

# Pre-lab: Stellar Spectra

To a first approximation stars have black body spectra; their color is related to their surface temperature. For blue stars the dominant wavelength (the peak of the black body curve) is in the UV and for red stars it is in the IR. The Sun's dominant wavelength is in the yellow part of the spectrum.

The three stars in the diagram at the right have different colors. Star (a) has relatively more blue light than red light so it looks rather blue and it actually has a high ultra violet flux. Star (b) also has relatively more blue light than red light so it also looks blueish. Star (c) has relatively more red light than blue light so it looks red.

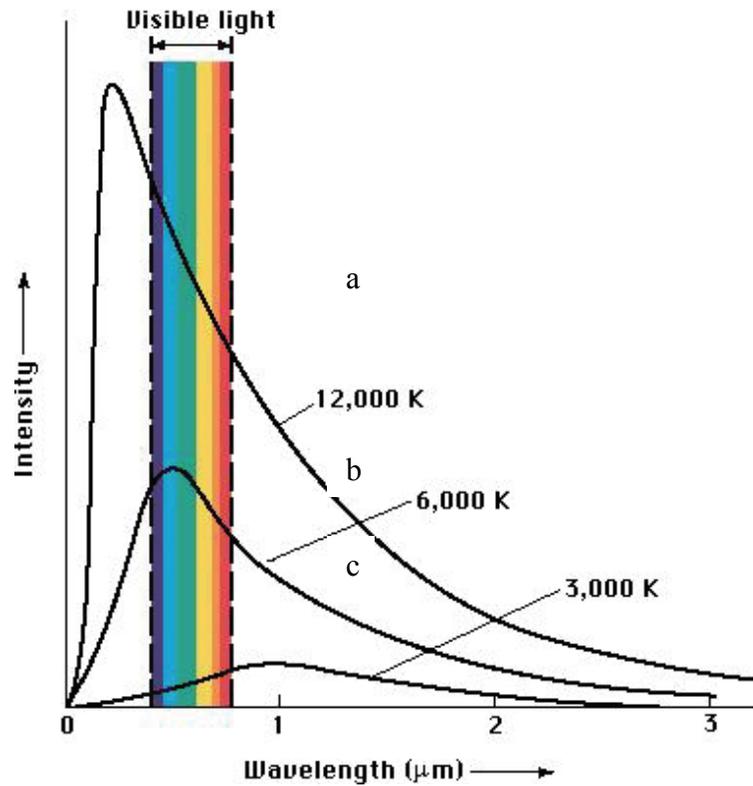


Fig 1 [http://www.physics.umd.edu/courses/Phys401/bedaque07/blackbody\\_curves.jpg](http://www.physics.umd.edu/courses/Phys401/bedaque07/blackbody_curves.jpg)

Stars are not “perfect” black bodies as illustrated in Figure 1. They have absorption lines. The cooler gas in the star's atmosphere basically absorbs photons coming from the hotter interior. Thus we obtain a black body spectrum that has absorption lines superimposed.

Figure 2 is a spectrum of a G-type star (like the Sun).

