The Spectral Winter "G"

A Beginners Project in Astro-Spectroscopy

Most everything we know about the stars, we glean from their spectra. If you are looking for a project that is different and interesting, that will give you better insight into understanding some of the fundamental discoveries in astronomy, then you should try observing stellar spectra.

You can learn to identify the types of stars visually. Rather than just looking in a handbook and saying "Regulus is a B7 star", you can observe Regulus, and verify its spectral type. You can identify many of its characteristic absorption lines, the features that let the astronomer know a stars' temperature, and the elements that exist in its atmosphere.

And, surprisingly, it really does not require a vast amount of investment. In fact, if you are an observer, you probably have most of what you need in your current collection of equipment. Additionally, what you will need is an eyepiece spectroscope, and the list of bright and interesting objects provided with this project.

The eyepiece spectroscope can be acquired by either purchasing one, such as the Rainbow Optics grating spectroscope, or by obtaining a GOTO (pronounced GO TOE) prism spectroscope which can occasionally still be found on either Ebay, or AstroMart. In either case you will spend from $200 - $250, about the price of a good eyepiece. (Note: Some amateurs attach cameras to their spectroscopes and record their data digitally. However, for this first project, since the stars are bright, it can be performed visually.)

The big question is where to start ... at what should you be looking? Where is a good beginning stellar spectra list to first study, to become acquainted with a full range of stellar objects from "Cool" to "Hot"?

The answer is the Winter "G" Asterism (also called "the Hexagon"). This assemblage of first and second magnitude stars is the perfect first observing project for those who wish to become acquainted with stellar spectra. Why? Because the Winter "G" contains a sample of almost every Spectral Class of star. Only the hottest ones are missing. To remedy this small problem, the author has modified the "G" slightly to include three hot O and B stars, resulting in the Spectral Winter "G". The two major advantages to this observing project are:

- The list contains at least one bright sample of each of the seven Spectral Types and,
- The ability of viewing them all in just one evening.

The Spectral Winter "G" consists of the following stars, listed in "G" order

Name	Constell. Desig.	Visual Mag.	Spectral Type	Temperature (K)
Capella A B	α Aur A B	0.08v	G8 + G0	4900 º - 5700 º
Castor A B	α Gem A B	1.58v	A1 + A5	9800 º - 8300 º
Pollux	β Gem	1.06v	K0	4770 º
Procyon A	β CMi A	0.34	F5	6530 º
Sirius A	α CMa A	-1.46v	A1	9880 º
Rigel	β Ori	0.18v	B8	11500 º
Aldebaran	α Tau	0.87	K5	4010 º
Betelgeuse	α Ori	0.45v	M2	3650 º
Alnitak*	ζ Ori	1.74	O9.5	31000 º
Alnilam*	ε Ori	1.70v	B0	25000 º
Bellatrix*	γ Ori	1.64	B2	21500 º

Notes: Statistics are from "The 170 Brightest Stars" by Jim Kaler stars.astro.illinois.edu/sow/bright.html
The three last stars marked with an asterisk (*) are the modifications made to the "G" by the author.

There are two Observing Worksheets attached. The first is for use with a Diffraction Grating Spectroscope. The second is for Prism Spectroscope applications. Each worksheet displays four blank spectra upon which to draw the observed lines. The dashed lines are the average position between visual colors. Note that the grating spectra are linearly spaced for all wavelengths, while the prism spectra begin broad in the blue and more squashed into the red. These are the characteristic spectral profiles of gratings and prisms due to diffraction and refraction, respectively.

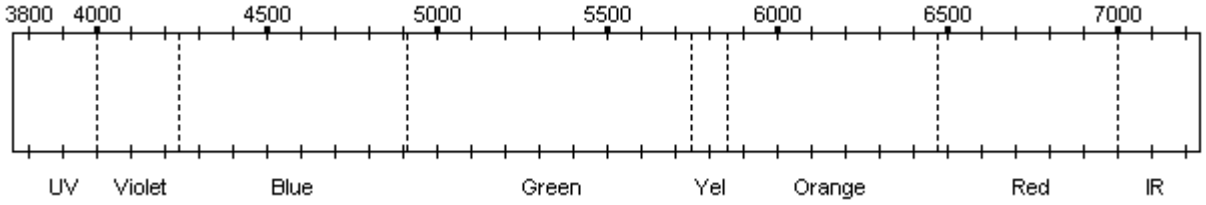
Characteristic Lines by Spectral Class

Below is a basic list containing a few elemental lines in stellar spectra. Some of the prominent, or characteristic, lines are shown that might be used to broadly identify the types. Observing all of them will depend upon equipment, the seeing conditions as well as your eye acuteness. Wavelengths are given in Angstroms.

