# CCD Measurements of the AC Component of WDS 01295+6317

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Abstract: Images of WDS 01295+6317AC were gathered with the Great Basin Observatory Telescope. Measurements of separation and position angle of the A and C components of the system were obtained. Our measurements aligned with two prior measurements of the stars, however a speckle observation from 2004 suggests a larger change in separation and position angle than we observed. In an effort to resolve this discrepancy and determine whether the A and C components are physical, we extracted parallax and proper motion data from the Gaia database. However, the stars are so distant (~2,200 pc for Component A and ~3,400 pc for Component C) that we must be careful in interpreting measurements of their proper motion and parallax. We therefore only suggest that the A and C components are not gravitationally bound.

## Introduction

In this research paper, we examine WDS 01295+6317 [MLB]. This star system is comprised of three component stars (01295+6317 [MLB 329A], 01295+6317 [MLB 329B], and 01295+6317 [MLB 329C]). Our telescope, the Great Basin Observatory (GBO), does not have the resolution to resolve the A and B components due to their close proximity. Therefore, we only observed the WDS 01295+6317 [MLB 329AC] system. This system was first measured in 1924. Prior to this study, it was last measured in 2004.

This research was conducted using the robotic GBO telescope (Figure 1) located in Great Basin National Park, Nevada. GBO operates under a cooperative that includes Great Basin National Park, Great Basin National Park Foundation, University of Nevada, Reno, Western Nevada College, Concordia University, and Southern Utah University. This telescope has an aperture of 27 inches as well as a focal ratio of f/6.5. Its SBIG STX 16803 camera has a field of view of 27' x 27'. The camera also has a plate scale of 0.4 arcsec per pixel. The GBO telescope is equipped with sixteen filters housed in two nested Finger Lakes filter wheels: LRGB, Ha, OIII, SII, BVRI, griz, and a diffraction grating.

*Figure 1: Located in Great Basin National Park, the GBO Planewave CDK700 telescope was used to acquire pictures of the WDS 01295+6317 [MLB 329AC] star system.*

WDS 01295+6317 (MLB 329AC) was remotely observed on January 19th, 2019. A sample image is shown in Figure 2, which shows that the A and B components were unresolved. Twenty images were collect-

*Received September 19, 2019; revised manuscript received April 3, 2020.*

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| WDS No. | ID | Nights | Date | Observations | | θ (°) | ρ (") |
|---|---|---|---|---|---|---|---|
| 01295+6317 | MLB 329AC | 1 | 2019.052 | 20 | Mean | 152.2 | 11.30 |
| | | | | | Std. Dev. | 0.1 | 0.03 |
| | | | | | Std. Error | 0.02 | 0.01 |

*Table 1. Data and observations from our images. Standard deviation, standard error, position angle (θ) and separation (ρ) are shown.*

ed of the targeted system with an exposure time of 60 seconds each: this exposure time was used to ensure that neither of the stars were overexposed. The images were taken with the V filter. The images were then calibrated to remove noise. This was done by applying dark, flat, and bias frames using AstroImageJ (Collins et al. 2017). The images were already plate solved by the imaging software. After the process of calibrating and plate solving was complete, the position angle (θ) and separation (ρ) were measured using AstroImageJ. The centroid of the star was utilized to improve the accuracy of the measurements.

## Results

Our measurements, together with the standard deviation and error, as well as the number of observations, are shown in Table 1.