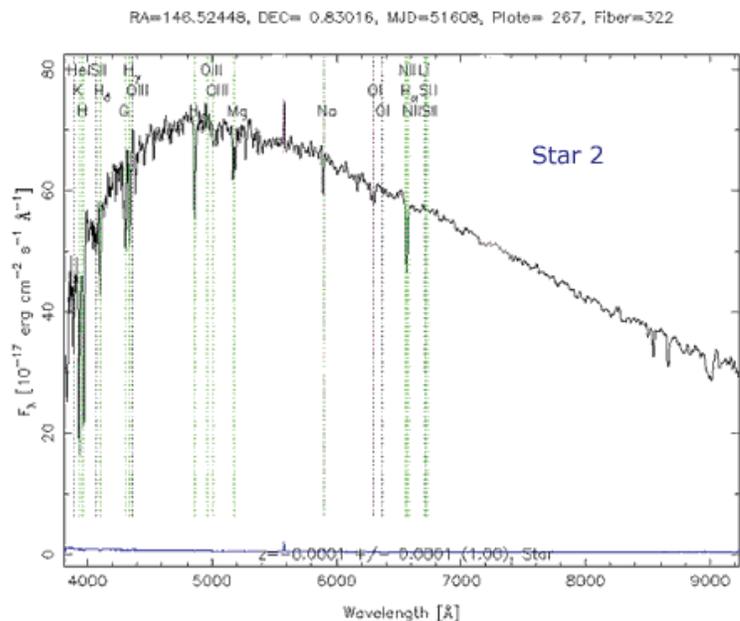


Fig 2 [http://outreach.atnf.csiro.au/education/senior/astrophysics/spectroscopy\\_questions.html](http://outreach.atnf.csiro.au/education/senior/astrophysics/spectroscopy_questions.html)



Spectra can be displayed in several fashions. The most intuitive method is shown in Figure 4. Since the positions of the absorption lines are more important than the overall colors, gray scale images (Fig 6) are adequate if you want rough spectral classifications.

However sometimes you need to classify stars more accurately. In that case we often analyze the intensity trace (the blue line in Figure 2, the black lines in Figure 5, and the black line in Figure 6 that you will see again during the lab) of the gray scale (or color) image (Figure 6). The intensity traces show the absorption lines (Figure 7) superimposed onto the black body curves (Figure 2). Take a pen and extend the black body spectrum of the B0, G1, and M0 stars in Figure 5. The spectrum should cover the range from 100 nm to 1000 nm and should show the position of the dominant wavelength.

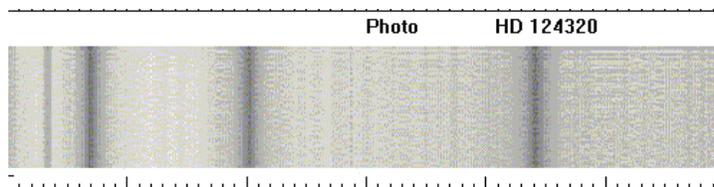


Fig 6

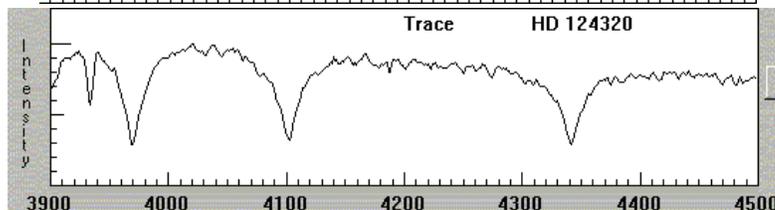
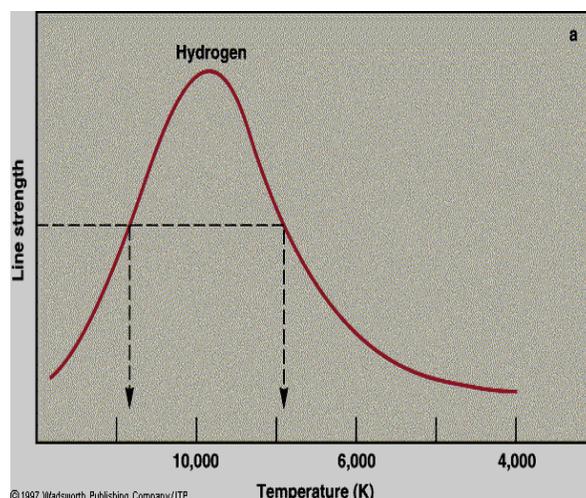


Fig 7

Figure 6 and 7 are taken from the CLEA spectroscopy laboratory <http://www3.gettysburg.edu/~marschal/clea/CLEAhome.html>

In addition to affecting the general black body shapes of stellar spectra (Figure 1), the temperature affects which absorption lines we see. In fact, the chemical compositions of stellar atmospheres do not vary significantly from star to star. Let's understand how the temperature affects stellar spectra.

