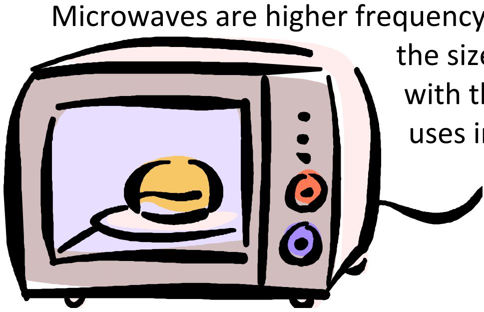
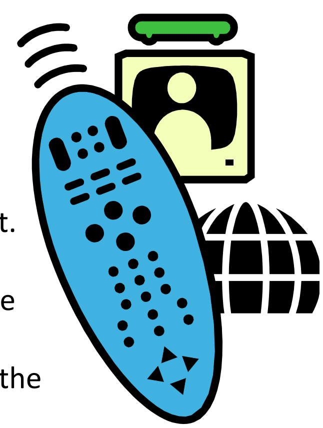
What are waves?
Waves are all around us! Whenever you watch TV, send a text message, or heat food in a microwave, you are using waves. Some waves, like sound waves, need molecules to travel through. This is why you can hear sound in our atmosphere but not in space. Some waves, however, do not need molecules to travel. These waves are called electromagnetic waves. The word electromagnetic comes from the two words 'electricity' and 'magnetism'. When an electric field and magnetic field move together, they make waves - electromagnetic waves! There are many types of waves along the electromagnetic spectrum, from very long radio waves to very short gamma rays. They differ from each other in wavelength. Wavelength is the distance between one wave crest to the next.

Radio Waves
Radio waves have the longest wavelengths in the electromagnetic spectrum. They can be as large as a football field to larger then our planet! They have the lowest frequency of all the electromagnetic waves. Radio waves can be used for televisions, radio stations, and cell phone signals. Because radio waves aren't blocked by sunlight, clouds, and rain, they are very useful to scientists studying space. Radio telescopes are used to view planets, comets, giant clouds of gas and dust, stars, and galaxies. By studying the radio waves originating from these sources, astronomers can learn about their composition (what they are made of) and their motion. We also use these radio waves to send messages to our spacecraft and receive information from their scientific instruments.

Microwaves
Microwaves are higher frequency then radio waves. They range in size from about 1 millimeter (that's about the size of a sharp pencil point) to about 1 foot long. You are probably most familiar with them when you heat your food up in a microwave, but they have a lot more uses including weather forecasting and cell phones! Microwaves can even pass through clouds, which make them an excellent wavelength for transmitting satellite communications.



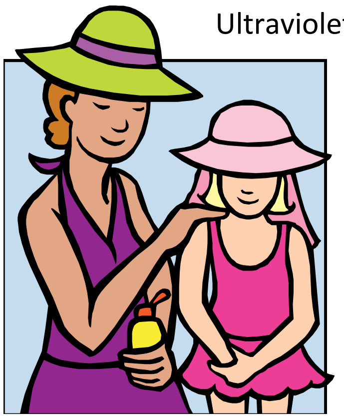


Infrared Waves
A remote control uses light waves just beyond the visible spectrum of light—infrared light waves—to change channels on your TV. Infrared waves are about the length of a grain of sand. While we cannot see infrared, we can sense some of the energy as heat. Some objects, such as a fire, are so hot they also emit visible light. Other objects are not as hot and only emit only infrared waves. Infrared energy can reveal objects in the universe that cannot be seen in visible light using optical telescopes. Many objects in space are also too cool and faint to be detected in visible light but can be detected in the infrared.

Visible Light
All electromagnetic radiation is light, but we can only see a small portion of this radiation. This is the part of the spectrum we call visible light. Each color of the visible light spectrum has a different wavelength. This is why when white light travels through a prism, the wavelengths separate into the colors of the rainbow. Violet

has the shortest wavelength and red has the longest wavelength. The Sun is the dominant source for visible-light waves our eyes receive. Most of the information we collect on a day to day basis is from the visible light part of the spectrum. Most light sources give out pure white light, but white light is made up of three different colors, red, green and blue. Visible light telescopes or optical telescopes gather and magnify visible light that our eyes can see. Using special cameras that work similar to how digital cameras work, astronomers can photograph planets, stars, and galaxies. Optical telescopes have been used on Earth for many years, but they work best when they are in space above the Earth's atmosphere which can alter the light.

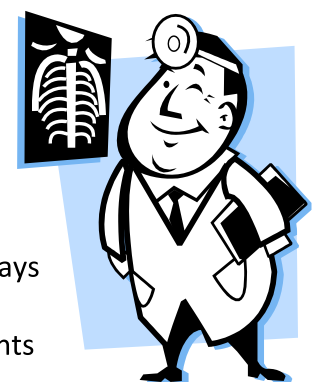
Ultraviolet



Ultraviolet (UV) light has shorter wavelengths than visible light and a high frequency. Although UV waves are invisible to the human eye, some animals, such as bumblebees, reptiles, and some birds, can see them. In fact, humans used this knowledge to create bug zappers, a UV light that attracts insect and lures them into a trap! Ultraviolet radiation from the sun penetrates our skin, and can cause sunburn or even worse, skin cancer. Sunscreens help prevent the rays from harming us. Tanning beds also release ultraviolet waves that can damage the skin. Young stars shine most of their light in the ultraviolet wavelength, so scientists are able to study the formation of new stars using ultraviolet telescopes. Since very little ultraviolet energy gets through Earth's atmosphere, Ultraviolet telescopes must be orbiting in space.

X-rays

X-rays have much higher energy and much shorter wavelengths than ultraviolet light. X-rays have very small wavelengths, so small that some x-rays are no bigger than a single atom of many elements. When you get an x-ray taken, x-ray sensitive film is put on one side of your body, and x-rays are aimed through the other side of your body. Because bones are so dense, they absorb more x-rays than skin does creating shadows of the on the x-ray film while the skin appears transparent. Earth's atmosphere blocks x-ray radiation. This is beneficial for us here on Earth, because x-rays are so energetic that they would harm almost every living thing on earth! Telescopes with x-ray detectors must be positioned above Earth's atmosphere. Such measurements can provide clues about the composition, temperature, and density of distant objects



Gamma Rays

Gamma rays have the smallest wavelengths and the most energy of all the waves in the electromagnetic spectrum. They are produced by the hottest and most energetic objects in the universe, such as supernova explosions, and black holes. On Earth, gamma waves are created by nuclear explosions, lightning, and radioactive decay. Gamma rays are ionizing, which means that they have such high energy that they can knock electrons out of atoms. Exposure to these high-energy waves can cause damage to cells in living things. Sometimes, though, these changes to cells can be helpful. Gamma radiation is used to kill cancer cells. Gamma-ray bursts are the most energetic and luminous electromagnetic events and can release more energy in 10 seconds than our Sun will emit in its entire 10-billion-year expected lifetime! Scientists can use gamma rays to determine the elements on other planets. This data can help scientists look for geologically important elements such as hydrogen, magnesium, silicon, oxygen, iron, titanium, sodium, and calcium.