Measurements of the Position Angle and Separation of the Double Star Systems WDS 15435-5151 HJ 4794, WDS 17007-2725 CVN 100AD, and WDS 19413+2944 SLE 668

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Abstract

We present new measurements of the position angle and separation of three double star systems: 15435-5151 HJ 4794, 17007-2725 CVN 100AD, and 19413+2944 SLE 668. An analysis of our new numbers, alongside the historical measurements of the systems and data from the Gaia mission, led us to believe that 17007-2725 CVN 100AD is likely an optical double, but the others are still of uncertain nature. Radial velocity measurements or improved parallax measurements for these systems in the future should lead to more conclusive results.

1. Introduction

We report new observations of three double stars, along with visualizations of the systems' histories and commentary on astrometric data about them from the Gaia mission. The systems' designations in the Washington Double Star (WDS) catalog are 15435-5151 HJ 4794 (HH Nor), 17007-2725 CVN 100AD, and 19413+2944 SLE 668.

All three systems were selected for seasonal visibility, separations of at least 8", and a total number of prior observations of around a dozen or fewer. Our primary goal was to provide new measurements for systems that haven't been studied extensively already.

HJ 4794 was first measured in 1835 by John Herschel (Herschel 1847). Including the first, there have been 13 observations of the system. CVN 100AD was identified in 2011 by G. Chauvin. (Chauvin 2015) It was also measured using pre-existing 2MASS images dated to 1998 and then observed again in 2015 by Gaia, for only three prior measurements overall. CVN 100 is a quadruple system, but we focus here on the AD pair. SLE 668 had 13 prior observations, spanning 1895 to 2015. Although identified by G. Soulié in 1984 (Soulié 1986), two earlier measurements of SLE 668 were made using pre-existing photographic plates dated to 1895 and 1900. These pre-discovery measurements were made as part of the US Naval Observatory's Astrographic Catalog 2000. (Urban 1998)

2. Equipment and Methods

All of the stars observed in this article were observed with Las Cumbres Observatory's Global Telescope network, using 0.4 meter telescopes containing SBIG 6303 cameras. These cameras have a pixel scale of 0.571 and a field of view of 29′x19′. We used the PanSTARRS-w filter. All image files were processed automatically by the LCO using their BANZAI pipeline.

Figure 1: 0.4 m telescope located at one of Las Cumbres Observatory's sites

Ten images of HJ 4794 and ten images of CVN 100AD were taken from Cerro Tololo Inter-American Observatory on the same day, September 19, 2022. Fifteen images of SLE 668 were taken from McDonald Observatory in Texas on Sep 29, 2022.

Once the images were received, we used *AstroImageJ* to measure the separation and position angle of our systems. We requested historical data for the systems from Dr. Rachel Matson at the Washington Double Star Catalog, and plotted the new and historical measurements together with Richard Harshaw's *Plot Tool*. (Harshaw 2022)

3. Data

Tables 1-3 show the new measurements for each system from our images. The three systems are presented in order of increasing right ascension. Tables 4-6 are summary statistics for our measurements, and tables 7-10 list the systems' historical data sent by the Washington Double Star Catalog. Table 10 shows Gaia data for all three systems.

Figures 2-4 show sample images of each star system in *AstroImageJ*, and finally the *Plot Tool* graphs are shown in figures 5-9. For two of the systems, zoomed-in *Plot Tools* are included for a clearer view of the cluster of measurements.

Table 1. WDS 15435-5151 HJ 4794 measurements.

Position Angle (°)	Separation (″)
148.2	12.42
148.1	12.42
148.2	12.43
148.2	12.42
148.3	12.39
148.1	12.40
148.1	12.40
148.2	12.41
148.3	12.41
148.2	12.38

Table 2. WDS 17007-2725 CVN 100AD measurements.

Position Angle (°)	Separation (″)
49.0	9.52
48.3	9.26
47.7	9.56
47.5	10.09
49.9	9.53
48.5	9.37
47.0	9.62
48.2	9.27
46.8	9.53
48.8	9.26

Table 3. WDS 19413+2944 SLE 668 measurements.

