Astrometric Observations of WDS 18574+0302 UC 242 Using the Great Basin Observatory

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Abstract

WDS 18574+0302 is a two-component system with 7 historical measurements prior to this work. In this study, we acquired 10 images of the system and used AstroImageJ to measure the separation and position angles of the stars. We plotted our measurements in comparison to those previously taken and found no significant trend in historical observations. However, the proper motions of the pair imply the stars are co-moving. Further study is needed to determine the nature of this pair.

1. Introduction

The system WDS 18574+0302 UC 242 was selected for this project due to its appropriate magnitude and declination to be observed by the Great Basin Observatory (GBO). A total of 8 observations of the system were made, including 7 historical points ranging from 1999 through 2015, along with our most recent observation from 2025. We compared our observations to the historical measurements to examine the motion of the system's components. Parallax and proper motion data from Gaia DR3 (Gaia Collaboration, Vallenari, A., Brown, 2023j) were also used to assess the motion of this pair and determine whether the binary was physically associated.

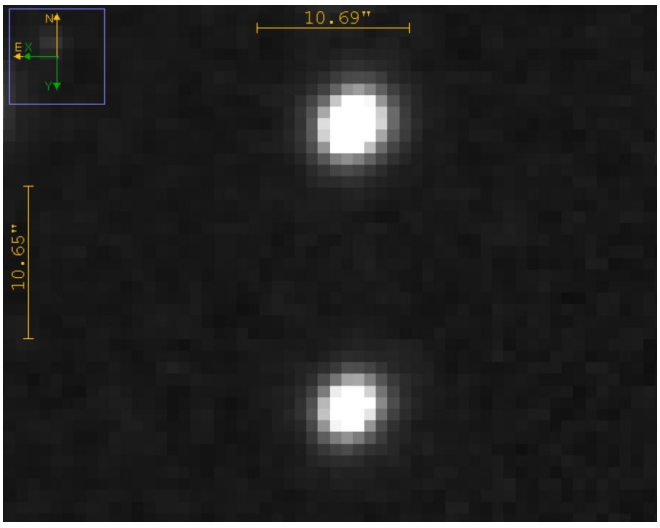

Figure 1: Finder chart for the components of WDS 18574+0302

2. Equipment and Methods

The GBO, which was used for this project, consists of a Planewave CDK 700 telescope with an aperture of 27 in. It is located in Great Basin National Park, and is managed as a partnership with Southern Utah University, University of Nevada-Reno, Great Basin National Park, and the Great Basin National Park Foundation (Anselmo, D., 2018). Since the stars in the system have visual magnitudes of 10.52 and 11.82, an exposure time of 30 seconds was used, and a total of 10 frames were taken. The images were acquired through the Sloan I filter with a 2 x 2 binning on September 8, 2025 (JD 2025.684932). The observatory camera is a ZWO 6200MM cooled camera with a pixel dimension of 9576x6388. A finder chart for WDS 18574+0302 is provided in Figure 1, while the observatory itself is shown in Figure 2.

Figure 2: The Great Basin Observatory (Courtesy Paul Gardner)

The celestial coordinates for the images were obtained via Stella Doppie. ASTAP (Kleijn, H., 2025) was used to calibrate the images, including the application of bias, dark, and flat frames to the 10 images. We then used AstroImageJ (Collins et al. 2017) to measure the separation and position angle. This measurement process in AstroImageJ is illustrated in Figure 3. We also examined seeing profiles for the stars in the system to ensure they were not overexposed. After completing the measurements, we calculated the mean and standard deviation for each component. Finally, we produced comparison plots between our data and the historical measurements using Plot (Harshaw, R., 2020).

