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Share-A-Thon Contribution

Strategies for a painless (less painful?) introduction of spectra

My starting assumption is that there are two truths:
1) A wise spectroscopist once said:

If a picture is worth a thousand words, then a spectrum is worth a thousand pictures.

2) Your average student is scared and/or stupefied by spectroscopy.

Given that I feel spectra are worth teaching, but are hard to understand and/or appreciate, I address the issue of spectroscopy with a multi-step learning process.

Bar Codes – Star Codes

Before I use introduce spectra, I present my students with a brief brain teaser, or puzzler. Students are presented with the 8.5x11 sheet of 16 "bar codes", asked to cut them out and look them over. I get students to point out that that each bar code square has up to 14 locations where lines might or might not be shown; and that a line can come in 5 different thicknesses. They also tend to notice that no two squares are the same.

The goal is to put these patterns into a unique sequence based on one rule: At one of the 14 locations, the lines can go from thin to thick, or from thick to thin; but they cannot be reborn. Once a line starts getting thicker, it cannot get thinner again.

There is only one correct sequence, although it can be started at either end. For the version of the barcodes_starcodes.pdf document included with this share-a-thon contribution, I will be happy to reply with the answer key in response to queries from fellow HOU-TRA's.

Construction of a handheld spectrometer to observe line emission sources

Students make their own spectrometer. I give them a postage stamp square of holographic diffraction grating material, purchased in bulk (6-foot x 5-inch roll) from Project STAR (Learning Technologies, Inc., www.starlab.com). Because the diffraction grating material is so sensitive to fingerprints, I take the time to cut the squares of diffraction grating and fold around the edges pieces of electrical tape to make a frame. The students get their own paper towel or wrapping paper tubes; and use electrical tape to attaché the grating material and make a slit at the other end. I go the homemade route because of budgetary constraints, although my dream would be to have for each of my students to receive one of the plastic Project STAR spectrometers with wavelength calibration.

Students construct the spectrometers on their own, bringing them to the next class for me to check out with an observation of a fluorescent lamp. The most common mistake is that a student will have the slit misaligned with respect to the direction of dispersion. As a class we look at the fluorescent lamp and at an incandescent bulb attached to a dimmer switch as part of an activity to guide their ability to really see the features we want them to see,

Spectral Safari

My goal is to have students recognize that a spectrometer can distinguish between different types of white light (or red, yellow, blue, etc). I want them to notice that through a spectrometer an incandescent (blackbody) light looks different from the light coming from the long fluorescent lights in the ceiling of our classroom, which are different from a compact fluorescent. I want them to notice that a filtered incandescent lamp that looks red produces a very different spectrum from a neon lamp or a red LED light, My spectral safari activities vary from year to year, I have not found the optimum method. Students have been given images of the target spectra and for each spectrum they must describe the location and appearance of the lamp that produced such a spectrum. Another method is to have them describe in words and/or illustrations the difference in the spectra from a given set of light sources that appear to have roughly the same color to the naked eye. I used to have them sketch or describe the spectrum from each light source, but was always frustrated by their results.

On-line Stellar Spectral Classification lab

A number of really slick on-line labs exist to do stellar spectral classification. I and my colleagues at Western Kentucky University produced a robust, browser/software inspecific activity that is maintained at my website (astro.wku.edu/gelderman/).

From images of spectra to spectral plots

It is much easier to work from two-dimensional plots of spectra. After attempting to provide the strongest possible grounding in images spectra, I shift the emphasis to showing students the correspondence between images and plots. This better prepares them to attempt labs relating to Stellar Composition, Doppler shift or the Hubble relation.