Measurement of Neglected Double Stars as Part of an Observational Astronomy Course

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Abstract: We report on the astrometry of 12 double stars obtained as part of a university observational astronomy course. The nature of most of the systems is undetermined based upon Harshaw's (2018) analysis, so that future monitoring of the systems is warranted.

1. Introduction

The study of double stars offers the opportunity to obtain information about the masses of stars if sufficient observations can be made to provide an orbital solution (e.g. Carroll and Ostlie 2007). Observations of a double star might reveal an elliptical path for the secondary star, which could eventually lead to a solution of an orbit. Such observations can be made with modern CCD detectors by obtaining images of the double and using a plate solution obtained from the position of stars of known position on the image to provide a plate solution and the coordinates of the two stars in the double. The position angle and separation may then be obtained and recorded. Such observations make good projects for beginning astronomy students, and groups such as the Institute for Student Astronomical Research, (Instar 2021) have been successfully doing such projects for many years, and we model these efforts after such programs.

2. Target Selection and Observations

The University of North Alabama (UNA) observatory is in an urban site with poor seeing. Therefore, the double stars are selected to be at least 10 arcseconds apart, brighter than 14th magnitude, in the right ascension range of 18 – 21 hours and from -20 to 10 degrees declination. We also required that the star not have any recorded observations since 1990 so that observations of the stars were needed. Software was written to produce a list of targets listed in the Washington Double Star Catalog (hereafter WDS) that fit our selection criteria. Students were then given the list and could select stars for themselves.

Observations were made with the UNA 0.36m Celestron SCT, with a focal length of 3910mm, with an ST10 CCD, which has a field of view of 13'X 8.8', with a scale of 0.36 "/pixel. The scale was determined from the known focal length of the telescope and the pixel size of 6.8 microns from the manufacturer. We then used the equation

$$S = \frac{206.265\mu}{f}$$

from Birney et al. (2006), where S is the scale in arcseconds per pixel, μ is the pixel size in microns and f is the focal length in millimeters. The plate solutions obtained verify this plate scale. The images were taken unfiltered, with 5 or 10 second exposures, with some adjustment depending upon the brightness of the star. Each star had five images taken of it, which provided multiple measurements of the positions of the components of the double. In addition to the stellar images, bias, dark and flat field images were obtained to calibrate the images, for which MaximDL was used. The historical observations of the double stars were obtained by request to the Naval Observatory database of the Washington Double Star Catalog (Matson 2021).

3. Data Reductions and Results

After the images were calibrated using MaximDL, we used Astrometry.net to obtain plate solutions and then used AstroimageJ to measure the positions of the stars in each system. Table 1 gives our measurements for each system. In Table 1, Column 1 gives the discoverer ID, column 2 gives the position of the primary, column 3 gives the position angle in degrees, column 4 gives the separation in arcseconds, column 5 gives the date in fractions of a year, and column 6 gives the number of nights observed. We discuss individual systems below.

Table 1. Measurements of Double Stars

Star	RA+DEC	PA	SEP	Date	N
TOB275AB	181502-1955	330.267 ± 0.126	20.267 ± 0.050	2020.751	1
TOB275AC	181502-1955	91.232 ± 0.275	23.165 ± 0.143	2020.751	1
TOB 275AD	181502-1955	46.876 ± 0.101	30.298 ± 0.056	2020.751	1
TOB275CF	181503-1955	109.579 ± 0.028	75.510 ± 0.133	2020.751	1
TOB275DE	181503-1955	36.842 ± 0.081	36.289 ± 0.068	2020.751	1
HJ 5507AB	190541-1539	62.677 ± 0.259	45.990 ± 0.165	2020.756	1
ARA1564	19104-2118	146.258 ± 0.165	15.144 ± 0.054	2020.773	1
ARA2234	18314-2259	325.874 ± 0.167	13.203 ± 0.049	2020.773	1
B2860A,BC	181507-2503	52.458 ± 0.010	26.406 ± 0.021	2020.773	1
HJ 1373	19134-1803	246.190 ± 1.18	7.377 ± 0.155	2020.795	1
SLV 7BD	181338-2104	330.930 ± 0.220	40.782 ± 0.153	2020.797	1
SLV 7BE	181338-2104	105.907 ± 0.098	64.441 ± 0.094	2020.797	1
SEE 390	193953-2100	75.074 ± 0.235	15.819 ± 0.056	2020.800	1
J 1623	181447-1939	29.264 ± 1.082	5.692 ± 0.399	2020.800	1
ARA1850	181126-2205	286.707 ± 0.211	8.380 ± 0.232	2020.800	1
LDS 697	195910-2155	314.584 ± 0.031	41.723 ± 0.043	2020.800	1
ARA 455	18093-1827	96.880 ± 0.029	11.517 ± 0.057	2020.825	1

Notes on Individual Systems

WDS 18150-1955 (TOB 275)

WDS 18150-1955 (TOB 275) was observed with ten 10-second unfiltered exposures. WDS 18150-1955 (TOB 275) has six components which lead to some ambiguity in identifying the individual stars. We provide a finder chart for the system in Figure 1. We obtained relative positions of components AB, AC, AD, CF and DE as done in the WDS.

