Astrometric Measurements and Historical Data Summary of WDS 05599-3703 (B 1044AD)

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Abstract: Position angle and angular separation for the double star system WDS 05599-3703 B 1044AD were measured from images acquired through the iTelescope network and processed through Maxim DL and MiraPro x64. A position angle of 189.9º and a separation of 27.3" were measured.

Introduction

The selection criteria for determining a double star system to study included a right ascension between 00 and 06 hours, a separation of at least 6 arcseconds, and a maximum differential magnitude of 6. The Washington Double Star catalog (WDS) (Mason and Hartkopf 2015), managed by the United States Naval Observatory (USNO), was used to find a candidate star system. WDS 05599-3703 B 1044AD fit this criteria, with a right ascension of 05h 59m 55.79s, a separation angle (Rho) of 21.3", and a differential magnitude of 4.58.

Historical data, provided by the USNO, shows two complete sets of previous measurements. There are other measurements that did not provide position angle (theta) or angular separation (rho), but instead provided data such as magnitude for a given epoch. The earliest measurement was made in 1999 indicating a theta of 215 º and a rho of 16.2". The other measurement, also taken in 1999, shows a theta of 216° and a rho of 15.8".

Double Star WDS 05599-3703 B 1044AD was selected with the objective of taking new astrometric measurements in an effort to assist in determination of the system's gravitational nature, while also evaluating the possibility of a chance alignment of the A star over the D star.

Materials and Methods

Images were taken through the iTelescope network where each observatory has multiple telescopes that could be used for scientific research. The first telescope used was the T27, Figure 1, located in Siding Spring, Australia at an elevation of 1122 meters. T27 has a resolution of 0.53 arc-secs/pixel, a pixel size of 12 µm square, and a position angle of 0º. The second telescope was the T30, Figure 2, also located at 1122 meters in Siding Spring, Australia. This telescope has a resolution of 0.81 arc-secs/pixel, a pixel size of 9 µm square, and a position angle of 086º.

Figure 1. iTelescope T27

Figure 2. iTelescope T30.

We requested images, with select filters, exposure length, and time windows for the images. The equip-

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Table 1. Number of images with filter and exposure time.

Filter	Images	Exposure (Seconds)
Luminance	1	60
Hydrogen Alpha	4	120
Blue	2	120
TOTAL	7	

ment used to measure our stars included 2 images of Luminance with 30 seconds exposure, one Luminance with 60 seconds of exposure, a Hydrogen-alpha with 120 seconds of exposure, and Blue with 120 seconds of exposure for T27 and T30, Table 1.

The luminance filter is a clear filter that was used to get a general image of the system. Hydrogen-alpha filters were used to acquire a narrow bandpass of light between the A and D stars. Because of the high magnitude of both the A and D stars, which are G type stars, we wanted to look at them in a color other than their peak wavelength to see less light, and consequently used a blue filter. These different filters were used to discern whether or not there were differences in measurement that could be attributed to the varying wavelengths corresponding to each filter.

Each image was processed through Maxim DL, software for astronomical imaging which processes data acquired through imaging array detectors such as CCDs (charge-coupled device). Mira Pro was used to clean, label, and calibrate images, along with measuring our position angle and separation. To ensure accurate measurements in Mira Pro, the vertical transfer function was set to 99.5% or 99.9%, based on trial and error to see which provided the clearest image. Each image was then measured using the Distance and Angle tool in Mira Pro. This statistically located the center of each star. Figure 3 is a CCD image after being processed in Maxim DL and MiraPro x64. Theta and rho of the AD pair was recorded and organized in an Excel spreadsheet. Then, we determined the mean, standard deviation, and the deviation of error for all measurements.

Data and Results

Table 2 shows the mean, standard error of the mean, and standard deviation for WDS 05599-3703 B 1044AD Theta and Rho. Table 3 shows the raw data from CCD image measurements made in this study. Parallax and distances were evaluated in Tables 4 and 5.

Discussion

The historical measurements of this system, Table 6, in-

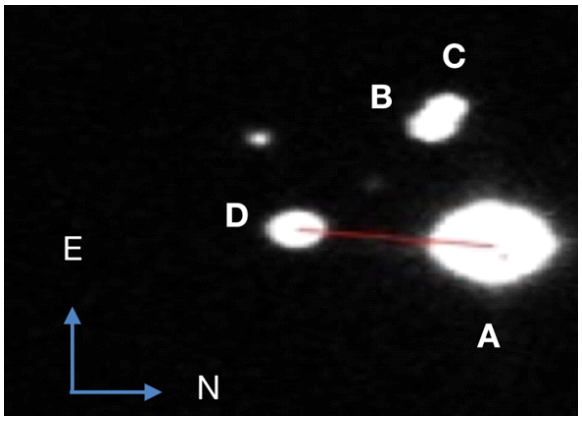

Figure 3. Processed CCD image of WDS 05599-3703B 1044B under a luminance filter with an exposure of 60 seconds.

