Astrometric Measurements of WDS 22267+4433 ES 1346 AC

A. Johnson[1], C. Jensen[2], N. Sagehorn[2], J. Kozubal[3], C. Ruiz4

1. Olympic College, WA, USA
2. Analy High School, CA, USA
3. Healdsburg High School, CA, USA
4. Piner High School, CA, USA

Abstract

The double star system WDS 22267+4433 ES 1346 AC was observed using the Las Cumbres Global Telescope Network (LCOGT) 0.4 meter telescope on October 19th, 2023. Upon observation, the position angle was 359.97° and the separation was 7.997″. This data was compared to historical data acquired from the Washington Double Star Catalog, the US Naval Observatory, and the Gaia Database. Because Gaia DR3 does not have parallax and proper motion values for the primary or secondary stars of this system, a comparison to the C component could not be made.

Introduction

The objective of our investigation into the double star system WDS 22267+4433 ES 1346 AC was to add to the existing databases and determine the existence of gravitational attraction between the two stars. The pair is located at 22h 26m 35.15s right ascension and 44° 35′ 08.6″ (*Stelle Doppie - Double STAR DATABASE,* n.d.), within the constellation Lacerta, in the Northern Hemisphere. The star system has been observed 7 times as denoted by the Washington Double Star catalog, with the first being in 1914, and the most recent being 2015, save our own observation. The magnitude of the primary star is 10.86, and the secondary 14.10, respectively.

Equipment and Procedures

Our team decided to focus on WDS 22267+4433 ES 1346 AC for a variety of reasons. First and foremost, as according to Stelle Doppie, the nature of this system, containing three stars, was unknown, allowing room for the potential discovery of gravitational attraction. Our original intent was to focus on the relationship between WDS 22267+4433 ES 1346 AB, however as the secondary star was too close to the primary to photograph and measure, we began to research WDS 22267+4433 ES 1346 AC instead. After doing a trial run by taking two photographs of the system with varying exposure times (2 and 4 seconds), we settled on 4 seconds for proper exposure. Utilizing the Haleakala Observatory (associated with LCOGT) 0.4-meter telescope, we took 10 photographs between 06:14:00 and 06:03:23 UTC.

Measurements of WDS 22267+4433 ES 1346 AC were analyzed using Afterglow Access. We measured each of the 10 images, as shown in Figures 1 and 2.

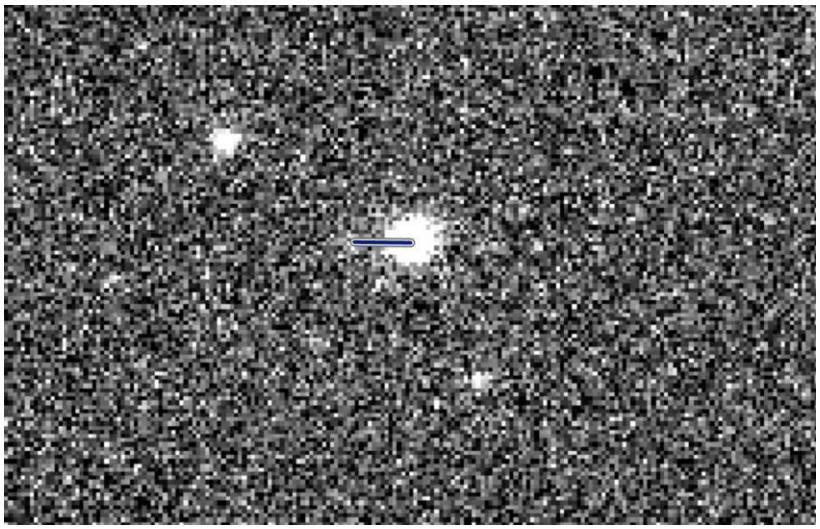

Figure 1: Photograph of WDS 22267+4433 ES 1346 AC taken on October 19th, 2023, as uploaded into the Afterglow Access workspace

Measurement	Value
Start	1,517.782, 1,021.287 +22:26:34.153, +44:35:8.613
End	1,504.337, 1,021.441 +22:26:34.176, +44:35:16.279
Length	13.446 pixels 7.67 arcsecs 0.1278 arcmins
Orientation	270.657 degrees CW of +Y 1.841 degrees E of N

Figure 2: The subsequent measurements as a result of Figure 1

Historical data on WDS 22267+4433 ES 1346 AC was requested and obtained from Dr. Rachel Matson at the US Naval Observatory on October 23rd, 2023. This data was used in comparison to data in the Stelle Doppie database, as well as the Gaia database, to understand the nature of our own observations.

