Astrometric Measurements of WDS 18445+3400 & WDS 14491+2628

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Abstract

New astrometric measurements of two double star systems, WDS 18445+3400 (STTA 172) and WDS 14491+2628 (AG 346), are presented. Images were taken using the Dorothy Hill Observatory, located in Queensland, Australia, and measurements of position angle and separation for each system were determined using AstroImageJ. Comparison of these new measurements (STAA 172: PA 5.3º, Sep 65.1", AG 346: PA 335.7º, Sep 9.57") with historical data indicates no orbital motion for either target and parallax data from Gaia DR3 show evidence of co-location in space for the primary and secondary stars in each system. It was concluded that both systems are physical doubles.

1. Introduction

WDS 18445+3400 (STTA 172), seen in Figure 1, has 30 recorded observations in the Washington Double Stars Catalogue (WDS) (Mason, 2013) between 1875 and 2018. Located in the constellation Lyra, this double star has a spectral class of F8 and has previously been classified as physical.

WDS 14491+2628 (AG 346), seen in Figure 2, has 17 recorded observations in the WDS between 1895 and 2016. It is located in the constellation of Boötes and has a spectral class of F5. Its classification remains uncertain in the WDS.

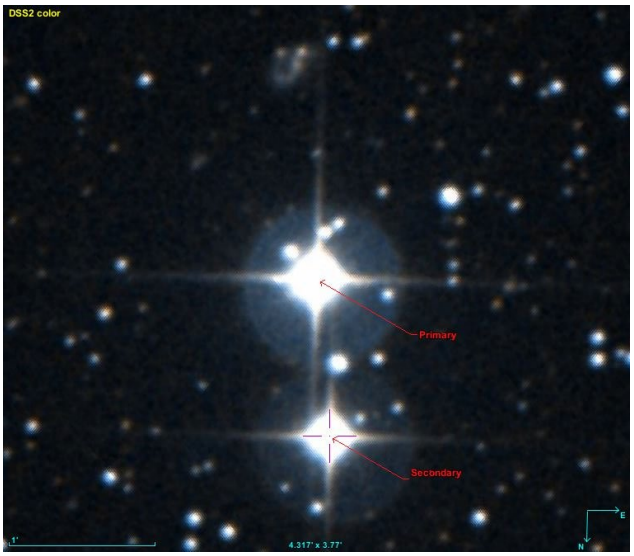

Figure 1: STAA 172, as imaged in SDSS and accessed via Aladin 11

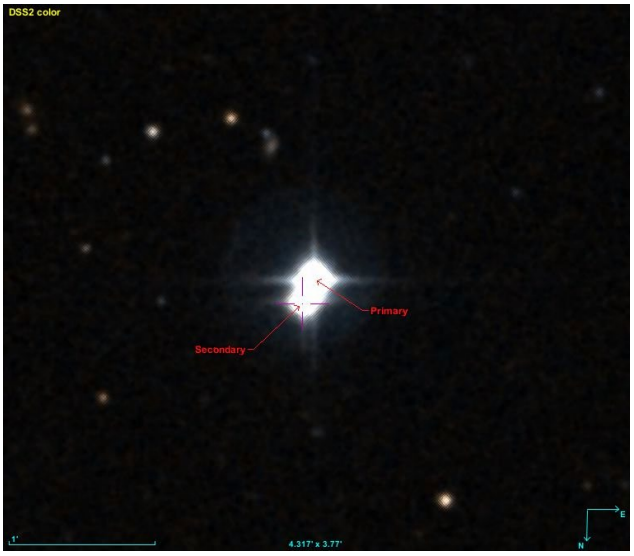

Figure 2: AG 346, as imaged in SDSS and accessed via Aladin 11

Both systems were selected from an initial candidate list generated by Dave Rowe's Double Star Selection Tool based on the following criteria: RA and DEC appropriate to time and location, magnitude of primary and secondary star between 4 and 10, separation between 8" and 100", and a maximum magnitude difference between the primary and secondary star (Δmag) of 3. AG 346 was chosen due to its uncertain nature, and STTA 172 was selected because, although it has been previously described as a physical double, it has not been measured since 2018.

Table 1. Summary of double star system parameters from Stelle Doppie (Sordiglioni, 2023a; Sordiglioni, 2023b).

