Astrometric Measurements of Double Star System STF 1727

Jasmine Wu[1], Emma Edmonds[1], Allen Priest[1], Grady Boyce[2], and Pat Boyce[2]

1. The Cambridge School, San Diego, California USA
2. Boyce Research Initiatives and Education Foundation (BRIEF), San Diego, California, USA

Abstract

We performed astrometric measurements on the double star system WDS 1309+3122 (STF 1727) on images obtained from the Las Cumbres Observatory. From our measurements, STF 1727 has a mean position angle of 332.86º and a separation of 7.42 arcseconds. Calculations of the distance between the stars and proper motion using GAIA DR2 data suggest that the system is a physical double.

Introduction

This paper presents the latest astrometric data measurements for the double star system 1309+3122 STF 1727. This was chosen from the Washington Double Star Catalog because it met criteria which we had imposed such as a difference in magnitude less than 3, brightness greater than 12 magnitude and separation no less than 5 arcseconds. After selecting several candidates, we narrowed down our selection by looking at the proper motion data which we found from the Gaia DR2 database. This data allowed us to select a star system with very similar motion indicating a likelihood that the stars might be a physical double.

In addition to the astrometric measurements of STF 1727, Figure 1, we hoped to utilize available data from Gaia DR2 to propose the likelihood of this system being a physical double by looking at the separation of the stars and their proper motion vectors.

STF 1727 was discovered by Friedrich Georg Wilhelm von Struve and was first measured in 1827. Friedrich Georg Wilhelm von Struve was an astronomer in the 19th century who helped found the modern study of double stars. Since the discovery of STF 1727, there have been 27 measurements of this system. The most recent measurement, obtained from Gaia DR2 data in 2015 by El-Badry and Rix, showed a separation of 7.549 arcseconds and a position angle of 332.995°.

Materials and Methods

We obtained a total of 14 CCD images of this system over two dates using a 0.4-meter telescope located in Tenerife, Spain via the Las Cumbres Observatory (LCO). This telescope utilizes SBIG CCD cameras to provide an image resolution of 0.571 arcseconds per pixel and a field view of 29 arcseconds by 19 arcseconds. For our observations, we used a clear filter and exposure times of 10 and 20 seconds. We obtained 4 images on April 6, 2021 and 10 additional images on April 9, 2021. The images were processed and calibrated using the Our Solar Sibling pipeline (OSS).

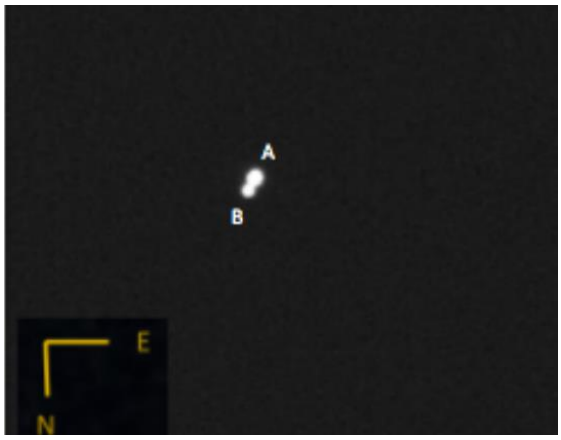

Figure 1. Image of STF 1727

The images were measured separately by two team members using the built-in centroid calculation capability of AstroImageJ Software to find the distances between the primary and secondary stars and their position angles. Once all images were measured, we calculated the mean, standard deviation, and standard error of the mean for the star separation distance and position angle.

Results

Shown in Table 1 below are the astrometric measurements for Epoch 2021.271. We calculated a mean separation angle of 7.42 arcseconds and a mean position angle of 332.86 degrees.

Table 1. Astrometric Measurements of STF1727

WDS 13099+30922 STF 1721 Measurement Results				
Telescope, images, filters	**Epoch 2021.271**	**Position Angle (deg)**	**Separation (arcsec)**	**Delta Magnitude**
LCO (kb81), 4, air	Mean	333.014	7.527	1.059
	Std. Dev.	0.266	0.038	0.015
	Std. Error	0.133	0.019	0.008
LCO (kb92), 10, air	Mean	332.806	7.383	1.069
	Std. Dev.	0.739	0.187	0.015
	Std. Error	0.234	0.059	0.008
Combined Data	Mean	332.865	7.425	1.066
	Std. Dev.	0.635	0.171	0.015
	Std. Error	0.17	0.046	0.004
Last Observed (Epoch 2015.5)		333	7.5	1.18

Discussion

A graphical representation of the historical measurements is provided in Figure 2. The earliest point from 1827 does not fit with the grouping of the other historical data points. Other measurements are labelled with the year they were made and the data point provided in this paper is highlighted in red.

