

How To Do Spectral Classification

Spectral classifications are mainly a temperature sequence. The plots show the amount of energy at each wavelength for a variety of stars. These are all absorption spectra, dark lines on a colored background.

For this lab, you are asked to use Wien's law to find the peak of the black body background as a first step. The formula is

$$T = \text{Temperature (in Kelvin)} = 29,000,000 / (\text{peak wavelength in \AA})$$

To estimate the wavelength at the peak of the black body curve, look for the underlying smooth curve. The spectral lines interfere so that the one highest point isn't the same as the peak of the black body curve. Emission, extra outgoing radiation from gas near the star, can increase the total amount of radiation at a few points. Try to ignore the lines and estimate the peak of the background smooth curve.

The temperature indicates the spectral type. There was a list of temperatures and corresponding spectral types as part of the Hertzsprung Russell diagram homework. There is also a table of temperatures and spectral types below. As you can see, the temperature differs a little among the different luminosity classes. So don't rely on the temperature exclusively. Use the spectral lines as well.

The sample spectrum shows the spectra of a hot star and a cool star. It also shows the positions of some of the more important absorption lines to use in spectral typing. Check the lines in the order below to decide the spectral type. When you describe the process you used for finding the spectral type, discuss how you used the lines.

1) Hydrogen Lines – There is a whole series of hydrogen lines. They all appear together, never one at a time. Look for the pattern. These are hydrogen Balmer lines (like the lines you saw from the emission lines from the spectrum tube).

The pattern of hydrogen lines is the strongest at A0. Hotter stars are so hot that the hydrogen atoms have lost their one electron, cooler stars are too cold for the hydrogen atoms to be in the second energy level required to produce the Balmer lines.

Stars hotter than A0 (i.e. O and B type stars) have few lines other than the hydrogen lines and the peak of the black body curve is at short wavelength.

If the hydrogen lines are not as strong as for A0, look to see whether there are other lines and whether the peak of the background black body curve is toward the short wavelengths or toward the long wavelengths. If you are looking at a hot star, judge the hydrogen line strengths and the peak of the background. If you are looking at a colder star, keep going.

H and K lines of Calcium This is a pair of lines due to once ionized Calcium (called Calcium II). The two calcium lines are the SAME strength, but one of them is at the same wavelength as a hydrogen line. So it blends with the hydrogen line and looks stronger when the hydrogen line is strong.

The H and K lines are not seen in hot stars. They start to become visible in A1 stars, breaking up the hydrogen pattern. They become stronger in cooler stars, as the hydrogen lines get weaker. They are the strongest lines in F and G stars.

Iron G Band is a blend of absorption lines near 4300 Å. It begins to appear in cooler (G and K) lines of Calcium weaken. There will be LOTS of lines along with the G band. So if you don't see

any hydrogen lines, the continuous background is weak, and the G band is strong, look at G- K- and some of the hotter M stars.

Titanium Oxide (TiO) molecular bands become strong in M stars. They are the first strong indications of molecules in stellar atmospheres. TiO bands will be seen in cool stars with the peak of the black body curve toward long wavelengths. The hydrogen lines will not be seen and the background will be weak where the Calcium lines should be.

If you see hydrogen lines, no other strong lines, and a background indicating a hot star (peak toward short wavelength), the star is an O or B star. Match the hydrogen line strengths and the continuum to decide the on the type.

Spectral Type	V	III	I, lab from K3
O9	35900		32500
O9.5	34600		
B0			26000
B1	31500		20700
B2	25600		17800
B3	22300		15600
B4	19000		13900
B5	17200		13400
B6	15400		12700
B7	14100		12000
B8	13000		11200
B9	11800		10500
A0	10700		9730
A1	9480		9230
A2	8810		9080
A5	8160		8510
A7	7930		
F0	7020		7700
F2	6750		7170
F5	6530		6640
F7	6240		
F8			6100
G0	5930	5910	5510
G2	5830		
G3			4980
G4	5740	5190	
G6	5620	5050	
G8		4960	4590
K0	5240	4810	4420
K1		4610	4330
K2	5010	4500	4260
K3		4320	4130
K4	4560	4080	
K5	4340	3980	3850
K7	4040		
M0	3800	3820	3650
M1	3680	3780	3550
M2	3530	3710	3450
M3	3380	3630	3200
M4	3180	3560	2980
M5	3030	3420	
M6	2850	3250	