System	Discover Code	J2000 Coordinates		Magnitudes		Spectral Class	Year Discovered
		RA	Declination	Primary	Secondary		
18445+3400	STTA172	18:44:30.74	33:59:46.1	7.91	8.66	F8	1875
14491+2628	AG346	14:49:4.12	26:27:39.6	9.95	10.40	F5	1895

2. Equipment and Methods

Astrometric images of the targets were collected using equipment from the Dorothy Hill Observatory (The Dorothy Hill Observatory, n.d.), located at the Marrapatta Memorial Outdoor Education Centre near Imbil, Queensland, in Australia. Images were taken using a monochrome FLI CCD equipped with Astrodon Luminance filter and attached to a 356mm Planewave reflecting telescope. The pixel scale of the camera was 0.72"/pixel in 1x1binning mode with a 50' x 50' field of view.

Initial images of varying exposure times were analysed to determine which exposure length gave resolved images that separated the primary and secondary stars while maintaining an acceptable signal-to-noise ratio. Once proper exposure time was determined, 20 images of each target were acquired on the night of June 13, 2022. Table 2 provides a summary of relevant imaging parameters for each target.

Table 2. Summary of relevant imaging parameters.

System	Number of Images	Exposure Length (s)	Capture Start (BJD)	Capture End (BJD)
18445+3400 (STTA 172)	20	10	2459744.09535	2459744.11580
14491+2628 (AG 346)	20	18	2459743.93213	2459743.99625

Acquired images were plate solved and calibrated for flat, dark, and bias via the Our Solar Siblings Pipeline (Fitzgerald, 2018). Astrometric measurements of each target were taken using AstroImage J software (Collins et al, 2017) (see Figures 3 and 4).

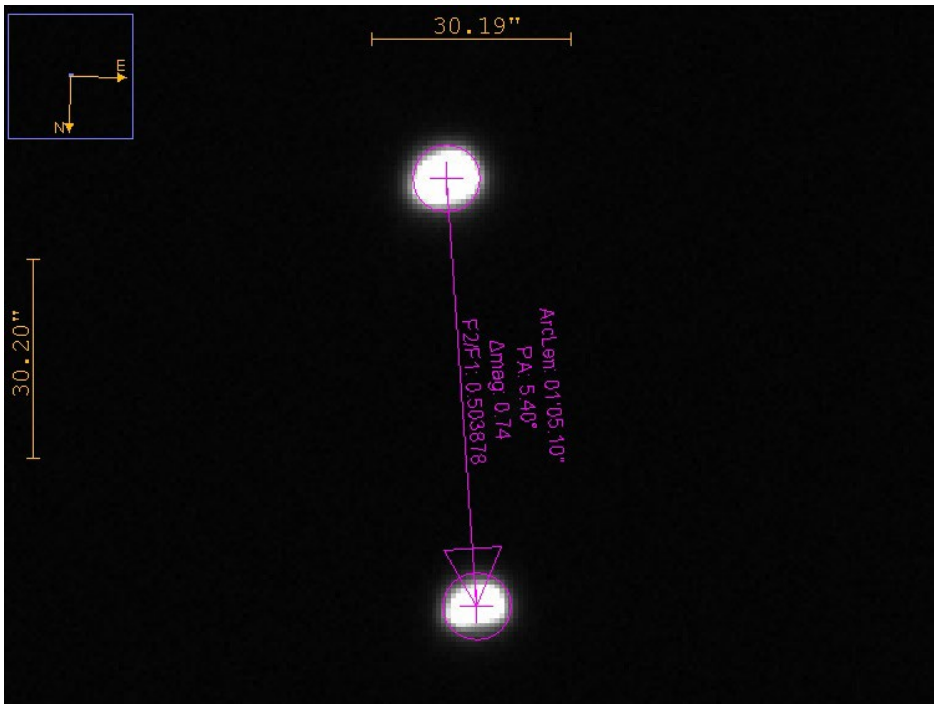

Figure 3: Screen capture of an example measurement taken in AstroImage J for STTA 172

