Spectral Analysis of the Constellation Stars of Triangulum (The Triangle)

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Abstract

This paper will elucidate the spectral features of the main stars in the constellation Triangulum. 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 apparent 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 captured for this analysis were obtained on the evening of November 18, 2023 (EST). Additional specifics for each capture are included with 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 in are the exposure times, 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 Trianguli

Alpha Trianguli, also known as Mothallah, Caput Trianguli, and also by other names, is a spectroscopic binary whose primary is a middle F-type star[1,2]. Based on this, we should expect to see a moderately hot star showing both hydrogen Balmer lines and a good number of metal lines.

The processed spectrum is presented here:

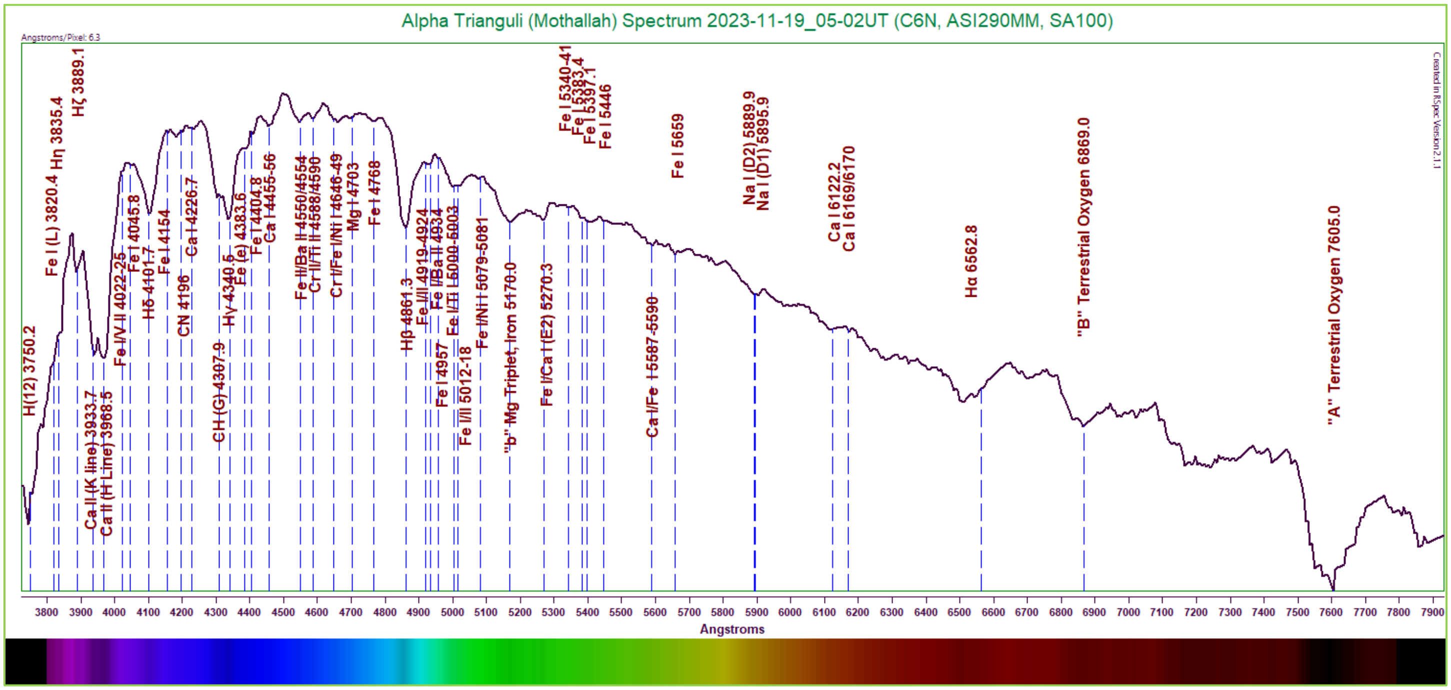

Figure 1: Alpha Trianguli (Mothallah) Spectrum (6.3 Angstroms/pixel)
Capture Details 1: Exposure 728ms, Gain 98, 55% of 337 frames stacked

This spectrum shows a lot of interesting characteristics. Many of the hydrogen Balmer lines are still quite evident, with the exception of the Hε line, which has been overpowered by the strong calcium H and K lines. The Fe I (L) and Hη lines are causing a stair-step effect on the lower end of the wavelength range. The magnesium triplet at 5170 Angstroms appears, not necessarily very strong, but quite evident. The Fe I/Ca I (E2) line above it also carves out a distinctive dip in the continuum. The sodium D1 and D2 lines are causing a small but detectable absorption as well at 5890-96 Angstroms. Numerous fainter metal lines can be seen in the spectrum, including iron, CN, calcium, chromium, and magnesium.

