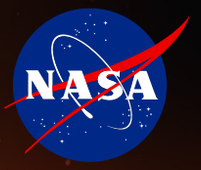
National Aeronautics and Space Administration



LIGHT IN THE UNIVERSE

Light is energy that can take on many forms.
Radio waves, microwaves, infrared, visible, ultraviolet,
X-ray and gamma radiation are all different forms of light.

www.nasa.gov

RADIO WAVES

Naturally occurring radio waves are made by lightning, or by astronomical objects.

Radio frequencies have been used in the medical field, for example to help treat sleep apnea.

NRAO Very Large Array

INFRARED

We experience far-infrared radiation every day in the form of heat that we feel from sunlight, a fire, or a warm sidewalk.

Infrared can also be used to detect protostars before they begin to emit visible light.

Spitzer Space Telescope

ULTRAVIOLET

Though ultraviolet wavelengths are invisible to the human eye, some insects, like bumble-bees, can see them.

Though some ultraviolet waves from the Sun penetrate Earth's atmosphere (and give us sunburns), most of them are blocked by various gases like ozone.

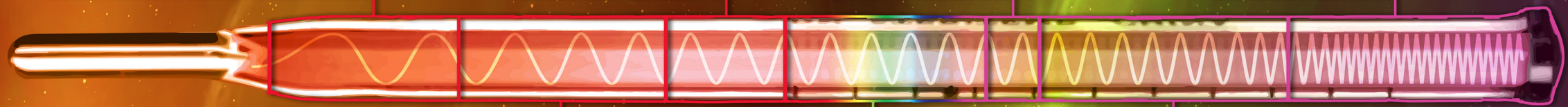
Solar Dynamics Observatory

GAMMA RAY

Natural sources of gamma rays include decays in the nuclei of atoms and lightning strikes, which can occur here on Earth as well as on other planets.

More typical production of gamma ray beams emanate from pulsars within the Milky Way galaxy.

Fermi Gamma-ray Space Telescope



MICROWAVES

Microwaves are good for transmitting information from one place to another because its energy can penetrate haze, light rain and snow, clouds, and smoke.

Active microwave experiments have also been done with objects in the solar system, such as determining the distance to the Moon or mapping the invisible surface of Venus through cloud cover.

Planck Space Telescope (no longer operating)

VISIBLE

Visible light (often referred to simply as light) is electromagnetic radiation that is visible to the human eye, and is responsible for the sense of sight.

The Sun is Earth's primary source of light. About 44% of the Sun's electromagnetic radiation that reaches the ground is in the visible light range.

Hubble Space Telescope

X-RAY

Earth's atmosphere is thick enough that virtually no X-rays are able to penetrate from outer space all the way to the Earth's surface.

The photons collected in space by X-ray telescopes reveal the hot spots in the Universe—regions where particles have been energized or raised to high temperatures by gigantic explosions or intense gravitational fields.

Chandra X-ray Observatory

H I G H L I G H T S

Light comes in different forms. The light that we see with our eyes is just a fraction of all light. Light also encompasses wavelengths ranging from radio waves to gamma rays in what is called the "electromagnetic spectrum."

Light can be described as a wave, with characteristics and behaviors that depends on how far apart the crests from each of its waves are spread (a.k.a. its "wavelength"). Alternatively, light can be viewed as composed of a stream of photons, with energies inversely proportional to the various wavelengths of light, so that short wavelengths correspond to high energies.

Nothing in the Universe can travel faster than light. In a vacuum, light travels at about 300,000 kilometers (186,000 miles) per second. This means light could circle the Earth 7.5 times in one second.

As light travels, its path can be bent when it goes from one medium to another (such as air to water). It can also be blocked (when a shadow occurs, for example), reflected (as with a mirror), or absorbed (like when a stone is heated by infrared light from the Sun.)

Humans have learned how to harness light and employ it in technologies ranging from medical devices to cell phones to giant telescopes.

CHANDRA.SI.EDU/LEARN_LIGHT.HTML

NASA's Marshall Space Flight Center in Huntsville, Alabama, manages the Chandra program for NASA's Science Mission Directorate in Washington. The Smithsonian Astrophysical Observatory in Cambridge, Massachusetts, controls Chandra's science and flight operations.