## Discussion

Table 2 shows that there are 3 measurements of the A and C components of WDS 01295+6317 in the literature, with the latest measurement dating to 2004. (Mason, 2019). Our measurement aligns with the discovery measurement and that taken in 2003, however the 2004 measurement is quite different from the others, as can be seen in Figure 3. The 2003 measurement was taken as part of the fourth US Naval Observatory

| Epoch | θ (°) | ρ (") |
|---|---|---|
| 1924.56 | 154.7 | 11.76 |
| 2003.7 | 152.2 | 11.331 |
| 2004.923 | 119.7 | 20.1 |
| 2019.052 | 152.2 | 11.30 |

*Table 2. Historical data for 01295+6317MLB 329AC, as well as our measurements.*

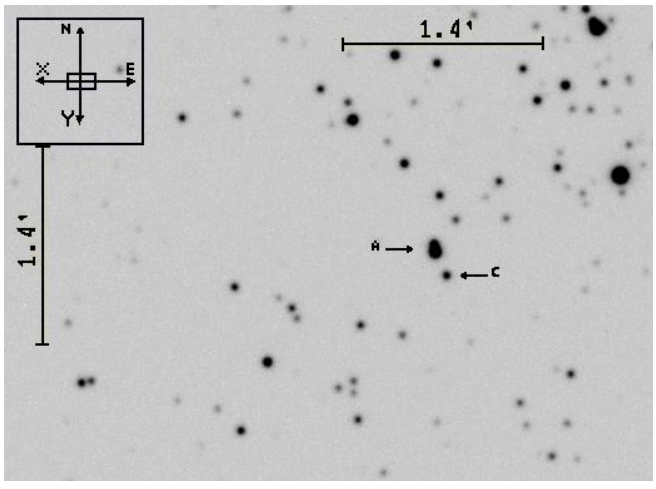


*Figure 2: The two stars measured from the WDS 01295+6317 [MLB] system. Shown to the top left is the A central star; the C component star is shown to the bottom right. The B component star is partially behind the A central star, accounting for its elliptical shape.*

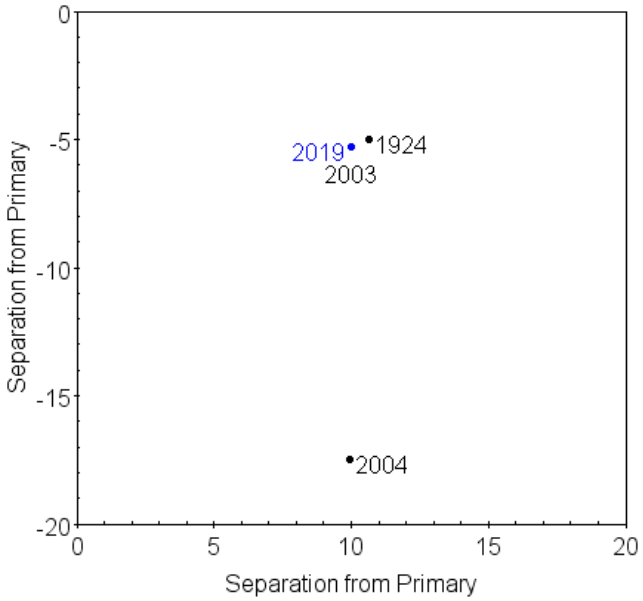


*Figure 3: This graph depicts our measurement (blue circle) of the C component, together with historical measurements (black circles). All measurements are in arcseconds, and the primary star is located at the origin. The data point from 2004 is a speckle observation from the USNO .*