Consider the Bohr Model of the Hydrogen Atom: You will need a certain minimum amount of energy to make the electron jump to its first excited level. If the star is too cool, there is not enough energy, and the electron will remain in its ground state. Thus no energy will be absorbed, and no absorption line will be seen. In hotter stars the energy supplied will be just right for the electron to jump to an excited level, thus producing an absorption line. However, if the star has too much energy (i.e., is too hot), all electrons will be in their most excited levels, in fact the hydrogen gas will be ionized) and no more energy can be absorbed. Again you will not see an absorption line.



In other words, too hot or too cool stars do not have hydrogen absorption lines, while stars of the right temperature will have a strong line. A-stars have the strongest Hydrogen lines; O stars are too hot and M and K stars are too cool. This game can be played for every single absorption lines of different elements as shown in figure 7. The presence of specific absorption lines and their strength is thus indicative of the surface temperature of the star.

## Spectral Lines of Stars of Different Temperatures

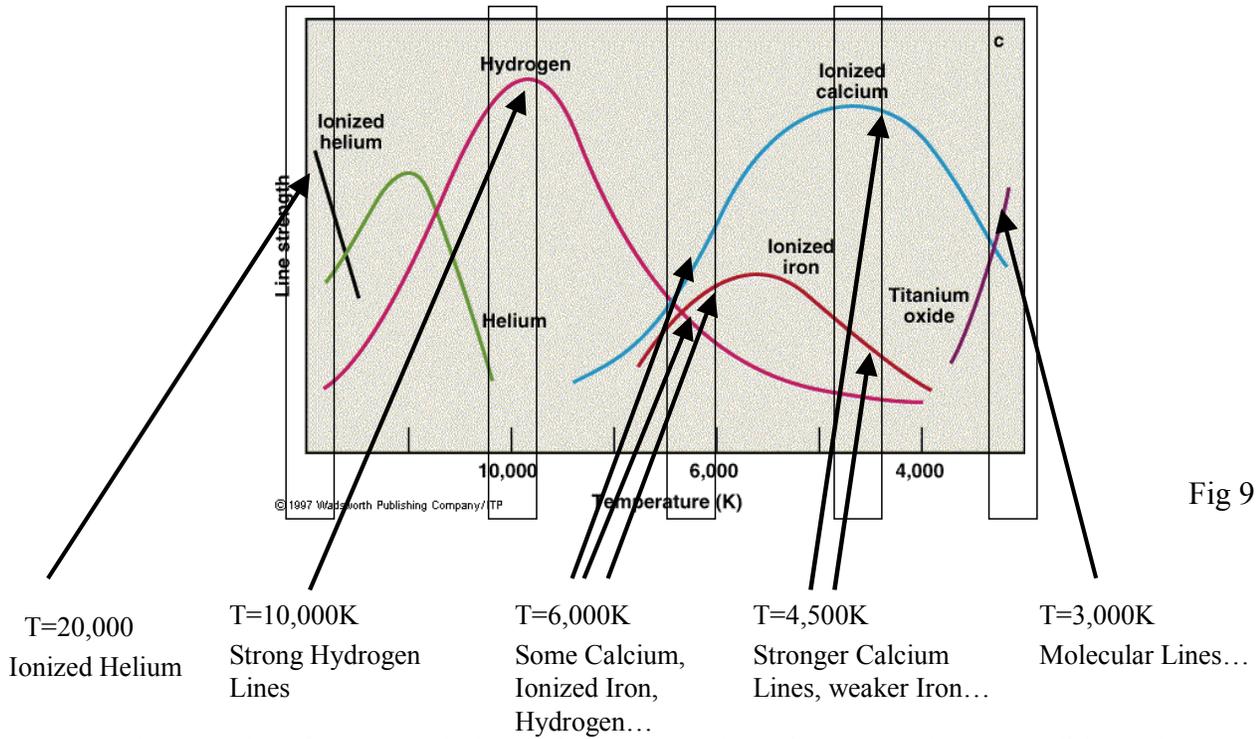


Fig 9

Figures 8 and 9 are taken from Foundations of Astronomy by Michael Seeds, 1999 edition, Figure 7-14.

G-type stars have strong ionized Calcium lines; why are these weak for O and K stars?

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Complete the Table below. Describe how to identify each spectral type

Spectral Type	Temperature Range	Dominant Absorption Lines