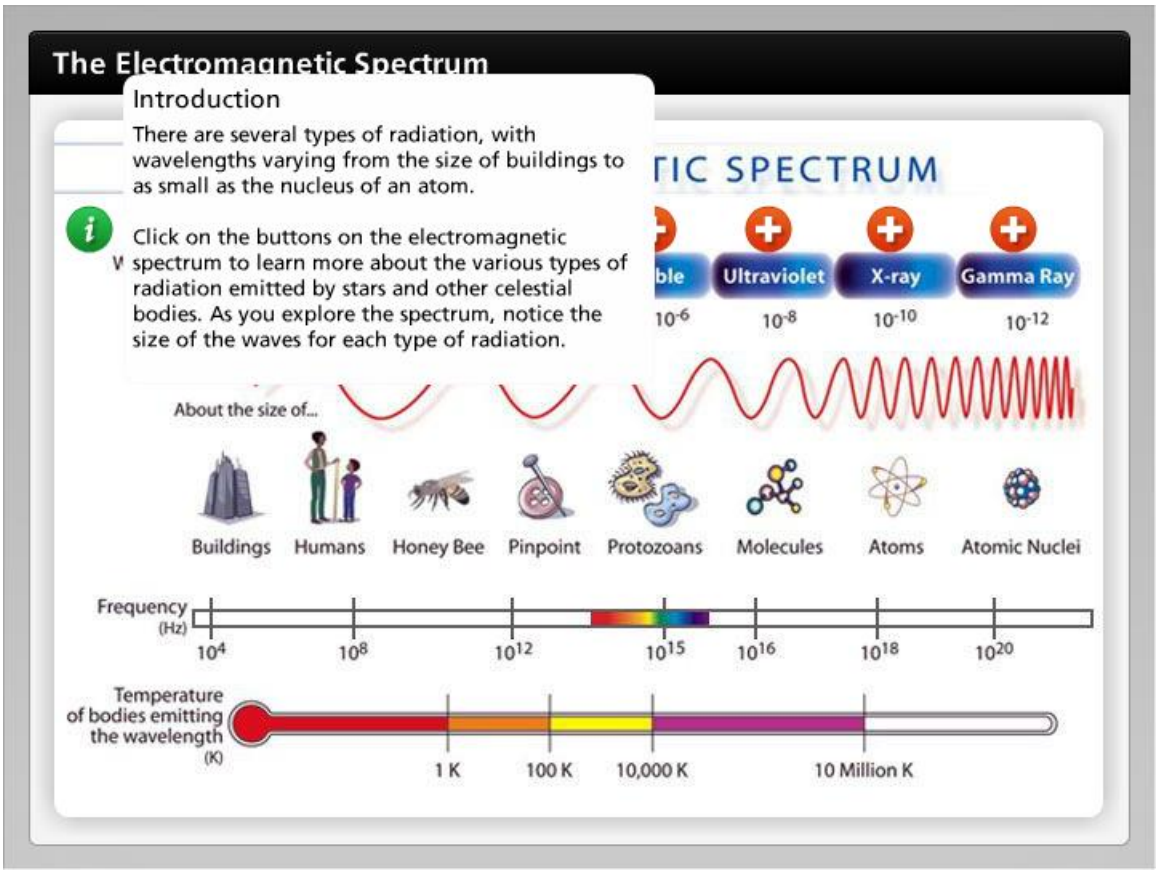
Module 4: Radiation and the Electromagnetic Spectrum
Topic 2 Content: The Electromagnetic Spectrum