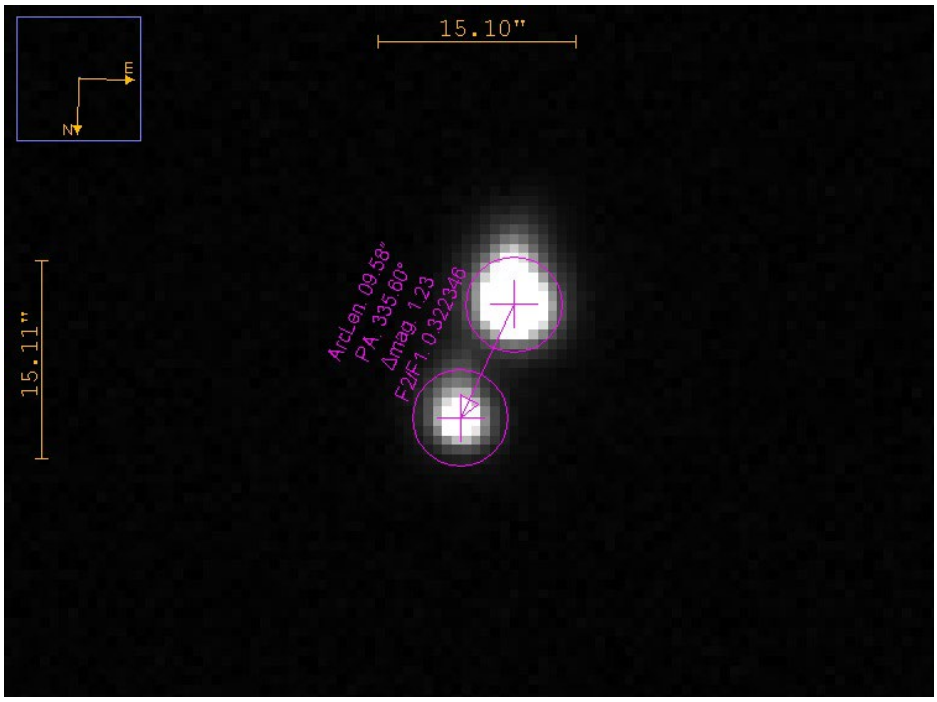

Figure 4: Screen capture of an example measurement taken in AstroImage J for for AG 346

3. Data

Mean position angle (θ) and separation (ρ) measurements for WDS 18445+3400 STTA 172 and WDS 14491+2628 AG 346, derived from the 20 images for each target, are presented in Tables 3 and 4, along with the standard error of the means (SEM).

Table 3. Position angle and separation measurements for WDS 18445+3400 STTA 172.

Date	Mean Position Angle, θ (º)	SEM Position Angle (º)	Mean Separation, ρ (")	SEM Separation (")
2022.4493	5.3	0.00948	65.1	0.022456

Table 4. Position angle and separation measurements for WDS 14491+2628 AG 346.

Date	Mean Position Angle, θ (º)	SEM Position Angle (º)	Mean Separation, ρ (")	SEM Separation (")
2022.4493	335.7	0.0867	9.57	0.0138

Historical data for each target was requested and obtained from the US Naval Observatory. This was plotted with the measurements in Tables 3 and 4 using the Plot Tool (Harshaw, 2020) and can be seen in Figure 5.

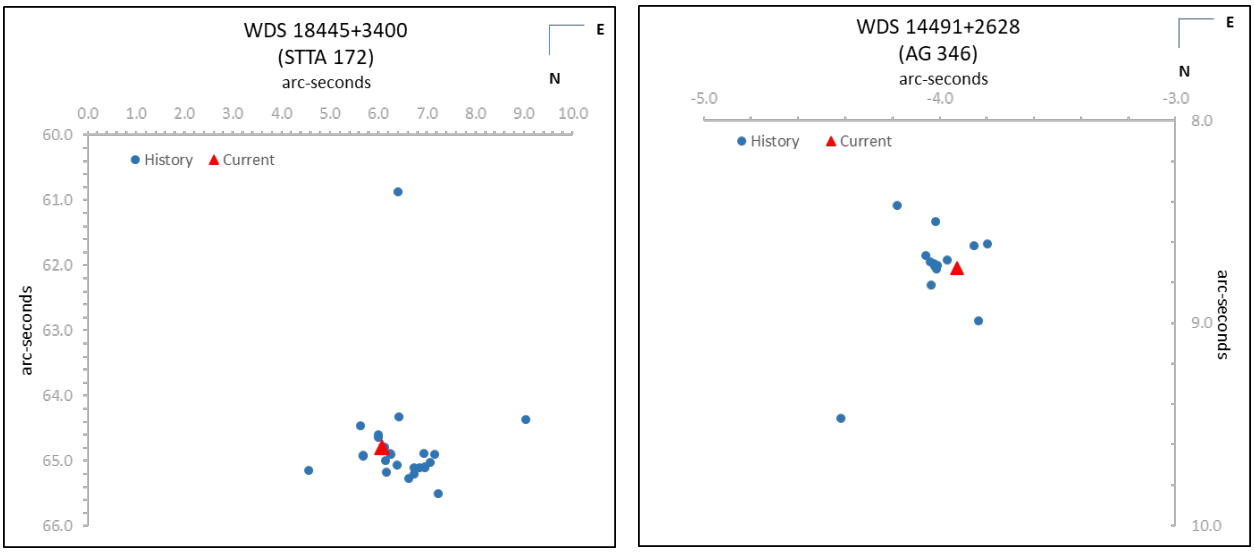

Figure 5: Measurements for WDS 18445+3400 STTA 172 (left) and WDS 14491+2628 AG 346 (right). Blue points (historical) represent the angular distance from the secondary star with the primary star located at the origin. The measurements from this study are plotted as red triangles.

