Astrometric Measurements of WDS 18175-1638 HJ 2829 AB, AC

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Abstract

The goal of this research project is to make astrometric measurements of WDS 18175-1638 HJ 2829 AB and AC. By taking photos and making new measurements we found that for pair AB, the new position angle was 320° and the new separation is 4.92 arcseconds. For pair AC, the new position angle that we measured was 168.2° and the new separation of the two stars is 6.2 arcseconds. In the end we found that there is a likely chance of AB being a common proper motion double and that AC may be optical due to the lack of sufficient evidence.

1. Introduction

For this paper we intend to gather information on WDS 18175-1638 HJ 2829 AB and AC to help determine if either pair is a physical or optical double. We chose this star system because the magnitude was sufficient for our observations and the fact that it was a triple star system was interesting because it could contain either two physical or optical doubles or one of each. This triple star system was first observed in 1830 and since then has been observed five additional times including our new observation.

2. Equipment and Methods

After finding a sufficient star system we requested images from Las Cumbres Observatory (LCO) using their 0.4-meter telescope and SBIG 6303 camera at Haleakala Observatory. Utilizing their PanSTARRS-w filter we took ten images with multiple exposure times, with that we found that an exposure time of 4 seconds gave us the best quality images. The images were calibrated with LCO's BANZAI pipeline system and were taken on September 28th, 2023 (2023.945). With these images we used *AstroImageJ* (Collins 2017) to measure our stars' separation (ρ) and position angle (θ) (refer to Figure 1 & 2). We calculated their average values, standard deviation, and standard error (refer to Table 1 & 3).
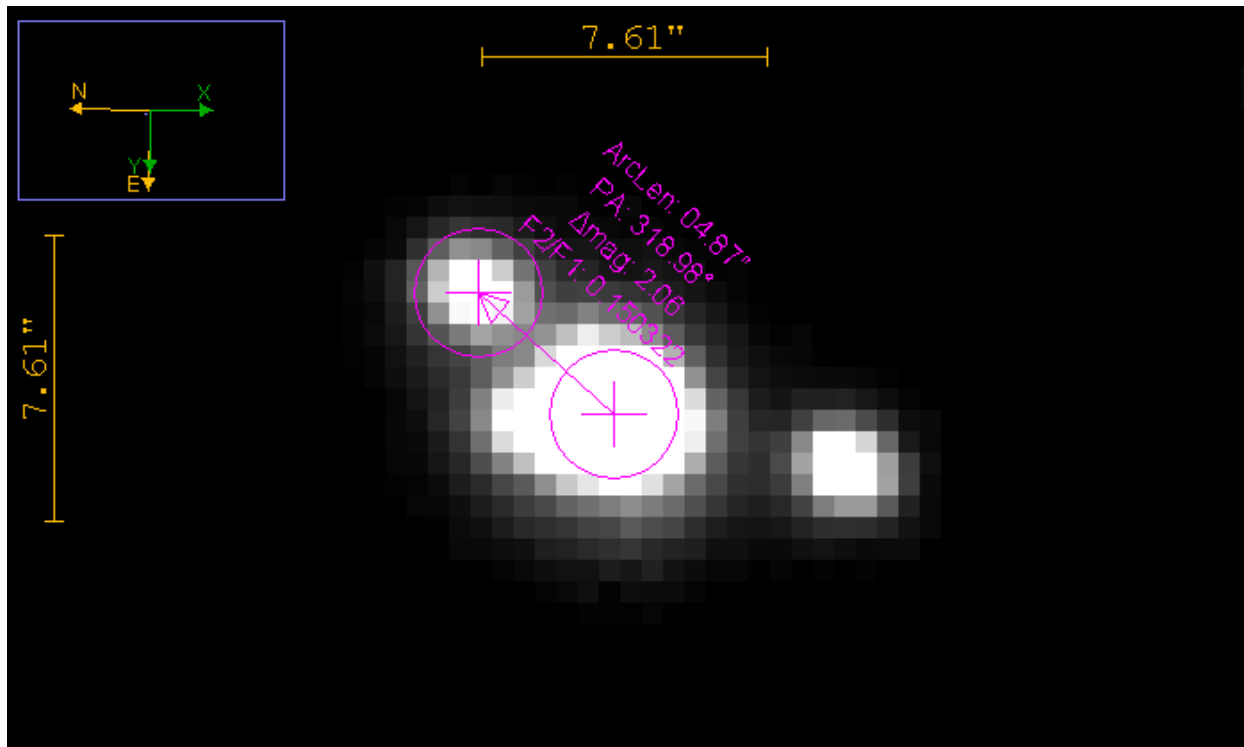
Figure 2: Shown here is an image of our star pair AB in the program AstroImageJ with the program's measurements of the position angle and separation.
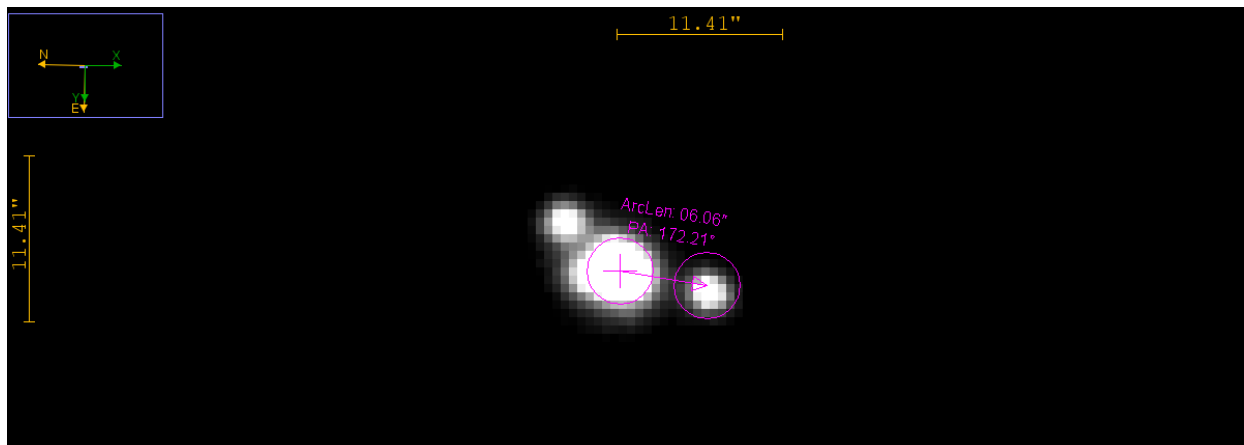