There are 18 measurements of the relative position of WDS 18150-1955 (TOB 275AB) from 1830.54 to 2020. We give the historical measurements of WDS 18150-1955 (TOB 275AB) in Table 2 and plot the measurements in Figure 2. For WDS 18150-1955 (TOB 275AB) we find average separation, ρ = 20.267 ± 0.050" and position angle, θ = 330.267 ± 0.1256°. This agrees well with the last recorded values from 2018.433 (Mason, Williams and Josties 2021), [ρ=20.129 ± 0.474" and θ = 331.2 ± 2.6°]. There does not appear to be any clear change in relative position of the two stars.

There were five previous measurements of WDS 18150-1955 (TOB 275AC) given in Table 3 and plotted along with our data in Figure 3. We find separation, ρ = 23.166 ± 0.143" and position angle, θ = 91.232 ± 0.275°, which agrees with the last recorded values [ρ = 91.5 ± 0.1" and θ =

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23.480 ± 0.270° from 2018.433; Mason, Williams and Josties 2021]. There is little change in relative position on the 23 years covered by the measurements.

For WDS 18150-1955 (TOB 275AD) we find separation, ρ = 30.298 ± 0.056" and position angle, θ = 46.876 ± 0.101°. The values from 2018.433 are ρ = 30.430 ± 0.350" and θ = 47.7 ± 0.1°. The measurement of WDS 18150-1955 [TOB 275AD] span the period from 1922.78 to 2020, with seven measurements in all, given in Table 4 and shown in Figure 4. There appears to be a trend for the stars to be getting closer together, but with little change in position angle.

For WDS 18150-1955 (TOB 275CF) we find separation, ρ = 75.510 ± 0.133" and position angle, θ = 109.579 ± 0.029°. The previous values from Mason, Williams and Josties (2021) are ρ = 75.46 ± 0.020" and θ = 109.7°. There are only five measurements of WDS 18150-1955 [TOB 275CF], from 1987.561 to 2020. We show these in Table 5. There is no change in relative position of the stars.

For WDS 18150-1955 (TOB 275DE) we find ρ = 36.289 ± 0.068" and θ = 36.842 ± 0.081° compared to ρ = 35.865 ± 0.412" and θ = 37.1 ± 0.1° from Mason, Williams and Josties (2021). We show the data for WDS 18150-1955 (TOB 275DE) in Figure 5 and represent the data in Table 6. The first data point from 1987 seems discrepant, with little change seen in the relative positions from other measurements.

Table 2. Measured positions of WDS 18150-1955 (TOB 275AB)

Year	PA	SEP
1879.41	331.0	21.32
1880.42	332.3	20.47
1880.59	332.6	20.30
1890.53	331.0	20.18
1912.54	331.4	20.30
1917.41	331.5	20.178
1918.34	331.4	20.50
1919.27	330.7	20.850
1922.78	329.4	20.587
1987.561	331.2	20.02
1991.84	330.7	20.28
1999.40	330.8	20.25
1999.589	330.8 ± 0.1	20.282 ± 0.008
2005.426	331.0	19.75
2017.494	331.3 ± 0.1	20.214 ± 0.089
2018.433	331.433 ± 2.6	20.129 ± 0.474
2020.751	330.267 ± 0.126	20.267 ± 0.050

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Table 3. Measured positions of WDS 18150-1955 (TOB 275AC)

Year	PA	SEP
1987.561	90.0	23.13
1999.40	90.6	23.37
1999.589	90.7	23.329 ± 0.021
2017.494	90.6 ± 0.1	23.211 ± 0.102
2018.433	91.5 ± 0.1	23.480 ± 0.270
2020.751	91.232 ± 0.275	23.165 ± 0.143

Table 4. Measured positions of WDS 18150-1955 (TOB 275AD)

