

HW 5

Charles Liu

Astronomy 138 - Dr. Matthew Duez

February 23rd 2025

Part 1: continuous spectrum

1. Begin with the sim in its default state: the visible spectrum is checked on, the speed is 0 km/s, and all other boxes are unchecked. What you see is called a continuous spectrum. Write a few sentences of description of the diffraction grating view; of the spectrometer view. For example, you might say that in the diffraction view all colors are present, and in the spectrometer view you might say that all colors are at the same brightness (same level on the y-axis).

In the diffraction grating view, all colors are present (from 400nm to 700nm wavelength) continuously. In the spectrometer, the brightness remains consistent across all wavelengths at 1.

Part 2: emission line spectrum

2. Select Continuous spectrum: None. Select several atoms from within the Emission spectra box. Describe the changes on the diffraction grating view, and the changes on the spectrometer view. Each bright shade of color that appears is called an emission line. Do any two atoms have the identical set of emission lines? Some of these lines are quite famous: the bright red line of hydrogen at 656 nm is the red color we see in interstellar clouds, and the double yellow line of mercury near 580 nm is found in fluorescent bulbs.

The diffraction grating spectra is no longer continuous and no longer has every color. Instead, some colors appear at specific wavelengths. No two atoms have identical sets of emission lines. In the spectrometer, it is no longer at constant brightness. Instead, at specific wavelengths, the brightness spikes. These wavelength spikes correlate with the diffraction grating view, and differ from each other in magnitude.

Part 3: absorption line spectrum

3. Select Continuous spectrum: Visible. Uncheck all emission lines. Select several atoms from within the Absorption spectra box. Describe the changes on the diffraction grating view, and the changes on the spectrometer view. Each missing shade of color is called an absorption line, because light is being absorbed (removed) from the spectrum. Is the continuous spectrum necessary for us to see absorption lines? Do any two atoms have the identical set of absorption lines?

In the diffraction grating view, virtually all colors are present except those at specific wavelengths. This correlates with dips in brightness in the spectrometer view. In the spectrometer view, the brightness is one except when at a wavelength where the color is absorbed by atoms. At those wavelengths, the brightness dips variably. No two atoms have the same absorption lines. It's necessary to see the continuous spectrum or otherwise we can't see the darkness/gaps.

Part 4: general questions

1. If an atom has an emission line at a given shade of color (e.g., hydrogen at 656 nm), then does that atom have an absorption line at that same shade of color?
Yes. Atoms absorb and emit energy at the same levels, so if it emits it at a given shade, it will also absorb that shade.
2. Use the slider button under the label km/s to change the speed of the glowing object: negative speeds for objects approaching us, and positive speeds for objects receding from us. Describe changes to each of the continuous spectrum, emission line spectrum, and absorption line spectrum as the speed changes. This change is called the Doppler effect, and is essential for measuring the speeds of objects located at a distance.

The spectrum's colors and properties (absorption lines, emission lines, etc.) are shifted based on the km/s. The higher the km/s, the more the spectrum shifts right (bluer), the lower, the more the spectrum shifts left (redder).

3. Suppose you were given a spectrum of a planet. The spectrum has a collection of absorption lines. Describe how you would use this simulation to identify what lines were present (or absent) in the spectrum, and therefore what atoms were present (or absent) on the planet.

Since it is absorption lines, we would click "visible" under continuous spectrum. We would then click atoms under "absorption spectra" to test and see if the gaps line up. If the gaps line up, we know the atom clicked is present on the planet. If not, we know it was absent. We

would also know whether the wavelength of light of the atom was present or not depending on that result.