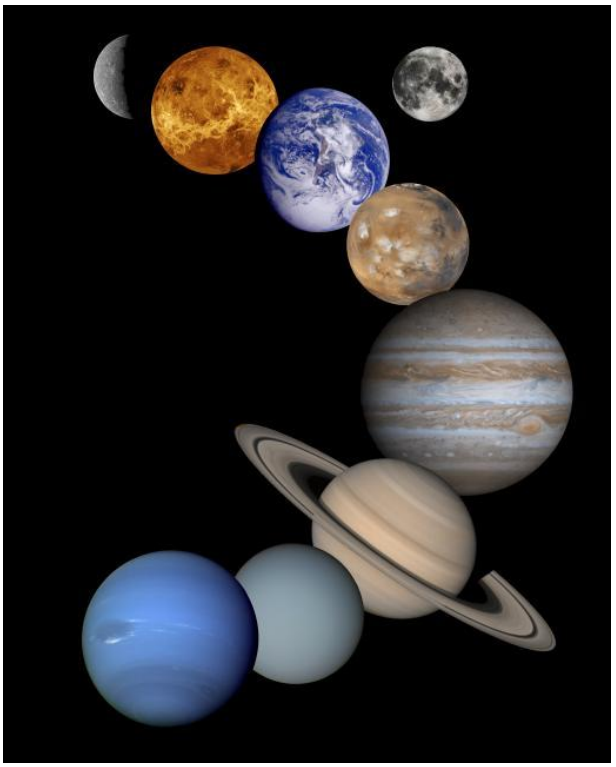
Cosmic Colors

An Adventure Along the Spectrum

Teacher's Guide



Cosmic Colors
An Adventure Along the Spectrum

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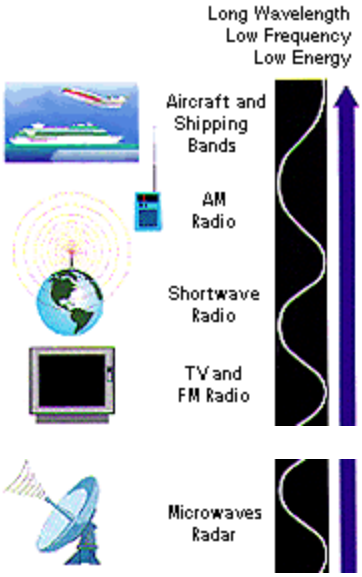
Introduction

We experience light and color every day. But the light we see is only a small part of the vast energy scale that we call the electromagnetic spectrum.

Measuring the electromagnetic spectrum

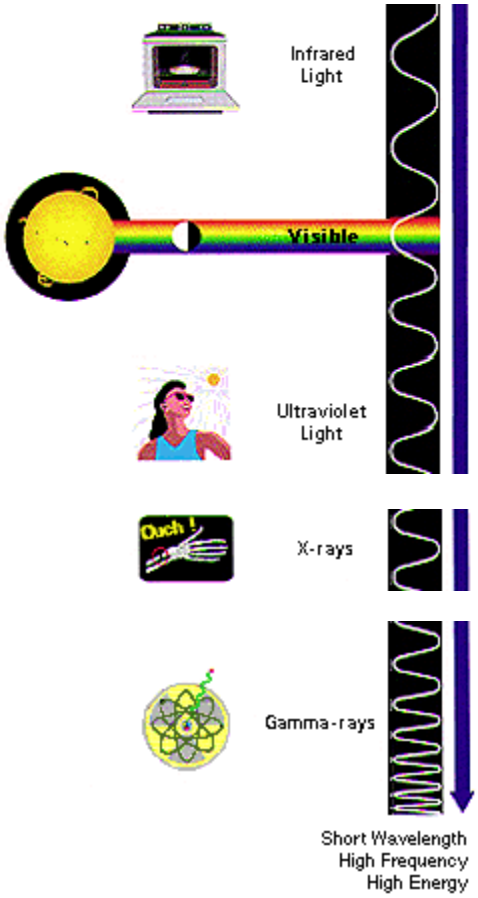
You actually know more about it than you may think! The electromagnetic (EM) spectrum is just a name that scientists give a bunch of types of radiation when they want to talk about them as a group. Radiation is energy that travels and spreads out as it goes-- visible light, that comes from a lamp in your house, and radio waves, that come from a radio station, are two types of electromagnetic radiation. Other examples of EM radiation are microwaves, infrared and ultraviolet light, X-rays and gamma-rays. Hotter, more energetic objects and events create higher energy radiation than cool objects. Only extremely hot objects or particles moving at very high velocities can create high-energy radiation like X-rays and gamma-rays.