Year	PA	SEP
1922.78	46.7	31.586
1987.561	47.5	33.46
1999.40	46.7	31.03
1999.589	46.8 ± 0.0	30.974 ± 0.008
2017.494	47.5 ± 0.1	30.625 ± 0.135
2018.433	47.7 ± 0.1	30.430 ± 0.350
2020.751	46.876 ± 0.101	30.298 ± 0.056

Table 5. Measured positions of WDS 18150-1955 (TOB 275CF)

Year	PA	SEP
1987.561	109.6	75.84
1999.40	109.7	75.38
1999.5119	109.7	75.44
1999.589	109.7	75.416 ± 0.020
2020.751	109.79±0.028	75.510 ± 0.133

Table 6. Measured positions of WDS 18150-1955 (TOB 275DE)

Year	PA	SEP
1987.561	34.3	32.93
1999.40	36.7	35.68
1999.509	36.8	35.74 ± 0.04
1999.589	36.7	35.719 ± 0.011
2017.494	37.2	35.848 ± 0.158
2018.433	37.1 ± 0.1	35.856 ± 0.412
2020.751	36.842 ± 0.081	36.289 ± 0.068

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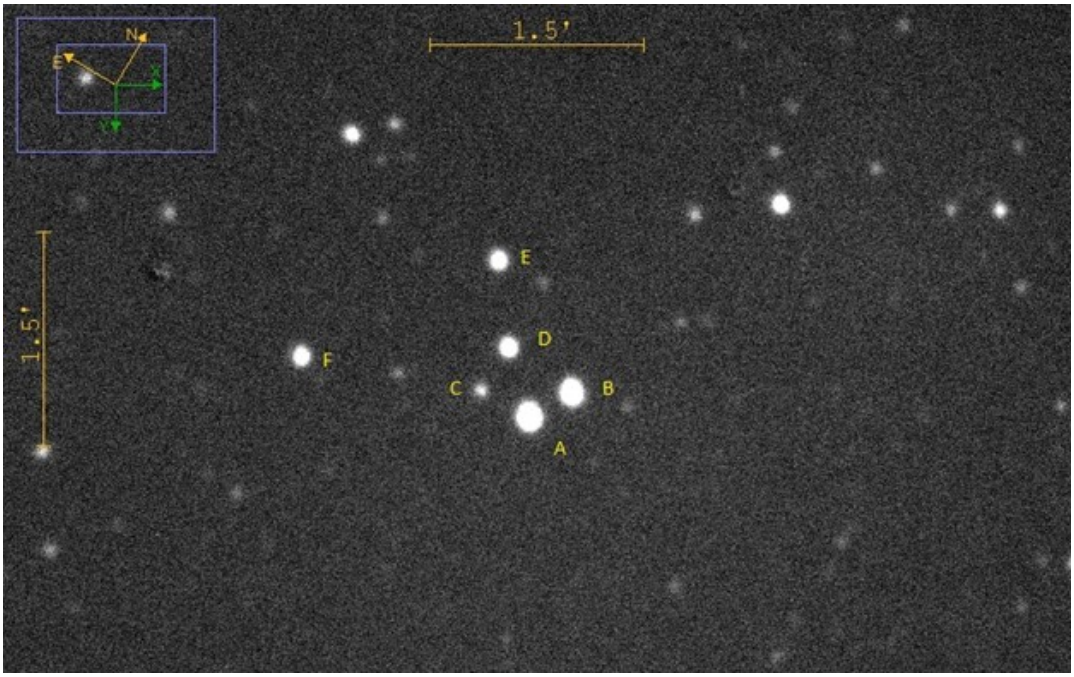

Figure 1. Finder chart from AstroimageJ identifying the components of WDS 18150-1955 (TOB 275).