Results

Table 1 contains the information obtained from our observation of WDS 22267+4433 ES 1346 AC on October 19th, 2023, at the Haleakala sector of the LCOGT network. We measured the separation in arcseconds, and the position angle in degrees East of North. The images are in chronological order. At the bottom of the table are the mean, standard deviation, and standard error.

Image Number (Chronological)	Separation (arcseconds)	Position Angle (degrees East of North)
1	8.102	1.407 (361.407)
2	8.069	359.88
3	8.364	358.196
4	7.922	1.126 (361.126)
5	8.504	358.569
6	7.692	1.033 (361.033)
7	8.229	358.965
8	7.542	358.832
9	7.879	359.801
10	7.67	1.841 (361.841)
Average:	7.997	359.97
Standard Deviation:	0.284	1.186
Standard Error:	0.0856	0.35771

Table 1: Measurements of WDS 22267+4433 ES 1346 AC as taken using Afterglow Access

Figure 3 shows the historical data along with our new data point for position angle (PA) over time.

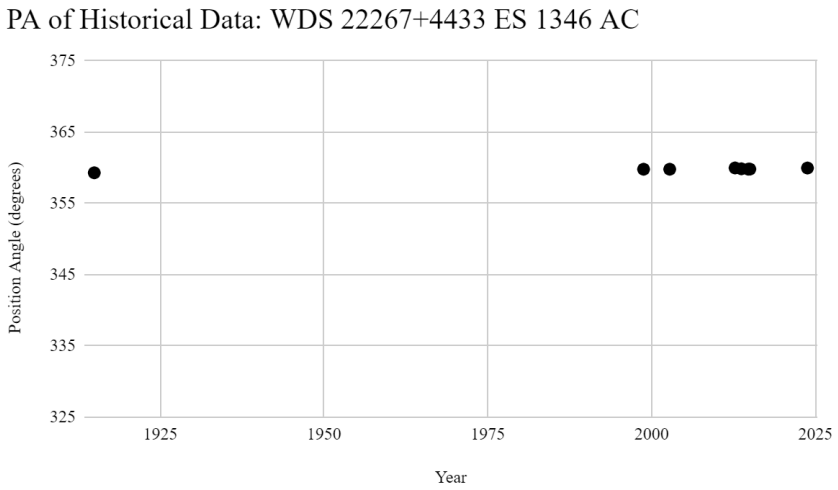

Figure 3: Position Angle (PA) of WDS 22267+4433 ES 1346 AC from Historical Data along with the newest data point

Figure 4 shows the historical data along with our new data point for separation over time.

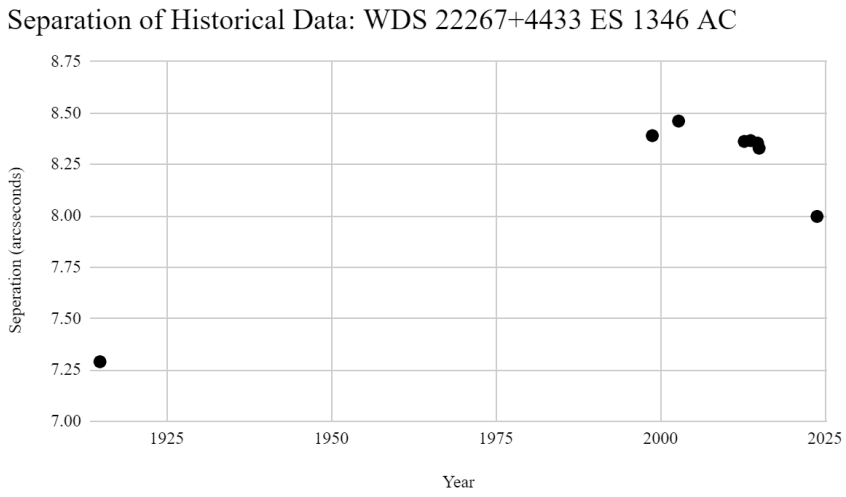

Figure 4: Separation of WDS 22267+4433 ES 1346 AC (arcseconds) from historical data, including the newest data point.