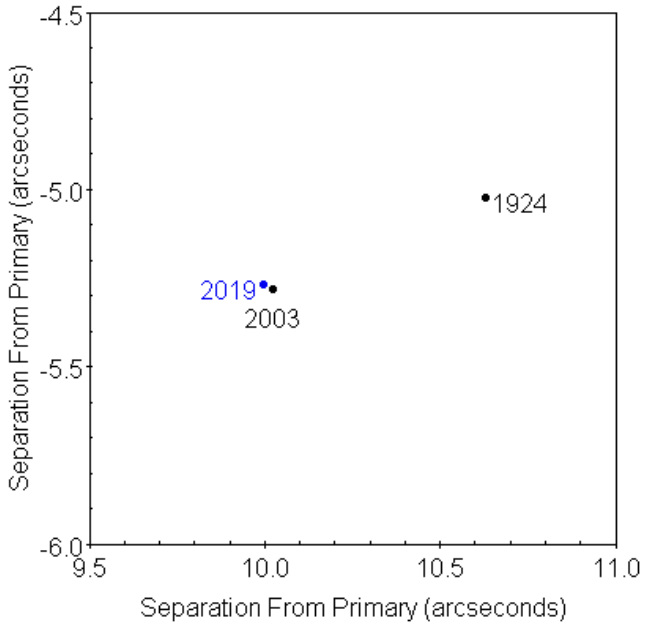


*Figure 4. Same as Figure 3, but with the 2004 data point omitted. It can be seen that our measurement is consistent with the measurements made in 2003 and 1924.*

CCD Astrograph Catalog (UCAC4; Zacharias et al. 2012), and as such is an astrometric measurement. In contrast, the 2004 measurement is a speckle interferometric observation and was taken as part of the USNO effort to take speckle measurements of double stars (Mason et al. 2006). These authors noted that their observation represented a large change in separation and position angle. Although the 2003 and 2004 observations were both made by observers at the same institution, it must be remembered that they were each made as part of large catalogs that were published at different times, and so it makes sense that the relatively large difference between the two may have gone unnoticed.

There is a possibility the data recorded in 2004 could have been misrecorded and/or miscalculated. As shown in Figure 3, the values for our data and the data from 1924 and 2003 are in agreement. However, the measurement from 2004 is inconsistent with the other measurements. We have shown in Figure 4 the observations of this pair with 2004 data omitted to better show the motion of the star over this time period. The points from 1924, 2003, and 2019 suggest that the C component is moving in a linear fashion, which could indicate that the A and C components are not gravitationally bound.

Proper motion and parallax information for these components was extracted from the Gaia DR 2 (Gaia Collaboration 2016, 2019), and is shown in Table 3. The A component has a parallax of 0.446 mas, while that of the C component is 0.298 mas. Converting these to distances and including the parallax error gives a distance range of 1800-2800 pc for Component A and a range of 3100-3600 for Component C. While there is some possibility of overlap in these distance ranges, these measurements suggest that the components are not physically associated.

If we examine the proper motion of the stars, we see that the RA component of their motion is rather similar, however their DEC proper motions appear to be different. Even so, the extreme distances of these stars make it difficult to draw any conclusions of their physicality, and we merely suggest that this pair may not be physical.

## Acknowledgements

This paper is a result of research conducted by undergraduate students at Dixie State University through the Department of Physical Science at Southern Utah University. The research was made possible by a collaboration with the partnership between Southern Utah University and the Great Basin Observatory. First, we would like to thank those who manage and maintain the Great Basin Observatory. We would also like to acknowledge Brian Mason for providing the historical data needed to complete our research. This research made use of AstroImageJ, Astrometry.net, and the Washington Double Star Catalog maintained at the U.S. Naval Observatory. This research also used data from the European Space Agency (ESA) mission Gaia (https:// www.cosmos.esa.int/gaia), processed by the Gaia Data Processing and Analysis Consortium (DPAC, https:// www.cosmos.esa.int/web/gaia/dpac/consortium). DPAC funding is provided by national institutions participating in the Gaia Multilateral Agreement.

| Component | Parallax (mas) | Distance (pc) | Proper Motion RA (mas/year) | Proper Motion DE (mas/year) |
|---|---|---|---|---|
| A | 0.446 ± 0.084 | 1800-2800 | -4.253 ± 0.101 | 0.115 ± 0.108 |
| C | 0.298 ± 0.021 | 3100-3600 | -4.228 ± 0.029 | 0.445 ± 0.028 |

*Table 3: Data obtained from ESA's Gaia astronomy satellite, which describes the movement and location of WDS 01295+6317 [MLB 329AC]. This given data was used to help determine if these are gravitationally bound, specifically the parallax.*

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