Astrometric Observations of WDS 20528+6307 Using the Great Basin Observatory

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Abstract
WDS 20528+6307 is a two-component system with 12 reliable historical measurements. For this paper, we acquired 10 images of the system to measure the separation and position angles of the stars. Measurements were plotted in comparison to the historical data, and an approximate 1.10" change in separation was found between 1986 and 2025. The plotted measurements were best modeled with a polynomial fit, which suggests that the stars are true binaries, or at least exert a gravitational influence on each other. Further observation is needed to determine the nature of this system.

1. Introduction
The system WDS 20528+6307 KPP 1724 was selected for this project. It was chosen because it was of the appropriate magnitude and declination to be observable by the Great Basin Observatory (GBO). A total of 14 reliable observations of the system have been made: 13 historical points taken from 1986 through 2016, and the most recent observation from 2025. The observations were compared to the historical measurements to examine the motion of the system's two measurable components. Parallax and proper motion data from Gaia DR3 (Gaia Collaboration et al. 2016b, 2023j) were also used to assess the motions of the stars and to determine if this system is physical.

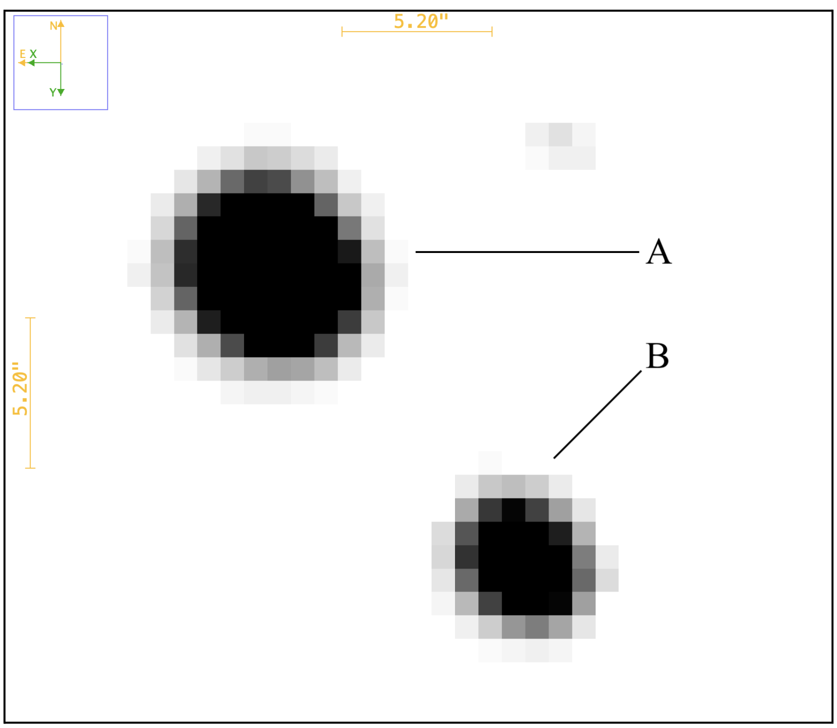

Figure 1: Finder chart for the components of WDS 20528+6307

2. Methods

The GBO was used for this project and 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 between Southern Utah University, University of Nevada-Reno, Great Basin National Park, and the Great Basin National Park Foundation (Anselmo, 2018). Since the stars in the system have visual magnitudes of 11.50 and 13.50, an exposure time of 60 seconds was used, and a total of 10 frames were taken. The images were acquired through the Sloan I (SI) filter with a 2 x 2 binning on September 15, 2025 (JD 2025.258). A finder chart for WDS 10520+0851 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 acquired using http://nova.astrometry.net/ (Lang, 2010). Astrometric Stacking Program ASTAP (HNSKY, 2025) was used to apply the bias, dark, and flat frames. AstroImageJ (Collins et al. 2017) was used to perform measurements of separation and position angle. The measurement process in AstroImageJ is shown in Figure 3. Seeing profiles of the stars in the system were examined to ensure they were not overexposed. Once the measurements were completed, the mean and standard deviation for each component were calculated. Comparison plots between the observed data and the historical measurements were produced using Plot (Harshaw, 2020).