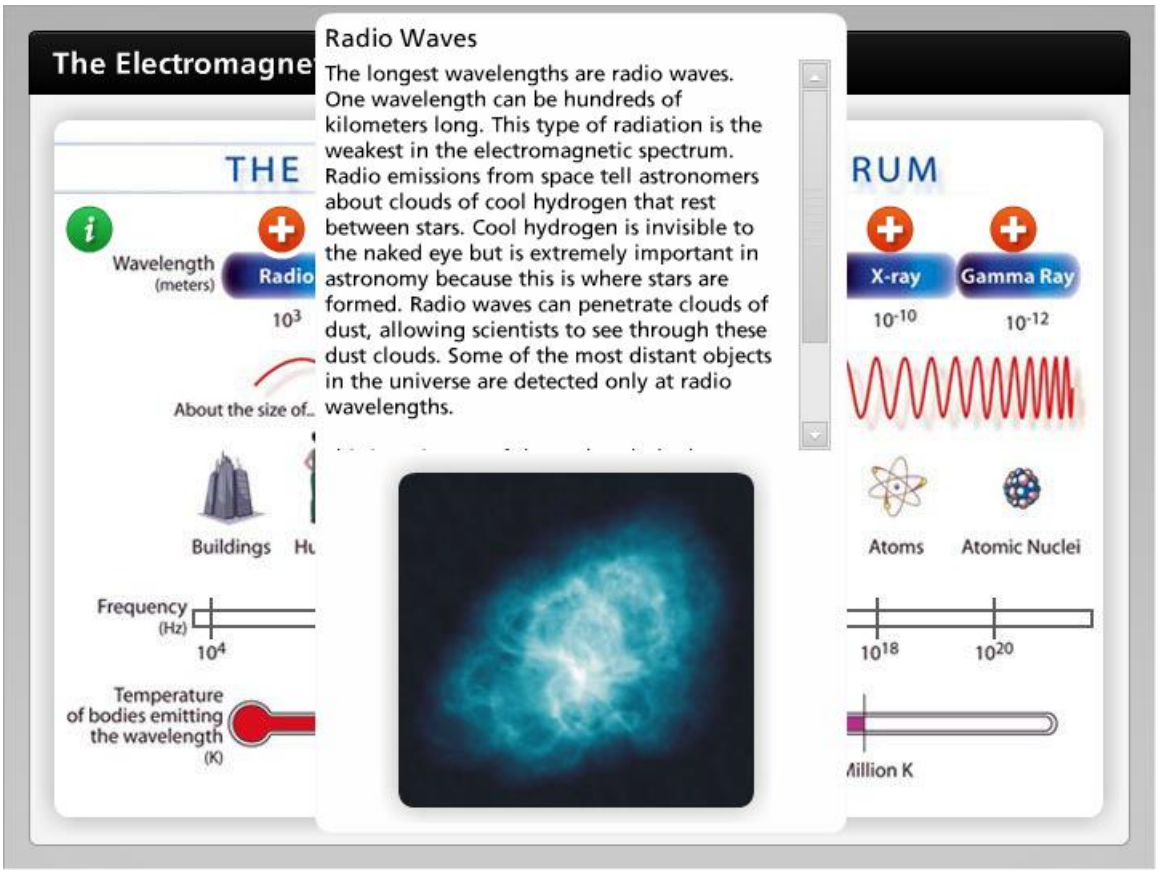
Introduction



There are several types of radiation, with wavelengths varying from the size of buildings to as small as the nucleus of an atom.

Click on the buttons on the electromagnetic spectrum to learn more about the various types of radiation emitted by stars and other celestial bodies. As you explore the spectrum, notice the size of the waves for each type of radiation.