Discussion

We are unable to make conclusions regarding the parallax, proper motion and rPM from data of the triple star system WDS 22267+4433 ES 1346 AC because the primary and secondary stars of the system don't have parallax or proper motion values in Gaia DR3.

As shown in Figure 3, we can see that our data follows the trend of position angle which essentially has not changed since the first observation 109 years ago. However, looking at the separation over the years shown in Figure 4 we see a concave down relationship such that on October 7, 2002 the star reached the highest separation of 8.461 arcseconds. Since the first data point in 1914 the separation has increased by 0.697, and then decreased from the separation denoted in 2015, at 8.328″. However, these are such small changes that they are likely in the noise.

The historical data values for position angle and separation, shown in Figures 3 and 4 along with our current measurement, were resolved to x-y coordinates (in arcseconds) using the following equations:

$$x = Sep * sin(PA)$$
$$y = -Sep * cos(PA)$$

where x is right ascension (RA), y is declination (DEC), ρ is the angular separation (SEP) and θ is the position angle (PA). This was graphed in Figure 5.

While there does appear to be some slight change and potentially the beginning of an orbital pattern around the primary star, it is inconclusive as to the orbital nature and requires further study in the future. It would help to get parallax and proper motion data on the primary star to compare this with the tertiary star.

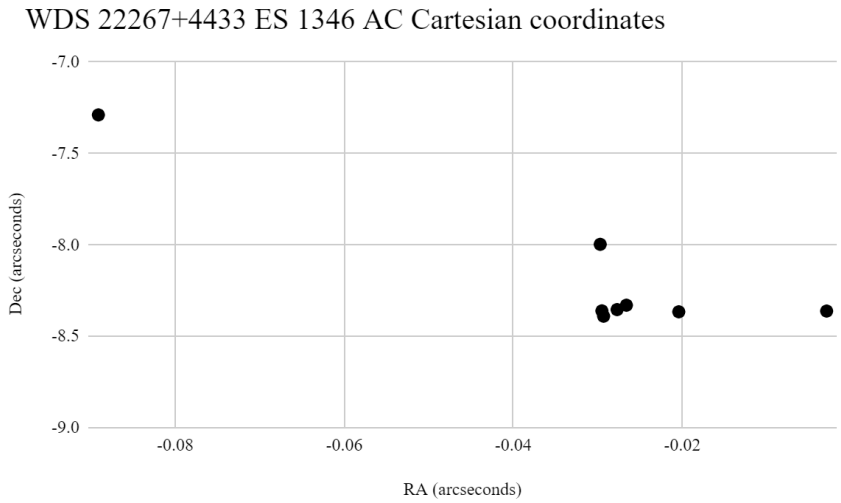

Figure 5: Cartesian Coordinates of WDS 22267+4433 ES 1346 AC

Conclusion

Our team studied the double star system WDS 22267+4433 ES 1346 AC in order to gather data to add to the existing database and to investigate the existence of gravitational attraction between the two stars. From our data collected in comparison with existing data, it is inconclusive as to a gravitational attraction between the A and C components of this star system.

The relationship between WDS 22267+4433 ES 1346 AB in the triple star system was unable to be studied during this research project because their separation could not be resolved by the 0.4-meter LCO telescopes. Future studies with different technology, such as larger telescopes and speckle interferometry, will be needed to determine the nature of this relationship. Stars A and B in this system do not have a recorded parallax value so future studies will need to be conducted in order to have a more complete record of the stars in this system.

Acknowledgments

Thank you, Dr. Rachel Freed, for being our mentor and teacher. We greatly appreciate you allowing us to use telescope time and your expertise during this research project.

Thank you, Dr. Rachel Matson from the US Naval Observatory, for providing us with the historical data of WDS 22267+4433.

Thank you to the Haleakala Observatory and the Las Cumbres Observatory Global Telescope Network for obtaining images of our star system.

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