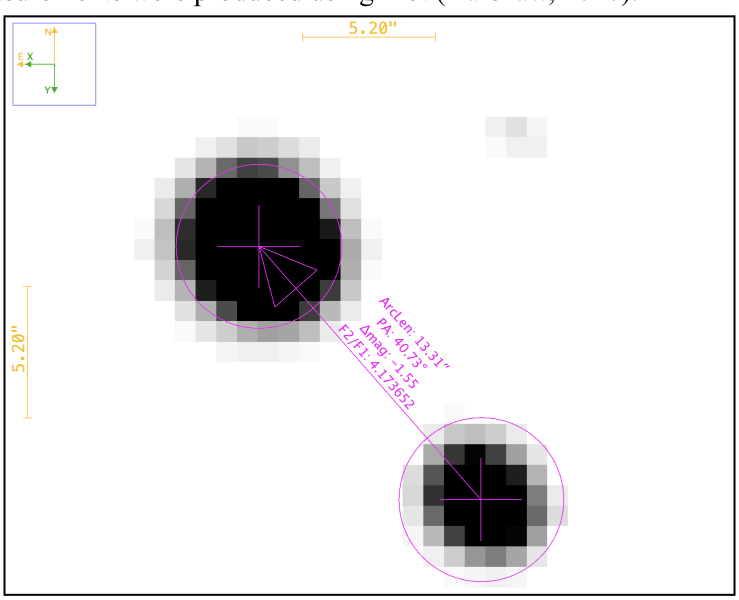

Figure 3: Measuring position angle and arc length with AstroImageJ

3. Results

The results of our work, based on the 10 collected images, are shown in Table 1. The mean values of separation (ρ) and position angle (θ), together with the standard deviations and standard errors for both components, are recorded here.

Table 1: Measurements of the separation (ρ) and position angle (θ) of WDS 20528+6307 for the AB components.

WDS 20528+6307	Position angle (θ)	Separation (ρ)
Mean Value	220.749°	13.294”
Standard Deviation	± 0.12°	± 0.03”
Standard Error of the Mean (n=10)	0.037°	0.01”

4. Discussion

To compare our measurements to past observations, we requested historical data from the Naval Observatory (Matson, 2024). There are 13 previously recorded measurements for this system in the Washington Double Star Catalog. The historical data, together with our measurements, are located in Table 2.

Table 2: Historical data for the AB components of WDS 20528+6307

Year	Position angle (θ)	Separation (ρ)
1986	221.819°	11.78”
1995	221.243°	13.18”
1999	220.600°	13.32”
2003	220.700°	13.33”
2010	220.589°	13.33”
2011	218.404°	13.82”
2012	220.680°	13.33”
2013	220.650°	13.33”
2014	220.670°	13.34”
2015	220.653°	13.34”
2015	220.610°	13.34”
2015	220.651°	13.34”
2016	220.650°	13.34”
2025	220.749°	13.29”

Figure 4 shows a plot of the measurements of WDS 20528+6307. Historical measurements are in green while the new measurement is in red. The observed change in separation is moderate, with an approximate 1.10" of total change over the past 40 years. A quadratic fit of the data is also shown, having an R^2 value of 0.9689. This fit indicates that the pair is exerting a gravitational influence on each other; however, a more rigorous ellipsoidal fit would be required for further confirmation.