Radio Waves

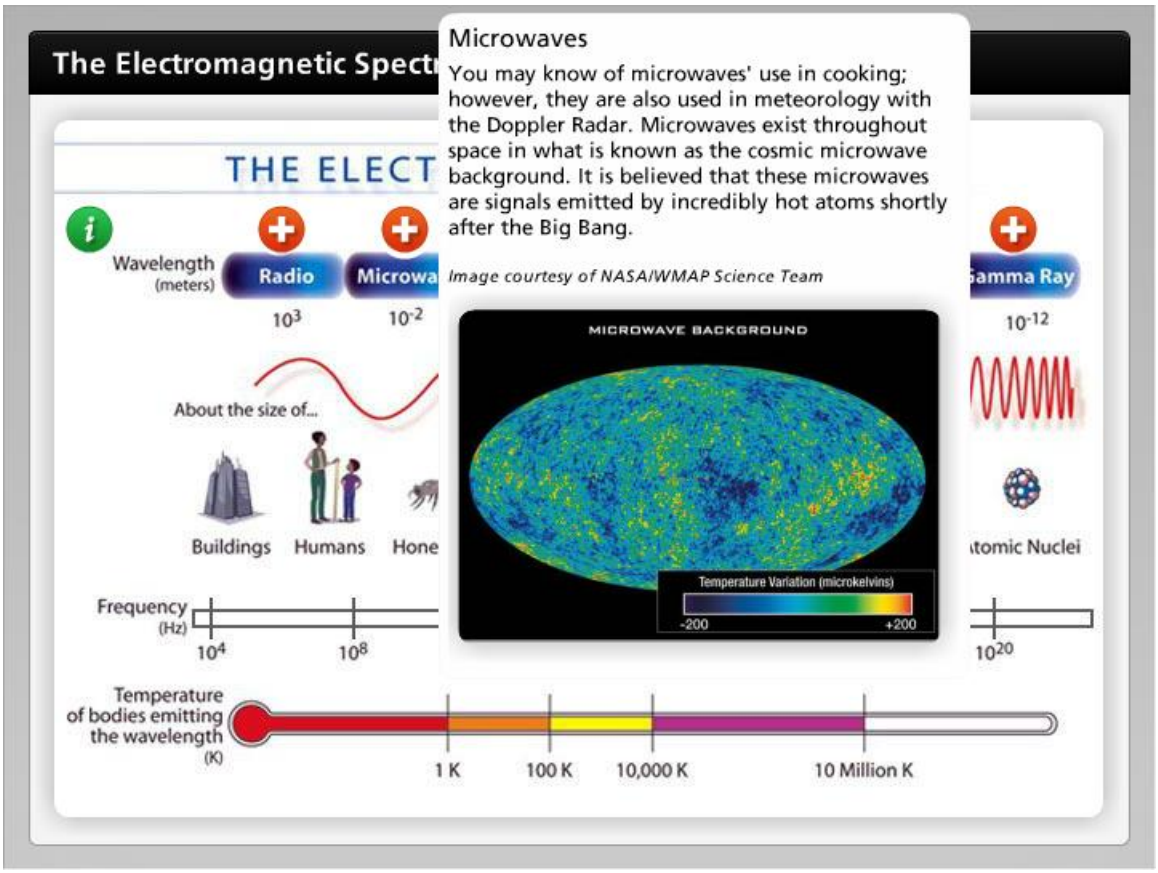


The longest wavelengths are radio waves. One wavelength can be hundreds of kilometers long. This type of radiation is the weakest in the electromagnetic spectrum. Radio emissions from space tell astronomers about clouds of cool hydrogen that rest between stars. Cool hydrogen is invisible to the naked eye but is extremely important in astronomy because this is where stars are formed. Radio waves can penetrate clouds of dust, allowing scientists to see through these dust clouds. Some of the most distant objects in the universe are detected only at radio wavelengths.

This is an image of the Crab Nebula shown with radio wavelength.

