Astrometric Measurements of WDS 15482+0134 EIS 1AB

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Abstract: Ten separations and position angles were obtained of WDS 15482+0134 AB with the CDK-700 telescope in the iTelescope array. The mean values of these measurements were compared to historical observations. Although there was a discrepancy between our separations and the historical data, the position angle matched quite well.

Introduction

Cuesta College, a community college in San Luis Obispo, California, offers ASTR 299, Astronomy Research Seminar. Once our team was formed we selected a double star system to observe. Our team decided to focus on double stars in the southern hemisphere and to obtain CCD images through the iTelescope array. The primary reason for choosing the southern hemisphere was to analyze systems that receive less telescope time, due to the large majority of earth-dwellers living in the northern hemisphere. The team was specifically interested in ordering observations from telescope T27, which resides in Siding Springs, because this Corrected Dall-Kirkham (CDK) telescope, manufactured by PlaneWave Instruments, was first prototyped by California Polytechnic students (Genet et al., 2010; Rowe, et al., 2010). By basing the selection in this defined location, the team narrowed the double stars based on a right ascension from 10 to 15 hours and a declination from 0 to -60 degrees for best viewing during spring.

Our student team selected WDS 15482+0134 / EIS 1AB, also known as the double star V382 Serpens, to obtain an updated separation and position angle. Discovered by astronomer T. Eisenbeiss in 1960, this system has only four recorded observations, with the latest observation made in 2006. What follows is the fifth separation/position observation of the 15482+0134 / EIS 1AB system reported to date.

This research project's goals were to contribute to the observations of this infrequently observed binary system. By doing this, the team hoped to learn the scientific process of research and publishing, as well as how to gather and analyze data as astronomers.

Figure 1: From left to right: Jenae Irving, Charles Ryan, Cassandra Kraver, Charles Van Steenwyk, and Nancy Forrest visiting the SOFIA airborne observatory at Armstrong Flight Research Center.

Observations and Reduction

Our observations utilize T27, a PlaneWave Instruments 27-inch (0.7m) CDK700 reflector (shown in Figure 2) with a focal length of 4638mm. This alt-az telescope was designed to be a multi-use telescope with the ability to accommodate for a variety of instruments. This telescope features a Finger Lake Instruments Pro-

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Figure 2. Telescope 27 at the Siding Spring, Australia Observatory

Line PL09000 CCD Camera and acquired the T27 telescope's images, providing a resolution of 0.53 arc seconds per pixel for a field of view of 27.1' by 27.1' as suggested by iTelescope.

Observations were obtained on May 3, 2016 with exposure lengths of 60 and 90 seconds for a Luminance filter and 120 and 150 seconds for a Hydrogen-alpha filter. Additional observations were made with a Luminance exposure of 60 seconds and H-alpha exposures of 120, 150, and 180 seconds on May 19, 2016. With two sets of images from different nights, errors caused by fluctuations in weather and atmospheric turbulence were mitigated, allowing for more precise measurements of separations and position angles. Despite this mitigation, telescope, and location, inclement weather during the observation windows may have caused some loss of precision.

MaxIm DL determined the World Coordinate System (WCS) positions for all of the images. MaxIm DL's PinPoint Astrometry function performed this process by matching the stars in the CCD images to the Fourth U.S. Naval Observatory CCD Astrograph Catalogue (UCAC4). The images taken with the H-alpha filter and 150 second exposures were not able to resolve the approximate location of the image in both observation sets, so they were not used.

Table 1 shows the astrometric calibration data for the ten successful images. The column heading #UCAC4 Stars explains how many stars matched up with the fourth U.S. Naval Observatory CCD Astrograph catalog out of all the stars in the plate. The camera angle refers to the angle formed from the horizon to the plate center, with the large difference in values indicating the different time of night between each observation set. Focal length shows the magnification and viewing field, which can vary depending on atmospheric effects, while plate scale indicates the "resolving power" of each plate capture.

With ten out of the fourteen images resolved, separation and position angle of the double star system was determined using Mirametrics Mira Pro x64. The Distance and Angle Function determined the separation between and the position angle from the first star's centroid to the second star's centroid. The function's Sample Radius was set to 15 pixels to allow for a large

Table 1: MaxIm DL astrometric calibration data.

