CCD Astrometric Measurements of WDS 07062-0218

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Abstract: Astrometric measurements were obtained from the double star system WDS 07062-0218 (HJ 750) using the iTelescope network and the software programs MaximDL v6 and Mira Pro x64.

Introduction

Movements of double star systems have been observed and recorded since 1718 with Edmond Halley's observations of Sirius, Procyon, and Arcturus (Ryabov and Yankovsky). Since then, double stars have been a major part of astronomy (Aitken). Double star systems can be defined by the characteristics of their movements over time, a branch of astronomy known as astrometry. When enough astrometric observations have been made, a determination can be made to weather the system is optical in nature, causing the pair to appear close together on the celestial sphere, but that are really quite distant from each other in space, or gravitationally bound. A gravitationally bound pair, which will be referred to as a binary pair, can help astronomers learn more about potential masses or radii of that system.

A star system was selected from the Washington Double Star Catalog (WDS) using a certain search criterion: (1) the star system with a right ascension between 00 hours and 08 hours is most favorable during the fall semester, (2) an angular separation distance above six arc seconds and (3) a difference in star magnitudes of less than six are most ideal for Charge Coupled Device (CCD) imaging. An angular separation higher than six arc seconds and a difference in star magnitudes greater than six would make distinguishing between the two stars difficult when taking measurements.

The candidate star system that matched these criteria is star system WDS 07062-0218 (HJ 750). This star system was last observed in 2010, making it seven years since its last observation. It has been observed seventeen times during the course of one hundred and ninety-three years (1827-2010), granting a significant amount of historical data to compare to. The separation of this star system was last measured at 9.04 arcseconds and its difference in magnitudes was measured at 0.5 leaving this star system well within the criteria selection. The difference between the first observed position angle (282 degrees) and the last position angle (265.06 degrees) gives a possibility of a new data point being observed. Figure 1 shows an image of the star system.

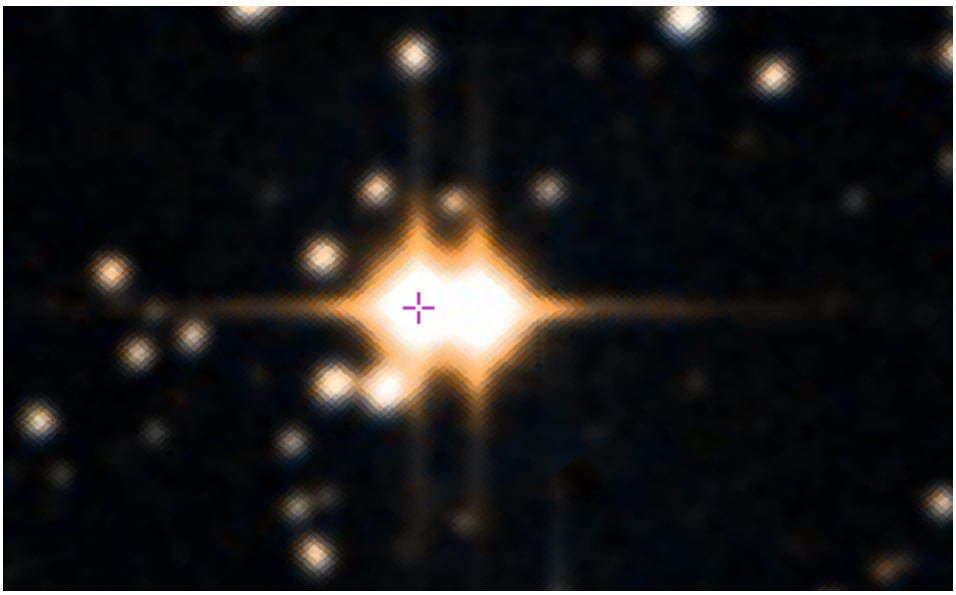

Figure 1. *WDS 07062-0218: the crosshair shows the A component. This image was taken from the Aladin Lite website.*

The star system HJ 750 was first discovered in 1827 by John Frederick William Herschel. This star system has since been observed seventeen more times with the most recent observation taking place in 2010, granting a significant amount of historical data to compare to. Table 1 displays the historical data for the year, separation angle, and position of the star system HJ 750. Although separation remains more less constant, position angle changed between first and last reported observation by nearly twenty degrees, making this interesting candidate.