Position Angle (°)	Separation (″)
267.8	10.88
267.8	10.90
267.8	10.90
267.8	10.88
267.9	10.86
268.0	10.87
267.8	10.90
267.9	10.87
267.9	10.91
268.0	10.91
267.8	10.89
267.8	10.89
267.8	10.89
267.9	10.86
267.9	10.87

Table 4. Average, standard deviation, and error values of 15435-5151 HJ 4794.

	Position Angle (°)	Separation (″)
Average	148.2	12.40
Standard Deviation	0.022	0.026
Standard Error of the Mean	0.0070	0.0083

Table 5. Average, standard deviation, and error values of WDS 17007-2725 CVN 100AD.

	Position Angle (°)	Separation (″)
Average	48.18	9.50
Standard Deviation	0.93	0.25
Standard Error of the Mean	0.29	0.079

Table 6. Average, standard deviation, and error values of WDS 19413+2944 SLE 668.

	Position Angle (°)	Separation (″)
Average	267.9	10.89
Standard Deviation	0.077	0.017
Standard Error of the Mean	0.020	0.0044

Table 7. WDS 15435-5151 HJ 4794 historical data sent by the WDS catalog.

Year[1]	Position Angle (°)[1]	Separation (″)[1]
1835.46	147.7	12
1894.53	145.7	12.76
1894.53	151	11.83
1903.52	147.9	12.41
1903.52	146.1	12.9
1917.35	148.2	12.57
1934.38	147.7	12.62
1964.50	147.6	12.58
1991.56	147.8	12.38
1998.414	147.9	12.47
1999.44	147.9	12.53
2010.5	147.9	12.34
2015.0	147.975	12.44

[1] Values given by the WDS catalog with different numbers of decimal places.

Table 8. WDS 17007-2725 CVN 100AD historical data sent by the WDS catalog.

Year[1]	Position Angle (°)[1]	Separation (″)[1]
1998.52	50.8	8.52
2011.547	52.1	8.194
2015.0	48.635	8.980

[1] Values given by the WDS catalog with different numbers of decimal places.

Table 9. WDS 19413+2944 SLE 668 historical data sent by the WDS catalog.

Year[1]	Position Angle (°)[1]	Separation (″)[1]
1895.73	266.9	11.07
1900.69	266.4	11.78
1984.4	266.5	11.05
1997.73	268.5	10.7
2002.465	268	10.95
2007.675	268.2	10.82
2008.732	267.9	10.93
2010.5	267.9	10.42
2012.52	267.98	10.89

2013.51	267.94	10.87
2014.532	267.93	10.89
2015	267.998	10.98
2015.408	268.04	10.9

[1] Values given by the WDS catalog with different numbers of decimal places.

Table 10. Gaia proper motion and parallax data.

	WDS 15435-5151 HJ 4794	WDS 17007-2725 CVN 100AD	WDS 19413+2944 SLE 668
PM RA A (″/yr)	-2	-7	-2
PM Dec A (″/yr)	-5	-29	-4
PM RA B (″/yr)	-5	-8	0
PM Decnation B (″/yr)	-5	0	-3
Parallax A (mas)	1.02	8.03	0.77
Parallax B (mas)	2.22	0.14	0.8222