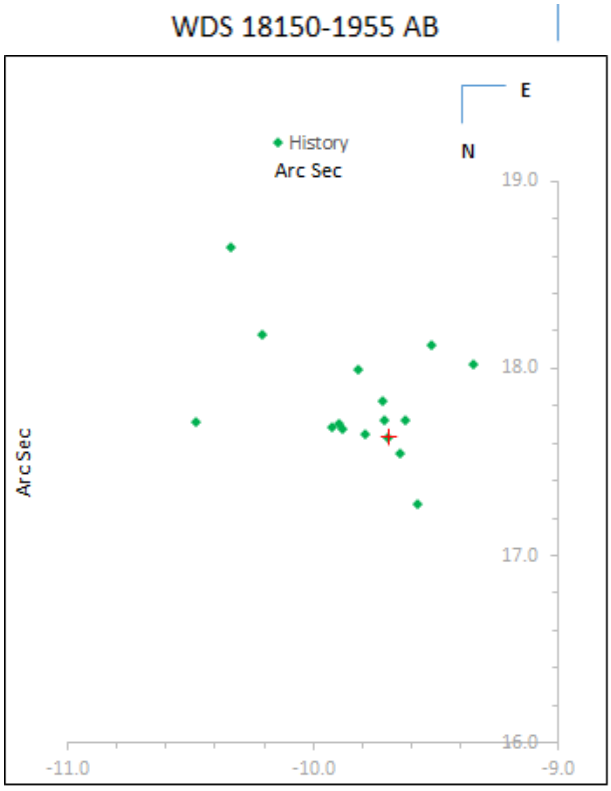

Figure 2. A plot of all measurements of WDS 18150-1955 (TOB 275AB). There does not seem to be any orbital motion detected.

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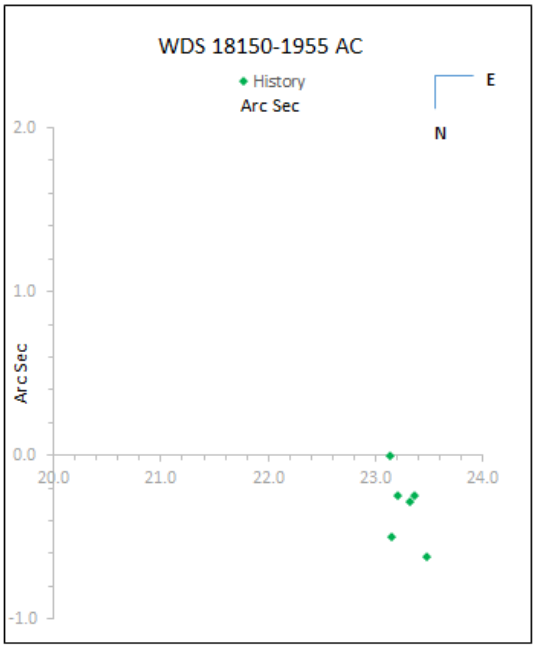

Figure 3. A plot of the recorded measurements of WDS 18150-1955 (TOB 275AC). Once again, there seems to be little change in the relative position of the stars.

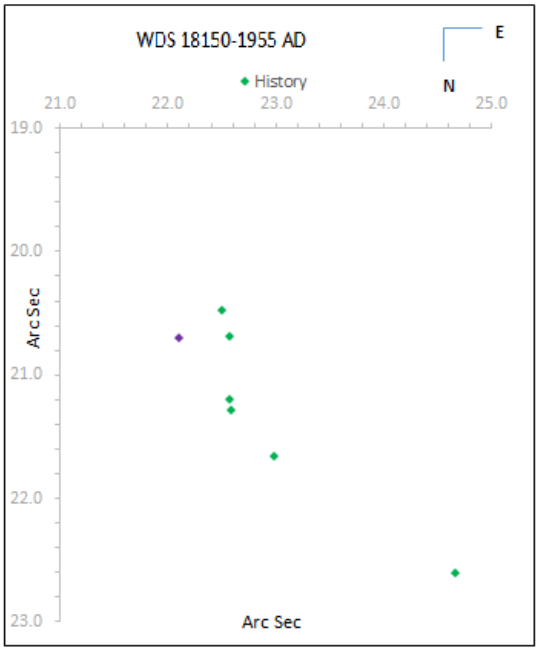

Figure 4. A plot of the historical measurements of WDS 18150-1955 (TOB 275AD). There appears to be a trend for the two stars to be moving closer together with little change in position angle.

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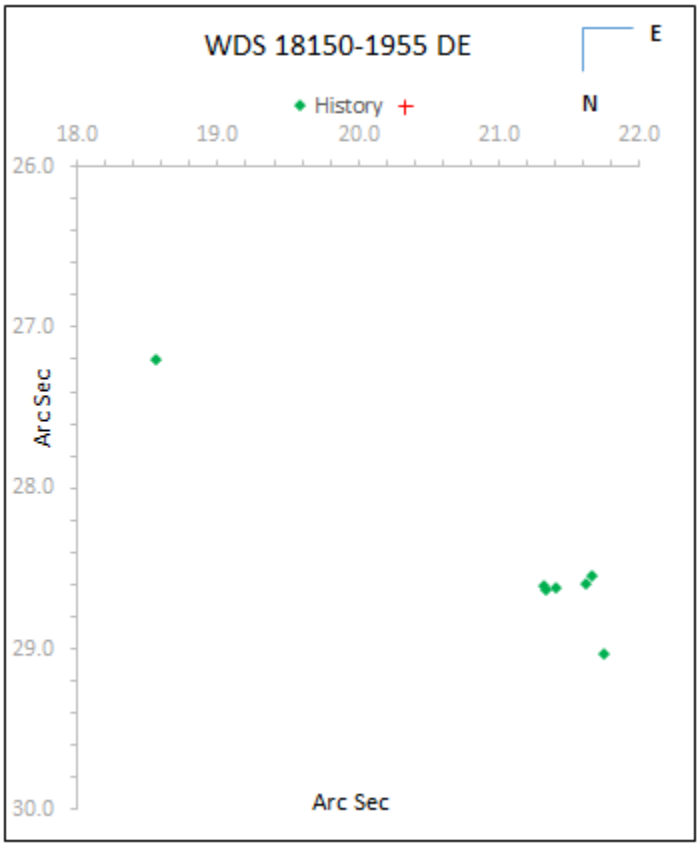

