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.

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
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!

1. BUILD Knowledge:

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
1. BUILD Knowledge:
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
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)
### 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