We can use Wien's Law to obtain a rough estimate of the star's temperature. Adopting a peak energy wavelength of 4495 Angstroms, we arrive at an estimate of 6447K. The star's listed temperature is 6288K[2]. In this case, our estimate comes in a little bit too high.

β Trianguli

Beta Trianguli, or Mizan, is another spectroscopic binary, this time of middle A-type[1,2]. That being the case, we can expect to see strong hydrogen Balmer absorptions, with perhaps a small amount of metals peeking through. We can also expect a curve representative of a hotter star than Mothallah above.

The processed spectrum follows:

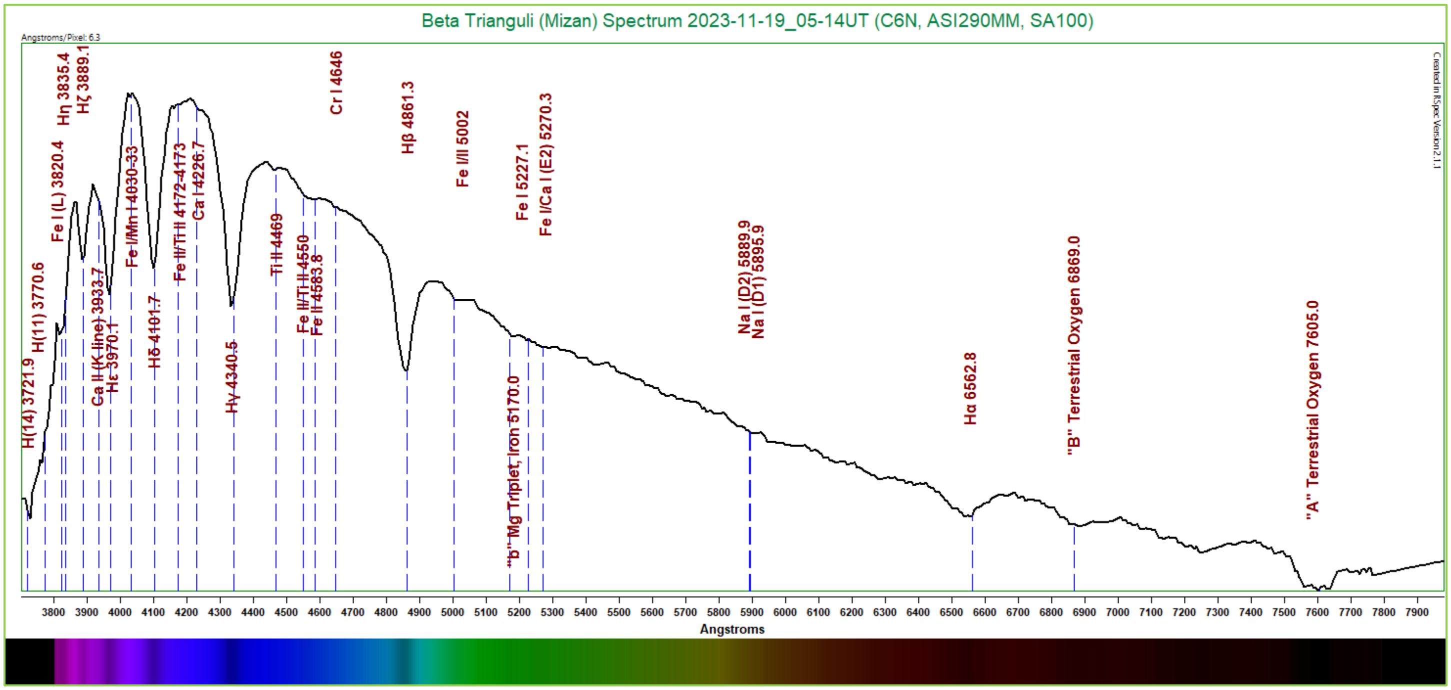

Figure 2: Beta Trianguli (Mizan) Spectrum (6.3 Angstroms/pixel)
Capture Details 2: Exposure 633ms, Gain 62, 60% of 391 frames stacked

We can indeed see some strong hydrogen Balmer lines, as expected. The Fe I (L) and Hη lines are causing a moderately sized step in the continuum near the lower wavelength region. The calcium K line is just barely beginning to deform the lower side of the Hε absorption. The magnesium triplet at 5170 Angstroms is very weak, causing only a small depression in the continuum. The sodium doublet at 5890-96 Angstroms is weaker still, with its presence very difficult to discern with certainty. Some fainter metal lines are marked, including iron, calcium, titanium, and chromium.