Figure 5. A plot of the historical measurements of WDS 18150-1955 (TOB 275DE).

WDS19057-1540 (HJ 5507AB)

Five 0.5 second unfiltered exposures were obtained of WDS19057-1540 (HJ 5507AB). We find average separation ρ = 45.990 ± 0.165" and average position angle θ = 62.677 ± 0.259°. Three previous measurements exist, spanning the years from 1900.92 (Burnham 1903) to 2000.327, (Hartkopf et al 2013), as supplied by Matson (2021). We give the measurements for WDS19057-1540 (HJ 5507AB) in Table 7 and plot the measurements in Figure 6 shows a plot of the measurements along with the historical data. There is little change in relative position in 20 years.

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Table 7. Historical measurements of WDS19057-1540 (HJ 5507AB)

Year	PA	SEP
1987.561	109.6	75.84
1999.40	109.7	75.38
1999.5119	109.7	75.44
1999.589	109.7	75.416 ± 0.020
2020.751	109.79±0.028	75.510 ± 0.133

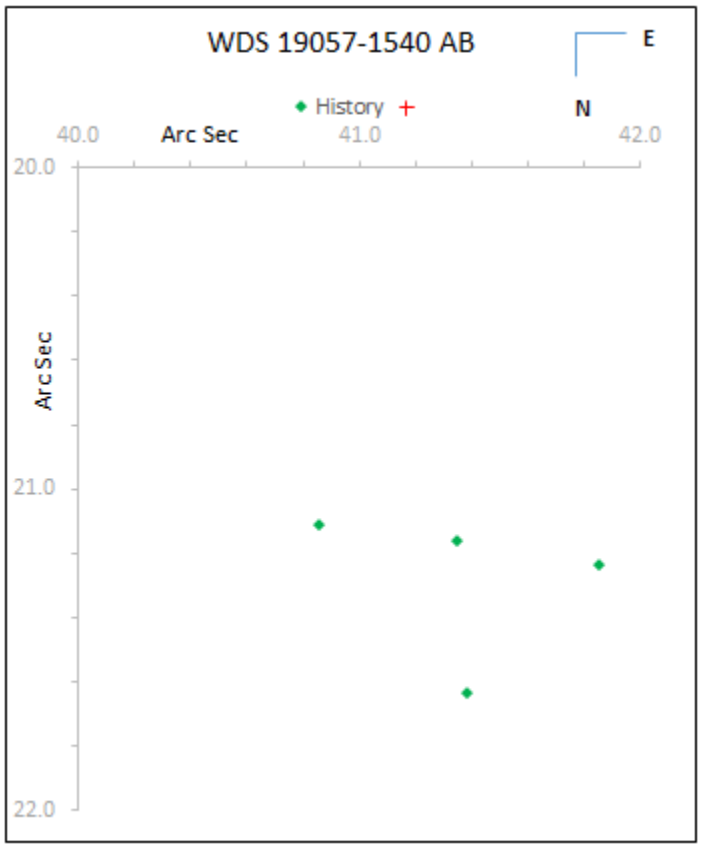

Figure 6. A plot of the measurements of WDS19057-1540 (HJ 5507AB). No systemic change is seen.

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WDS 19104-2118 (ARA1564)

WDS 19104-2118 (ARA1564) yielded an average ρ = 15.144 ± 0.054" and θ = 146.258 ± 0.165°. There are ten previous measurements spanning the years between 1920.75, (Urban et al. 1998), and 2015.0, (Knapp and Nanson 2018). Figure 7 shows a plot of our measurements combined with the historical data which are given in Table 8. Knapp & Nanson (2018) obtained θ = 145.781° and ρ = 14.864".

