Name: ____

Exercise Nineteen: Indoor/Outdoor

Spectroscopy in Astronomy

In this lab you will observe examples pertaining to Kirchhoff's three laws of spectral analysis. You will use a simple prism spectroscope to observe continuous, emission, and absorption spectra.

I. The Spectroscope

A spectroscope is a device used by astronomers (and others) to separate light into its various color components. Basically, there are two types of spectroscopes; one uses a prism, usually of glass, the other uses a diffraction grating which is made of a plate of glass with very fine and accurately spaced scratches on one face. The grating or prism in a spectroscope is called the dispersing element. Your instructor will show you examples of diffraction gratings and prisms.

1. A spectroscope will be set up for your inspection. Make a schematic drawing of it, noting the position of the source to be examined, the entrance slit, the prism or diffraction grating, and the imaging eyepiece. Indicate on your drawing the path of a ray of white light from the source through the spectroscope. What do you think are the roles of the entrance slit and the imaging eyepiece?

If the spectroscope examined used a grating (prism) as a dispersing element, it would take the place of the prism (grating) in your diagram.

II. Kinds of Spectra

Kirchhoff's laws describe the conditions necessary for the observation of the three different types of spectra; continuous, emission, and absorption.

- *Continuous spectra:* A luminous solid, liquid, or very dense gas will emit light at all wavelengths, producing a continuous spectrum.
- *Emission spectra:* A rarefied (not dense) luminous gas will emit light at only certain wavelengths. Such spectra appear as bright lines superposed on a black background or on a faint continuous spectrum.
- *Absorption spectra:* If white light from a continuous spectral source is passed through a rarefied cool gas, the gas will subtract certain wavelengths from the continuous spectrum. Such spectra appear as dark lines superposed on a continuous spectrum. These dark lines appear at the same wavelengths as the emission lines would if the same gas were luminous. The wavelengths of these lines correspond to atomic transitions within the atoms of gas.

III. Physical Observations

Continuous Spectra

1. Observe a light bulb with a hand-held spectroscope. Open the slit up wide, and then focus the eyepiece so the edges of the spectrum are sharp. Narrow the slit until the spectrum is easily visible, but not too bright. The spectroscope is now focused. Can you explain why a light bulb produces a continuous spectrum?

Emission Spectra

2. Using the spectroscope, observe the light coming from the following discharge tubes, and draw their spectra. Adjust the slit so that the lines you see are narrow. No focus adjustment should be necessary.

Source	*Spectrum*	*Remarks*
Nitrogen gas	V B G Y O R	
Air	V B G Y O R	
Helium gas	V B G Y O R	
Mercury vapor	V B G Y O R	
Hydrogen gas	V B G Y O R	

3. Now observe a fluorescent light and a street light. Make sketches of their spectra here:

Source	*Spectrum*	*Remarks*
Fluorescent light	V B G Y O R	
Street light	V B G Y O R	

4. With reference to Kirchhoff's laws, why should the discharge tubes, fluorescent light, and street light produce emission spectra?

5. Why do you think the fluorescent lights produce both emission lines and a continuous spectrum?

6. Comparing the spectra from the different discharge tubes, what can you say about the composition of air? Of street lights?

Absorption Spectra

7. Using a gas flame to burn salt crystals, observe and draw the spectrum.

V B G Y O R

8. Now place a light bulb behind the burning salt flame, and reobserve and redraw the spectrum.

V B G Y O R

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