CCD Measurements of WDS 00382+0305 for Differentiation from WDS 00382+0304

Harrison Torgerson, Carson Blickenstaff, Cameron Pace

Southern Utah University, Cedar City, Utah, United States

Abstract

The objective of our research was to differentiate WDS 00382+0305 from WDS 00382+0304 through CCD measurements of WDS 00382+0305. Our images were taken at the Great Basin Observatory. The images were imported into AstroImageJ, plate solved, calibrated, and measured to determine the separation and position angle. We observed a separation of 24.04" and a position angle of 155.08°. This is consistent with previous historical measurements. Proper motion and parallax data for the system were extracted from the Gaia database. The comparison of our measurements to both Gaia and historical data indicate that WDS 00382+0305 shows no physical relation between its two component stars.

Introduction

There has been some confusion regarding the proper identification of WDS 00382+0304. First observed in 1904, there are 10 measurements for this system found in the literature, and our 2020 measurement brings the total observations to 11. In the 17th installment of speckle interferometry at the USNO, Mason, et al. 2011 indicated that they were unable to detect the secondary component of WDS 00382+0305. It would appear that in their analysis, Mason et al. 2011 inadvertently combined some of the information of WDS 00382+0305 and WDS 00382+0304 (their table 4). For instance, the discoverer designation of WDS 00382+0305 is listed as HDO 32 in their table 4, which is in fact the discoverer of WDS 00382+0304. Additionally, the table attributes the year of discovery and measurements of WDS 00382+0304 (1868, ρ =4.0, θ =45) to WDS 00382+0305. Interestingly, Mason and his team provide measurements (ρ = 24.23" and θ = 155.7°) in Table 2 of their paper that are consistent with other measures of WDS 00382+0305, but again listed the discoverer as HDO 32 rather than the actual discoverer (BU 9031). In an attempt to clarify the confusion surrounding WDS 00382+0305, Knapp & Nanson 2018 observed the system in 2015 and recorded a position angle and separation consistent with previous measurements for the system.

The purpose of this paper is to ascertain the actual data for WDS 00382+0305. We chose this system due to its visibility with the GBO telescope, and because it had ten different measurements ranging from 1904 to 2015 making it a candidate for possible physical determination. In order to evaluate the physicality of WDS 00382+0305, we compared our measurements to historical data, and also obtained proper motion and parallax data from the Gaia database (Brown, et al. 2018).

Methods

We observed WDS 00382+0305 (Figure 1) using the Great Basin Observatory located in Great Basin National Park. The telescope is a Planewave CDK 700 with a focal ratio of f/6.5 and an aperture of 27 inches. The camera is an

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SBIG STX 16803 with a 27'x27' field of view and a plate scale of 0.4 arcsec per pixel (Musegades, et al. 2018). The GBO is maintained and operated by the Great Basin National Park and the Great Basin National Foundation, in cooperation with Western Nevada College, Concordia University, University Nevada-Reno, and Southern Utah University.

Images were taken remotely on February 6, 2020. We acquired 9 images using an exposure time of 180s with a V filter. We chose this exposure time to prevent overexposing the images. We then calibrated and plate solved using the AstroImageJ software (Collins, et al. 2017). AstroImageJ was also used to perform the astrometry of measuring separation (ρ) and position angle (θ) for the system: the centroid feature was also employed to ensure that the separation was measured from the centers of the stars. We then exported these measurements into Excel to obtain the mean, standard deviation, and standard error.

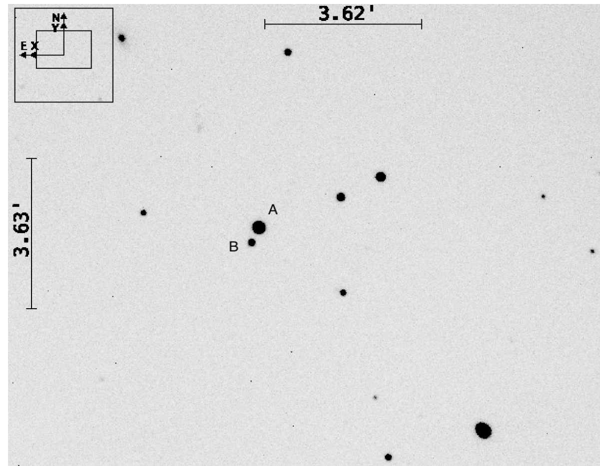

Figure 1 - Finder chart for the A and B components of WDS 00382+0305.

Results

The mean, standard deviation, and standard error of both separation and position angle measurements are shown in Table 1.

WDS No.	Nights	Date	Observations		θ°	p"
00382+0305	1	Feb. 06, 2020	9	Mean	155.08	24.04
				Std. Dev.	0.124	0.001
				St. Error	0.041	0.001

Table 1 - The mean, standard deviation, and standard error of all the measurements taken for WDS 00382+0305.