Epoch	Theta	Rho
1827.5	282°	3"
1879.77	273.2°	8.39"
1893.08	271.1°	8.9"
1893.08	271°	8.89"
1893.08	270.6°	8.88"
1896.18	269.2°	8.95"
1893.08	269.8°	9"
1893.08	270.2°	8.92"
1906.4	270.8°	8.43"
1911.43	271.2°	8.64"
1936.24	269.5°	9.28"
1938.17	267.3°	8.76"
1964.193	272.42°	8.84"
1964.198	272.13	8.82"
1964.812	272.39°	8.81"
1964.837	272.39°	8.82"
1964.935	272.46°	8.83"
1983.046	262.4°	8.58"
1998.94	265.8°	8.96"
2000.098	265.9°	8.99"
2010.5	264.6°	9.04"

Table 1. *Historical data for the star system HJ 750.*

Equipment, Observations, and Data Analysis procedures

Charged Coupled Device (CCD) images of the double star system WDS 07062-0218 were taken using the iTelescope Network's T17 telescope located in New South Wales, Australia. The T17 telescope is a Planewave 17" CDK with a focal length of 2912mm mounted on a Paramount PME. The T17 telescope also has a resolution of 0.92 arcsecond per pixel.

The T17 telescope located in New South Wales was chosen because the star system HJ 750 has a declination of -02 degrees and the T17 telescope takes images with declinations between +20 through -90 degrees. The location of T17 was ideal given the low declination of our system.

The filters used to take the CCD images were a combination of Hydrogen-Alpha, Luminance, and Blue. Two images were taken of each filter with a length of 90 and 120 seconds with the Hydrogen-Alpha filter, a length of 60 and 90 seconds with the Luminance filter, and a length of 60 and 120 seconds with the blue filter. The CCD images were taken on November 13, 2017 at a right ascension of 07 06 15.43 hours and a declination of – 02 19 37.1 degrees.

Once the images were received iTelescope by the iTelescope data reduction pipeline to smooth out the distortions and adjust the resolutions. The data was imported in MaximDL v6 was used to insert World Coordinate System (WCS) positions into the Flexible Image Transport System (FITS) headers. This was done by measuring the stars in the CCD image and comparing them to the Fourth U.S. Naval Observatory CCD Astrograph catalogue (UCAC4).

To find the astrometric measurements position angle and separation of the star system, the calibrated WCS images were then imported into Mira Pro x64. Using Mirametrics' proprietary algorithm Mira Pro x64 was then able to get an accurate measurement of these parameters between A and B component centroids of the star system. Figure 2 displays an image using the blue filter that has been processed using MaximDL v6.

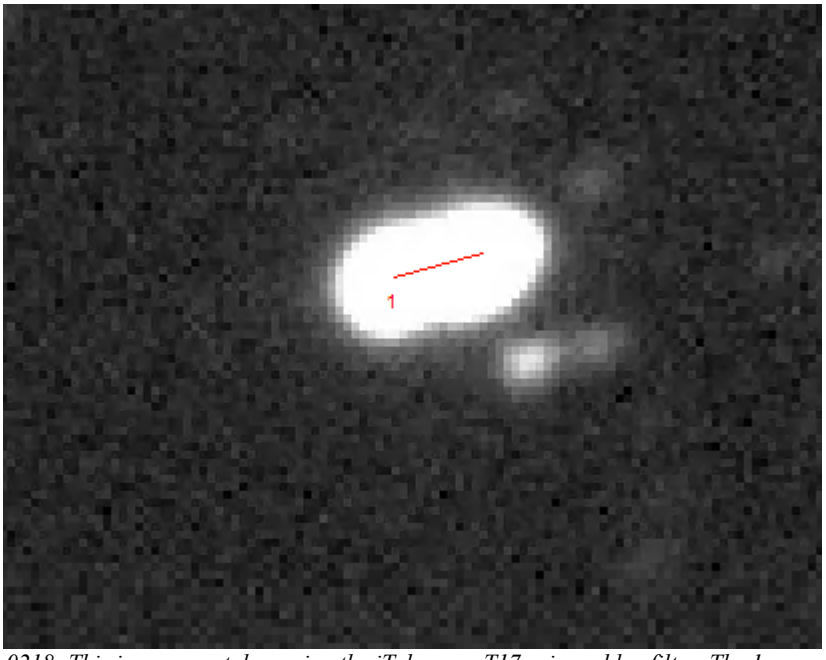

Figure. *WDS 07062-0218: This image was taken using the iTelescope T17 using a blue filter. The 1 represents the primary star and the line connects the centroids between the primary and secondary star.*

Results

Table 2 shows the position angle and separation, respectively, of each image taken using the different filters and exposure times. The average of the position angle and separation were taken of all of the six images giving the final results of the position angle at 265.06 degrees and the separation at 8.64 arcseconds.

