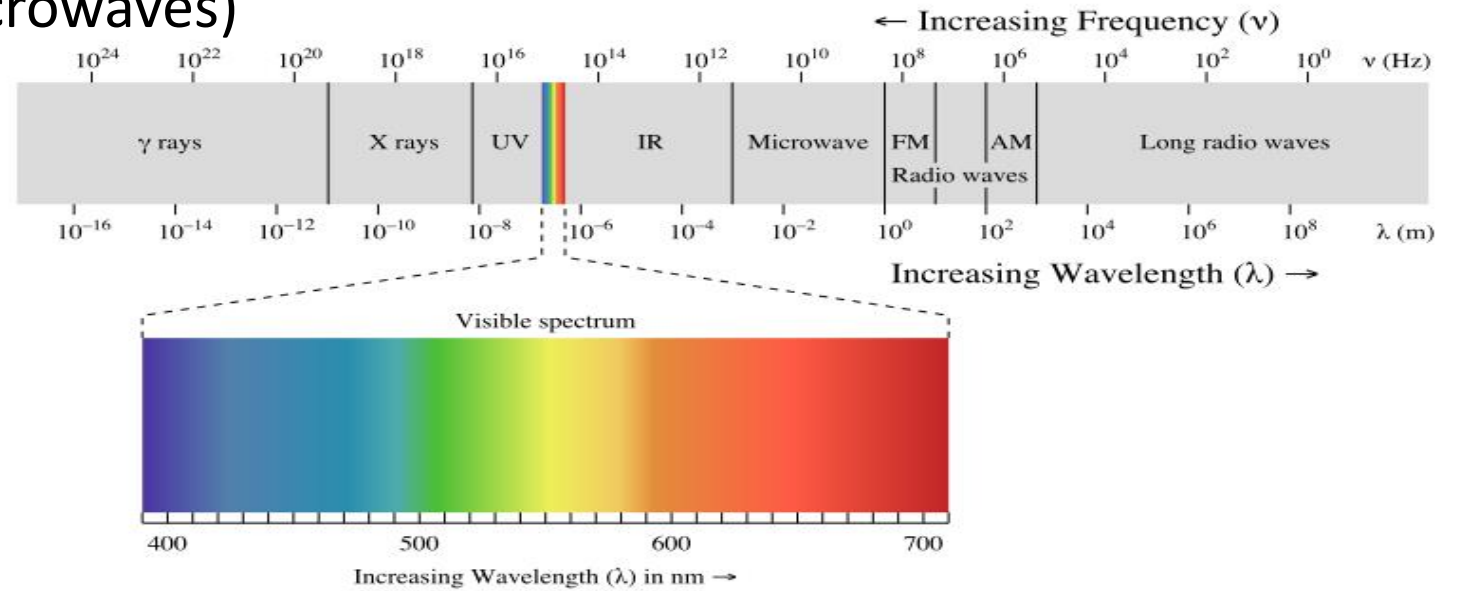
# Infrared Waves - Uses

- Heat lamps used to keep food warm in fast food restaurants
- Some airports use infrared to determine whether passengers arriving from other countries have a fever (carriers of infectious diseases)
- LANDSAT, a Canadian observation satellite, uses infrared to observe crops/forests and to monitor insect, disease, fire damage to the environment

