Analysis of Historical Data & Astronomical Measurements of WDS 03063+5100AB, C

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Abstract

WDS03063+5100 AB, C is a two-component system with 14 historical measurements of the AB component but only 3 measurements for the AC component. For this paper we acquired 11 images of the system and measured the separation and position angles of the components. The average measurements were then compared to the historical data. Although the AB component has measurements going back to 1904, the physical nature of this component is unclear due to the difficulties and subsequent uncertainties associated with early measurements conducted by hand. The AC component, which has fewer but more modern measurements, appears to show linear motion, indicating the pair are not physical. GaiaDR2 data was also extracted for the system, which indicated that none of the three stars had similar parallaxes or proper motions. From this we conclude that this system is not physical.

Introduction

For this project, we observed the AB and AC components of WDS03063+5100. The AB component has 14 measurements from 1904 to 2016, while the AC component has 3 observations from 1989 to 2003. We selected this system in order to better understand whether or not its components are physically associated. Additionally, the system also met the requirements for magnitude, separation, and observability for the Great Basin Observatory (GBO). We compared our observations to the historical measurements in order to examine the motion of the system's components. Parallax and proper motion data from the Gaia database (Gaia Collaboration et al. 2018) were also used to assess the motions of the stars.

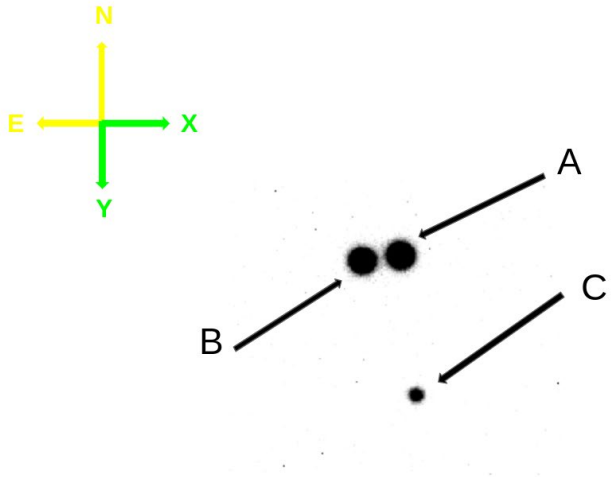

Figure 1. Finder chart for the components of WDS03063+5100.

Methods

We used the GBO telescope to take 15 images with an exposure time of 60 seconds each. The images were acquired through the V filter with a 1 x 1 binning on November 10, 2021. A finder chart for WDS03063+5100 is provided in Figure 1. The GBO (Figure 2) is the first research telescope in a national park and is equipped with a PlaneWave 0.7m CDK 700 and an SBIG STX-16803 CCD camera. This combination produces a plate scale of 0.4 arcsec per pixel. The GBO's focal ratio is f/6.5 and, combined with the CCD, provides a field view of 27 X 27 arcminutes. The telescope is equipped with 16 filters: LRGB, Ha, OIII, SII, BVRI, g'r'i'z', and a diffraction grating (Anselmo et al. 2018).

Figure 2. The Great Basin Observatory.

The astrometry for the images was accomplished with the use of http://nova.astrometry.net/ (Lang 2010). AstroImageJ (Collins et al. 2017) was used to apply the bias, dark, and flat frames as well as perform measurements of separation and position angle. We also examined seeing profiles for the stars in the system to ensure that they were not overexposed. Once the measurements were completed, we calculated the mean and standard deviation for each component. Comparison plots between our data and the historical measurements were produced using PlotTool (Harshaw, 2020).

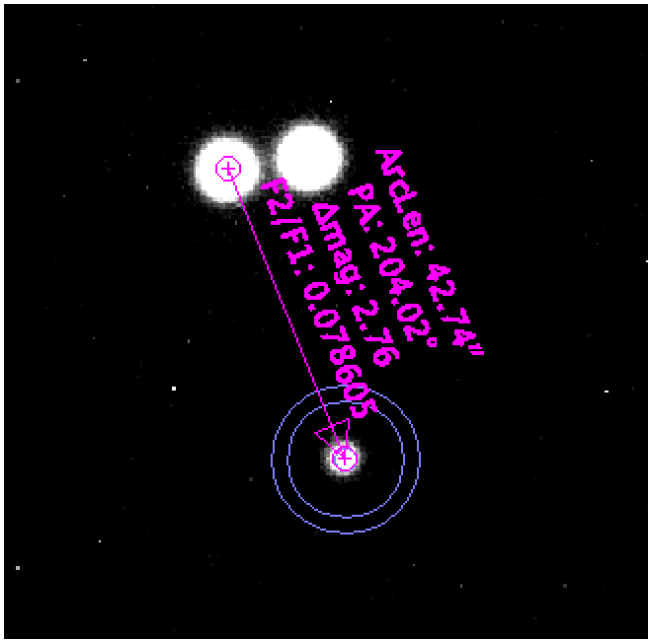

Figure 3. Measuring position angle and arc length with AstroImageJ.

