Most of what we know about the universe and how it works is the result of astronomical discoveries made by spectroscopy.

Spectroscopy is the analysis of the light we receive from an object. The dispersion of the light from the object into its component colors (or wavelengths) enables astronomers to infer many physical properties of that object, including temperature, velocity, composition, and distance.

For our purposes we will focus on visible light. The violet end of the visible spectrum has a wavelength of around 400 nanometers (nm). The red end has a wavelength of about 740 nm. Although the visible spectrum runs from red to violet, the short wavelength end is often called the "blue end" of the spectrum. Think primary colors. When starlight falls onto a grating or spectograph, it produces a spectrum—a rainbow band of light. If you plot the intensity of the light in that band (y-axis) against the wavelength (x-axis, blue to the left and red to the right), you generate a curve that is the main component of what you see in a typical spectral plot. The curve typically has a peak (the wavelength corresponding to maximum intensity) somewhere in the range of wavelengths recorded. However, most of what we learn about the objects we observe comes from discrete spectral lines within the spectrum.

Let's briefly discuss the three types of spectra, which will shed light on the source of the actual lines we see in them.

1) Continuous spectrum: This includes all wavelengths of visible light and shows all the colors of the rainbow. It's produced by a dense, opaque, hot object, for example, the "surface," or photosphere, of a star. This type of spectrum has no separate lines in it! The image at the very top of this article showing the visible light spectrum is an example of a continuous spectrum.

2) Emission line spectrum: This consists of discrete bright lines at specific wavelengths. These can only be produced by a hot, low-density gas. The specific lines are determined by the type of gas. For example, hydrogen, when heated, will emit radiation only at specific wavelengths, which are different than the wavelengths of radiation emitted by other gases.

3) Absorption line spectrum: Absorption lines can be thought of as the opposite of emission lines. While emission lines add light of specific wavelengths to a spectrum, absorption lines subtract it. Therefore, absorption lines can only be seen when they are superimposed on a continuous spectrum.

How, then, are these different types of spectra produced in stars? The continuous spectrum originates from the dense, opaque photosphere of the star. This light next passes through a thin, slightly cooler layer of gas at the top of the star's photosphere (between the stellar surface and you, the observer). The result is that the gas in the cooler upper atmosphere of the star absorbs some light from the star's surface before it reaches you, and consequently "subtracts" the specific wavelengths unique to that atmospheric gas, giving rise to the absorption lines!

Different types of gas produce different patterns and strengths of lines. Emission and absorption lines are typically named after the elements responsible for them as well as the element's "ionization state." The atoms of elements have electrons that move between energy states, "up and down," to simplify things, depending on whether they are absorbing or releasing energy (in the form of a specific wavelength of light). When absorbing light they will move up to a higher level and produce an absorption line. When they release energy, they move down to a lower level and produce an emission line. The wavelength of emission and absorption is the same for a