Table 8. Historical measurements of WDS 19104-2118 (ARA1564)

Year	PA	SEP
1920.75	145.4	14.233
1921.76	145.8	14.40
1921.76	142.7	14.202
1922.78	146.2	14.557
1999.51	145.3	14.67
1999.67	145.7 ± 0.5	14.757 ± 0.072
2000.323	146.3 ± 0.4	15.013 ± 0.141
2013.716	145.73 ± 0.20	14.860 ± 0.053
2014.679	145.92 ± 0.20	14.884 ± 0.053
2015.0	145.781	14.864
2020.773	146.258 ± 0.165	15.144 ± 0.054

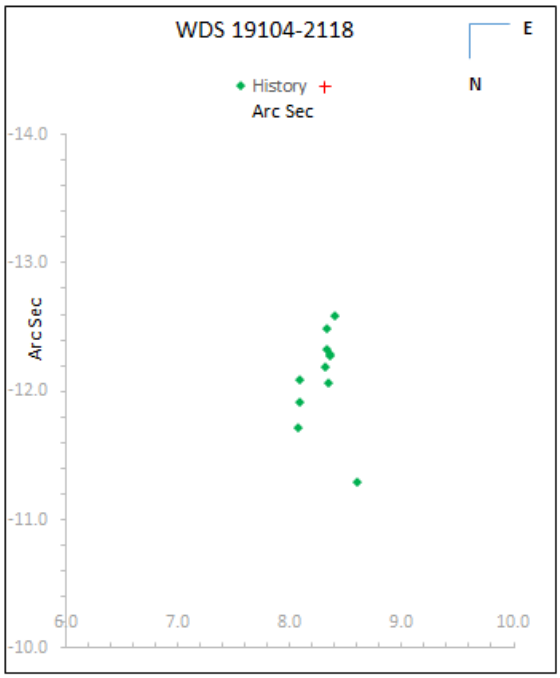

Figure 7. A plot of the relative position of WDS 19104-2118 (ARA1564) showing the historical measurements.

WDS 18314-2259 (ARA2234)

We obtained five 10 second unfiltered images of WDS 18314-2259 (ARA2234). We find an average ρ = 13.203 ± 0.049" and θ = 325.874 ± 0.167°. There are 11 previous measurements (Matson 2020), given in Table 9 along with our measurement. Figure 8 shows a plot of our measurements along with the historical data. There seems to be a trend towards the separation increasing as the position angle increases, with the exception of the 1910.66 measurement.

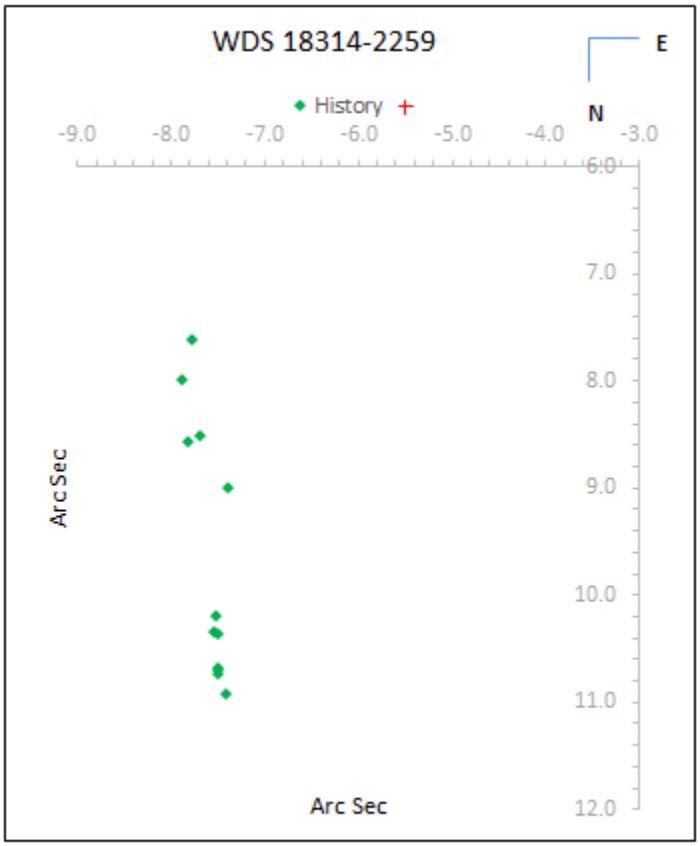

Figure 8. Plot of the historical observations of WDS 18314-2259 (ARA2234).

Table 9. Historical observations of WDS 18314-2259 (ARA2234).