Figure 2: Shown here is an image of our star pair AC in the program AstroImageJ with the program's measurements of the position angle and separation.

3. Data

For the AB pair, the average position angle was 320° and average separation was 4.92 arcseconds. For AC, the average position angle was 168.2° and average separation was 6.2 arcseconds. Also, we requested the historical data (refer to table 2 & 4) for this system from Washington Double Star Catalog. After discarding any incomplete data, we placed it in Plot Tool (Harshaw 2020) and made several graphs based on the data (refer to Tables 1 & 2.) In Figures 3 & 4 we enlarged the graph to get a better look at both stars' paths around the main star.

Table 1: New measurements of WDS 18175-1638 HJ 2829 AB.

Image	Position Angle(°)	Separation (")
1	319.5	4.87
2	321.2	4.98
3	320.3	4.94
4	319.4	4.80
5	320.1	4.90
6	320.1	4.85
7	318.7	4.89
8	320.1	5.11
Average =	320.0	4.92
ST DEV=	0.7	0.16
ST ERROR=	0.2	0.03

Table 2: The historical Data of WDS 18175-1638 HJ 2829 AB.

Year	Position Angle (°)	Separation (")	Made By	Type
1830.57	300	2.5	HJ-1833c	Mb
1903.57	322.3	5.25	BU-1906	Ma
1999.33	320.1	4.89	TMA2003	E2
2015.0	320.225	4.989	Kpp2018m	Hg
2023.945	319.9	4.92	AMSA	CCD

Table 3: New measurements of WDS 18175-1638 HJ 2829 AC.

Image	Position Angle (°)	Separation (")
1	168.1	6.27
2	168.5	6.24
3	168.1	6.28
4	168.2	6.20
5	168.5	6.25
6	168.4	6.26
7	168.1	6.23
8	167.9	6.234
Average =	168.2	6.2
ST DEV=	0.2	0.02
ST ERROR=	0.1	0.01

Table 4: The historical Data of WDS 18175-1638 HJ 2829 AC.