- **Type O**: Hottest blue stars (>55,000 °K to 30,000 °K). Ionized Helium (4541 and 4687) predominates. Occasionally the Hydrogen Balmer lines are seen weakly (see Balmer Series below under Type A) as well as very weak neutral Helium (3888, 4472 and 5877). Other very faint ionized Oxygen, Nitrogen, Silicon and Carbon lines may be present.
- **Type B**: Hot blue stars (30,000 °K to 10,000 °K) .Neutral Helium (3888, 4121, 4472 and 5877) lines dominate and max at B2. Hydrogen Balmer lines become progressively stronger through this type. Other very faint ionized Magnesium, Silicon and Carbon lines may be present.
- **Type A**: Blue stars (10,000 °K to 7,400 °K). Hydrogen Balmer lines dominate and max at A0. The H and K lines of ionized Calcium (3968, and 3934) become strong as neutral metals may appear weak. The Hydrogen Balmer lines: Hα - 6563; Hβ - 4861; Hγ - 4340; Hδ - 4102; Hε - 3770.
- **Type F**: White stars (7,400 °K to 6,100 °K). Hydrogen lines are weakening. H and K lines of ionized Calcium strengthen as well as many fine lines due to other metals.
- **Type G**: Yellow stars (6,100 °K to 5,300 °K). Many fine lines appear due to many neutral metal elements such as Iron, Manganese and Calcium. The broad molecular CH G-band (4314) appears.
- **Type K**: Orange-red stars (5,300 °K to 3,800 °K). Hydrogen lines are gone. Broad TiO bands (4661, and 4955) begin to appear. The ionized Calcium lines are strong. CH band is very strong.
- **Type M**: Red stars (3,800 °K to 2,200 °K). Broad TiO bands (4661, and 4955) dominate the spectrum. Neutral metal lines throughout the spectrum.

Notes and Observing Suggestions

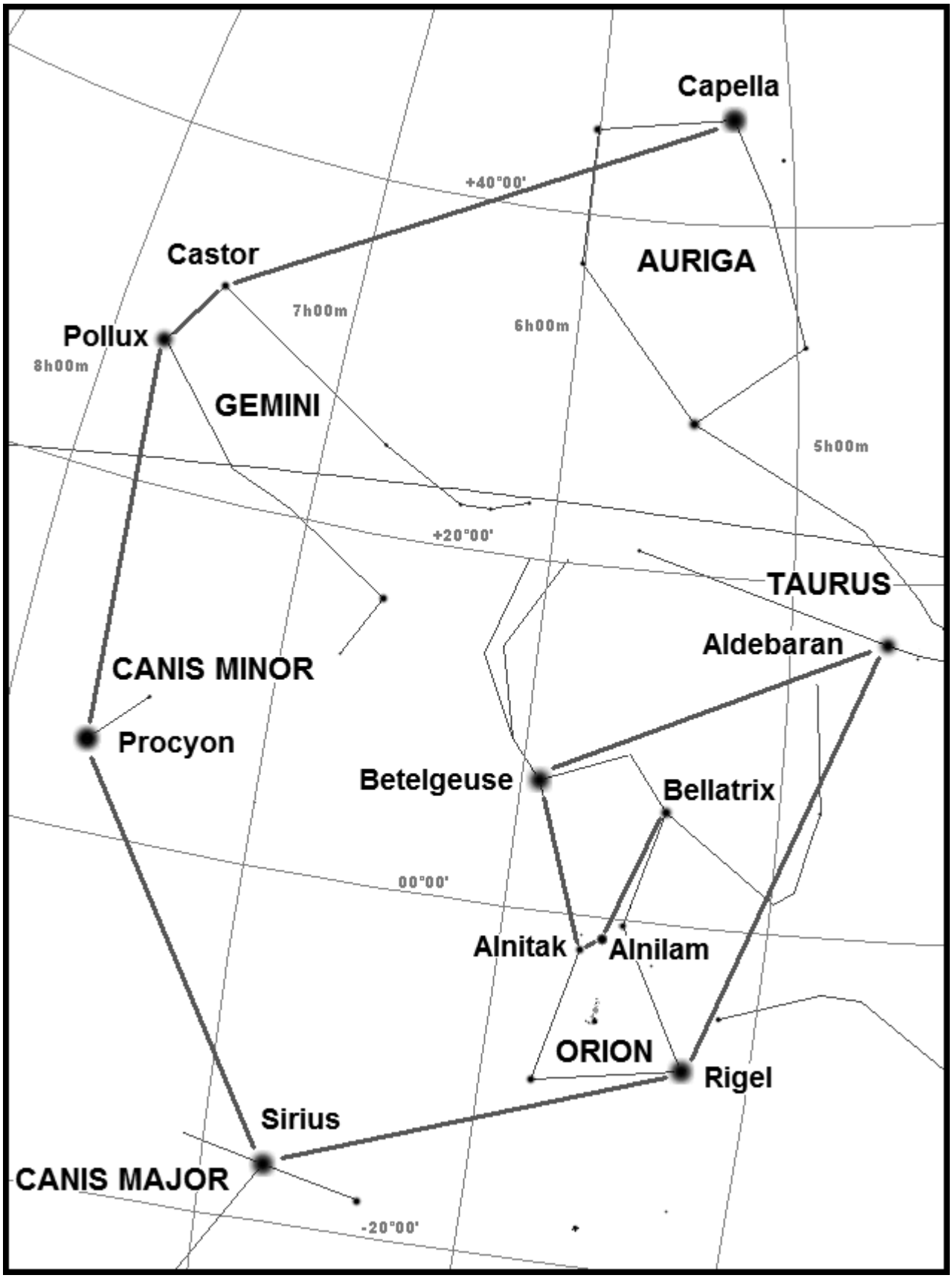
Everyone's eyes respond differently to light. To "Calibrate" your eye response to the grating or prism work sheet spectrum, observe a bright A0 star, such as Sirius or Vega, which contains the very strong Balmer absorption lines of Hydrogen. Compare the positions of these Hydrogen lines with respect to where you perceive the location of the color boundary lines (i.e. between violet and blue, blue and green, etc.). Determine if they match the standard dashed color boundary lines shown on the blank work spectrum as illustrated below.