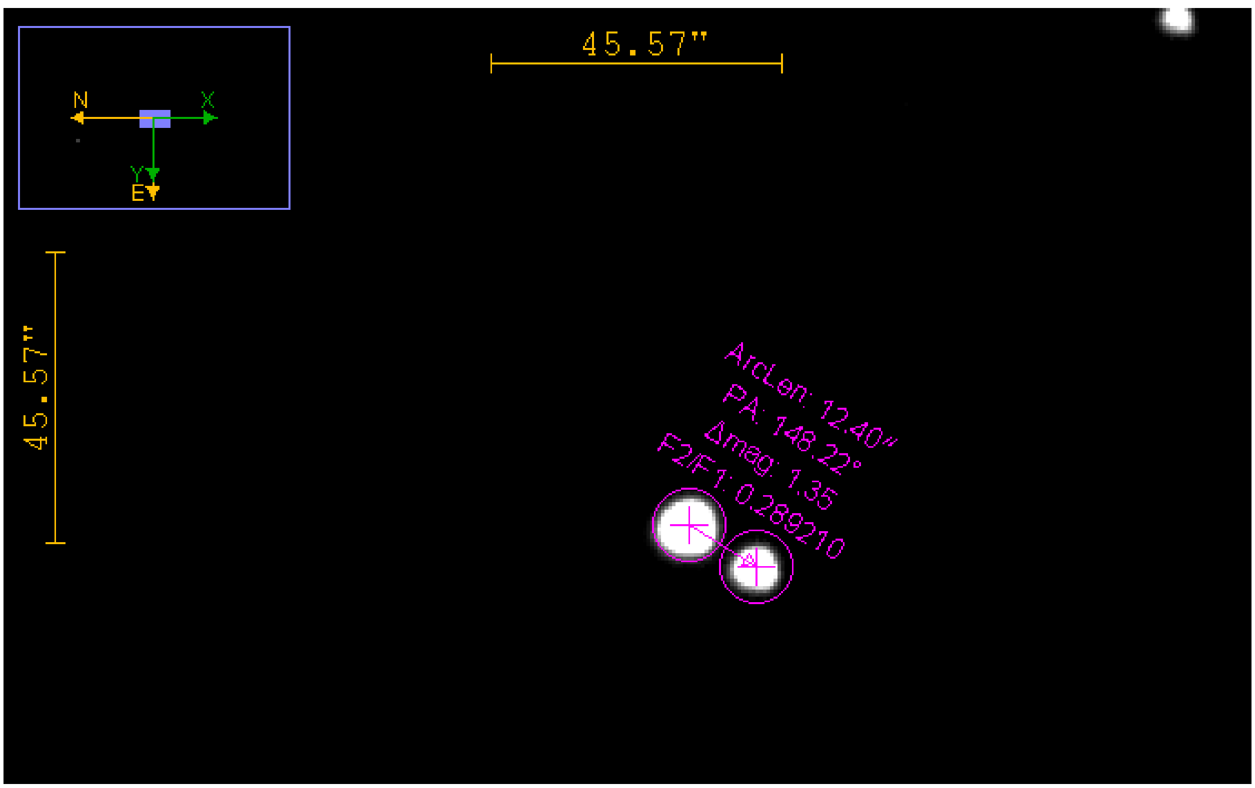

Figure 2: image of WDS 15435-5151 HJ 4794 star system from AIJ

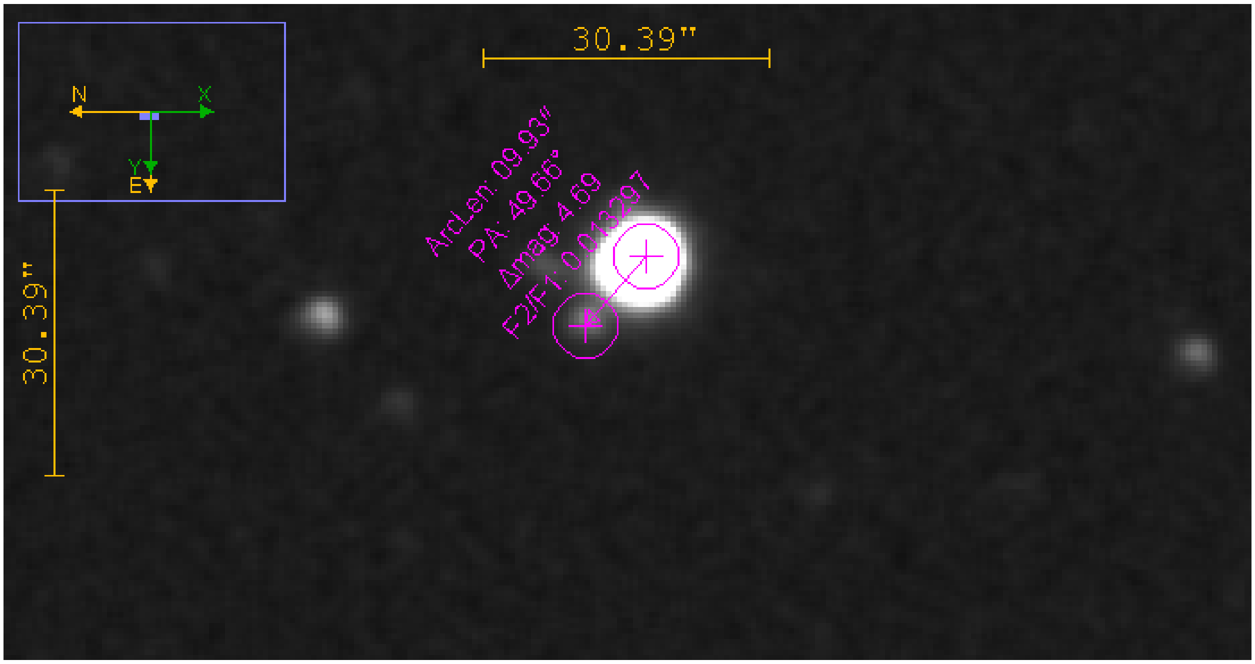

Figure 3: image of WDS 17007-2725 CVN 100AD star system from AIJ

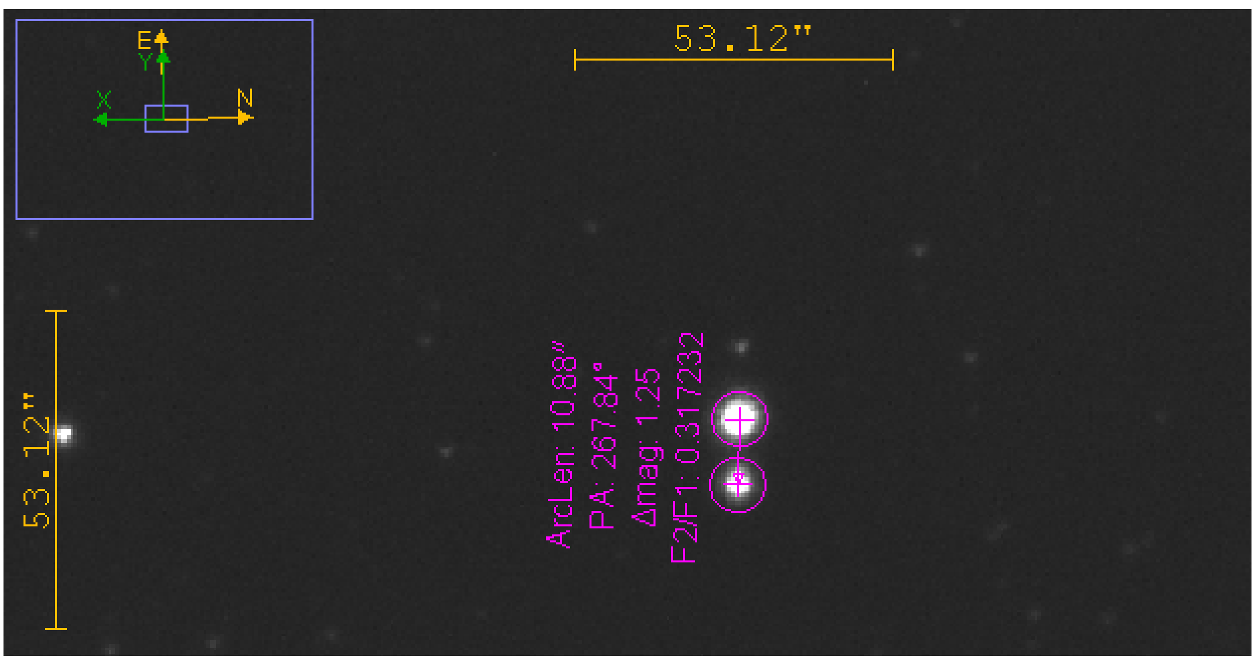

Figure 4: image of WDS 19413+2944 SLE 668 star system from AIJ

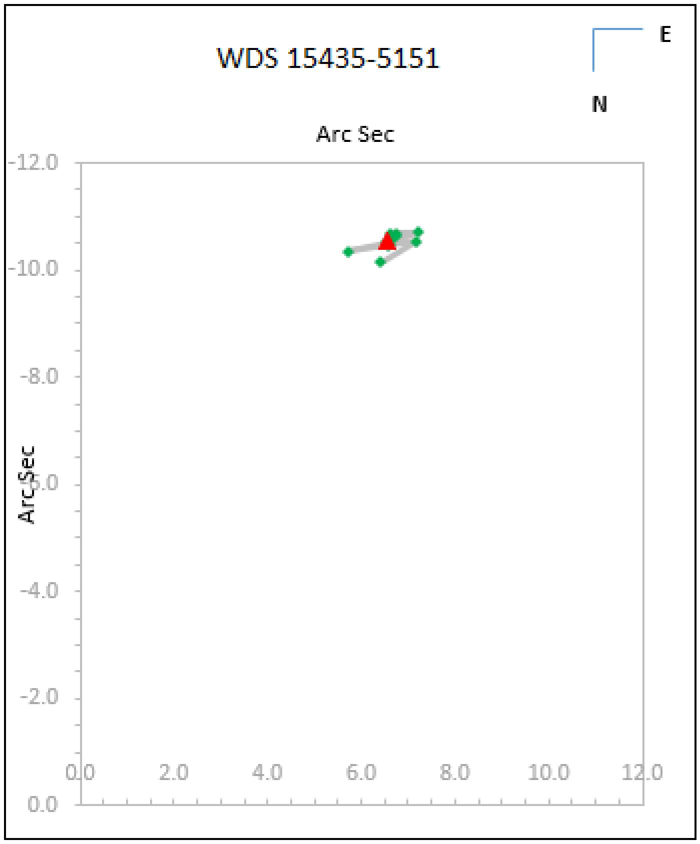

Figure 5: Plot Tool historical motion graph of WDS 15435-5151 HJ 4794

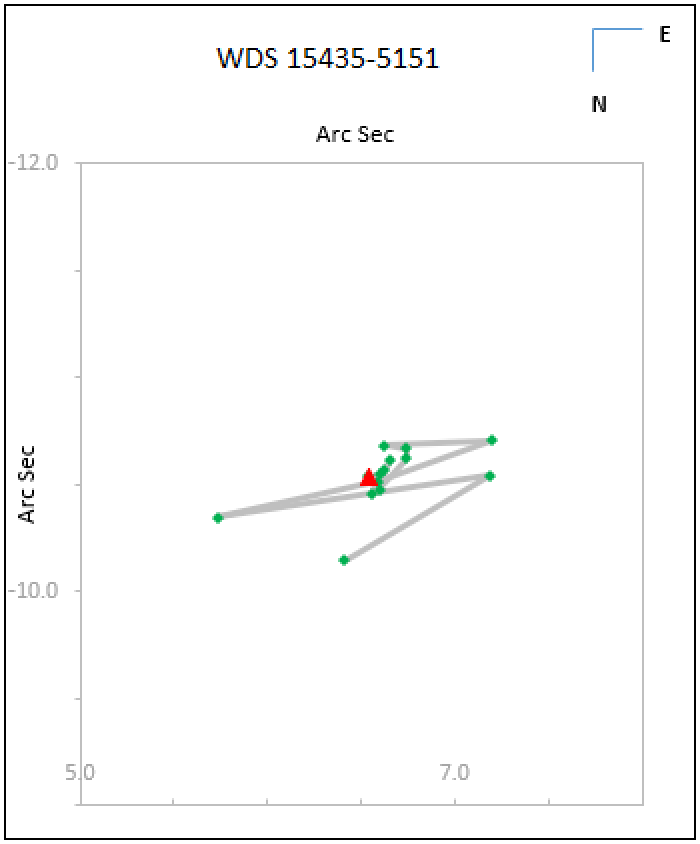

Figure 6: Zoomed-in Plot Tool historical motion graph of WDS 15435-5151 HJ 4794

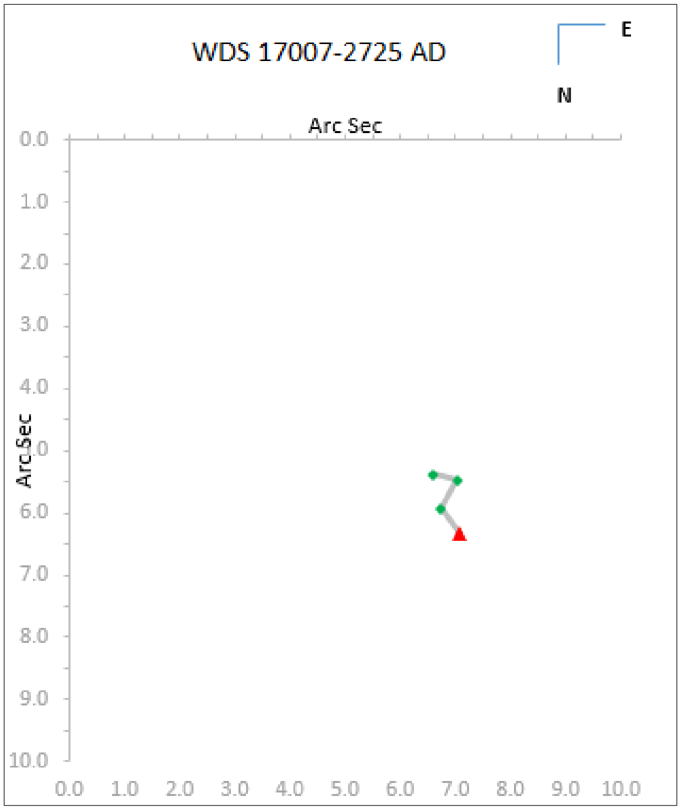

Figure 7: Plot Tool historical motion graph of WDS 17007-2725 CVN 100AD

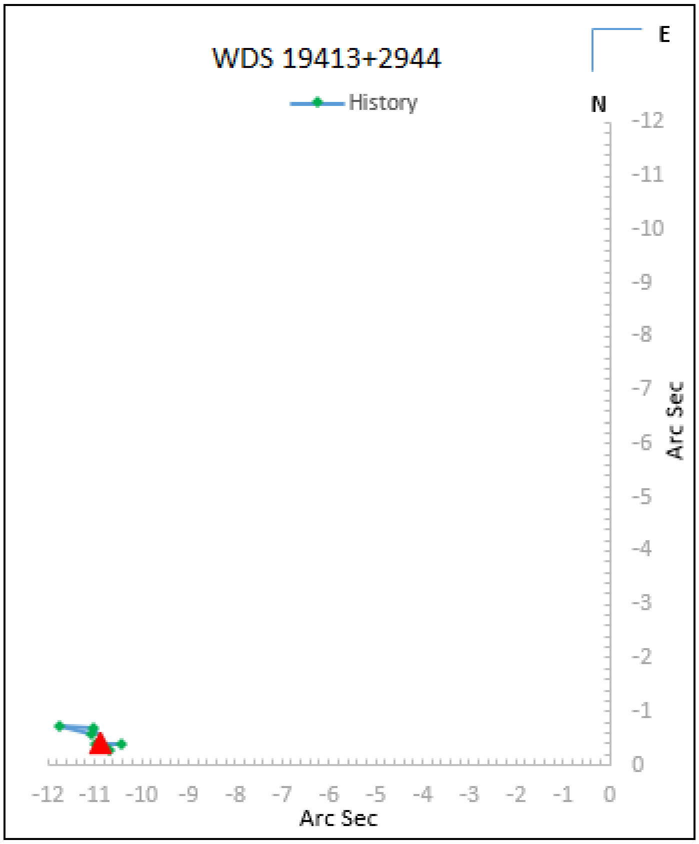

Figure 8: Plot Tool historical motion graph of WDS 19413-2944 SLE 668

