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 historical measurements. For this paper, 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 a slight linear trend, although the separation of the system has changed by less than 1.10" over the last 40 years. This might suggest that the stars are not physical; however, they have very similar proper motions and parallax angles (2.063 mas for the primary and 2.551 mas for the secondary), which indicates that they are part of a moving group, if not true binaries. 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 observations of the system have been made, including 13 historical points that were taken from 1986 through 2016, along with our most recent observation from 2025. We compared our observations to the historical measurements in order to examine the motion of the system's 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.

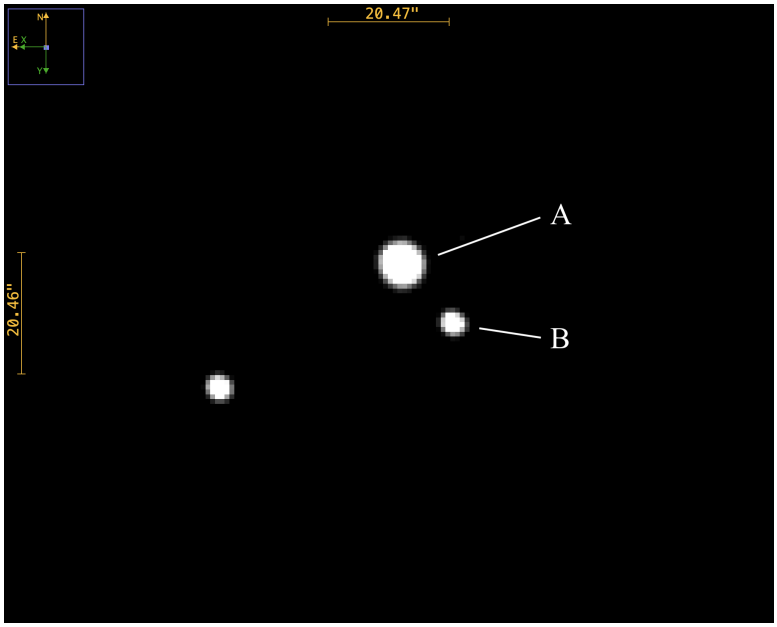

Figure 1: Finder chart for the components of WDS 20528+6307

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 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

The celestial coordinates for the images were acquired using http://nova.astrometry.net/ (Lang 2010). AstroImageJ (Collins et al. 2017) is used to apply the bias, dark, and flat frames as well as perform measurements of separation and position angle. This measurement process in AstroImageJ is shown in Figure 3. We also examined seeing profiles for the stars in the system to ensure that they were not overexposed. Once the measurements were completed, we calculated the mean and standard deviation for each component. Comparison plots between our data and the historical measurements were produced using Plot (Harshaw, 2020).

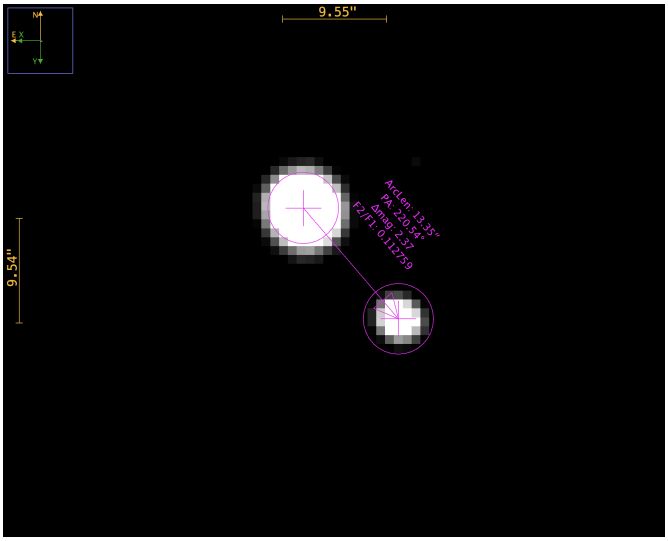

Figure 3: Measuring position angle and arc length with AstroImageJ

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. It can be seen that very little apparent motion (less than 1.10”) has been observed over the last few decades.

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 our new measurement is in red. The observed change in separation is quite small, varying by less than 1.10” over the past 40 years. A quadratic fit to the data is also shown, having an R^2 value of 0.9689.

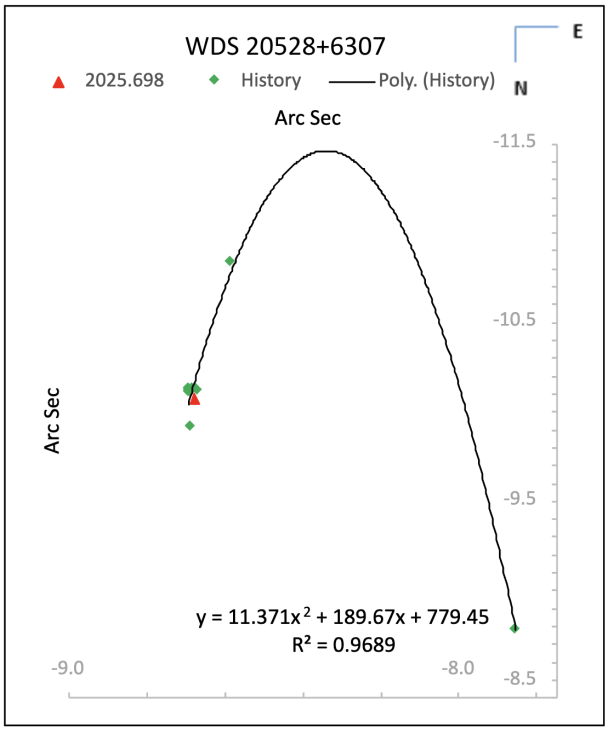

Figure 4: Historical and current measurement of WDS 20528+6307. Green data points represent historical measurements, while the red point represents our measurement from 2025. Very little change in position has been observed since the original observation in 1986

However, such a fit has little use when the change in separation is so small. From the historical measurements alone, it is difficult to determine whether this pair is physical or not.

To further understand the nature of the components in this system, we retrieved parallax and proper motion data from the Gaia DR3 database, which is 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 is indicative of “good” data. The RUWE value for Component A and Component B is 1.174 and 1.152, respectively. Both of our stars have magnitudes near 1, so we can be reasonably confident that the Gaia measurements are of good quality. WDS 20528+6307 is relatively nearby, at only about 483 pc away, which boosts confidence in the measurement of parallax and proper motion. The proper motions are very similar, indicating that the stars are traveling together.

In summary, the agreement in parallax values and the alignment of proper motions strongly suggest that the stars are interacting gravitationally. Although the available orbital information is not yet sufficient to provide definitive proof, the evidence supports that this system is likely a physical pair. A more detailed calculation of the system’s binding energy will be required to determine whether it is truly gravitationally bound, and thus confirm it as a bona fide physical binary.

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

Component	Parallax (mas)	Distance Range (pc)	RA Proper Motion (mas/yr)	DEC Proper Motion (mas/yr)	RUWE
A	8.5991	483.09	2.063	-47.686	1.174
B	8.5874	561.80	2.551	-46.991	1.152

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