Astrometry of STF 1619AB

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Abstract

Our team made an astrometric measurement of the double star STF 1619 AB and found the separation to be 6.78 arc seconds and the position angle to be 264.97 degrees. Our analysis of historic observations as well as our own supports the contention that STF 1619 AB is a gravitationally bound binary system.

Introduction

A group of students from Paso Robles High School formed an astrometry seminar research team. The main goals of the team's research were observations and the analysis of the binary star STF 1619AB, as seen in *Figure 1*, to help further the information on the orbit of the stars, as well as gain experience measuring binary stars. Through observations and analysis, despite the longevity of this specific orbit, additional data was contributed to hopefully lead to more discoveries about this double star. This was done to help either disprove or support the published elliptical orbit. In order to do this, observations of the double star system and the measurement of its position angle (in degrees) and the separation (in arcseconds) were needed. This binary star was chosen due to its extremely long elliptical period, along with the possibility of past measurements straying from the orbital path into a linear path and being considered an optical binary star.

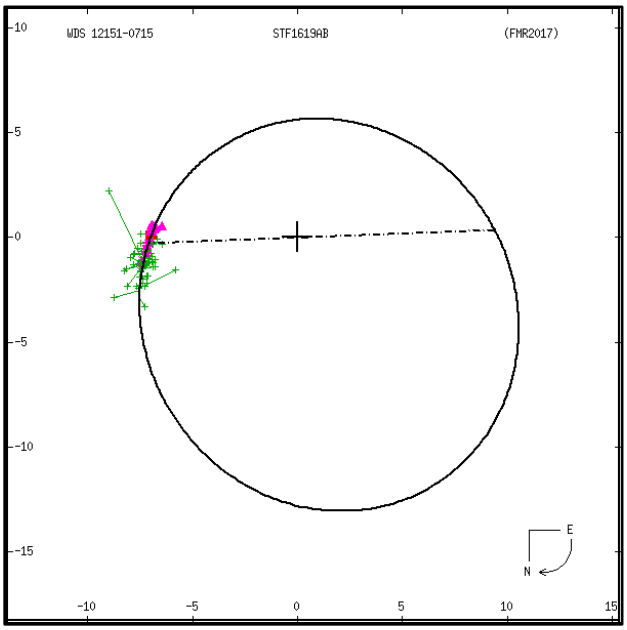

Figure 1: Image of STF 1619 AB orbit from 6th orbital catalog (USNO)

The first published research on (12151-0715 STF 1619 AB (HD 106515)) was in 1795, and the most recent one was in 2020. Friedrich Georg Wilhelm von Struve is attributed as the discoverer of the binary by making multiple published observations with a larger telescope in 1795. STF 1619 AB has been studied for

almost 230 years, yet all of the past observations indicate that the orbital period is tremendously long with the data points concentrated only in a certain area of the orbit as seen in *Figure 5*.

Equipment and Procedures

Las Cumbres Observatory (LCO) provided observing time to obtain the digital images. Images of STF 1619 AB were taken on a 0.4 meter telescope from South African Astronomical Observatory (SAAO) in Sutherland, South Africa on March 19, 2024 (2024.219444) using a Bessel V filter. There were 16 images taken at exposure of 1 second. In *Figure 2*, the process of taking 16 images is supported due to differing atmospheric conditions resulting in unique data and images. Multiple images were analyzed to account for shifting positions due to atmospheric turbulence.

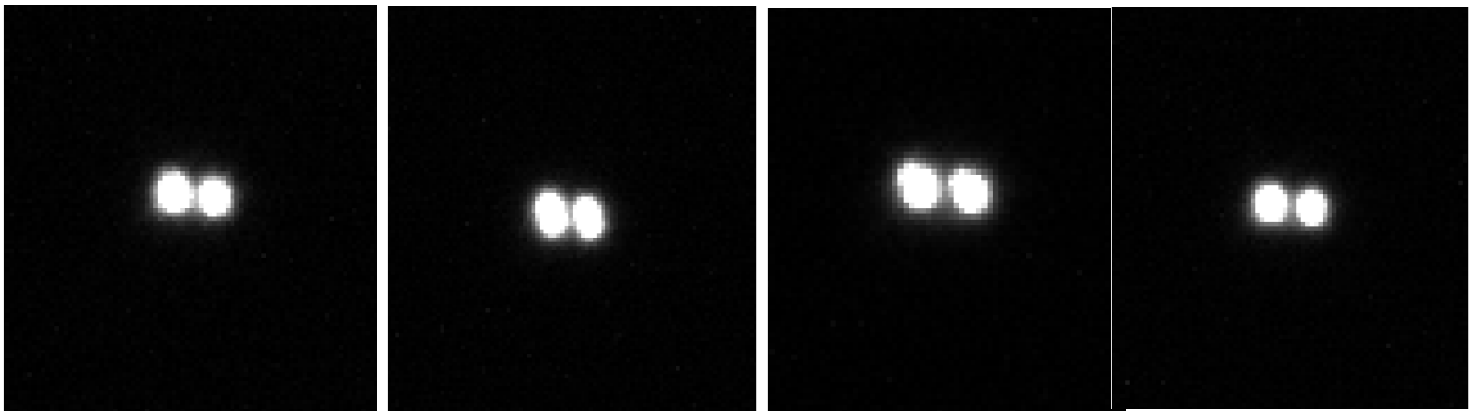

Figure 2: Sample images taken from Sutherland, South Africa at 1 second exposure showing differences due to atmospheric conditions

