**Spectroscopy**

Professor: Now astronomy didn’t really bloom into the science it is today until the development of spectroscopy. Spectroscopy is basically the study of spectra and spectral lines of light, and specifically for us, the light from stars. It makes it possible to analyze the light emitted from stars. When you analyze this light, you can figure out their distance from the earth, and identify what they are made of, determine their chemical composition.

Before we get into that though, it’s probably a good thing to back up a bit. You all know how when you take a crystal prism and pass a beam of sunlight through it, you get a spectrum, which looks like a continuous band of rainbow colors. The light that we see with our human eyes as a band of rainbow color falls in a range of what’s called visible light. And visible light spectroscopy is probably the most important kind of spectroscopy. Anyone want to take a stab at the scientific term for visible light? And I’m sure all of you know this because you all did the reading for today.

Student: Optical radiation. But I thought being exposed to radiation is dangerous.

Professor: Yes, and no. If you are talking about radiation, like in the element Uranium, yeah, that’s dangerous. But radiation as a general term actually refers to anything that spreads away from its source. So optical radiation is just visible light energy spreading out.

OK, so we’ve got a spectrum of a beam of sunlight and it looks like the colors bleed into each other. There are no interruptions, just a band flowing from violet to green, to yellow, to… you get the idea. Well, what happens if the sunlight’s spectrum is magnified?Maybe you all didn’t do the reading. Well, here’s what you’d see. I want you to know this that this spectrum is interrupted by dark lines called spectral lines.

If you really magnify the spectrum of the sunlight, you could identify more than 100,000 of them. They may look like kind of randomly placed, but they actually form many distinct patterns. And if you were looking at the spectrum of some other star, the colors would be the same. But the spectral lines would break it up at different places, making different patterns. Each pattern stands for a distinct chemical element, and so different sets or patterns of spectral lines mean that the star has a different chemical composition.

Student: So how do we know which spectral patterns match up with which elements?

Professor: Well, a kind of spectroscopic library of elements was compiled using flame tests. A known element, say a piece of iron for example, is heated in a pure gas flame. The iron eventually heats to the point that it radiates light. This light is passed through a prism, which breaks it up into a spectrum. And a unique pattern, kind of like a chemical fingerprint of spectral lines for that element appears.

This process was repeated over and over again for many different elements, so we can figure out the chemical makeup of another star by comparing the spectral pattern it has to the pattern of the elements in the library. Oh, an interesting story about how one of the elements was discovered through spectroscopy. There was a pretty extensive library of spectral line patterns of elements even by the 1860s.

A British astronomer was analyzing a spectrograph of sunlight, and he noticed a particular pattern of spectral lines that didn’t match anything in the library. So he put two and two together, and decided there was an element in the sun that hadn’t been discovered here on the earth yet. Any guesses about what that element is? It actually turned out to be pretty common and I’m sure all of you know it. OK, let’s try something else. Any of you happened to be familiar with the Greek word for “sun” by chance?

Student: Something like “Helius” or something like that. Oh it must be “Helium”. So you are saying that Helium was discovered on the sun first.

Professor: Yes, and this is a good example of how important spectroscopy is in astronomy.