WDS 07062-0218		
Filters-Exposure Times	**Position Angle (degrees)**	**Separation (arcseconds)**
Hydrogen-Alpha-90	264.967°	8.827″
Hydrogen-Alpha-120	264.982°	8.837″
Luminance-60	265.274°	8.422″
Luminance-90	264.981°	8.34″
Blue-60	265.082°	8.815″
Blue-120	265.108°	8.598″
Mean	265.0656667°	8.639833333″
Std. Deviation	0.117783983	0.220767223
SEM	0.04808511°	0.090127841″

***Table 2**. Position angle and separation for each image taken of WDS 07062-0218. The mean, standard deviation, and Standard Error of the Mean are also shown.*

Discussion

In the Figures 4 and 5, separation over time and position angle over time are plotted respectively, combining historic data and our latest measurement. The separation over time, figure 4, is constant over the course of over 150 years, however the position angle over time has changed, when Herschel's measurements are omitted, in which the position angle over time, figure 5, is decreasing. The separation stays constant at about 9 arcseconds while the position angle has decreased from 273.2 degrees in 1879 to 265.07 degrees in 2017. This data shows that the distance between the two stars has not changed over the past 150 years, but the position angle has changed by a factor of 12 degrees, which is a possibility that this system could be a double star system but there is not enough data to prove this.

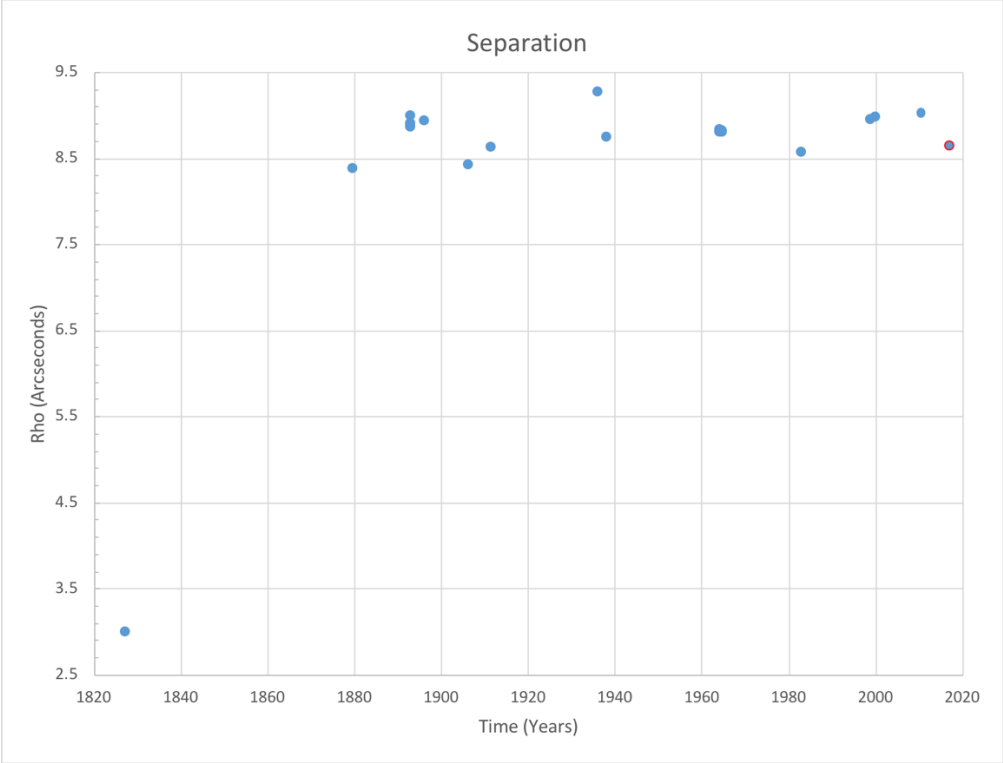

Figure 4. *Shows HJ 750 separation over time. In this table, the new data point is highlighted in red.*

