

XII...Seeing Auroral Lights from Space

Introduction:

What does the Ultraviolet Imager on the IMAGE satellite do? Do you remember using a "magic decoder " to find hidden messages? These decoders worked by having you look through a colored filter to reveal the hidden message. Your decoder absorbed the parts of the picture in your color and only the other colors were visible. In these lessons, the students will experiment with using color filters. Then the students will see how the sun's light can be broken into many colors through the use of a spectrograph. The students will learn that some light is not visible to our eyes, but could be ultraviolet. It is ultraviolet light that is used in satellites to make images of things we can not normally see. The Extreme Ultraviolet Imager (EUV) and the Far Ultraviolet Imager (FUV) are both highly specialized cameras that filter out extraneous light, recording images only through specific light energy.

Materials:

Crayola crayons

Paper- white

Red Cellophane- Available at Michael's Craft stores (store locations at <http://www.michaels.com/craft/online/home>) or Ben Franklin Craft Stores (store locations at <http://www.benfranklinstores.com/newpage/bfcrafts.htm>)

Diffraction grating - (can be ordered from Arbor Scientific - use lens of Rainbow glasses; or Edmund Scientific (1-800-728-6999 or <http://www.edsci.com>)

Objectives:

- The students will explore how the use of filters can change what you see.
- The students will explore that visible light can be divided into a spectrum of colors.
- The students will explore that not all light is visible, for example ultraviolet.
- The students will explore that instruments like the FUV and EUV use ultraviolet light to make images of items in space.

Shoe box with lid
Index cards (3x5)
Scissors
Tape
Rubber bands

Prism - Equilateral (can be ordered from Arbor Scientific)

UV Beads - these are beads that change color in the presence of Ultra Violet light and are available from Arbor Scientific at (1-800-367-6695 or <http://www.arborsci.com/catalog.htm>)

- bag of 200 beads for \$5.95

Procedure:

- The students will be creating their own magic decoders. Each student will need to write a message in blue or purple crayon very lightly on a 3x5 index card. Then each student will need to color over the message using red, orange and yellow crayons to hide their message. Have the students exchange messages and give them a decoder (red cellophane) to find the message on their new paper. If the hidden messages are done carefully, the messages should be hard to decode without the filter. The FUV and EUV instruments use this same filtering mechanism when collecting information in space.
- What does a spectroscope do? A spectroscope demonstrates white light split into its component colors. The students will need to cut an opening at each end of the box the same size as the rainbow glass lens or the diffraction grating. Next, cut an index card in half, and tape the two halves over one cut opening creating a vertical slit (about 3/16" wide). Cover the other opening by taping the lens of the rainbow glasses or the diffraction grating on. (The students may find that they need to rotate the diffraction grating so that the spectrum extends in both directions from the slit.) Place the lid on the box and use rubber bands to hold the lid on. The students will need to point the box at a light source (never the sun!) and look through the diffraction grating to see the spectrum of colors, which should be displayed on the side of the box. Can the students see seven separate colors or do some blend together? Have the students draw and label the colors of the spectrum observed, in the center of a piece of white paper. Then students can hold their spectroscopes up to other light sources, draw the observed spectrum, and compare the results.
- How does the visible light split into colors? To demonstrate this, you will be modifying the spectrograph made in the previous activity. Carefully remove the rainbow glasses or diffraction grating, this opening will now become the viewing opening. Move one of the index cards at the other end to widen the slit for the sun's light to enter. This next part gets tricky and takes a lot of adjustments, but it makes it easier for group demonstrations and longevity of the equipment. Locate the approximate mid-point of the inside of the lid, and using long pieces of tape suspend the prism so that it hangs down low enough to be visible through the slit in the side. You may need to put the lid on the box and make adjustments to the location and rotation of the prism several times until the spectrum is visible on the inside of the lid, close to the viewing opening. Once you have the prism set, add extra tape to hold it securely. This instrument operates by pointing the side of the box with the slit (or the lens) toward the sun, looking through the viewing opening toward the lid and by making simple changes in the angle of the box toward the sun until you see the spectrum.

- Initiate a discussion with the students about what they observed. The students should now realize that visible light is divided into a spectrum of color by using a scientific instrument. Explain to the students that there are more non-visible lights that exist. Again with slight modifications to the spectrograph, the presence of non-visible light, namely ultraviolet can be demonstrated. The UV beads are very sensitive to UV light from sunlight, so you will need to do the next few parts inside. String 8-10 UV Beads onto a pipe cleaner or a rubber band having the students note the color. Then tape the strand of UV Beads to the inside of the lid where the spectrum is displayed. Take the box back outside, adjust the angle of the box so that the spectrum is on the beads. The beads will appear to be lit up by the spectrum, after a few minutes, carefully hold the box up over the students heads and lift the lid just enough for the students to see the UV Beads. They should see that some of the beads are now different colors. What made only these beads change color and not all of them? Explain to the students that the color components of light have different wavelengths. You can demonstrate wavelengths on the board by drawing two different sets of waves. One of the waves peaks will be further apart than the other. The colors of the spectrum and ultra violet light have different wavelengths, which affects our ability to see them. Take some of the UV Beads outside and allow the students to watch them change color. Why was the color change more dramatic without the prism and box? Why would a scientist want to use an ultra violet filter when making observations in space?

Conclusions:

The students will develop and modify an instrument that will help them understand how scientist use filters to remove extraneous light in order to focus on specific information.