Discussion

Our observations in Table 1 are consistent with those made by Knapp & Nanson 2018. This confirms the fact that WDS 00382+0305 was confused by Mason et al. 2011 in their Table 4, and that the correct measurements of ρ and θ were provided in their Table 2. With the Mason et al. 2011 measurements included, the number of historical observations is 10 from 1904 to 2015. Our results are shown together with the historical data for WDS 00382+0305 in Table 2 (Matson, 2019). Figure 2 shows the separation of the secondary star from its respective primary over this time period. The plot indicates that the secondary star has a linear relationship with respect to the primary star, suggesting that the two stars are not physically related.

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To further investigate the physicality of the system, we extracted parallax and proper motion measurements from the Gaia database: these are shown in Table 3 (Brown, et al. 2018). The B component is relatively nearby, with a parallax of 6.7 mas and a distance of about 150 pc. In contrast, the A component has a measured parallax of only 2.0 mas and a distance of about 500 pc. This indicates that the components of the system are about 330 parsecs apart, which suggests that they are not physical. The proper motion vectors are plotted in Figure 3, and along with the measurements in Table 3, indicate that the two stars do not share a common proper motion. The linear motion of the secondary, combined with the dissimilar parallax and proper motion indicate that WDS 00382+0305 is an optical double rather than a physical binary.

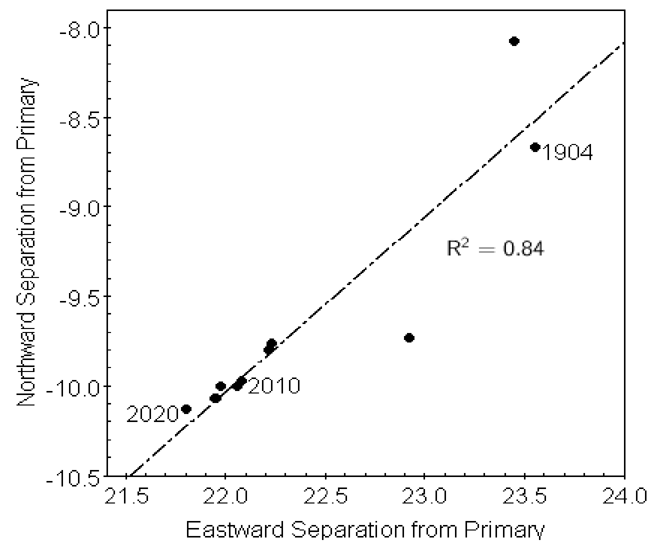

Figure 2 - Plot of historical measurements of the system and a line fitted to the data. The Mason et al. 2011 observation is labelled with the year of its measurement (2010), as is our observation and the discovery observation. This plot shows that the B component appears to move in a linear fashion with respect to the A component, suggesting that stars are not physically associated.

Epoch	*θ* (°)	p(")	Aperture (m)	Reference Code
1904	159.8	25.1	1	Bu_1906
1908	161.0	24.80	0.5	Doo1915b
1944	157.0	24.9	1.2	Hsw2004
2000	156.2	24.278	0.2	UC_2013a
2000	156.3	24.28	1.3	TMA2003
2010	155.6	24.22	0.4	WIS2012
2010	155.7	24.23	0.7	WSI2011b
2012	155.53	24.146	0.2	UR_2015
2014	155.36	24.152	0.2	UR_2015
2015	155.355	24.148	1	kpp2018m
2020	155.08	24.04	0.7	

Table 2 - Historical values of theta and rho including our measurements.

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Component	A	B
Parallax [mas]	2.0269 (±0.045)	6.6775 (±0.079)
Proper Motion RA	24.674 (±0.104)	6.567 (±0.149)
Proper Motion DE	-7.285 (±0.071)	-26.259 (±0.150)
Distance [pc]	505 -- 483	152 -- 148

Table 3 -Information collected from the Gaia database (Brown, et al. 2018). The table records the position of the stars, the parallax values in milli arc seconds as well as the distance in parsecs, and the proper motion for each star provided in component form.

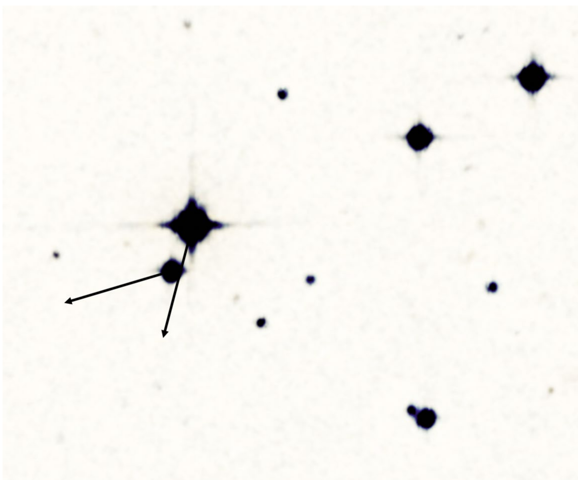

Figure 3 - Proper motions for the system from GAIA (Brown, et al. 2018). The proper motions suggest that the stars are not physical.

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