Here are the different types of radiation in the EM spectrum, in order from lowest energy to highest.



Radio: Yes, this is the same kind of energy that radio stations emit into the air for your boom box to capture and turn into your favorite Mozart, Madonna, or Justin Timberlake tunes. But radio waves are also emitted by other things ... such as stars and gases in space. You may not be able to dance to what these objects emit, but you can use it to learn what they are made of.

Microwaves: They will cook your popcorn in just a few minutes! Microwaves in space are used by astronomers to learn about the structure of nearby galaxies, and our own Milky Way!



Infrared: Our skin emits infrared light, which is why we can be seen in the dark by someone using night vision goggles. In space, IR light maps the dust between stars.

Visible: Yes, this is the part that our eyes see. Visible radiation is emitted by everything from fireflies to light bulbs to stars ... also by fast-moving particles hitting other particles.

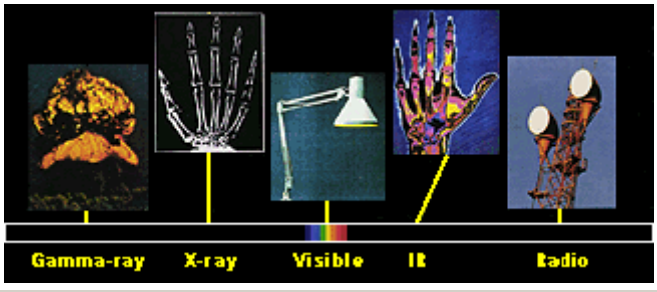
Ultraviolet: We know that the Sun is a source of ultraviolet (or UV) radiation, because it is the UV rays that cause our skin to burn! Stars and other "hot" objects in space emit UV radiation.

X-rays: Your doctor uses them to look at your bones and your dentist to look at your teeth. Hot gases in the Universe also emit X-rays .

Gamma-rays: Radioactive materials (some natural and others made by man in things like nuclear power plants) can emit gamma-rays. Big particle accelerators that scientists use to help them understand what matter is made of can sometimes generate gamma-rays. But the biggest gamma-ray generator of all is the Universe! It makes gamma radiation in all kinds of ways.

A Radio Wave is not a Gamma-Ray, a Microwave is not an X-ray ... or is it?

We may think that radio waves are completely different physical objects or events than gamma-rays. They are produced in very different ways, and we detect them in different ways. But are they really different things? The answer is 'no'. Radio waves, visible light, X-rays, and all the other parts of the electromagnetic spectrum are fundamentally the same thing. They are all electromagnetic radiation.



Radio waves, visible light, X-rays, and all the other parts of the electromagnetic spectrum are fundamentally the same thing, electromagnetic radiation.

Student Activities

Electromagnetic radiation can be described in terms of a stream of photons, which are massless particles each traveling in a wave-like pattern and moving at the speed of light. Each photon contains a certain amount (or bundle) of energy, and all electromagnetic radiation consists of these photons. The only difference between the various types of electromagnetic radiation is the amount of energy found in the photons. Radio waves have photons with low energies, microwaves have a little more energy than radio waves, infrared has still more, then visible, ultraviolet, X-rays, and ... the most energetic of all ... gamma-rays.

★ NASA - Space-Based Astronomy Educator Guide

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Space.Based.Astronomy.html

The units of study in this guide include hands-on science activities about the electromagnetic spectrum.

Resource Type: Educator Guide **Grade Level:** 5-8

Subjects Covered: History > Historical Overviews | Physical Science > Chemistry | Physical Science > Optics | Space Science > Astronomy | Space Science > Telescopes | Technology > Photography and Imaging | Technology > Rocketry |

★ NASA - The Electromagnetic Spectrum Unit

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/The_Electromagnetic_Spectrum.html

Investigate the visible light spectrum using five activities. This unit calls for students to build simple spectroscopes to study visible light. Lesson plans in this unit include Simple Spectroscope; Project Visible Spectra; Cereal Box Spectroscope; Red Shift, Blue Shift; Wavelength and Energy; and Resonating Atmosphere. Reproducible student sheets are included.

Note: This activity is part of the NASA Space-Based Astronomy Educator Guide, listed above.