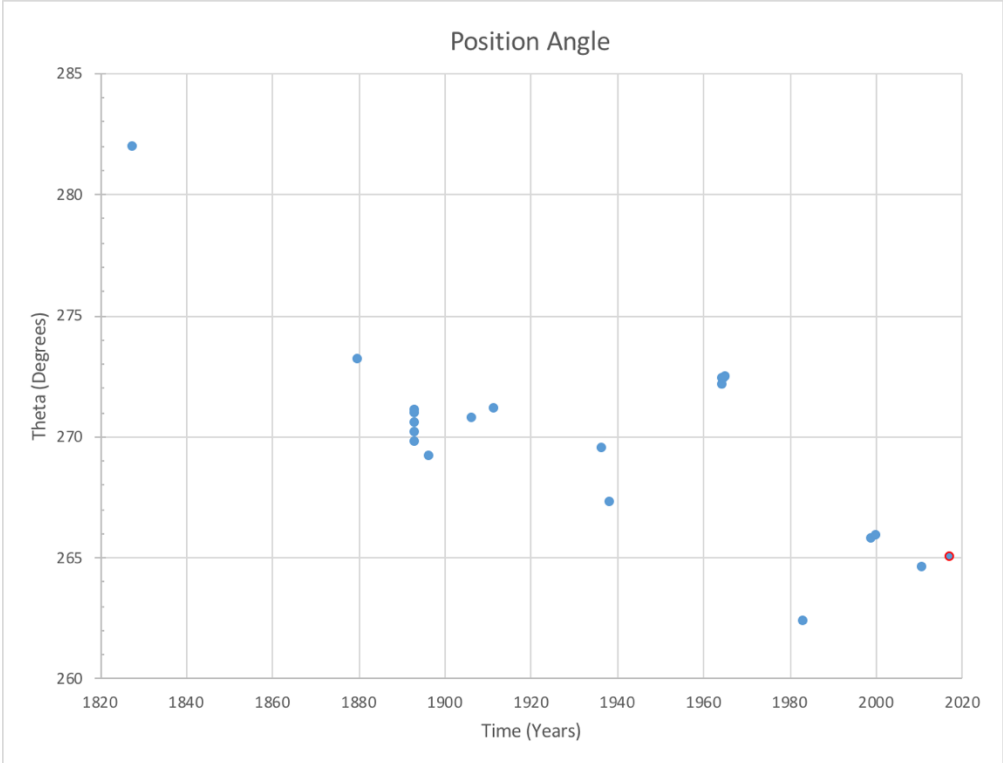

Figure 5. *Shows HJ 750 Position Angle over time. In this table, the new data point is highlighted in red.*

Figure 3 shows the orbital plot of the measurement taken for this paper and the historical measurements taken in the past. The plot does not give enough information about the apparent motion of the star system because there is not enough data.

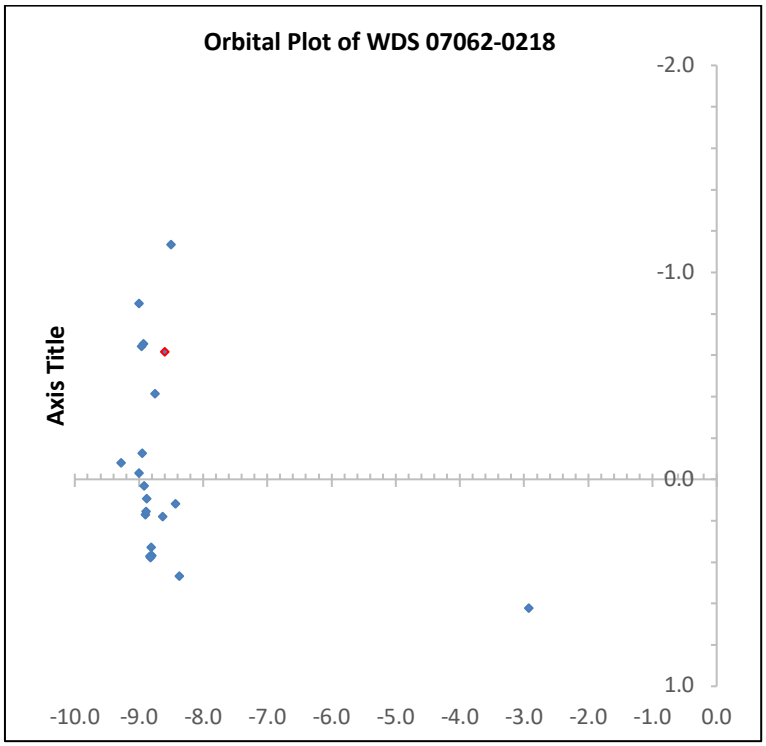

Figure 3. *Shows the orbital plot for WDS 07062-0218. In this table, the new data point is highlighted in red.*

Conclusions

The iTelsecope T17 located in New South Wales, Australia was used to obtain six images, two of each of the filters Hydrogen-Alpha, Luminance, and Blue. The images were then processed using MaximDL v6 and Mirametrics Mira Pro x64 to measure the separation and position angle of the star system. The separation of the star system appeared to be fairly constant with the historical data, but the position angle has appeared to change over time. However, our results still cannot prove that the star system HJ 750 is a physical double star system.

Acknowledgements

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