Results

The results of our work, based on the 11 collected images, are shown in Table 1. The mean values of ρ and θ, together with the standard deviations and standard errors for both components, are recorded here.

WDS03063+5100	Position Angle (θ)	Separation (ρ)
Mean Value AB	99.78	11.35
Standard Deviation AB	0.04	0.02
Standard Error of the Mean AB	0.01	0.005
Mean Value AC	187.83	42.01
Standard Deviation AC	0.58	0.34
Standard Error of the Mean AC	0.29	0.17

Table 1. Statistical values of the separation (ρ) and position angle (ϑ) of WDS03063+5100 for the AB and AC components.

Discussion

In order to compare our measurements to past observations, we requested historical data from the Naval Observatory (Matson, 2021). There are 14 previously recorded measurements for the AB component and 3 measurements of the AC component in the Washington Double Star Catalog. The historical data for the AB component, together with our measurements, is located in Table 2, while Table 3 contains the measurements for the AC component. Figure 4 shows a plot of the measurements of the AB component. At first glance, this component appears to show linear motion. However, we have labeled some of the data points to demonstrate that this is in fact not the case. The data appears to be somewhat scattered. However, it seems clear that we can rule out orbital motion in this case.

The situation for the AC component seems to be more straightforward. Figure 5 shows the three historical measurements, together with our new measurement as well as a fitted trendline. The linear motion of this component seems readily apparent, with a remarkably high R^2 value of 0.9994. This seems quite suggestive of linear motion, which indicates that these components are not physical.

To further understand the nature of the components of this system, we retrieved parallax and proper motion data from the Gaia EDR3 database (Gaia Collaboration et al. 2018), which can be found in Table 4. While the quality of the Gaia data can be measured in a number of ways, one of the most common is by examining the reduced unit weight error (RUWE, Luri et al. 2018). If the RUWE is close to 1.00, we can be reasonably confident that the Gaia measurements are of good quality. The Gaia data for all three of these stars is quite close to 1.00, suggesting that we can be confident in these measurements. The parallax angles for all three components are quite dissimilar, yielding a distance for Component A of about 2,600 pc, while the distance of Component B is about 530 pc and Component C is at a distance of about 800 pc. The proper motions of the components are also very different, which further suggests that the components of this system are not physical. Taken together with what was seen with the historical data, it seems that none of the components of WDS 03063+5100 are physically bound.

Historical Data AB Component		
Year	**Position Angle (θ)**	**Separation (ρ)**
1904	99.00	11.55
1904	98.30	11.31
1904	99.10	11.37
1909	98.70	11.43
1930	98.60	11.59
1947	101.3	10.69
1958	99.40	11.47
1992	100.3	11.39
1999	100.4	11.35
2003	100.4	11.39
2006	99.90	11.36
2008	100.4	11.36
2016	100.4	11.38
2016	99.93	11.16
2021	100.4	11.38

Table 2. Historical data for the AB components of WDS 03063+5100.

Historical Data AC Component		
Year	**Position Angle (θ)**	**Separation (ρ)**
1989	187.2	42.37
1999	187.7	42.08
2003	187.8	42.03
2021	188.6	41.55

Table 3. Historical data for the AC components obtained from the WDS 03063+5100.

Component	Parallax (mas)	Distance-range calculation w/ pace (pc)	RA Proper Motion (mas/year)	Dec Proper Motion (mas/year)	RUWE
A	0.379±0.013	2550 - 2730	0.363±0.015	-1.304±0.011	1.100
B	1.88±0.015	528 - 536	-3.601±0.017	-13.455±0.013	0.971
C	1.24±0.014	816 - 797	3.477±0.016	-9.446±0.012	0.923

Table 4. Gaia EDR3 data for WDS 03063+5100.