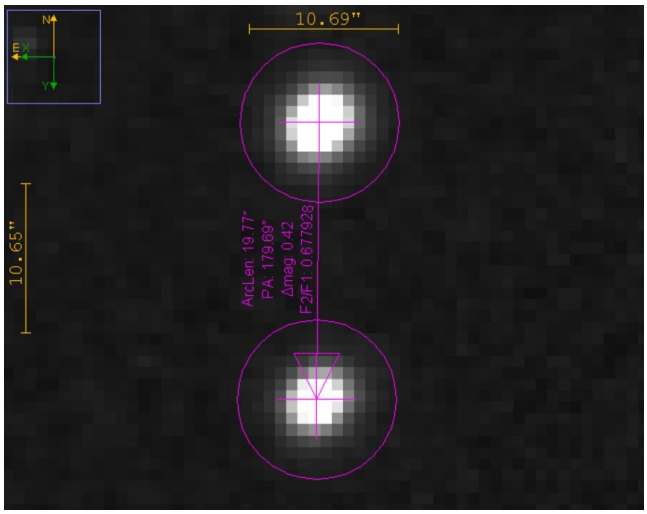

Figure 3: Measuring the position angle and arc length for components of WDS 18574+0302 using AstroImageJ

3. Results

The results of our work, based on the 10 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.

Table 1. Measurements of the separation (ρ) and position angle (θ) of WDS 18574+0302

WDS 18574+0302	Position Angle (θ) [°]	Separation (ρ) ["]
Mean Value	179.7	19.80
Standard Deviation	±0.1	±0.03
Standard Error of the Mean (n=10)	0.03	0.01

4. Discussion

In order to compare our measurements to past observations, historical measurements were obtained from the U.S. Naval Observatory (Matson, R., 2025). Seven historical observations are listed in the Washington Double Star Catalog. The historical data, along with our measurements, are shown in Table 2.

Table 2. Historical data for the components of UC 242

Year	Position Angle (θ)	Separation (ρ)
1999.606	179.8°	19.86"
2000.666	179.8°	19.83"
2012.397	179.8°	19.81"
2013.448	179.7°	19.81"
2014.535	179.7°	19.80"
2015.0	180.0°	19.81"
2015.407	179.8°	19.80"
2025.687	179.8°	19.80"

These measurements span approximately 26 years and have shown little movement (less than 0.10 arcsec), so we cannot make definitive conclusions about the motion of this pair from the historical data.

To further study the motion of this pair and determine if the stars are physically bound, we employed the Space Velocity Vector method to determine the pair components' angular space motion differences (Nugent, R., 2025) by using the Gaia data found in Table 3.

Table 3. Gaia DR3 data for the components of system UC 242

Quantity	Primary	Secondary
Gaia DR3 Numbers	4280728276825542016	4280728281122281344
PM RA (mas/yr)	64.2219 ± 0.0692	63.6781 ± 0.0186
PM DEC (mas/yr)	37.7635 ± 0.0687	39.7506 ± 0.0179
Parallax (mas)	5.2925 ± 0.0727	5.3342 ± 0.0197
Radial Velocity (km/s)	-14.87 ± 2.59	-16.98 ± 2.17

After converting the proper motion data from mas/yr to km/s, we calculated the angular space motion difference *v* by taking the inverse cosine of the quotient of the dot product and product of the magnitudes of the 3D velocity vectors (Nugent, R., 2025):

$$v = cos^{-1} \frac{PRI * SEC}{|PRI| * |SEC|}$$

Note that |PRI| * |SEC| refer to the magnitude of the primary and secondary component space velocity vectors. Applying this calculation for UC 242 yields a ν value of about 2.2652°. This would be classified as a Common Space Motion (CSM) pair, implying that the stars are co-moving.

We also performed a normal probability distribution calculation on the parallax of the two stars A and B, and the calculation showed that there is a 7.8 % chance that the two stars are within 63,240 AU (one light-year) of separation, indicating the pair is unlikely to be physically associated.

5. Conclusion

The data from the recent observation shows little change from all previous observations. We determined that this pair exhibits Common Space Motion per Nugent's SVV calculations method. This indicates that the stars are most likely moving in the same direction. However, given the low probability that the two stars are within 63,240 AU of one another, we do not believe these stars are physically associated. Our results are inconclusive as to the nature of this pair and suggest further study is needed.

Acknowledgements

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