

Streetlight Spectroscopy with A CD

A very simple and inexpensive spectrograph can be constructed using an old music CD that no longer plays or one of the CDs from an Internet service provider that frequently arrive in the mail box and we usually toss in the trash. If you have ever noticed that light reflected off a CD at shallow angles is broken up into its component colors just as light that passes through a prism. Light passing through a prism is broken into its component colors by the principle of refraction. In the case of the CD, light striking the radial track is diffracted to produce the rainbow of colors. The neighboring tracks on the CD are only about $1.6\ \mu\text{m}$ ($1\ \mu\text{m} = 10^{-6}$ meters) apart. These closely spaced tracks act just like a diffraction grating. On a DVD disk the tracks are only about $0.74\ \mu\text{m}$ apart, which means that a DVD will give you better higher resolution spectrograph. And you thought that a disposable movie DVD wasn't good for anything but the trash. If you look carefully at the spectrum produced by a CD/DVD, as you vary your angle of observation from a grazing angle to roughly perpendicular to the disk you will notice that there are several sets of spectra of decreasing brightness visible as the angle of observation increases. These different spectra are what are called "orders". The direct reflection off the disk is referred to as the 0^{th} order. The first spectrum past the direct image is called the 1^{st} order spectrum. The next and fainter spectrum is called the 2^{nd} order spectrum, and so on. The diagram below illustrates this point.

Caution: Never look directly at the Sun with the spectroscope.

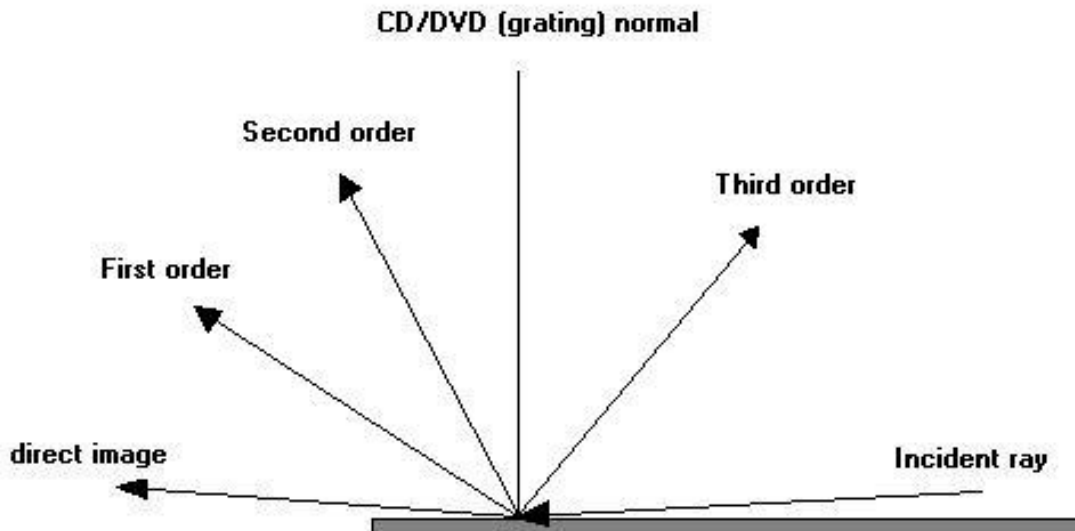


Figure1: Spectra formed by a CD grating

Construction of the Spectroscope

The heart of your spectroscope (the grating) will be a pie shaped wedge cut from a CD or DVD disk. The outside edge of the CD/DVD segment will need to be about one inch wide. The best way to cut up a CD/DVD is to layout the lines to cut along with a fine felt tipped marker and use a stout pair of sharp scissors to cut along the lines you have marked on the plastic of the disk. To prevent the plastic of the disk from cracking while you are cutting run some warm tap water over the disk for a couple of minutes and then cut a wedge out of the disk.

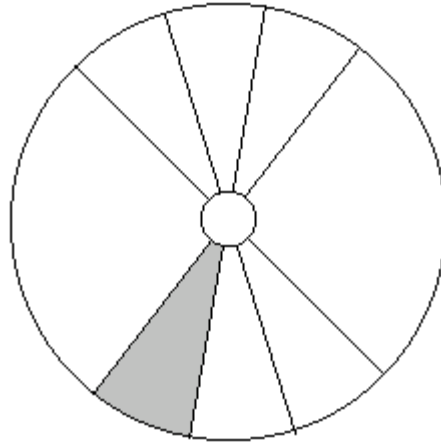


Figure 2: CD ready to be cut into wedges

Using the attached sheet of card stock cut out the spectroscope along the solid lines and fold it along the dotted lines. Place the CD wedge onto the space indicated on the spectroscope and tape it into place as indicated. Using a sharp razor blade cut along the outline of the slit making sure that the cuts are clean and straight. A straight edge should help keep the cuts straight. Next, fold along the dotted lines, matching the letters on the various tabs and tape together. Your spectroscope is now ready to use.

