Spectral Analysis of the Constellation Stars of Canis Minor (The Little Dog)

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Abstract

This paper will elucidate the spectral features of the main stars in the constellation Canis Minor. The selection of stars was chosen to coincide with those typically used to trace the constellation lines that form the geometric shape of the constellation itself[1]. Though other stars within the boundary of the constellation (as determined by the IAU) may be objects of interest, the analysis is confined to the stars forming the constellation lines.

The stars in the constellation will generally be presented in order of their accepted Bayer designations, using Greek letters to rank them roughly in order of decreasing brightness. Alpha (or α) is usually the brightest star in a constellation. Afterward, Beta (β), Gamma (γ), and so on indicate decreasing apparent magnitude. It is usually the brightest stars that define the constellation lines. Of course, there are deviations from this rule that have been retained for historical consistency.

Equipment Used

All spectra used in this analysis were captured using the following equipment and resources:

Telescope: Celestron Advanced C6-N Newtonian Telescope, with an aperture of 6 inches, and a focal length of 750mm. This makes the focal ratio f/5.

Mount: Meade LX85 German Equatorial Go-To Mount. The mount was aligned using the three-star method.

Camera: ZWO ASI290MM monochrome camera.

Transmission Grating: The SA100 grating was employed to produce the spectra used in this analysis. The grating has 100 lines per millimeter.

Capture Software: The ASI Studio suite of programs was used in the capture process. Following capture, the same suite was used to stack images and export them as TIF files for evaluation and analysis.

Analysis Software: Rspec v2.1.1 by Field Tested Systems, LLC.

Reference Material Used in Analysis: The *Spectral Atlas for Amateur Astronomers* by Richard Walker and *Spectroscopy for Amateur Astronomers* by Marc F. Trypsteen and Richard Walker were both used to assist in identifying specific facets of the resulting spectra, and proved invaluable in this process. Wikipedia and Stellarium were also instrumental in obtaining information regarding the various stars.

Data Processing Details

All of the spectra obtained for this analysis were obtained on the evening of March 27, 2024 (EDT). Additional specifics for each capture are included for each star's spectrum in the pages that follow. The times presented there are given in UT, as is desirable for any astronomical work. Also included are the exposure lengths, number of frames captured, and the percentage of those frames which were applied to the stacking process. The determination of this percentage was subjectively chosen based on the quality of the footage captured—the accuracy of the tracking, the steadiness of the atmosphere at the time, etc.

The tracking of the Meade LX85 mount used in the capture process has limitations regarding its accuracy. Therefore, some gain was applied during the captures in order to shorten the exposure times. This was kept to a minimum, as excessive use of it does compromise the quality of the exposures. No bias, dark, or flat frames were used for these captures, nor were reference stars captured for individual sessions. The captures must

therefore be considered "Quick and Dirty," and so are unsuitable for professional or purely scientific applications. However, this author believes that they are adequate for general demonstration purposes. Refinements to these results are certainly possible if extra steps were taken to account for camera read noise, image defects in the optical train, and specific atmospheric influences that differ from those encountered when generating the initial response curve (Alpha Lyrae on July 18, 2023). Also, no sharpening or other image modifications were made to the stacked images. Most of the spectra therefore show telluric absorption bands; some of these are labeled, where others are not.

α Canis Minoris

Alpha Canis Minoris, commonly known as Procyon, is a middle F-type star[1]. Based on this, we can expect a somewhat hot star still showing fairly strong hydrogen Balmer lines in its spectrum. We can also expect a good number of metals beginning to peel through, as well.

The processed spectrum is as follows:

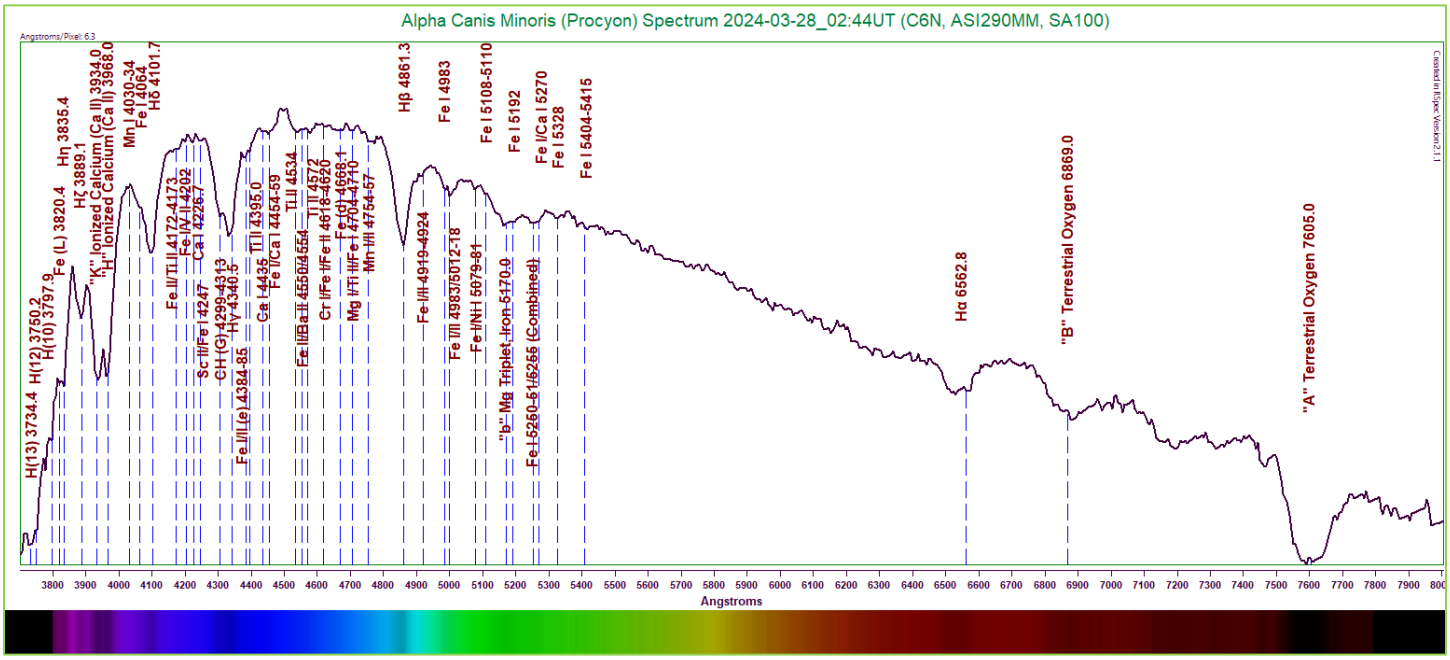

Figure 1: Alpha Canis Minoris (Procyon) Spectrum (6.3 Angstroms/pixel)
Capture Details 1: Exposure 133ms, Gain 0, 35% of 1823 frames stacked

We can see many of the hydrogen Balmer lines present in this spectrum. The Hε line, however, is overtaken by the calcium H line. The Fe (L) line sits alongside the Hη line to create a prominent "step" in the continuum at 3820-3835 Angstroms. The calcium H and K lines present a very deep pair of absorptions at 3934-3968 Angstroms. The CH (G) band is visible at 4299-4313 Angstroms as a small bump below the peak of the Hγ absorption. The magnesium triplet at 5170 Angstroms is fairly strong here, combining with flanking iron lines to create a broad dip in the continuum. Moving toward longer wavelengths, the continuum becomes increasingly noisy. There is no recognizable trace of the sodium doublet. As expected, however, a good number of fainter metal lines can be seen throughout the spectrum, including manganese, iron, calcium, scandium, titanium, chromium, and magnesium. Many of these are very faint, and so must be regarded dubiously.

Employing Wien's Law, we will attempt to estimate the star's effective temperature. Using a visually estimated peak energy wavelength of 4489 Angstroms, we arrive at a result of approximately 6455K. The listed value for the temperature is 6530K[2]. Our estimate is remarkably close.

β Canis Minoris

Beta Canis Minoris, also called Gomeisa, is classified as a late B-type star[1]. We can therefore expect a hotter star than Procyon above, with slightly stronger hydrogen Balmer lines and fewer metals present.

The processed spectrum is as follows:

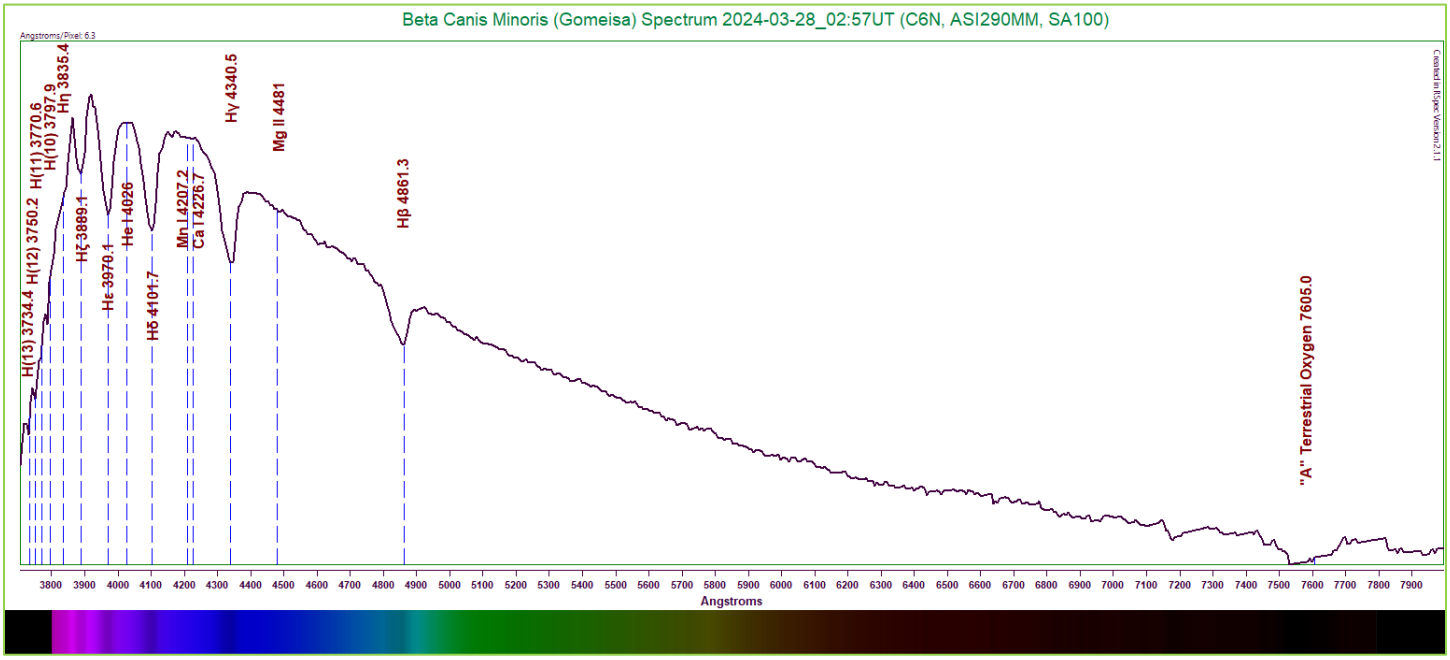

Figure 2: Beta Canis Minoris (Gomeisa) Spectrum (6.3 Angstroms/pixel)
Capture Details 2: Exposure 303ms, Gain 95, 40% of 814 frames stacked

Compared to Procyon above, this spectrum appears much smoother, with far fewer features. Many of the hydrogen Balmer lines are present here, with the notable exception of the Hα line. The visible ones are quite distinct, with the exception of the Hη line which is very weak, wity the absorption is only causing a slight hump in the continuum line. One helium line at 4026 Angstroms appears, but is also extremely weak, causing only a flattening at the peak between the Hε and Hδ lines. Only three other extremely weak absorptions are noted—manganese at 4207.2 Angstroms, calcium at 4226.7 Angstroms, and magnesium at 4481. The first two appear to cause a small, combined dip in the continuum; this is very slight, though, and should be regarded cautiously. The third is likewise extremely weak, but appears to cause a deviation from the continuum line.

Wien's Law will be used to estimate the star's effective temperature. However, since this is an early-type star, we can expect our estimate to come in far under the mark. Using a visually estimated peak energy wavelength of 3919 Angstroms, we arrive at an estimate of 7394K. The established temperature of the star is listed as 11772K[2]. Indeed, our estimate falls significantly short.

Conclusion

Canis Minor is small, only composed of two stars. Spectra for both were easily acquired. Line identification for Beta Canis Minoris seemed unusually difficult for some reason, but otherwise the analyses went well. The one regret I had for the capture session was that I did not also capture a spectrum for Gamma Canis Minoris. I noted the star's deep orange color when zeroing in on Beta, but I was pressed for time as the Moon was rising rapidly and beginning to flood the sky with unwanted light.

Contact

Any comments, questions, criticisms, etc. can be directed to anthonyspectro@gmail.com.

References

[1]: As determined using Stellarium v1.1. (Of course, not all sources agree as to the exact stars used in forming the shapes of the constellations. Alternate designations are also applied to most stars.)
[2]: As indicated by Wikipedia.
[3]: *Spectral Atlas for Amateur Astronomers* by Richard Walker
[4]: *Spectroscopy for Amateur Astronomers* by Marc F. Trypsteen and Richard Walker