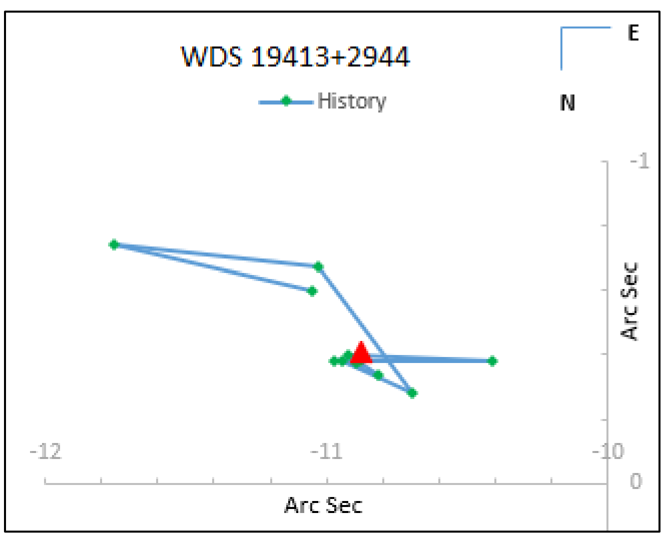

Figure 9: Zoomed-in Plot Tool historical motion graph of WDS 19413-2944 SLE 668

4. Discussion

Our study of WDS 15435-5151 HJ 4794 is inconclusive both in terms of the new measurements and the pre-existing data. The historical observations, taken in order, show an erratic zigzag. Given that this occurs within a span of only around two arcseconds, this is largely attributable to atmospheric effects and general measurement uncertainty. The system's parallax numbers and its proper motion numbers are somewhat at odds. The parallax of star B is nearly double that of star A, lending towards the belief that this is an optical double system, although both parallaxes are quite small–roughly one and two milliarcseconds–and shouldn't be taken entirely at face value. The proper motion