Year	Position Angle (°)	Separation (")	Made By	Type
1830.57	150.	3.5	HJ_1833	Mb
1903.57	165.2	6.32	Bu_1906	Ma
1999.33	167.3	6.33	TMA2003	E2
2000.262	167.3	6.30	UC_2013	Eu
2015.0	167.406	6.27	Kpp2018	Hg
2023.945	168.3	6.24	AMSA	CCD

Table 5: Data taken from Gaia mission Data Release 3.

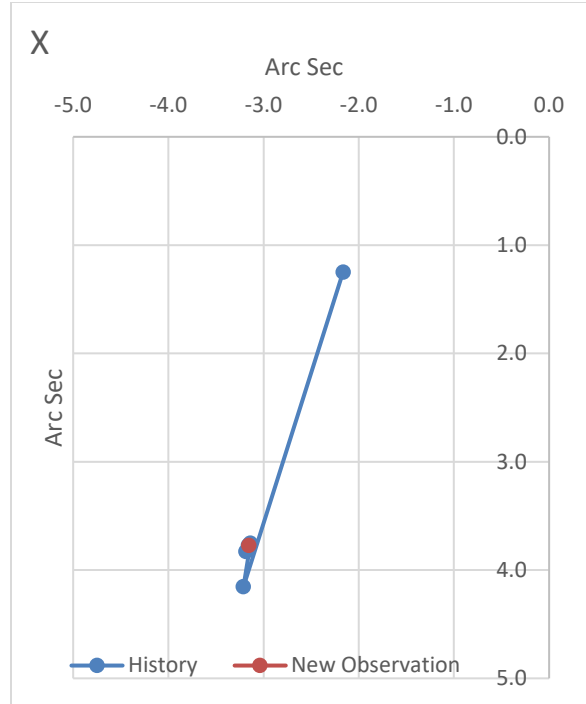| Stars	Parallax (mas)	Proper Motion Right Ascension (mas/yr)	Proper Motion Declination (mas/yr)
A	0.5767	0.099	-1.489
B	0.5047	0.108	-1.534
C	0.7419	0.253	-1.203

Figure 3: All Historical data and new data of AB presented together. New data represented by the orange dot. The primary star is at (0,0).
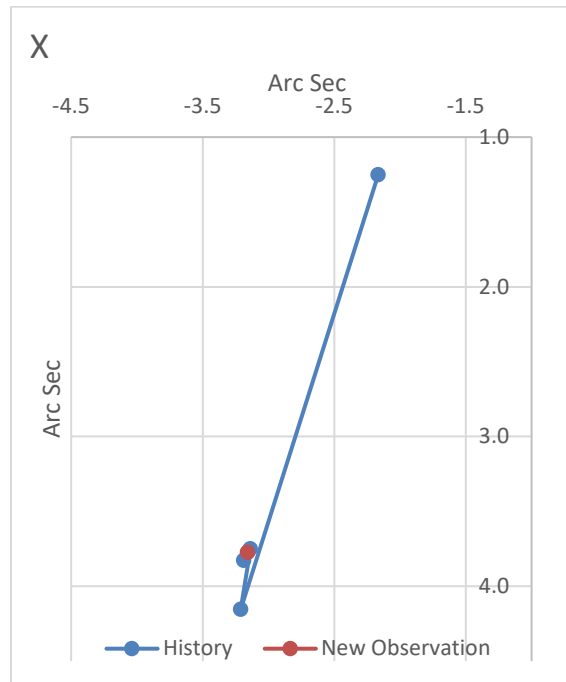