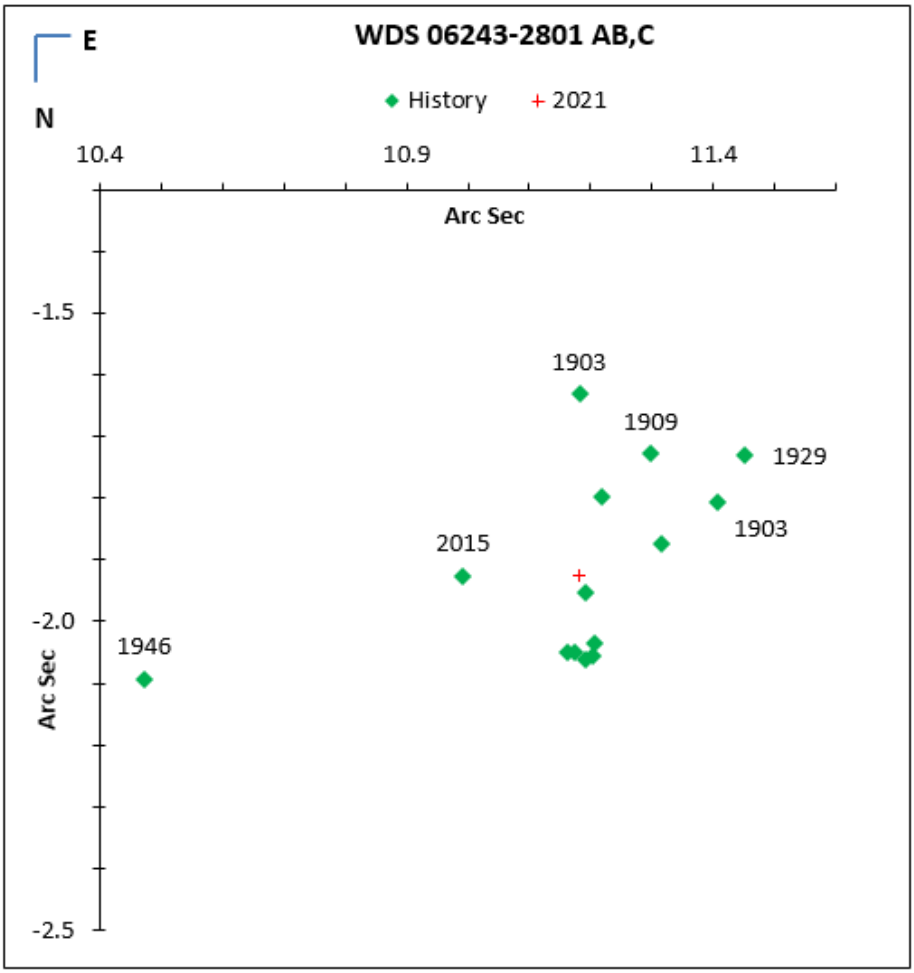

Figure 4. Historical and new data for the AB components.
The data appears scattered, perhaps due in part to the difficulty associated with measurements conducted by hand.

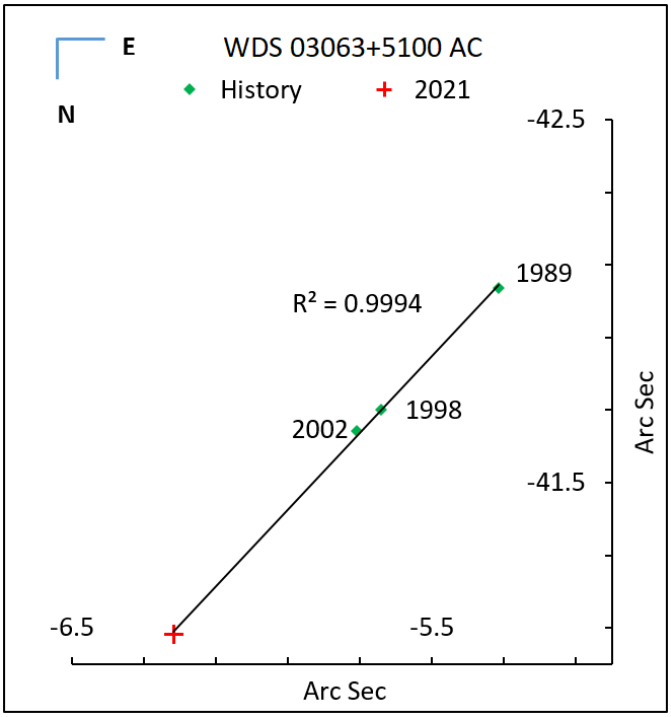

Figure 5. Plot of the historical data, together with our measurement, of the AC components. The motion appears to be remarkably linear, suggesting that these components are not physical.

Acknowledgements

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