# Photographing and Identifying Stellar Absorption Lines

## Introduction

The purpose of this exercise is to take spectrographs of several celestial objects and to identify the spectral lines present. At the conclusion of this exercise you should know why astronomers are confident that the chemical elements found on Earth are also found in the stars; the heavens and the Earth are made of the same materials.

## Taking the Spectrographs

Equipment needed:

1. A single lens reflex (SLR) 35 mm camera with a 135 mm telephoto lens
2. A diffraction grating filter which fits on the 135 mm lens
3. A tripod
4. A cable release
5. High speed (1600 ISO) film

Procedure:

Attach the filter and the cable release to the camera and mount the camera on the tripod. The aperture of the lens should be at the maximum opening (i.e., the smallest f/stop) and the shutter speed should be set to B ("bulb"). Finally, focus on infinity to insure a sharp picture.

Select a bright star and examine it through the finder. You will see a streak of color, the brighter the star, the more vivid the colors will be. It is important that this streak be ***perpendicular*** to the direction of sky motion, so that with a long time exposure, a broad band of color will be recorded. One way to be sure that the streak has the proper orientation is to see if it points to Polaris. Normally you won't be able to see both your star and Polaris at the same time – look in the finder, estimate the direction of the streak, then look at Polaris. If the streak is not pointing at Polaris, then you have to ***rotate the filter*** (***not*** the lens focusing adjustment) until it is.

When you are setup, it is time to take the picture. An exposure time of ***3 minutes*** gives a nice broad smear of color. Take several pictures of stars with different colors. Also, if the Orion nebula (M42) is available, be sure to take a picture of that also. Finally, if there are planets in the sky, take their spectra. Planets, of course, shine by reflected sunlight, so, as a first

approximation, you are really taking the Sun's spectrum when you take a spectrograph of a planet.

After development you will notice that this simple method has some limitations. It only works for the brightest stars and, in addition, you will always see non-spectral streaks from all the adjacent stars. Sometimes this interferes with identifying the lines on the photograph, but usually it is a problem that you can work around.

Identifying Spectral Lines

This part of the exercise assumes that scanned images of a number of spectral photographs taken as described above are available.

1. Open the Paint program available with all Windows operating system.
2. Download the bitmap file containing the spectra. Your instructor will tell you the name of the file.
3. The top spectrum will be of a bright class A star such as Sirius with easily identifiable dark lines. The first line from the blue end of the spectrum is the hydrogen delta line (**$H_{delta}$**) that has a wavelength of **410.174 nm.** The scale of the photograph is **.884 nm/pixel**. Therefore, using the Paintbrush cursor find the ***x-dimension pixel value*** for each line. Use the $H_{delta}$ line as the reference. Find the value of the other lines in nanometers by multiplying the difference between each line and the reference $H_{delta}$ in pixels times .884.

Example: Suppose the difference in pixels between $H_{delta}$ and line X is 47. Then

X =410.174 + 47*.884 = 451.722 nm

Complete the table below using the data you have.

**Spectral Absorption Lines** Scale of Photographs:_____ nm/pixel

| Object | Line number | Pixel value | Δ pixels (line – $H_{delta}$) | λ (nm) | Line |
|---|---|---|---|---|---|
| Sirius | 1 | | 0 | 410.174 | $H_{delta}$ |
| | 2 | | | | |
| | 3 | | | | |
| | 4 | | | | |
| M42 | 1 | | | | |
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**Strongest Absorption Lines in Typical Stars**

| **Wavelength nm** | **Absorption line** |
|---|---|
| Hydrogen Balmer Lines (A and B stars) | |
| 656.3 | $H_{\alpha}$ |
| 486.1 | $H_{\beta}$ |
| 434.1 | $H_{\gamma}$ |
| 410.2 | $H_{\delta}$ |
| 397.0 | $H_{\varepsilon}$ |
| 388.9 | $H_{\zeta}$ |
| 383.5 | $H_{\eta}$ |
| Lines in F through M stars | |
| 396.8 | Calcium (Ca) II H line |
| 393.4 | Calcium (Ca) II K line |
| 589.0 | Sodium (Na) I D doublet line in type M stars. |
| 589.6 | Sodium (Na) I D doublet line in type M stars |