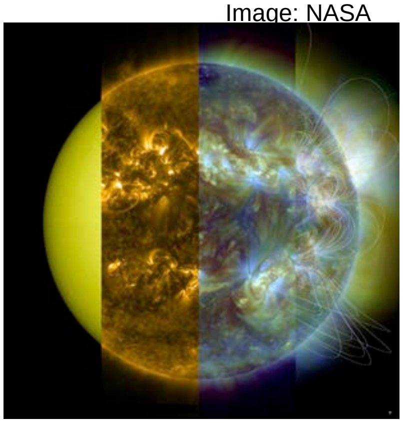
Module 2: Why do we study the Sun?

Activity C: Solar Research in Action! – Build a Spectroscope

Overview

Our Sun is a star that it has the same characteristics as other stars in the universe. The Sun consists of plasma and super-heated gases, which interact to give off heat, light and other types of energy that are classified as the Electromagnetic (EM) Spectrum. The EM Spectrum is composed of various forms of energy arranged according to their increasing frequency and decreasing wavelength – from low energy Radio Waves to high-energy Gamma Rays.

Image: NASA



Solar scientists can interpret the Sun's and other stars' "fingerprint" characteristics by using a sophisticated instrument called a spectroscope. A spectroscope can detect Visible light as well as all the invisible light wavelengths of Radio Wave, Microwave, Ultraviolet, X-ray, and Gamma Ray radiation in the EM Spectrum. This information can enlighten scientists as to what elements a star is burning for fuel, its temperature, and even the speed and direction an object is moving or rotating in space.

Team Goal

As a group, your goal is to construct a spectroscope to refract Visible light into its rainbow of colors, and classify each color according to its wavelength and frequency along the Electromagnetic Spectrum.

Materials

Teacher Overview

The focus of Module 2C is to enable students to explore and understand the concept of the Electromagnetic Spectrum by modeling how the Solar Dynamic Observatory (SDO) instruments record images in different wavelengths of light energy.

Our Sun is a star that it has the same characteristics as the other stars in the universe. The Sun consists of extremely hot gases and plasma that interact to give off heat, light, and other types of energy that are classified as the Electromagnetic (EM) Spectrum. The EM Spectrum is composed of various forms of energy arranged according to their increasing frequency and decreasing wavelength – from low energy radio waves to high-energy gamma rays. The Sun gives off light energy that we can see in the Visible (white) light waveband of the electromagnetic spectrum. Visible light lies mid-point along the EM Spectrum. Visible light can bend or refract, which causes it to separate into the color spectrum – the rainbow "ROY G BIV" color bands.

Solar scientists use spectroscopes to interpret the Sun's and other stars' composition. A spectroscope gives an EM Spectrum "fingerprint" of the elements contained in stars, including our Sun. Each element has a unique spectral pattern so by analyzing the spectrograph pattern of a star it is possible for scientists to determine what specific elements make up the star and its atmosphere.

•"Graphing the Rainbow" worksheet
•"Build a Spectroscope" lab sheet
•Cereal box
•Scissors
•Tape

Shared with class:
•Spectra gas tubes – Helium, Hydrogen, Nitrogen & Neon
•Power source
•Diffraction gradient

Objectives
Students will be able to:

- Create and use a spectrograph (spectroscope) to observe visible light (white light) by refracting it into its color spectrum (ROYGBIV).
- Demonstrate that the Sun emits radiant energy within the Electromagnetic Spectrum.
- Understand how astronomers use special tools (spectroscope) to learn more about objects that are so far away.
- Explain how spectroscopy data helps astronomers learn more about the composition of the Sun and other stars.

Essential Vocabulary

- Electromagnetic Spectrum
- Wavelength
- Frequency
- Spectrograph/Spectroscope
- Spectroscopy
- Refraction

Module Lesson
Time: 1 block period/1-2 class periods

Materials:
Per team:

- Cereal box
- Scissors
- Tape
- Linear diffraction grating slide (1000 lines/mm available from www.sciencestuff.com & www.rainbowsymphonystore.com)
- "Graphing the Rainbow" worksheet
- "Build a Spectroscope" lab sheet

Shared with class:

- Spectra gas tubes – Helium, Hydrogen, Nitrogen & Neon (gas spectra tubes)
- Power source

Teacher Prep:

- Order holographic diffraction grating slides & spectra gas tubes
- Students bring in sturdy box
- Build a sample spectroscope as a student demonstration
- Make copies of "Graphing the Rainbow" worksheets & "Build a Spectroscope" lab sheets
- Set-up light station with gas tubes
- Prepare remaining materials

Engage & Explore!

<u>1. BUILD Knowledge:</u>

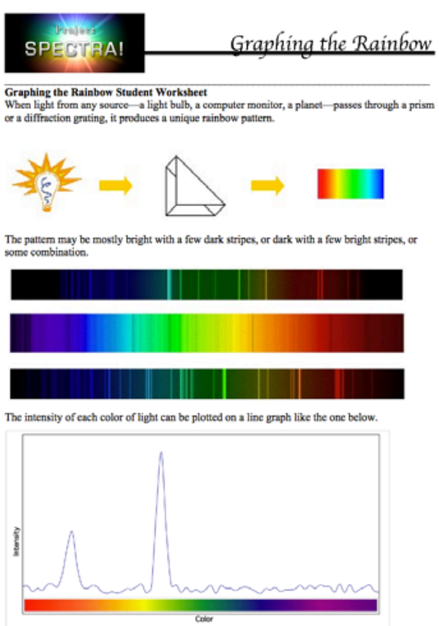
EM Spectra

The Sun gives off light energy that we can see in the Visible (white) Light waveband of the Electromagnetic Spectrum. Visible Light is mid-point along the EM Spectrum. Visible Light can bend or refract, which causes it to separate into the color spectrum of the rainbow Red, Orange, Yellow, Green, Blue, Indigo, and Violet – the ROYGBIV color bands. Get familiar with how to look at different wavelengths of visible light with these NASA and LASP resources:

[Spectroscopy in Action Video]
[Spectroscopy Explained]
[Graphing the Rainbow Activity]

Student Engage/Explore Activities
<u>1. BUILD Knowledge:</u>
EM Spectra
Have a demonstration model of a spectrograph available for groups to see before building their own. Provide each team with one copy of "Graphing the Rainbow" instructions teams and have teams read aloud the instructions together. Then, students within each team complete the spectra worksheet together.

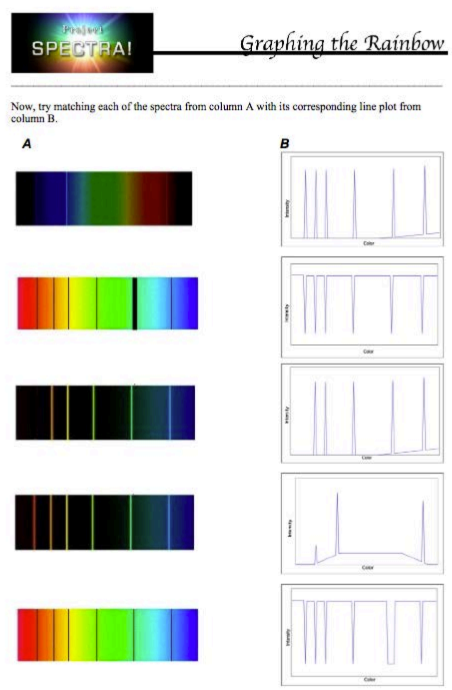
[Spectroscopy in Action Video]
[Spectroscopy Explained]
[Graphing the Rainbow Activity]


Project SPECTRA! *Graphing the Rainbow*

Graphing the Rainbow Student Worksheet
When light from any source—a light bulb, a computer monitor, a planet—passes through a prism or a diffraction grating, it produces a unique rainbow pattern.

The pattern may be mostly bright with a few dark stripes, or dark with a few bright stripes, or some combination.

The intensity of each color of light can be plotted on a line graph like the one below.


Project SPECTRA! *Graphing the Rainbow*

Now, try matching each of the spectra from column A with its corresponding line plot from column B.

A B

2. CREATE Resources & CONNECT to the Real World:

Build a Spectroscope

In this activity, your group will create a functional artifact as part of the Module 4 SDO Exploration Museum 3-D Solar Exhibit. As a scientific team, take turns reading the "Build a Spectroscope" lab sheet background information and instructions aloud. Next, gather the required materials and follow the instructions to construct your spectroscope. Refer to the demonstration spectrograph to ensure your design is correct. Then, complete the "Build a Spectroscope" lab sheet questions. During the investigation, make sure each team member views each of the mystery gas tubes using your spectroscope. Have fun seeing things in a "new light"!

Build a Spectroscope Activity (see attached file)

Student Engage/Explore Activities

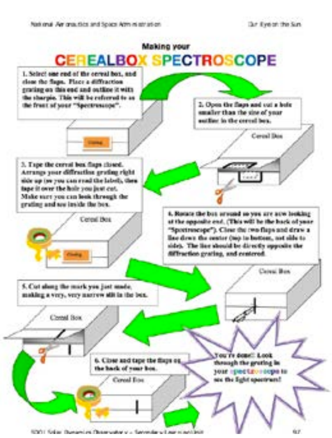
2. CREATE Resources & CONNECT to the Real World:

Build a Spectroscope

In this activity, groups will create a functional artifact as part of their Module 4 SDO Exploration Museum 3-D Solar Exhibit. Hand out instructions and materials for the "Build a Spectroscope" activity to each group. As a team, students will take turns reading the "Build a Spectroscope" background information and instructions aloud. Next, teams gather the required materials and follow the instructions to construct their spectroscope. Remind students to refer to the demonstration spectroscope to ensure their design is correct. After teams have read and reviewed the steps of the activity, they may rotate through each of the mystery gas stations. Team members view the gas tube with their spectroscope and the team collectively answers the activity worksheet questions.

Build a Spectroscope Activity (see attached file)

SDO Lesson Suite



Excellent, you're an EM Spectrum Expert!

Differentiation/Extension
EM Exploration:
Set up different direct light sources (projector, flashlight, headlamp, etc.) and provide a variety of clear shaped prisms for students to informally explore the refraction of visible light into its rainbow spectrum. Students note the colors that they observe, the order of the colors, and the thickness of the color bands that each of the various shaped prisms refract. From this information, students create a color poster of the colors (ROYGBIV) that make up the visible light waveband and creatively illustrate each color in the correct order from the longest wavelength/lowest frequency (red) to the shortest wavelength/highest frequency (violet).

Internet Resources
Stanford Solar Center Spectroscope
STEREO Build a Spectroscope
LASP Build & Use a Spectrograph
NASA Spectroscope pp. 93-100