Image courtesy of NRAO/AUI and M. Bietenholz

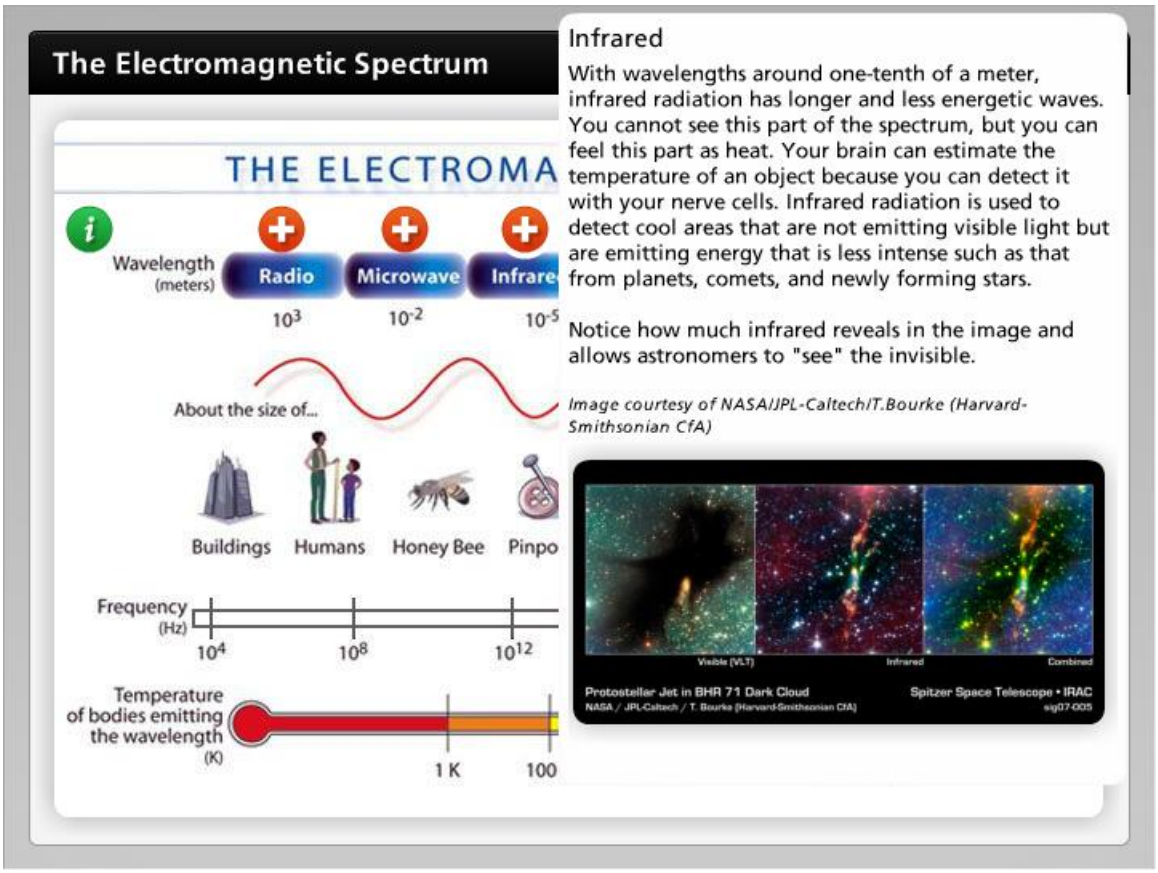
Microwaves



You may know of microwaves' use in cooking; however, they are also used in meteorology with the Doppler Radar. Microwaves exist throughout space in what is known as the cosmic microwave background. It is believed that these microwaves are signals emitted by incredibly hot atoms shortly after the Big Bang.