To provide context regarding how these two double star systems have evolved over time, the historical measurements for position angle and separation were plotted in time series graphs in Figures 6 and 7.

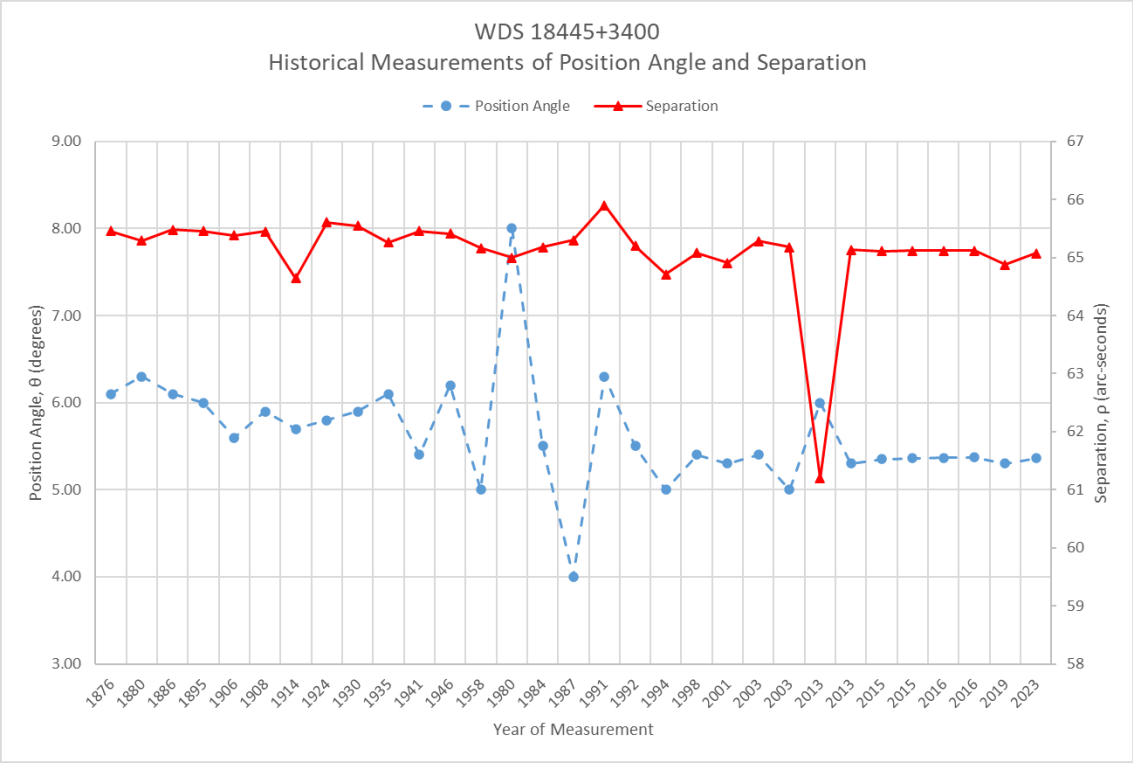

Figure 6: Time series of position angle and separation for WDS 18445+3400 STTA 172