If they do not, you may wish to make more personalized boundaries on your work sheet copies for better accuracy when recording the more complicated lines of the cooler (F, G, K and M) stars. You might also like to estimate the UV and IR cutoff sensitivity of your eye.

When observing spectra for line details, just like observing visual objects such as planets, galaxies, etc., you should take your time on each subject. The middle and cooler stars usually have a few strong lines with many fine ones that may take some practice to detect visually.

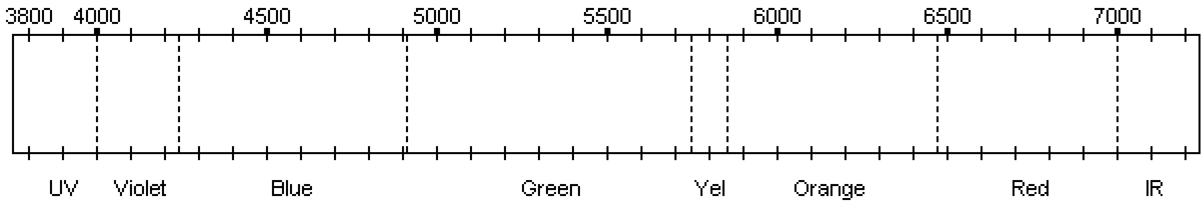
Sky Chart of the Spectral Winter “G”



Astrospectroscopy Worksheet

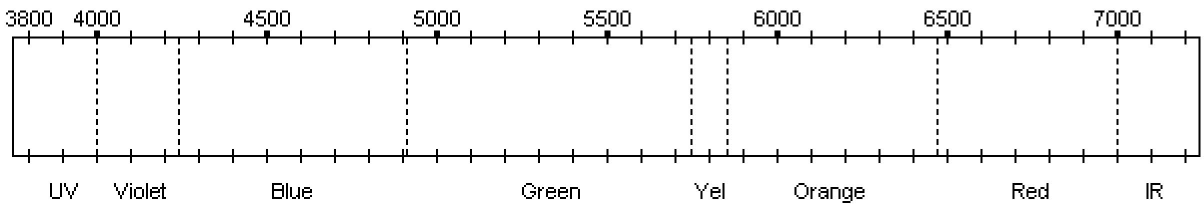
Diffraction Grating Spectroscope Visual Observations

Observer Name ______________________________



Object: ____________________ **Spec. Type/Class:** ________ **Obs. Date:** ________ **Time:** ________

Notes: ____



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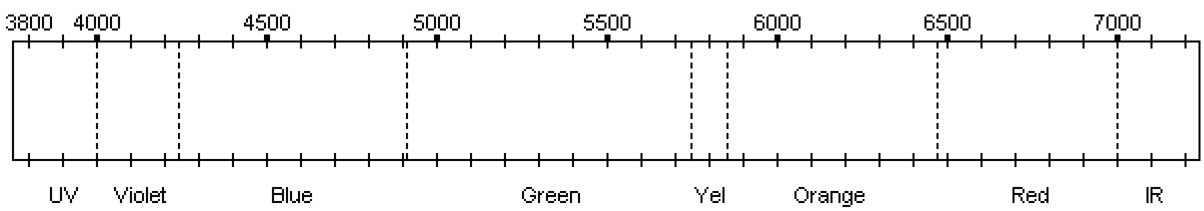
Notes: ____