Image courtesy of NASA/WMAP Science Team

Infrared

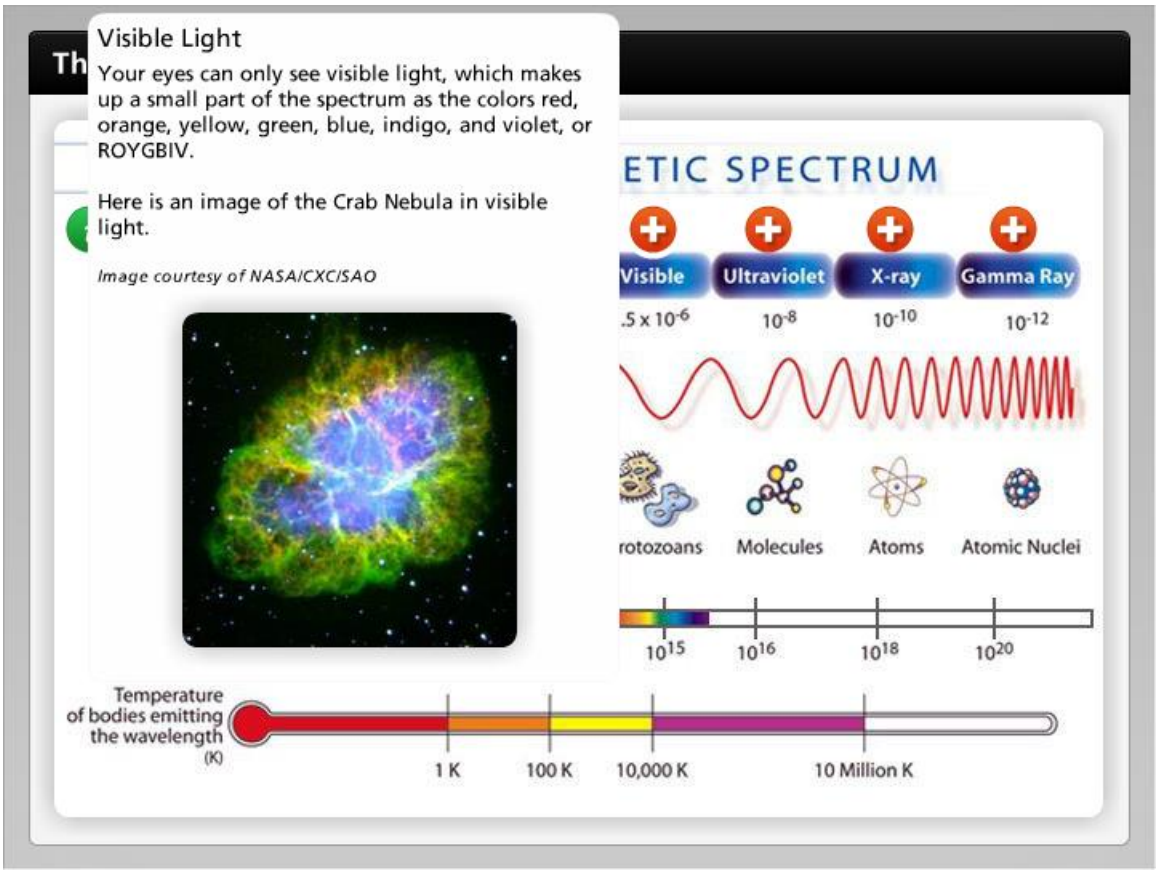


With wavelengths around one-tenth of a meter, infrared radiation has longer and less energetic waves. You cannot see this part of the spectrum, but you can feel this part as heat. Your brain can estimate the temperature of an object because you can detect it with your nerve cells. Infrared radiation is used to detect cool areas that are not emitting visible light but are emitting energy that is less intense such as that from planets, comets, and newly forming stars.

Notice how much infrared reveals in the image and allows astronomers to "see" the invisible.

Image courtesy of NASA/JPL-Caltech/T.Bourke (Harvard-Smithsonian CfA)

Visible Light

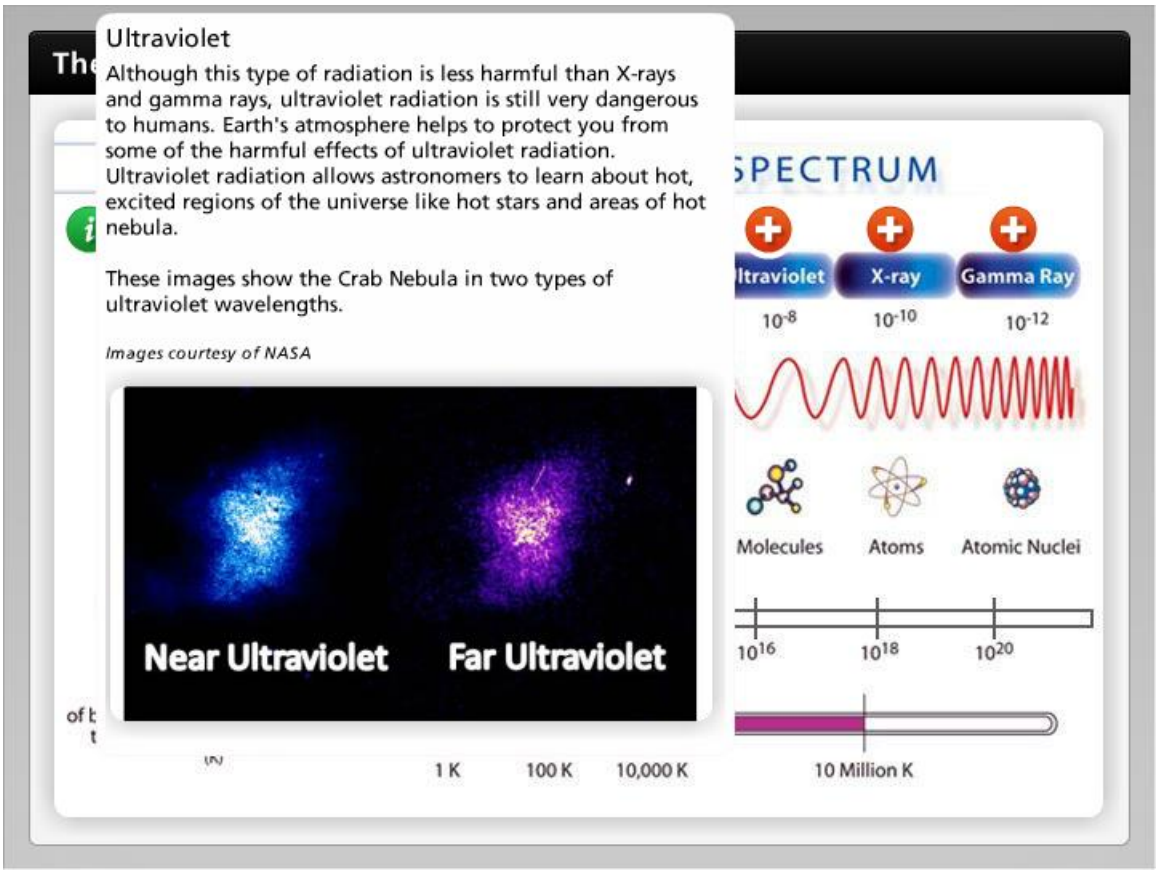


Your eyes can only see visible light, which makes up a small part of the spectrum as the colors red, orange, yellow, green, blue, indigo, and violet, or ROYGBIV.