Date	Filter	#UCAC4 Stars	Image Center's RA/DEC	Camera Angle	Focal Length	Pixel Scale
5/3/2016	Luminance	193 of 1017	RA 15h 48m 09.3s, Dec +01° 34' 16.4"	+169° 29.9' (R)	4531.0 mm	0.54628"/Pixel
5/3/2016	Luminance	157 of 931	RA 15h 48m 09.3s, Dec +01° 34' 14.8"	+169° 30.0' (R)	4531.2 mm	0.54625"/Pixel
5/3/2016	Luminance	152 of 1074	RA 15h 48m 09.4s, Dec +01° 34' 13.5"	+169° 29.8' (R)	4531.0 mm	0.54628"/Pixel
5/3/2016	Luminance	159 of 1088	RA 15h 48m 09.4s, Dec +01° 34' 11.7"	+169° 30.1' (R)	4530.8 mm	0.54630"/Pixel
5/3/2016	H-alpha	68 of 209	RA 15h 48m 09.5s, Dec +01° 34' 09.1"	+169° 30.2' (R)	4532.6 mm	0.54608"/Pixel
5/3/2016	H-alpha	76 of 225	RA 15h 48m 09.4s, Dec +01° 34' 07.4"	+169° 29.2' (R)	4530.7 mm	0.54631"/Pixel
5/19/2016	Luminance	235 of 688	RA 15h 48m 09.4s, Dec +01° 34' 17.2"	+180° 07.4' (R)	4531.4 mm	0.54623"/Pixel
5/19/2016	H-alpha	48 of 193	RA 15h 48m 09.4s, Dec +01° 34' 15.4"	+180° 05.2' (R)	4530.3 mm	0.54636"/Pixel
5/19/2016	H-alpha	66 of 268	RA 15h 48m 09.4s, Dec +01° 34' 13.3"	+180° 05.2' (R)	4530.5 mm	0.54634"/Pixel
5/19/2016	H-alpha	50 of 284	RA 15h 48m 09.5s, Dec +01° 34' 13.5"	+180° 07.5' (R)	4538.4 mm	0.54539"/Pixel

Table 2: New observations performed by team, with overall means, standard deviations, and standard errors.

Date of Observation	Position Angle (°)	Separation (")
2016.336	352.17	17.493
2016.336	352.41	17.580
2016.336	352.29	17.447
2016.336	352.31	17.477
2016.336	352.43	17.672
2016.336	352.46	17.638
2016.380	352.27	17.250
2016.380	352.38	17.572
2016.380	352.32	17.499
2016.380	352.51	17.361
Mean	352.36	17.50
Standard Deviation	0.11	0.16
Standard Error	0.0335	0.0497

enough circumference of the tool annulus to properly locate each star's centroid. Excel was then used to compile the data retrieved from Mira Pro x64 and to derive the standard deviations and standard errors of mean of the separation and position angle.

Results

Table 2 shows the observational results from one set of six images, taken on May 3rd, 2016, and the second set of four images, taken on May 19th. In addition, Table 2 shows the overall means (also shown in Table 3), the standard deviations, and standard errors for position angle and separation. Table 3 lists the relevant historical data from the WDS catalog, as well as the latest set of new mean observations taken by the team, showing comparisons between the two sets of data.

Discussion

The deviation of our measurements could have been produced by the possible overexposure induced by the long exposure time, listed in Table 3. This was mitigated by limiting the centroid sample values in Mira Pro. However, many of the plates were overexposed, which may have led to systemic saturation, perhaps skewing the results.

As can be seen from Table 2, our position angle agrees well with the historical observations at 2000.327, and 2000.430, holding to a difference of 0.08° to 0.24° (less than 2 standard deviations), and agrees moderately with 1950.542 at 1.24° difference, but disagrees with the observation on 2006.301, the most recent, by 4.26° (close to 40 standard deviations), suggesting that this most recent observation may be an outlier.

The mean separation agrees somewhat less well with historical observations, whose values stay between a minimum of 17.83" (2000.327) and maximum of 17.90" (2000.430). Our listed separation differs from the historical range by 2.3 standard deviations, with a mean value of 17.50", around 2 standard deviations from all historical observations. The possible errors in finding the centroid due to overexposure may be responsible for this difference. Of note, however, is that the longer exposure times (potentially more saturated) tended to agree better with historical observations than did the normal exposures.

Conclusion

The Cuesta/Cal Poly team met all of our observational goals in this report by ordering observations from iTelescope and running analysis on the results. The team learned how to use Maxim DL and Mira Pro to analyze position angles and separations, how to resolve the plate scale, and how to go about preparing the data acquired for analysis and publication, all essential parts of the observation process. Doing all this allowed the team to add another data point on the observations of WDS 15482+0134 EIS 1AB, completing our primary goal of contributing to the WDS astronomical catalog.

Table 3: Historical data on double star system, courtesy WDS star catalog

Date of Observation	Position Angle (°)	Difference (°)	Separation (")	Difference (")	Observation Source
2016.380	352.36	-	17.50	-	***New***
1950.542	353.60	+1.24	17.85	+.35	Eisenbeiss et al. 2007
2000.327	352.42	+.06	17.83	+.33	Eisenbeiss et al. 2007
2000.430	352.60	+.24	17.90	+.40	Hartkopf et al. 2013
2006.301	356.62	+4.26	17.85	+.35	Eisenbeiss et al. 2007

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