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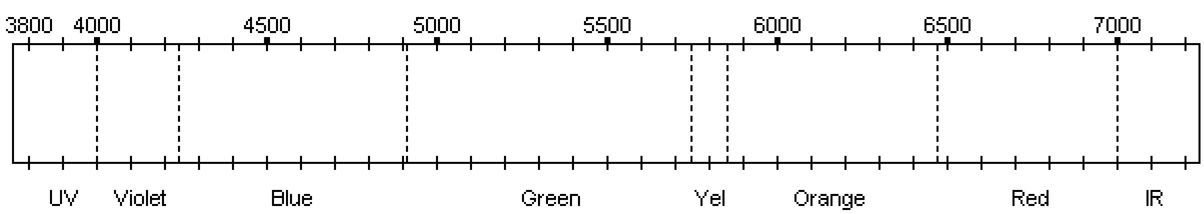
Notes: ____



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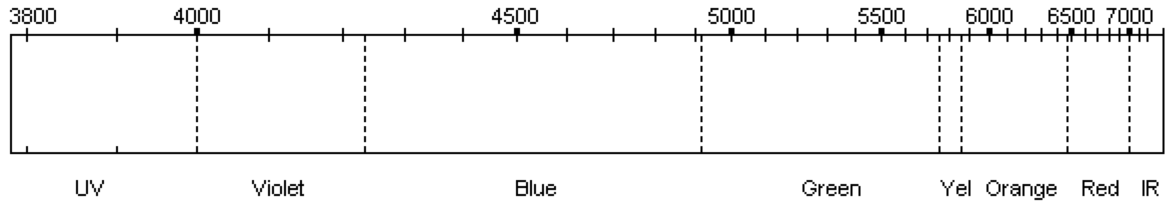
Astrospectroscopy Worksheet
Prism Spectroscope Visual Observations

Observer Name ________________________________



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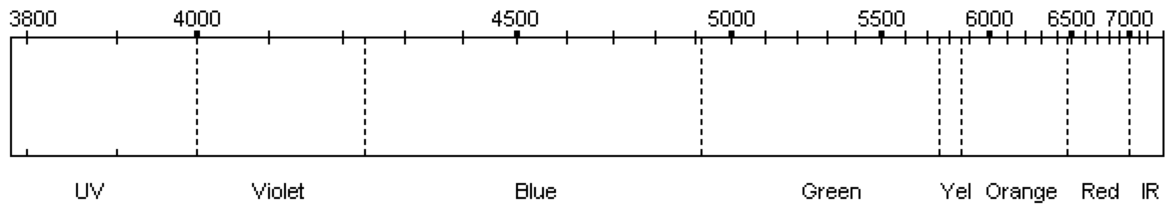

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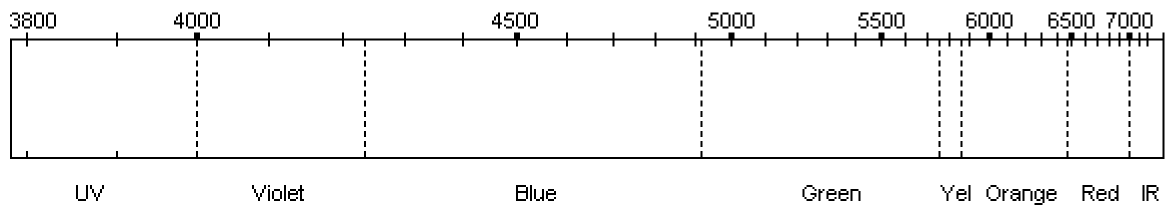

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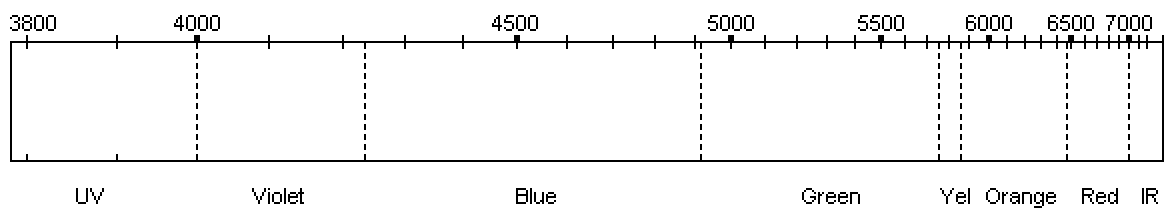
Notes: ____



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