Here is an image of the Crab Nebula in visible light.

Image courtesy of NASA/CXC/SAO

Ultraviolet

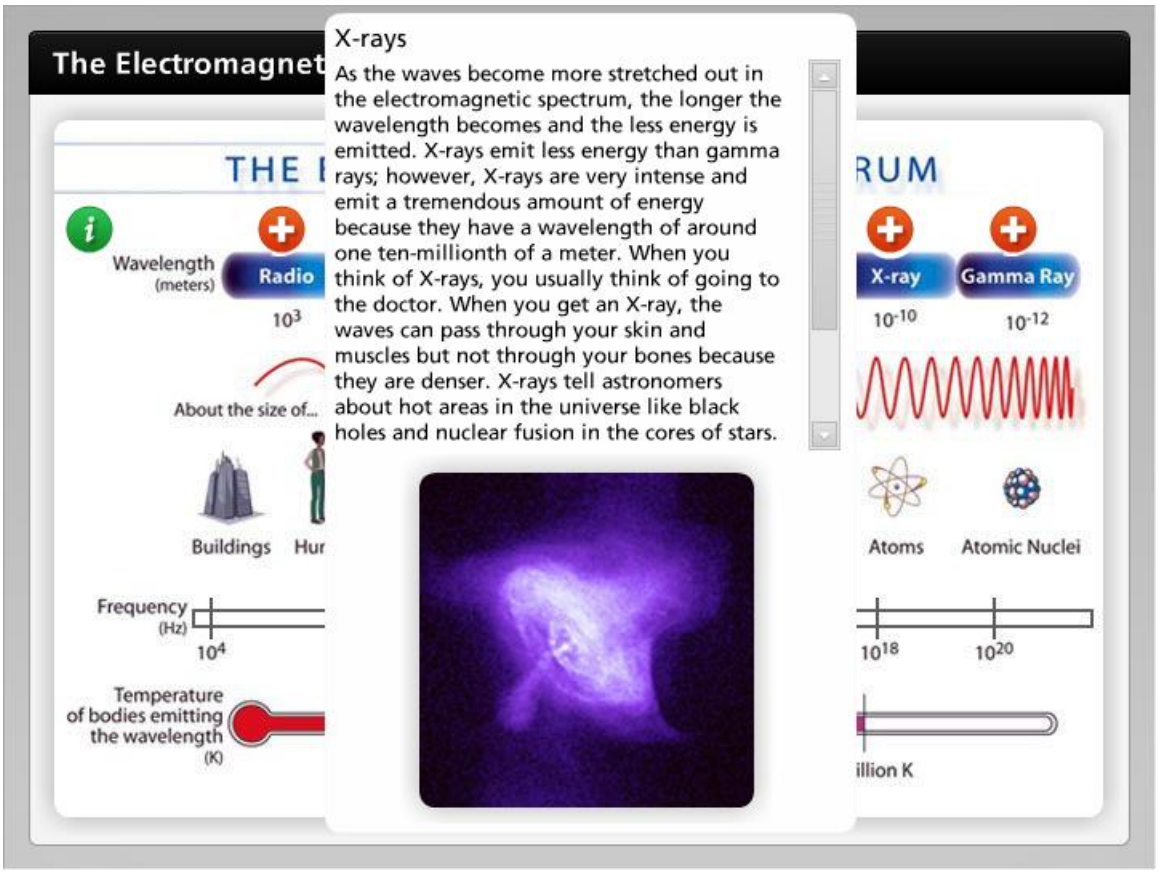


Although this type of radiation is less harmful than X-rays and gamma rays, ultraviolet radiation is still very dangerous to humans. Earth's atmosphere helps to protect you from some of the harmful effects of ultraviolet radiation. Ultraviolet radiation allows astronomers to learn about hot, excited regions of the universe like hot stars and areas of hot nebula.

These images show the Crab Nebula in two types of ultraviolet wavelengths.