Figure 4: All Historical data and new data of AB presented together zoomed in. New data is represented by the orange dot.
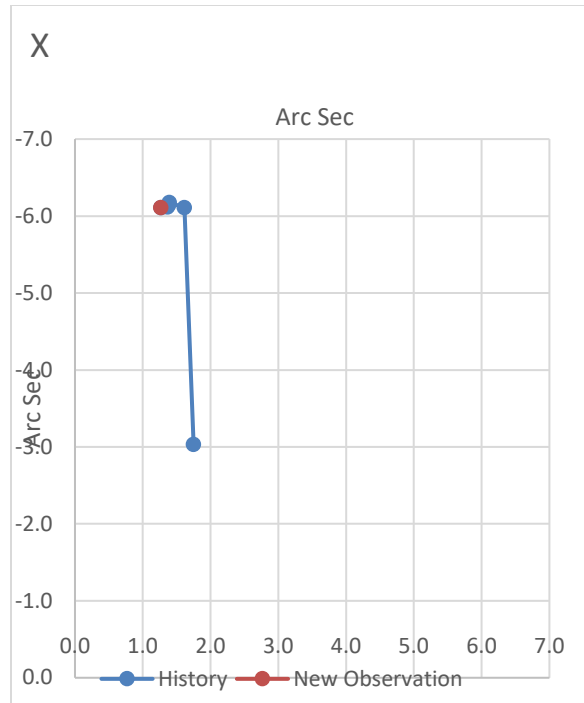
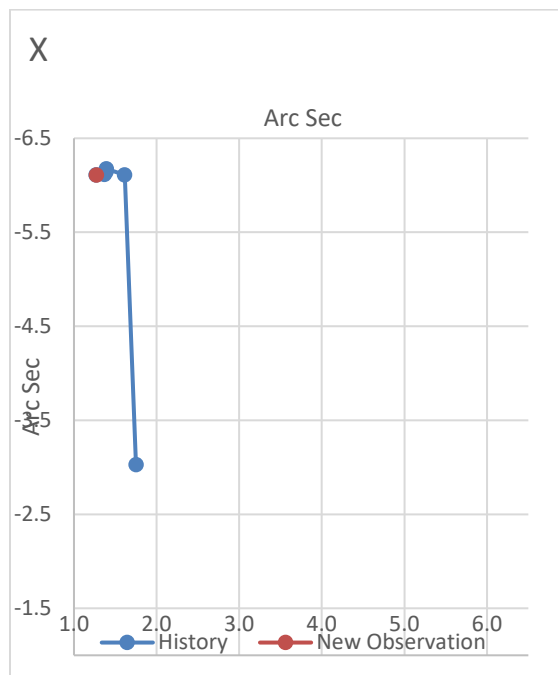*Figure 5: All Historical data and new data of AC presented together. New data represented by the orange dot.*

Figure 6: All Historical data and new data of AC presented together zoomed in. New data is represented by the orange dot.

4. Discussion

Both pairs AB and AC have the first data point from 1830, In this time astrometric tools and measurements were less accurate. If the 1830 points are disregarded, both pairs would show less than half an arcsecond of motion in the span of 1900 to 2023. Pair AB shows a slight amount of zig-zag motion in that time, presumably due to measurement error. Pair AC does go in one direction consistently, but it still is only about a half arcsecond in the span of 120 years. In general, neither historical data graph is especially helpful in identifying the nature of these pairs. Still, as both paths appear to be linear this could point to an optical double, a common proper motion double, or an edge-on binary.

The parallax and proper motion data in Table 5 from the Gaia mission was more helpful in providing a plausible answer with how accurate our instruments are today. The parallax and proper motion of stars AB are very close, having a percent difference of 12% parallax, 9% PM right ascension, and 3% PM declination. Pair AC on the other hand has percent differences of 28% parallax, 150% right ascension, 19% declination. For these reasons, we recommend classifying AB as a common proper motion double star system, while AC is probably an optical double.

5. Conclusions

The separation and position angle were measured for WDS 18175-1638 HJ 2829 AB and AC by measuring data given from photos taken. The separation and position angle did not provide any obvious conclusions but the Gaia data advocates for star pair AB to be a common proper motion double (CPMD) and star pair AC to be an optical double. However, we cannot say either of these with a high degree of confidence.

Acknowledgements

References

Collins, K., Kielkopf, J., Stassun, K., & Hessman, F. (2017) AstroImageJ: Image Processing and Photometric Extraction for Ultra-precise Astronomical Light Curves. Astronomical Journal, 153, 77. Retrieved from https://ui.adsabs.harvard.edu/abs/2017AJ....153...77C/abstract

Harshaw R. (2020) Using Plot Tool 3.19 to Generate Graphical Representations of the Historical Measurement Data. Journal of Double star Observations, 16(4), 386-400. Retrieved from http://www.jdso.org/volume16/number4/Harshaw_386_400.pdf