Astronomy 350, Autumn 2002
Lab 2: A Simple Long-Slit Grating Spectrometer
Due: Wed November 6

Pre-Lab Exercise

During the lab session on October 23, we constructed a simple long-slit grating spectrometer out of slide-mounted transmission gratings, a cardboard tube, some construction paper, card stock, and a whole bunch of electrical and masking tape.

Each of you now has a hand-held, medium dispersion spectrometer you can use to make simple observations of terrestrial light sources.

The goal of this lab is to put a simple spectrometer in your hands and get you to make observations of seemingly mundane light sources with it, with the idea of getting you to start thinking about what a spectrum is, training you to look at spectra critically for clues that inform you about the nature of the light source, and to demonstrate, in the best way I know, that all light sources have underlying physics that is only revealed by observing its spectrum. You can poke, and prod, and speculate all you like based on appearance ("looks kind of yellow"), but a spectrum tells the definitive tale.

Lab Exercise

In your notebook, make a sketch of your spectrometer, including the pertinent dimensions (especially the spectrometer tube length and the width and length of the slit). Make any brief notes of particular features of the spectrometer.

Using a fluorescent lamp as an emission-line source, assess the performance of your spectrometer. In particular, there is a pair of green lines in the middle of the spectrum that should be visible. How well does your spectrometer resolve these two lines? For example, do they appear as two sharply defined lines with darkness between them, or do the lines appear relatively fuzzy, with only a little bit of darkness between them? Or, do you see two lines at all?

Take your spectrometer out in the evening, and make observations of the following light sources. For each, note

1. Where was the light source located, and roughly how bright was it?
2. How easy or difficult was it to observe its spectrum with your spectrometer?
3. What spectral features do you observe? Is it a continuous spectrum, an emission-line spectrum, a mix of the two? Does it show absorption features in the spectrum?
4. Judging from the type spectrum, can you tell what kind of light source it is, e.g., is it a hot solid or liquid, a hot, thin gas, or a hot, thick gas?
5. If the source produces an emission-line spectrum, can you identify what gas (or gasses) are present in the source? A set of "standard" gas-discharge tube lamps is available to help you calibrate your eyes.
6. Any other features of interest you would like to note? (e.g., if you caught the light source while it was turning on, does the spectrum look any different from when it does after it was running at full brightness for a while?)

Sources to observe:

1. A bright, white flood lamp used at an outdoor athletic field (the lights at the volley-ball "beach" near the North Campus dorms or the West Campus fields are examples).
2. Compare the spectrum observed from city streetlights that use high-pressure sodium (HPS) and low-pressure sodium (LPS) lamps. HPS lamps are found on the main streets in town (e.g., the ones on the tall poles hanging out over High Street), whereas LPS lamps are used in alleys and residential areas where very bright lights are not needed. HPS lamps are whiteish-yellow in color and very bright, while LPS lamps are more of a reddish-yellow color and not as bright. LPS lamps also tend to be long and thin, while HPS are round.
3. Having observed HPS and LPS lamps, look at some of the decorative lamps on poles around campus. What kind of lamp are they, judging from their spectrum?
4. Find a clear-glass neon lamp, of the kind used for Beer logos or businesses. You want the ones you can see clearly through. Look at it spectrum? Can you see the lines of Neon clearly?
5. Now, look at "neon" signs of other colors (green, while, purple, blue, red), usually distinguished by being translucent glass tubes you cannot see through. What does their spectrum look like? Do they contain Neon? If not, what is the gas they contain? How do you think they get their colors?
6. Incandescent lamps have a continuous spectrum because they get their light from heating a metal filament (usually tungsten) to a temperature of 1000-2000K with an electric current. In your survey of lamps used outside various businesses or buildings, did you encounter any incandescent lamps being used for outdoor lighting?

It is OK to take rough notes while you are observing (it will be hard enough to juggle a notebook, pen/pencil, and spectrometer on the street), and write up a lab summary for your notebook. However, putting the rough notes into your notebook may be useful for future reference, so you don't lose some scrap of paper somewhere when writing the lab up later.