Table 2. The mean, standard error of the mean, and standard deviation for astrometric measurements of WDS 05599-3703 (B 1044AD)

Statistics	Theta (°)	Rho (")
Mean	189.9°	27.3"
Standard Deviation	1.04°	0.29"
Standard error of mean	0.39°	0.11"

Table 3. Summary of raw data from CCD image measurements made in this study.

Image	Exposure (Seconds)	Theta (°)	Rho (")
1	60	189.1	27.2
2	120	190.1	27.6
3	120	191.7	27.7
4	120	190.5	26.9
5	120	188.7	27.2
6	120	190.2	27.0
7	120	189.1	27.2

Table 4. Parallax and error measurements for both stars

Inputs	Parallax	Error
Star A	18.8	0.0378
Star D	2.28	0.0307

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Table 5. Min, Mid, and Max distances from both stars to earth in Parsecs and Light Years

Results	Min Distance (Parsecs)	Mid Point (Parsecs)	Max Distance (Parsecs)	Min Distance (Light Years)	Mid Point (Light Years)	Max Distance (Light Years)
Star A	53.08	53.19	53.3	173.06	173.4	173.75
Star D	432.77	438.6	444.58	1410.83	1429.82	1449.34

dicate some shift in Theta and Rho, Figure 4, from the first measurement in 1999. To determine these distances, parallax angles were used to determine the distance of each star from Earth in both parsecs and light years, Table 5. From the parallax data, it appears that the A and D stars are most probably not gravitationally bound, which complies with the nature of most G class stars. The line of sight distance between the two for the most optimal configuration (A at its furthest distance, and D at its closest to us) is 379.47 parsecs, or 1,237.08 light years. Therefore, the inference is that the system of stars is not gravitationally linked; their connection appears to be that of an optical alignment. Therefore, given the large distance between these stars, there is no gravitational connection.

Conclusion

The measurements from this study indicate that there has been a decrease in position angle and an increase in separation for WDS 05599-3703 B 1044AD since its first recorded measurement in 1999. When viewed from the perspective of the positional measurements in this study, and consideration given to the distances between the stars, it is proposed that these are optical double stars and not gravitationally bound.

Acknowledgements

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References

Mason, B. and Hartkopf, W. 2015, The Washington Double Star Catalog. Astrometry Department, U.S. Naval Observatory.

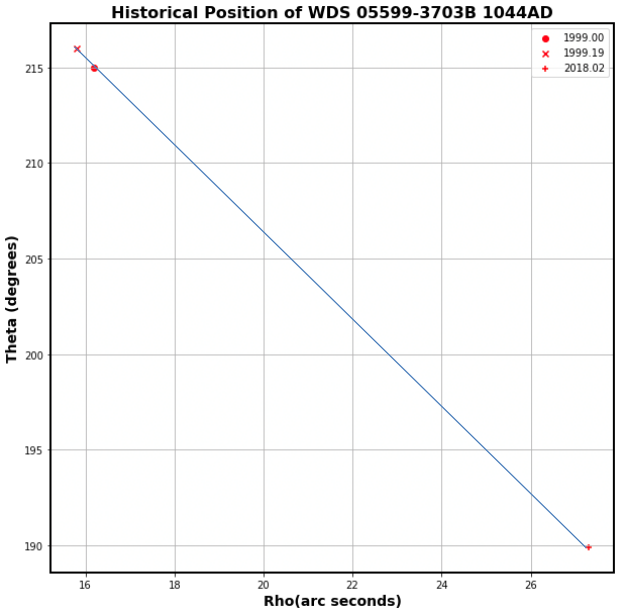

Figure 4. Historical Position of WDS 05599-3703B 1044AD

Table 6. Current measurements and data available on WDS 05599-3703B 1044AD courtesy of the Washington Double Star Catalog.

Epoch (Decimal Year)	Epoch (Julian Date)	Theta	Rho
1999.00	2451179.5	215°	16.2″
1999.19	2451248.5	216°	15.8″
2018.02	2458126.5	189.9°	27.3″