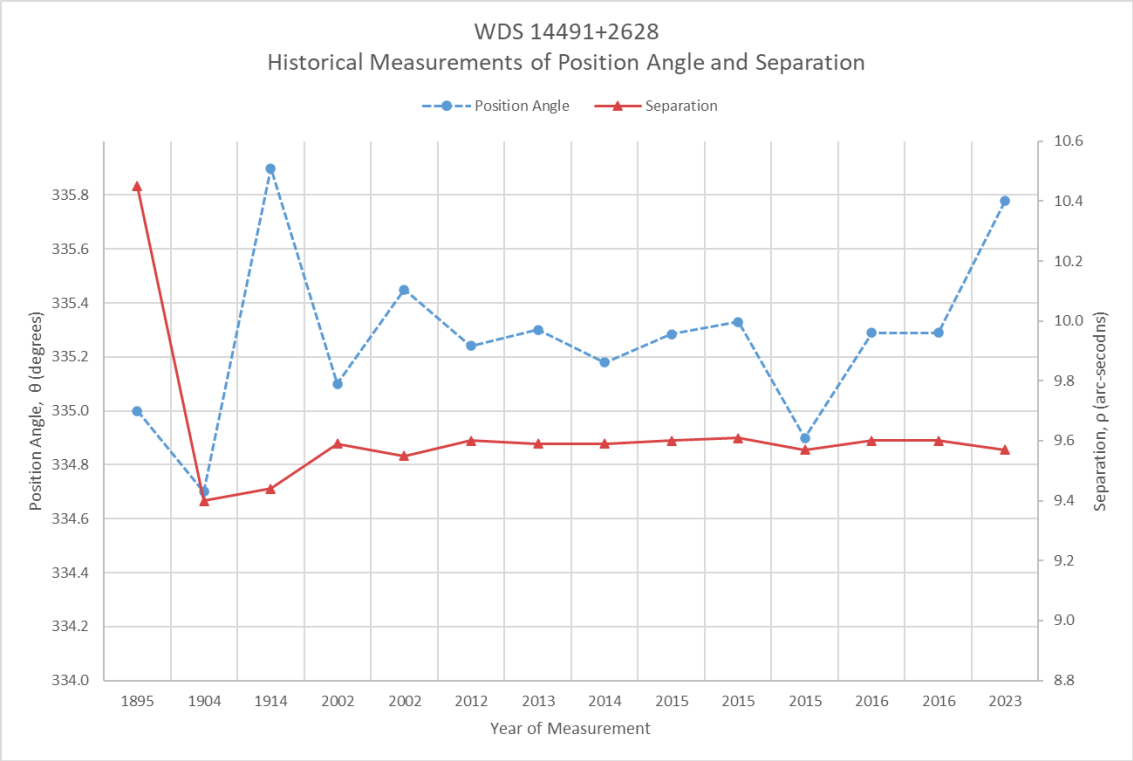

Figure 7: Time series of position angle and separation for WDS 14491+2628 AG 346

In addition, proper motion and parallax measurements were obtained from Gaia DR3 (Gaia Collaboration, et al., 2023k) and are shown in Table 5.

Table 5. Gaia DR3 data for WDS18445+3400 STTA 172 and WDS14491+2628 AG 346, where 'A' designates data for the primary star and 'B' designates data for the secondary star.

Target Name	Proper Motion RA A (mas/yr)	Proper Motion Dec A (mas/yr)	Proper Motion RA B (mas/yr)	Proper Motion Dec B (mas/yr)	Parallax A (mas)	Parallax B (mas)
WDS18445+3400 (STTA 172)	12.82±0.02	-15.57±0.02	12.99±0.02	-18.16±0.02	18.27±0.02	18.25±0.02
WDS14491+2628 (AG 346)	-70.71±0.02	45.94±0.02	-69.08±0.02	45.43±0.02	6.37±0.02	6.40±0.02

4. Discussion

When viewed in the context of historical data, the cluster of points seen in Fig. 5 provides no evidence of any orbital relationship for WDS18445+3400 STTA 172. This lack of orbital trend is also very evident from the plot of historical measurements over time in Fig. 6. Beyond a few outliers, the system exhibits no real increase or decrease of either separation or position angle over time. As the data in Table 5 indicates that the primary and secondary stars in WDS18445+3400 STTA 172 have similar proper motions, although

their proper motions in declination show some difference. Considering this, in addition to the two stars' almost identical parallax, the classification of this double star as a physical double can be supported.

Figure 6 shows no evidence of an orbital relationship for WDS14491+2628 AG 346. This lack of orbital trend is supported by the time series in Figure 7, which shows relatively stable position angle and separation for this system over time. The data in Table 5 shows very similar proper motion and parallax for the primary and secondary stars in this system; therefore, WDS14491+2628 AG 346, whose classification was previously reported as uncertain, can be safely assumed to be a physical double.

In general, the new measurements presented in this report are well aligned with previous measurements of both systems and co-location in space of the primary and secondary stars within each system can be strongly supported.

5. Conclusions

Images of two separate double star targets, WDS18445+3400 STTA 172 and WDS14491+2628 AG 346, were taken using the Dorothy Hill Observatory in Queensland, Australia, and astrometric data from these systems analysed to draw conclusions regarding the nature of these double stars. Historical data for each system was requested from the U.S. Naval Observatory and compared to the measurements of position angle and separation presented in this report. Neither system showed evidence of orbital motion, and this, in combination with nearly identical parallax for primary and secondary stars in each system, leads to the conclusion that WDS18445+3400 STTA 172 and WDS14491+2628 AG 346 are both physical doubles.

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