Colors of the Aurorae

Photographs of the aurora tend to be dominated by just a few colors, primarily green followed by red. This activity explores the source of these colors by using simple diffraction gratings or spectrometers and spectrum tubes.

Objectives

This activity is a pared down variation on the Spectroscopes activity found in PASS, *Colors From Space*. It has students explore the colors given off from oxygen and nitrogen when they are excited by high-energy particles, just as happens during the aurora. In this activity, the students will be able to:

1. Record the spectral lines of nitrogen and oxygen.
2. Compare the colors of these spectral lines to actual photographs of the aurora.

Materials

For the class

- Spectrum Tube Power Supply
- Spectrum tubes for Nitrogen and Oxygen
- Bright White light source.
- Pictures of Aurora

For each 3-4 students

- Sets of colored pencils to draw the colors of the emission lines.

For each student

- Sheet of paper for drawing Spectra.
- Diffraction Grating OR Spectrometer**

You can get free (for cost of shipping) spectroscope posters from Stanford Solar Center complete with gratings that easily fold into a useable spectroscope. See http://solar-center.stanford.edu/posters.html

In Class

1. Do you have any ideas on what causes the colors in the Northern Lights?

Show pictures of the aurora. If these are not available, prompt them to recall what colors were most prominent in the video and pictures from the planetarium show. Accept any answers at this point.

2. Diffraction gratings and spectra.

Hand out diffraction gratings or spectroscopes to the students and turn on the white light source.

Some of you may know that when we see a light that often what we are seeing is not the one color our eyes are telling us is there, but we are actually seeing a mixture of colors. You are now each being provided with a device that allows us to separate light into its component colors. In the center of the room is a source of light.

What color does this source appear to your eyes? [White.]

3. The colors in white light.

Hold your diffraction grating up to your eye, and look toward the white light source.

What do you see through the grating? [Rainbows.]

Make sure that students are looking just off to the side of the light source and not directly at the source. Have the students sketch what they see on the Drawing Spectra sheet.

4. Spectrum of nitrogen.

Let the students look at the glowing nitrogen spectrum tube.

** This can be as simple as a piece of diffraction grating mounted in a slide mount to the spectrometers as described in PASS *Colors From Space*. The spectrometers will allow older students to actually measure the wavelengths of the emission lines. Learning Technologies, Inc. (http://www.starlab.com) sells an excellent spectrometer that would be suitable for this activity also.

Now we are turning on a light that is made by passing an electrical current through a tube filled with nitrogen gas.

Do you know anything about nitrogen gas and where it is found? [Nitrogen gas is in our atmosphere, and is the most common gas in the Earth's atmosphere. It accounts for about 80% of the air we breathe.]

Compare the color of the light before looking through the diffraction grating and after looking through the grating.

What do you see now? Do you see any colors that appear in the aurora?

Students should see a pattern of bright lines with spaces in between them. These bright lines are known as emission lights and are caused by the atoms of nitrogen converting the energy from the electrical current into visible light. Have them sketch this on their Drawing Spectra data sheets.

5. Spectrum of oxygen.

If nitrogen gas is the most common gas in our atmosphere, does anyone know what is the second most common gas is? [Oxygen.]

We will now look at the light from the second most common gas, which is oxygen.

How is this different from nitrogen? How is it the same? Do you see any colors similar to that of the aurora?

Again, students should see a pattern of bright emission lines, but these will be in different places and of a different pattern. Again, have them sketch what they see.

6. Discuss sources of colors in the aurora.

We have seen how an electrical current passing through a gas can cause it to glow with light of very specific colors. In this case, we looked at the colors given off by the two most common gasses in the Earth's atmosphere. We noted that the colored lines given off by these gasses contain the same colors that we see in the aurora.

How can we put all this together to explain the colors of the aurora?

Students may have to review, or may remember that the aurora are caused by charged particles that hit our atmosphere and cause atoms to emit light. With older students, the concept may be in place that an electrical current is the flow of electrons or charged particles. They can then relate the charged particles in the Earth's magnetosphere that cause aurorae to the flow of charged particles in the spectrum tubes. With younger students, you may have to just explain that when electrical particles from space smash into the gases of our atmosphere they will see a glow of these colors.

Going Further

1. Hunt for spectra of elements on the Worldwide Web.
2. Look at spectra of other elements found in air, e.g. H_2O and CO_2.