numbers, however, are relatively similar and, taken without the parallax, could lead to the possibility that these stars are a physical double. Seeing as they must be taken together though, no real conclusion can be drawn from the current data.

The data gathered for the system WDS 17007-2725 CVN100AD suggest that it is likely not a physical double due to the two parallax numbers being drastically different (8.03 mas and 0.14 mas) along with the somewhat different proper motion values. As seen in the *Plot Tool* graph, the secondary star continues to follow a general northward trend. If this system were to be observed over a longer period of time, a better conclusion could be drawn but because of the substantial differences between the Gaia data, this system is likely optical.

For WDS 19413+2944 SLE 668, similar to HJ 4794, neither the *Plot Tool* visualization nor the Gaia data are conclusive. The new observation of SLE 668 is consistent with historical measurements, which lie in a small region and seem to be dominated by error and uncertainty in measurements rather than true motion of the system. The proper motion and parallax measurements from Gaia are consistent with a physical pair but are far from convincing on their own. Radial velocity values are not available, even in Gaia DR3. As a result, the nature of SLE 668 remains uncertain. Given how slowly the system is moving—less than two arcseconds in over 120 years—there is no need to measure the position angle and separation again any time soon. Refinements in the stars' proper motion and parallax values, as well as radial velocity measurements, may be of use, however.

5. Conclusions

For all three systems, we have presented updated measurements of position angle and separation. In all three cases, these new measurements are consistent with the systems' history, but haven't provided any compelling evidence about their physical or optical nature.

WDS 15435-5151 HJ 4794 and WDS 19413+2944 SLE 668 are move very slowly, but improved proper motion, parallax, and radial velocity data could potentially reveal something new about the systems. Checking future large-scale surveys for data about these star systems may be fruitful.

WDS 17007-2725 CVN100AD, considering the differences in its parallax and proper motion declination values in Gaia DR2, is likely optical.

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