Resource Type: Classroom Activity, Lesson Plan **Grade Level:** 5-8

Subjects Covered: General Science > Light | General Science > Matter

★ NASA - Space Place: See All the Cosmic Colors!

http://spaceplace.nasa.gov/cosmic-colors/en/
Learn how new telescopes add to human knowledge and understanding of the universe. Explanations and images are given for optical, radio, infrared, ultraviolet, X-ray, and gamma ray telescopes.
Resource Type: Web Site **Grade Level:** 5-8, 9-12

Subjects Covered: Physical Science > Heat and Light | General Science > Light

★ NASA - Build Your Own Spectroscope

http://solar-center.stanford.edu/activities/cots.html
Students build and learn how to use their own spectroscope to observe how white light can be refracted to form a color spectrum.
Resource Type: Web Site **Grade Level:** K-4, 5-8, 9-12

Subjects Covered: Physical Science > Heat and Light | General Science > Light

★ NASA - Wavelength and Energy

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Wavelength_Energy.html
Demonstrate the relationship between wavelength, frequency and energy by using a rope.
Resource Type: Classroom Activity **Grade Level:** 5-8

Subjects Covered: | General Science > Solar System and Stars

★ NASA - Electromagnetic Math

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Electromagnetic_Math.html
Electromagnetic Math is designed to supplement teaching about electromagnetism. Students explore the simple mathematics behind light and other forms of electromagnetic energy including the properties of waves, wavelength, frequency, the Doppler shift, and the various ways that astronomers image the universe across the electromagnetic spectrum to learn more about the properties of matter and its movement.

Resource Type: Classroom Activity, Lesson Plan, Educator Guide **Grade Level:** 5-8, 9-12

Subjects Covered: Mathematics > Computation and Estimation | Mathematics | Mathematics > Geometry | Mathematics > Algebra | Mathematics > Graphs | Mathematics > Measurement | Physical Science > Heat and Light | Space Science > Solar System and Planets |

★ NASA - Discovering Color With a Prism

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Discovering_Color.html

Sir Isaac Newton first performed this experiment about 300 years ago. Newton let a beam of sunlight pass through a glass prism and observed the spectrum. Students will make similar observations. Instructions for making a prism out of plastic are included.

Resource Type: Classroom Activity, Lesson Plan **Grade Level:** 9-12

Subjects Covered: Physical Science > Heat and Light | Physical Science > Optics

★ NASA – Multi-Wavelength Milky Way

http://mwmw.gsfc.nasa.gov/

The site presents and explains how data sets across the electromagnetic spectrum are used by astronomers to learn about the Milky Way's shape, size and composition.

Resource Type: Web Site **Grade Level:** K-4, 5-8, 9-12, Graduate Professional

Subjects Covered: Physical Science > Heat and Light | Space Science > Astronomy | General Science > Light

Audiovisual Resources

★ NASA - Cool Cosmos: Multi-wavelength Astronomy Gallery

http://coolcosmos.ipac.caltech.edu/cosmic_classroom/multiwavelength_astronomy/multiwavelength_museum/

Learn about the wealth of data available at wavelengths beyond the familiar visible spectrum. Discover important characteristics of astronomical phenomena, and learn about which types of radiation are best suited for studying certain objects.

Resource Type: Web Site **Grade Level:** 5-8, 9-12

Subjects Covered: Physical Science > Heat and Light | General Science > Light

★ NASA - Atmospheric Arcade

http://calipsooutreach.hamptonu.edu/arcade.html

Enjoy these fun animations that teach about aerosols and facts relating to the atmosphere: The Light Spectrum, Layers of the Atmosphere, The Greenhouse Effect, Atmospheric Aerosols Book, Cloud Match Game, and Changes in Atmospheric Optical Depth.

Resource Type: Computer Activity, Web Site **Grade Level:** K-4, 5-8, 9-12

Subjects Covered: Earth Science > Environment | Earth Science > Meteorology | General Science > Earth's Weather | General Science > Light | General Science > Planet Earth

★ NASA Launchpad: Spectroscopy

http://www.youtube.com/watch?v=oRm0z8ggJSk

This NASA video introduces the electromagnetic spectrum and gives examples of space-based objects as observed through spectroscopy.

Resource Type: Video. **Grade Level:** 5-8

Subjects Covered: Physical Science > Electromagnetic Spectrum > Spectroscopy