

16B Spectroscopy

How do we know other stars are like the sun?

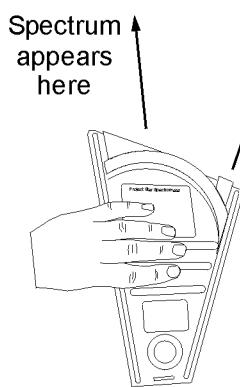
With the exception of the sun, stars appear as mere specks of light in the night sky. Using spectroscopy, astronomers can analyze the light from stars to determine their temperature, chemical composition, and even how fast they are moving. In this Investigation, you will learn how to analyze light using spectroscopy to determine which elements are present in different light sources. You will then analyze the light emitted by a main sequence star (the sun) to determine its chemical composition.

Materials

- Project STAR spectrometer
- Colored pencils
- Access to light from incandescent and fluorescent light fixtures

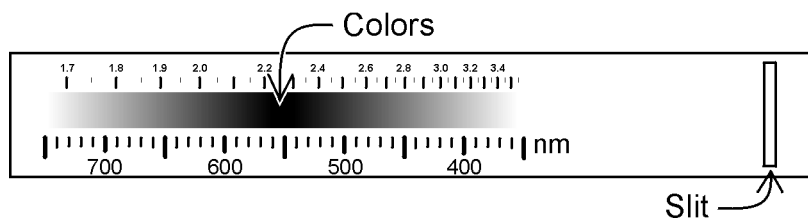
1 The spectrometer

A **spectrometer** splits light into a spectrum of colors and displays the different colors of light along a scale. The lower scale measures the wavelength of different colors of light in nanometers (nm). One nanometer is one trillionth of a meter so individual light waves are very small! Red light has the longest wavelength, around 650 nm. Blue light has the shortest wavelength, around 400 nm.

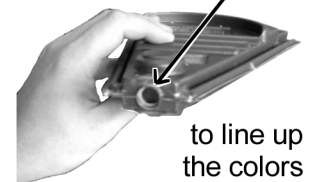


PoirSafety Tip: Never look directly into any light source—especially the sun!

1. Hold the spectrometer so the printed side faces up.
2. Look in the short end with one eye while you point the slit at a bright light. *Direct your eye to the left to see the colors.* You should see a band of colors in between two rows of numbers (scales) like the diagram below.
3. If the colored band is crooked, rotate the disk until the colored band lines up between the two scales.



Rotate the grating here ...



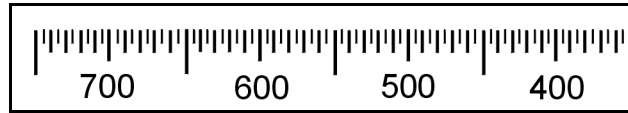
- a. While looking through the eyepiece, point the slit of the spectrometer directly at an incandescent bulb. Use colored pencils to show where the different colors of light appear in on the spectrometer scale.



- b. Blue light has the highest energy and red light the lowest. Based on your observations with the spectrometer, what is the relationship between wavelength and amount of energy?

2 Using a spectrometer to identify elements in a fluorescent light

1. Look through the spectrometer at light from a fluorescent bulb (most likely the ones in your classroom). You should see colored lines (called **spectral lines**) instead of a smooth rainbow like you saw from the incandescent light.
 2. You should see a green line at 546 nanometers on the scale. If the green line is not at 546 nanometers, ask your teacher to calibrate the spectrometer for you.
- a. Use colored pencils to sketch the lines you observe. Be very precise in your sketch by placing the lines you see in the *exact* positions on the scale below.



- b. Identify the wavelength of each spectral line, from left to right, then fill in Table 1.

Table 1: Spectral lines produced by a fluorescent light

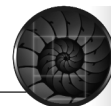
| Line number | Spectral line color | Spectral line wavelength (nm) |
|-------------|---------------------|-------------------------------|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |

3 What do the lines mean?

When elements are heated until they are hot enough to emit light (like those elements that make up stars), they produce characteristic spectral lines. Each element produces a pattern of spectral lines that is like a fingerprint. Shown to the right are some examples of the spectral lines produced by four different elements. Each line has a specific wavelength (these values are not shown in the diagram).

The light produced by a fluorescent source is created when electric current is passed through a gas inside of the tube. This gas, which is made of only one element, absorbs energy, and emits light.





a. The light from most fluorescent tubes comes from only one element. Compare the spectral lines you observed with the ones in the diagram above. Which element does the bulb contain?

b. Fluorescent tubes have special instructions for disposal and must not end up in a landfill. Based on your spectral analysis of the gas inside the tube, why is this so?

c. Stars are made up of more than one type of element. When astronomers use a spectrometer to analyze the light produced by stars, they observe the combined spectral lines of all of the elements present in the star. What specific information would an astronomer need to know in order to determine which elements are present in a star?