Year	PA	SEP
1910.66	320.6	11.656
1921.35	315.4	11.22
1921.36	314.4	10.875
1928.30	317.9	11.46
1928.30	317.6	11.611
1991.54	323.6	12.67
1999.51	324.1	12.78
1999.555	323.9 ± 0.1	12.805 ± 0.013
2010.5	325.0 ± 0.6	13.06 ± 0.14
2013.716	324.96 ± 0.38	13.053 ± 0.090
2015.0	325.056	13.099
2020.773	325.874 ± 0.167	13.203 ± 0.049

WDS18151-2503 (B 2860A,BC)

WDS18151-2503 (B 2860A,BC) was observed on Oct 8th, 2020. The double has three components in the WDS but we are unable to resolve B and C, so that we measured the relative positions of Star A and BC. We found an average separation of ρ = 26.406 ± 0.021" and average position angle of θ = 52.458 ± 0.010°.

There are five previous measurements, given in Table 10, the most recent value being from 2000.74, (2MASS 2003), with a value of 52.0° and 26.42" for position angle and separation, respectively. Figure 9 shows a plot of the historical measurements along with our values. The stars appear to be getting closer with time with little change in position angle.

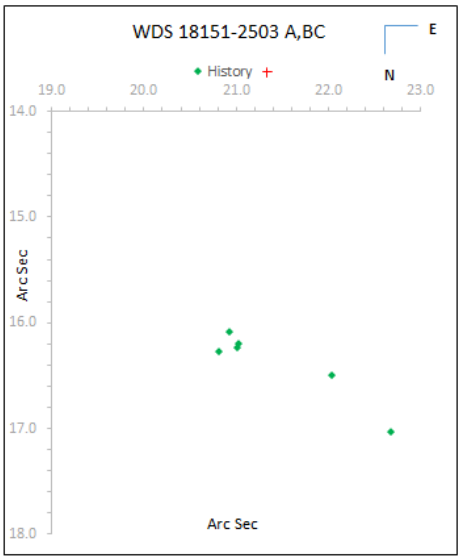

Figure 9. A plot of the historical data for WDS18151-2503 (B 2860A,BC).

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Table 10. The historical data for WDS18151-2503 (B 2860A,BC).

Year	PA	SEP
1911.58	53.1	28.362
1912.52	53.2	27.535
1991.87	52.3	26.551
1999.454	52.4 ± 0.2	26.541 ± 0.041
2000.74	52.0	26.42
2020.773	52.458 ± 0.010	26.406 ± 0.021

WDS19134-1803 (HJ 1373)

WDS19134-1803 (HJ 1373) was observed on the night of October 16, 2020. We obtained an average separation of ρ = 7.377 ± 0.155 and average position angle of θ = 246.190 ± 1.18. There are 14 previous measurements. Figure 10 shows a plot of the relative position measurements of WDS19134-1803 (HJ 1373) which are given in Table 11. Harshaw (2018) concludes that this is a physical system, and so the changes may represent orbital motion, making it important to continue monitoring this system.

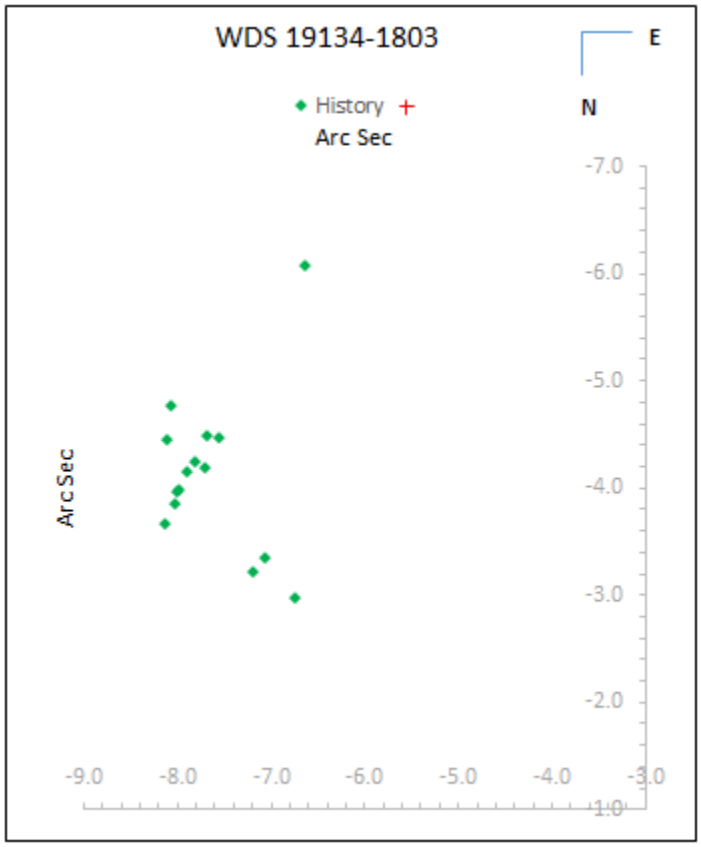

Figure 10. A plot of the historical data for WDS19134-1803 (HJ 1373).