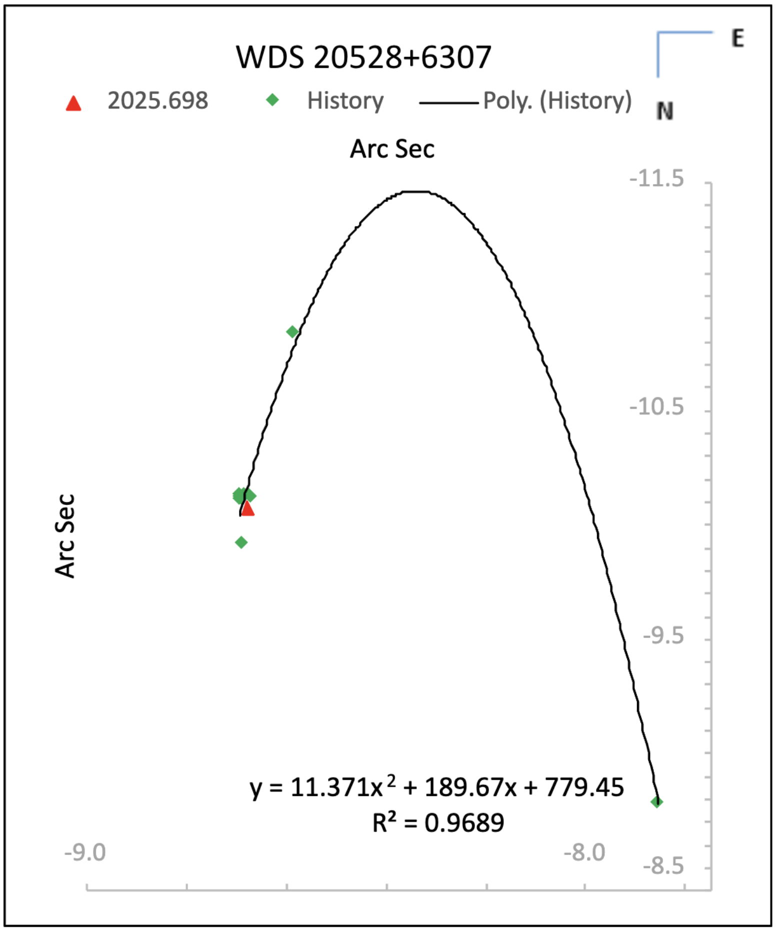

Figure 4: Historical and current measurement of WDS 20528+6307. Green data points represent historical measurements, while the red point represents our measurement from 2025. There has been an approximate 1.10" change in position since the original observation in 1986.

From the historical measurements alone, it is difficult to conclude that this pair is physical. To further understand the nature of the components of this system, we retrieved parallax and proper motion data from the Gaia DR3 database, which can be found in Table 3.

The reduced unit weight error (RUWE, Luri et al. 2018) is frequently used to evaluate the quality of Gaia data, and an RUWE value near 1.0 indicates reliable parallax data (Pearce, 2022). RUWE values greater than approximately 1.2 often indicate the presence of a stellar companion (Krolikowski et al. 2021). The RUWE value for Component A is 1.174, implying confidence that its Gaia measurements are of good quality, and this value being close to 1.2 provides evidence to postulate that it is being influenced by a stellar companion. The proper motions are very similar, indicating that the stars are traveling together. There is also a significant overlap in the parallax angles, suggesting the stars are close enough to exert a significant gravitational influence on each other.

Table 3: Gaia DR3 data for WDS 20528+6307.

Component	Gaia DR3 Source ID	Parallax (mas)	Distance Range (pc)	RA Proper Motion (mas/yr)	DEC Proper Motion (mas/yr)	RUWE
A	Gaia DR3 2196841966222594944	8.5991 ± 0.0141	116.28 - 116.55	2.063 ± 0.019	-47.686 ± 0.018	1.174
B	Gaia DR3 2196841961921480960	8.5874 ± 0.0143	116.41 - 116.64	2.551 ± 0.019	-46.991 ± 0.018	1.152

Conclusions

This study presents new astrometric observations of the double star system WDS 20528+6307, extending the historical record. When combined with the thirteen previous measurements in the Washington Double Star Catalog, our data reveal only a modest change in separation: approximately 1.10 arcseconds over four decades, indicating slow relative motion between the components.

Analysis of Gaia DR3 parallaxes and proper motions further supports the interpretation that the pair is likely physically associated. The similar proper motions and overlapping parallax values suggest that both stars share a common space motion, while the RUWE value (1.174) for Component A hints at a mild astrometric perturbation consistent with the influence of a stellar companion.

Although the present data are insufficient to provide definitive orbital parameters or a full dynamical solution, the observational evidence strongly favors the conclusion that WDS 20528+6307 is a physical pair rather than an optical alignment. Future high-precision astrometric monitoring and an ellipsoidal orbital fit will be essential to confirm gravitational binding and determine the system's orbital characteristics and mass ratio.

Acknowledgements

This project was made possible thanks to a partnership with Southern Utah University and the Great Basin Observatory (GBO). We would like to thank those who operate the GBO. This research made use of AstroImageJ, Astrometry.net, and the Washington Double Star Catalog, maintained by the U.S. Naval Observatory. This work has 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). Funding for the DPAC has been provided by national institutions, particularly the institutions participating in the Gaia Multilateral Agreement.

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