We can use Wien's Law to estimate the temperature, but since this is an early-type star we can expect our estimate to fall short. Using an estimated peak energy wavelength of 4039 Angstroms, we arrive at a temperature of 7175K. The listed temperature for the star is 8186K[2].

γ Trianguli

Gamma Trianguli is classified as an early A-type star[1,2]. This means we can expect to see pronounced hydrogen Balmer lines, like with Mizan above, but perhaps with fewer metal absorptions present and a slightly higher temperature.

The spectrum is presented below:

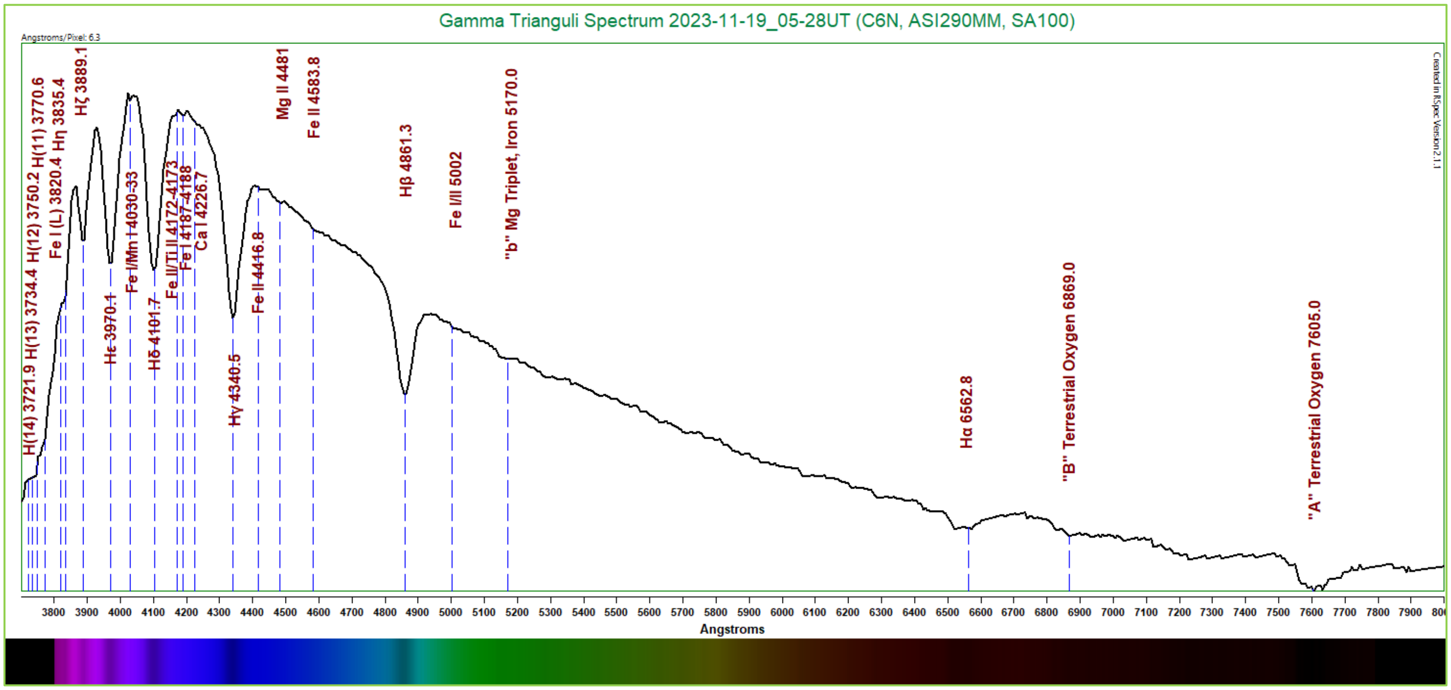

Figure 3: Gamma Trianguli Spectrum (6.3 Angstroms/pixel)
Capture Details 3: Exposure 626ms, Gain 113, 75% of 397 frames stacked

Here we can see another similar curve. The hydrogen Balmer lines are strong throughout. Very interesting is the series of hydrogen absorptions in the 3721-3750 Angstroms range, which are causing a plateau at the low wavelength region. The Fe I (L) and Hη lines can again be seen causing a step along the continuum. The magnesium triplet at 5170 Angstroms is barely visible here, evident only by a small absorption. Several additional very faint metals can be seen in the spectrum, including iron, calcium, and magnesium.

Employing Wien's Law, we will estimate the temperature. Of course, we can again expect our estimate to be too low since we are dealing with an early-type star. Accepting a peak energy wavelength of 4024 Angstroms, we calculate a temperature of approximately 7201K. The current accepted temperature for the star is 9440K[2]. As expected, we come in under the mark.

Conclusion

This was a nice, short one for a change! The stars were easily located and captured. No real surprises along the way.

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