Data Analysis

Measurement	Value
Start	1,196.524, 1,198.348 +12:15:6.309, -07:15:27.141
End	1,205.651, 1,197.425 +12:15:5.852, -07:15:27.75
Length	9.174 pixels 6.829 arcsecs 0.1138 arcmins
Orientation	95.773 degrees CW of +Y 264.883 degrees E of N

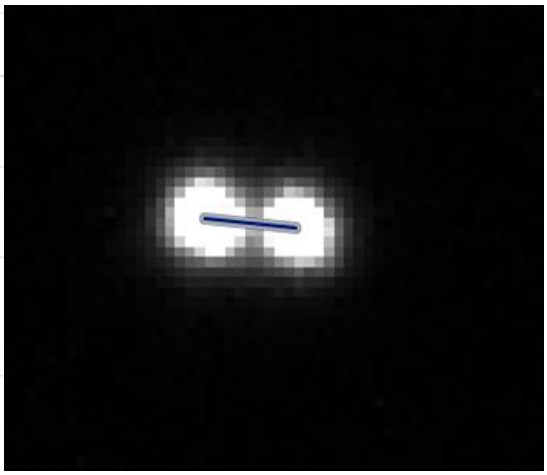

Figure 3: Analysis of STF 1619 AB binary star using Afterglow

Table 1: Calculated separation and position angle of 16 images using Afterglow

Image #	Separation (Arcseconds)	Position Angle (degrees)
1	6.81	264.79
2	6.64	266.17
3	6.81	264.59
4	6.77	265.32
5	6.82	264.99
6	6.85	265.14
7	6.78	264.66
8	6.83	264.83
9	6.78	265.18
10	6.77	264.54
11	6.80	264.93
12	6.76	265.22
13	6.77	264.75
14	6.76	264.70
15	6.78	264.77
16	6.84	264.97
Trial Average	**6.78**	**264.97**
Standard Deviation	0.05	0.40
Standard Error of Mean	0.01	0.10

Results

The 16 images were analyzed using the program Afterglow (Reichart et al., 2023), which allowed the team to get the primary and secondary stars' centroids' right ascension (RA) and declination (DEC). Statistical analysis was used to determine the standard deviation and standard error of the mean as seen in *Table 1*. The observations were taken on 2024.219444 (April 19th). The separation was calculated to be 6.78 arc seconds and the position angle to be 264.97 degrees.

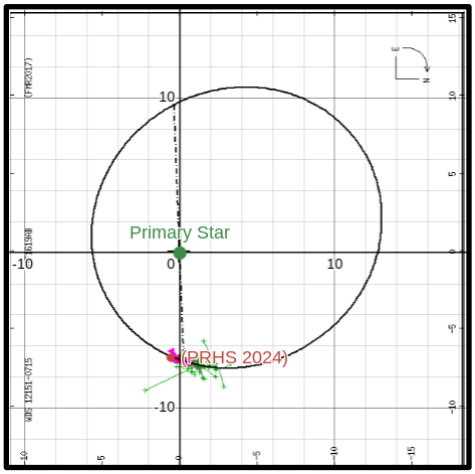

Figure 4: STF 1619 AB orbital plot showing newest measurement

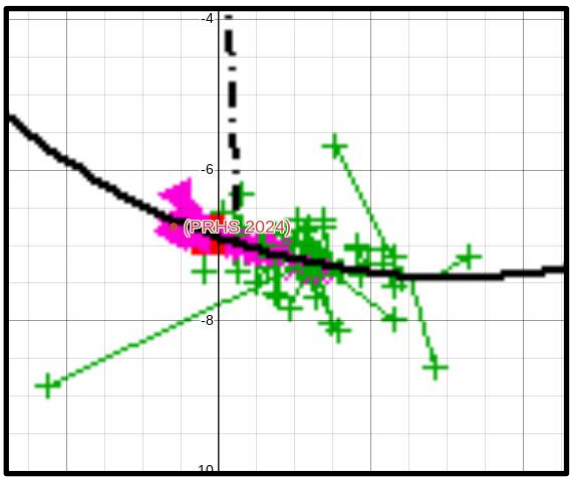

Figure 5: STF 1619AB orbital plot zoomed in to show detail

Conclusion

The objective of this research was to gather data about the orbit of this binary star by measuring the position angle and separation along with gaining experience of measuring binary stars. The results are consistent with previous observations as seen in *Figure 5*. Our analysis of historic observations as well as our own supports the contention that STF 1619 AB is a gravitationally bound binary system

Acknowledgments

We thank Rachel Freed for reviewing the paper. Las Cumbres Observatory provided digital images of the binary star, which were later analyzed. Dan Reichart et al. (2023) developed Afterglow, which was used to analyze the images. Russ Genet provided the Desmos template used to place our observation with the historic observations of this double star.

References

Genet, R., (2023), Desmos Graphical Analysis of Known Binaries, *Awaiting publication*. 3rd draft, acquired by email.

Reichart, D. E., Haislip, J., Kouprianov, V., Fu, R., Selph, L., Xu, S., ... & Converse, S. (2023). Next-Level, Robotic Telescope-Based Observing Experiences to Boost STEM Enrollments and Majors on a National Scale: Year 1 Report. *arXiv preprint arXiv:2304.02545*.

USNO (2024): https://crf.usno.navy.mil/data_products/WDS/orb6/orb6orbits.html