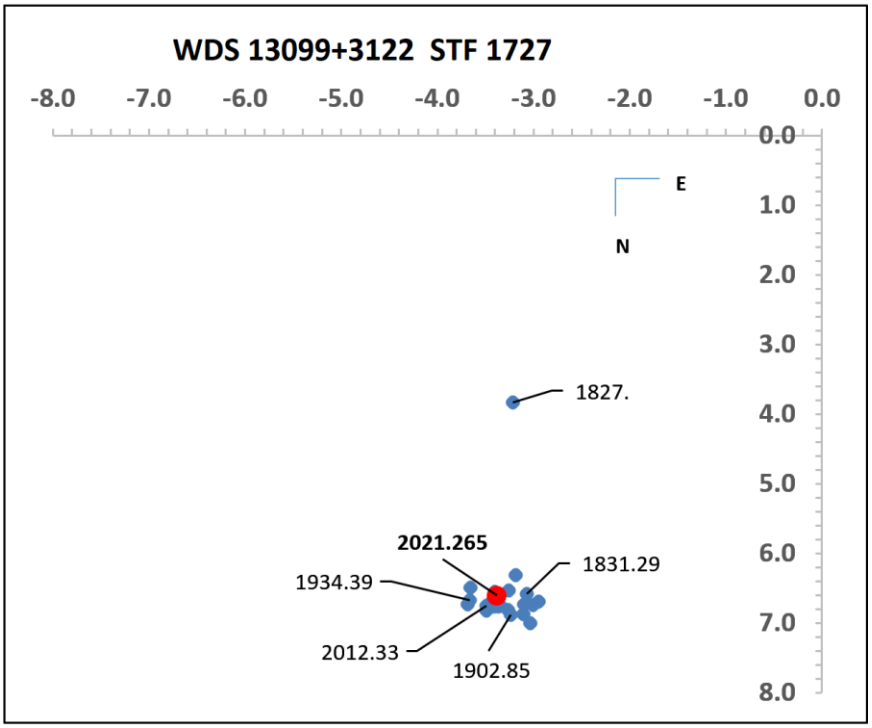

Figure 2: Historical measurements for STF 1727

We found a wealth of information about the stars of this pair from the Gaia DR2 dataset. These data included values for the parallax and proper motion or both stars of this system, Table 2. This information was beneficial in further determination of the likelihood that these stars are a physical double system.

Table 2: Parallax and Proper Motion Data for HJ 1250 from Gaia DR2

	Parallax Value	**Parallax Error**	**Proper Motion: RA**	**Proper Motion: DEC**
Primary Star	8.3848	0.013	-20.827	-47.662
Secondary Star	8.3959	0.0129	-19.269	-46.701

Utilizing parallax, we calculated a radial distance of 388.8 light years, or 119.2 parsecs to the primary star and a distance of 388.28 light years to the secondary star. With a separation angle of 7.42 arcseconds, we calculated the separation distance between the stars of 0.014 light years or 885 AU. Further utilizing the parallax data and error estimates in the Gaia DR2 dataset, we calculated an 68% probability that the stars are within one light year of one another. This small separation distance is certainly within expectations of a physical double star pair.

To further determine whether these stars form a physical double, we used the proper motion data from the Gaia DR2 dataset to calculate the Harshaw Statistic, the ratio of the vector difference to the vector sum, to compare their relative proper motions proposed by Richard Harshaw (Harshaw 2014). Harshaw showed a strong correlation between this stastic and the likelihood of a double star pair actually being gravitationally bound. The resulting value of 0.018 strongly indicates that the proper motions of these stars are nearly identical and, therefore, that the stars are moving together. Figure 3 is a graphical representation of the stars' proper motion provided by Aladin10 software utilizing the data from Gaia DR2 to plot motion vectors. This similar motion and close proximity of these stars is a strong indication that the star system STF 1727 is a physical double.

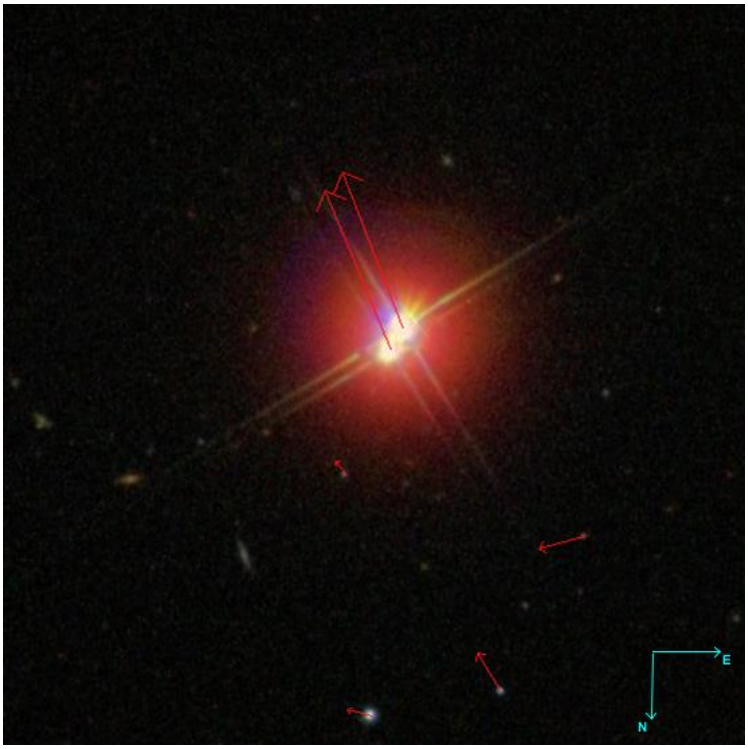

Figure 3. Screenshot from Aladin 10 using Gaia DR2 proper motion data

Conclusion

We made astrometric measurements of the double star system WDS 1309+3122 (STF 1727) through the use of 14 CCD images obtained from the Las Cumbres Observatory telescope network (LCO). We calculated a high probability that these stars are within one light year of each other and by calculating the Harshaw statistic, found their proper motion to be very similar to one another. These data indicate a very high probability that the two stars of STF 1727 for a physical double star pair. We recommend that a 'T' note be attached to the historical data in the Washington Double Star Database to indicate that this star pair is a physical double.

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