Notes for Hermograph's *Classroom Astronomer*
Spectrum Viewer for Elements, Mixtures and Molecules

Usage tips

1) Sometimes, especially for distant or tiny sources of light, a slight vertical shaking of the Viewer will extend the visible features into lines instead of dots, making a better match up to the comparison spectra.

2) The measuring scales are only approximations. Do not rely on them for precision measures of visible lines.

3) The best way to identify a spectrum source is to a) identify the brightest/strongest line that is visible, by color, b) use that to find those comparison spectra with the same strongest line, marked with a white dot below it, to eliminate the other spectra, c) count how many bright lines are visible (OR key dark absorption features) in total and in the red, green, and blue-violet regions and check those counts against the spectra you've selected in step b.

4) You can also adjust the distance of the Viewer card so that the spectra in the window is to the same scale of the comparison spectra and match up the lines and patterns directly.

WARNINGS!

1) Under no circumstances should you use the Spectrum Viewer to see the spectrum of the Sun! The Viewer does nothing to stop the Sun's harmful rays or reduce intensities, and damage to the eye can be immediate. Hermograph Press, *The Classroom Astronomer*, and its personnel and related companies can not and will not be held responsible for injuries or damages by the use of this product, accidentally or deliberately, for viewing the solar spectrum.

2) The film in the Viewer window is sensitive to the oils in human fingernails. Do NOT touch the film! It can eat away the film and its diffraction grating rulings. Fingerprints can be removed with some film cleaners, anti-static cleaners and even a light brushing with an eye-glass cleaner but these, too, will ultimately degrade the film. You can add a piece of transparent film, such as for use with overhead transparencies, on each side to protect the film if you wish. Degraded-by-usage/fingerprints Viewers can not be returned.

3) The colors you see with your eye may not completely match up the hues in the comparison spectra for a variety of reasons. Not all eyes see all colors exactly the same, and some can see a bit into the ultraviolet (UV) or infrared (IR). Both film and digital cameras do not have the same response to each color/wavelength of light as human eyes. Even the printing process (or age of the unit, over time) can cause the colors to differ and to change with exposure to light and the environment.

Notes about the spectra of various gas tubes

Not all gas tubes are created equal. Some may have trace elements, and most react badly to being turned on for long periods. In such cases, element lines may flare from invisible to dramatic, such as the yellow line in Chlorine and Air. In other cases, trace impurities or heat or molecules made of the otherwise-single element, may cause a continuous background spectrum, as frequently observed in Hydrogen gas tubes.

Note that the spectrum of Hydrogen and Deuterium (Hydrogen with an extra neutron) are indistinguishable at this scale of observation. It requires an accurate spectrophotometer to see the slight changes in the main lines of Hydrogen-alpha (red), -beta (blue), etc.

v.1.0

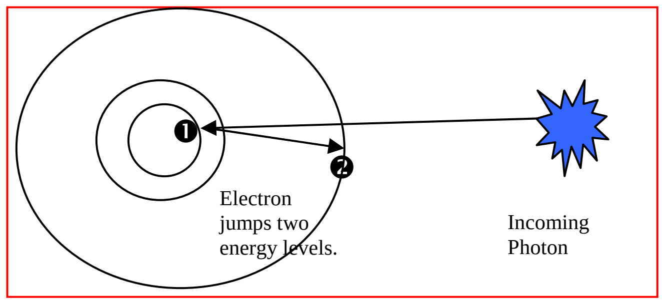
How are spectra made?

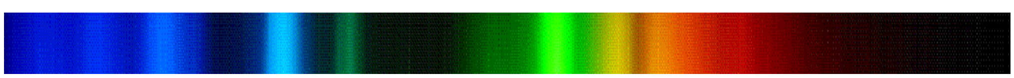
There are three kinds of spectra, though sometimes they can be viewed together.

All spectra require a source of energy (heat). Hot objects produce a **continuous background spectrum,** such as seen in the background of "impure" hydrogen spectra and most of the others here, such as Iodine (I) or Oxygen (O). This is more a macroscopic spectrum that has more to do with the atom reacting to heat rather than something atomic, as the next two types of spectra.

Continuous Spectrum

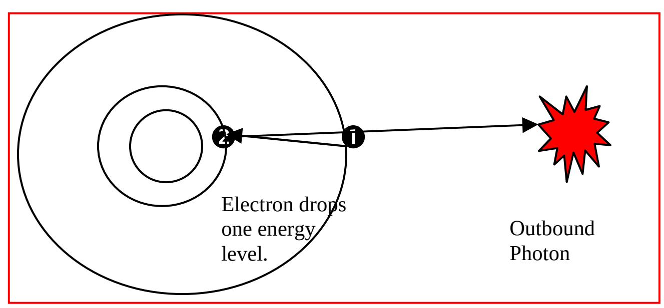
Dark lines or absorption lines: An element (a single atom of a specific substance, like Helium) has a nucleus of protons and neutrons, surrounded by "clouds" where electrons will be found (indicated by solid lines in the drawings — clouds are hard to draw...). These "clouds" are centered at different distances from the nucleus — the nucleus is not involved in these spectra — which correspond to higher levels of electron energy. If an electron in an energy-level "cloud" (a lower one) receives the precise amount of energy it needs to jump to a higher level, it will absorb that photon of energy/light and climb into that specific, higher energy-level. It can not jump just part-way; it is all the way or no jump at all. If that electron is in material, such as a gas, in front of the heat source that produces a continuous spectrum, you will see a dark gap in front of the background spectrum (see the thin absorption line in the red in the Oxygen spectrum, or the large dark bands in the green part of Nitrogen or Air). Not all dark regions in all spectra are absorption lines! But dark areas in the next type of spectra are simply—dark, nothing there…





Absorption line in High Pressure Sodium Lamp ↥

Bright lines (emission spectra or emission lines) seen in most of the spectra on the Viewer are also caused by specific photons of energy that match the gaps between different energy-levels in the element's (or elements') atomic structure. In this case, though, it is from an electron already in a higher energy-level. Electrons, however, prefer to be as close to the nucleus as possible. As soon as it can, a higher-level electron will release the precise amount of energy (also known as a quantum of energy) to slip down to a lower energy-level in the atomic cloud around the atom's nucleus, not necessarily the energy-level it came from. In doing so it releases the energy as light, a single ray of color.



Emission ↥ Absorption ↥

Low Pressure Sodium Lamp with emission and absorption lines