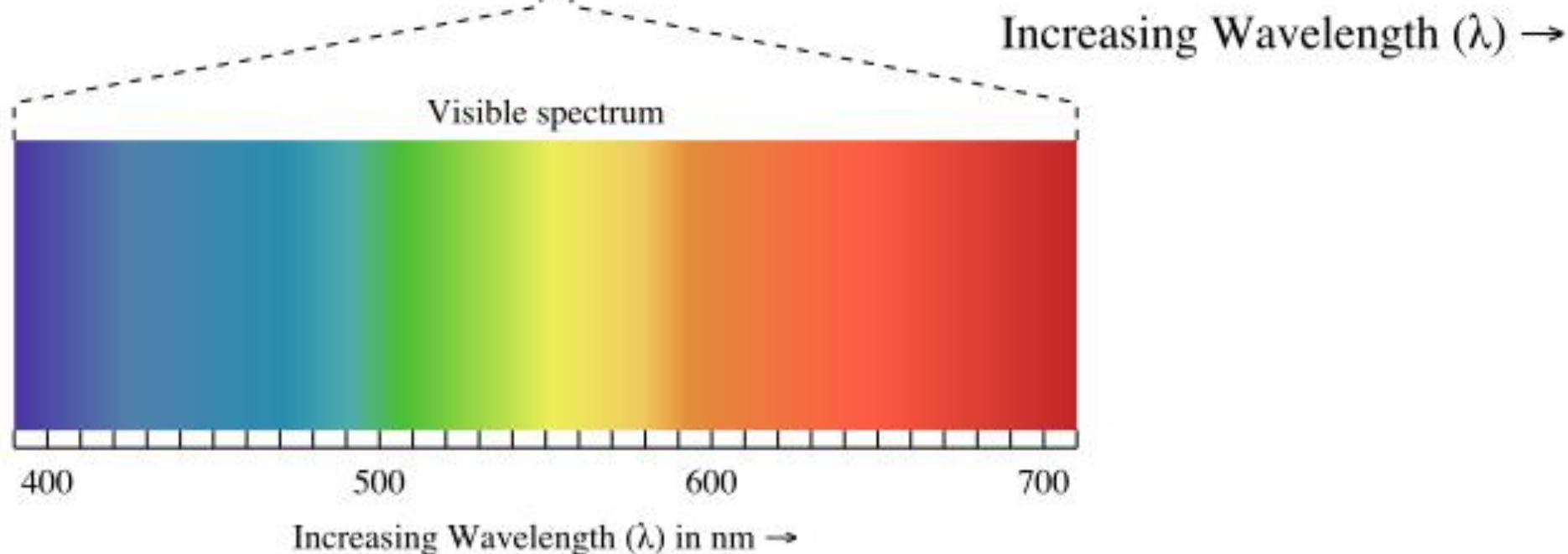
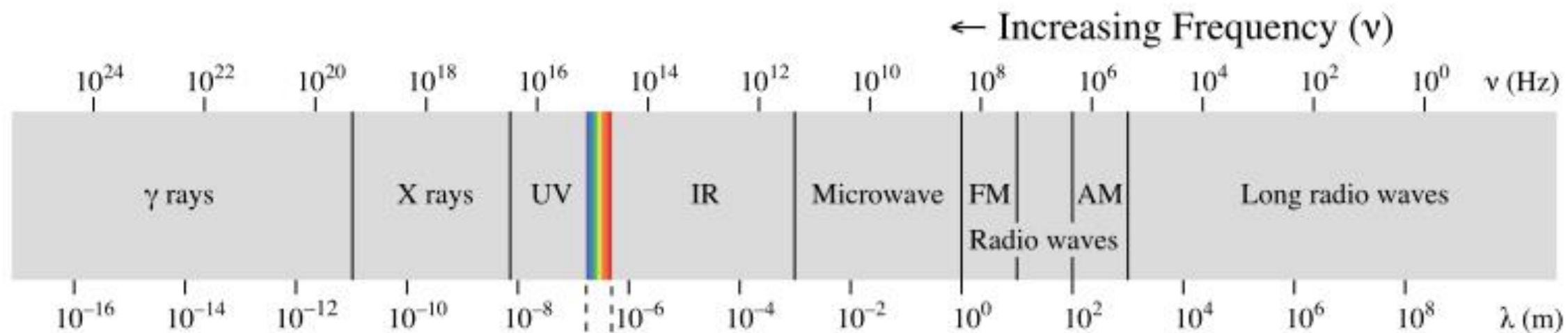


# Summary

- There is a spectrum of energy waves called the **electromagnetic spectrum**
  - Visible light (the colours of the rainbow) is only a small portion of the larger spectrum
  - Different electromagnetic waves have different wavelengths and frequencies
  - Radio waves (FM, AM, Microwaves)
  - Infrared waves
  - Visible light spectrum







# Questions

1. Where is visible light found on the electromagnetic spectrum?
2. Which type of electromagnetic radiation has the longest wavelength?
3. Why does an empty plate not heat up in the microwave?
4. What are two uses of radar?
5. What is another term for heat radiation?

Complete the above 5 questions. **Due: Wed. Dec. 18, 2019** in preparation for a **REVIEW Q!**