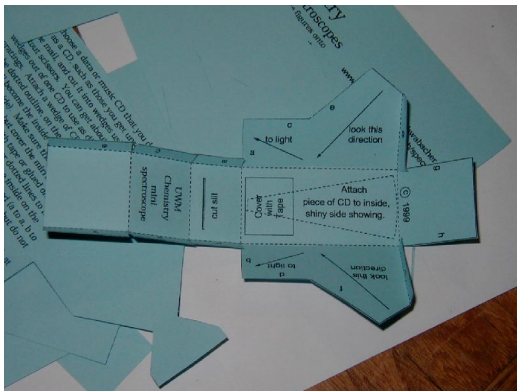


Figure 3: Spectroscope cut and folded

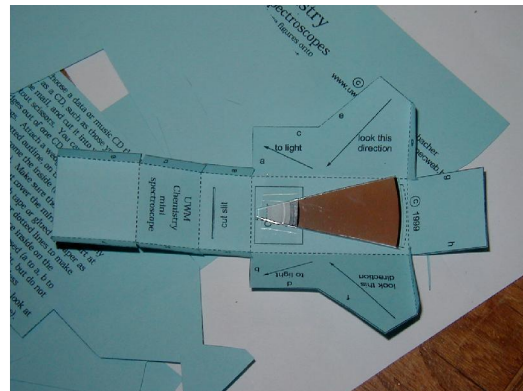


Figure 4: Grating taped in place

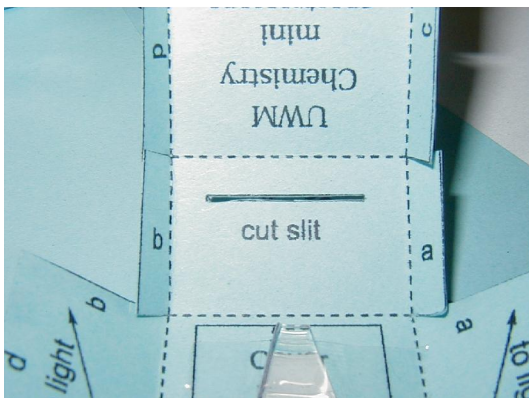


Figure 5: Slit cut out

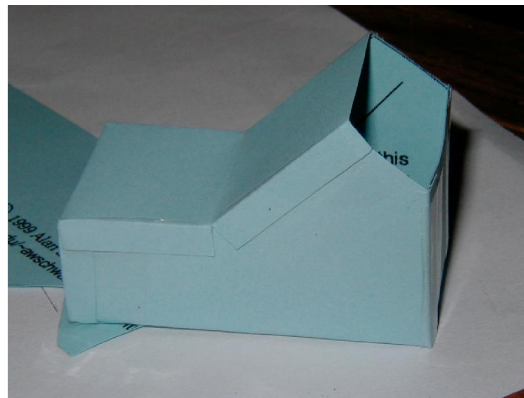


Figure 6: Spectroscope fully assembled

Observations

1. Observe an incandescent bulb. What colors do you see? Classify the spectrum (continuous, bright line or dark line).

Colors seen: _____

Spectrum type: _____

2. Observe a fluorescent bulb. What colors do you see? Classify the spectrum (continuous, bright line or dark line).

Colors seen: _____

Spectrum type: _____

3. Observe a white street lamp. What colors do you see? Classify the spectrum (continuous, bright line or dark line).

Colors seen: _____

Spectrum type: _____

4. Observe an orange street lamp What colors do you see? Classify the spectrum (continuous, bright line or dark line).

Colors seen: _____

Spectrum type: _____

5. Observe several “neon” signs having different colors. Try visiting your favorite watering hole where they generally have lots of “neon” signs. Who knows you may impress someone enough to get a free beer. If you don’t have a favorite watering hole try a strip-mall that has some shops with “neon” signs.

a. Sign #1

Overall Color (w/o the spectroscope): _____

Colors seen: _____

Spectrum type: _____

b. Sign #2

Overall Color (w/o the spectroscope): _____

Colors seen: _____

Spectrum type: _____

c. Sign #3

Overall Color (w/o the spectroscope): _____

Colors seen: _____

Spectrum type: _____

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Bibliography

- Randel, David A (2002) *Practical Amateur Spectroscopy*, ed. Stephan F. Tonkin, 1st edn. Springer-Verlag
- Schwabacher, Alan (1999) *Mini Spectroscopes*. University of Wisconsin-Milwaukee. See www.uwm.edu/~awschwab/specweb.htm