Images courtesy of NASA

X-rays

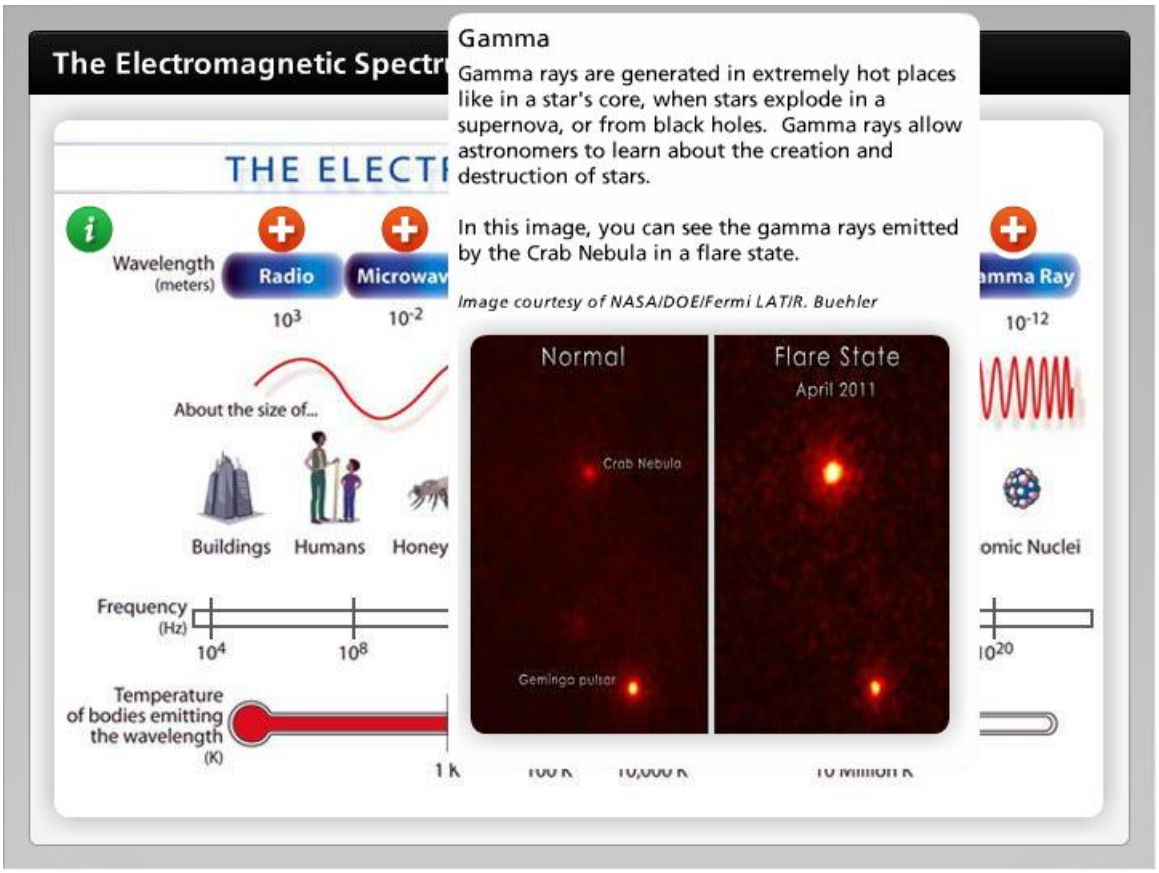


As the waves become more stretched out in the electromagnetic spectrum, the longer the wavelength becomes and the less energy is emitted. X-rays emit less energy than gamma rays; however, X-rays are very intense and emit a tremendous amount of energy because they have a wavelength of around one ten-millionth of a meter. When you think of X-rays, you usually think of going to the doctor. When you get an X-ray, the waves can pass through your skin and muscles but not through your bones because they are denser. X-rays tell astronomers about hot areas in the universe like black holes and nuclear fusion in the cores of stars.

Here is an image of the Crab Nebula in X-ray and how it would look in the visible part of the spectrum.

Image courtesy of NASA/CXC/SAO

Gamma



Gamma rays are generated in extremely hot places like in a star's core, when stars explode in a supernova, or from black holes. Gamma rays allow astronomers to learn about the creation and destruction of stars.

In this image, you can see the gamma rays emitted by the Crab Nebula in a flare state.

Image courtesy of NASA/DOE/Fermi LAT/R. Buehler