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Table 11. The historical data for WDS19134-1803 (HJ 1373).

Year	PA	SEP
1828	227.5	9.
1879.48	241.2	9.26
1879.53	239.4	9.38
1880.44	242.2	8.92
1910.903	241.5	8.90
1912.56	241.5	8.77
1917.39	243.7	8.94
1917.39	244.4	8.919
1917.39	243.4	8.920
1917.86	245.7	8.93
1918.81	239.4	8.78
1918.81	239.7	8.902
1998.48	245.9	7.87
1999.63	244.6 ± 0.0	7.826 ± 0.016
2020.795	246.190 ± 1.18	7.377 ± 0.155

WDS18138-2104 (SLV 7BD,BE)

We obtained five 5 second unfiltered exposures of WDS18138-2104 (SLV7) on the night of October 17, 2020. We found an average separation of ρ = 40.782 ± 0.153" and position angle of θ= 330.930 ± 0.220° for star D relative to star B, and an average separation of ρ = 64.441 ± 0.094" and position angle of θ = 105.907 ± 0.098° for star E relative to star B.

There are 12 historical observations from 1830.57, (Hershel 1833), to 1998.41 (2MASS 2003). We give the historical measurements bot both in Tables 12 and 13 and plot these along with our measurement in Figures 11 and 12. In both cases the measurements from 1830.57 and 1835.58 are very different from the more modern measurements.

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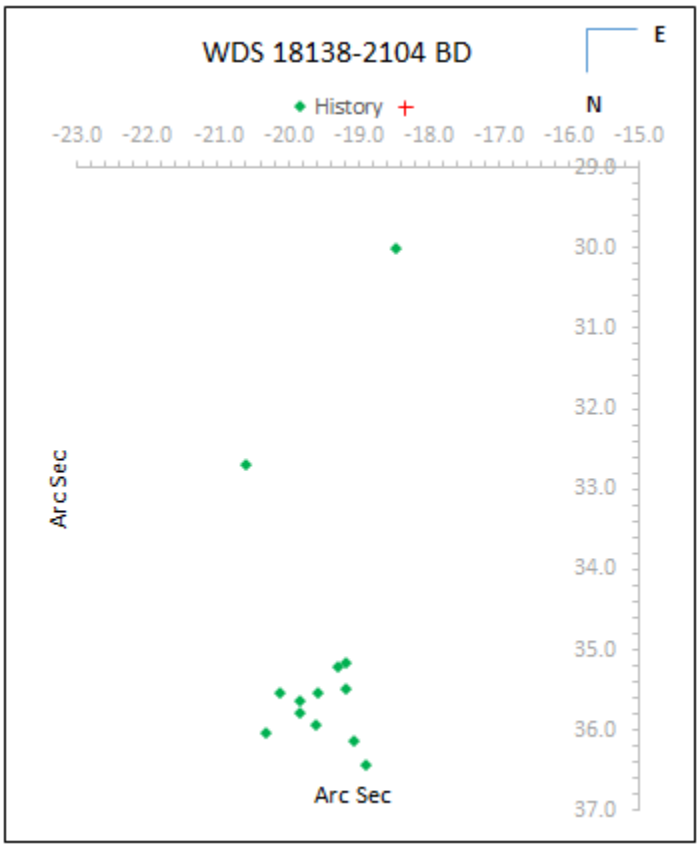

Figure 11. A plot of the historical data for WDS18138-2104 (SLV7BD).

Table 12. The historical data for WDS18138-2104 (SLV7BD)

Year	PA	SEP
1830.57	327.8	38.65
1835.58	328.4	35.23
1879.37	331.4	40.93
1892.56	332.6	41.04
1892.72	330.6	41.36
1901.57	332.2	40.86
1909.51	331.6	40.34
1919.27	331.3	40.140
1920.30	331.4	40.041
1923.28	330.5	40.820
1968.551	331.14	40.577
1998.41	331.0	40.92
2020.797	330.930 ± 0.220	40.782 ± 0.153

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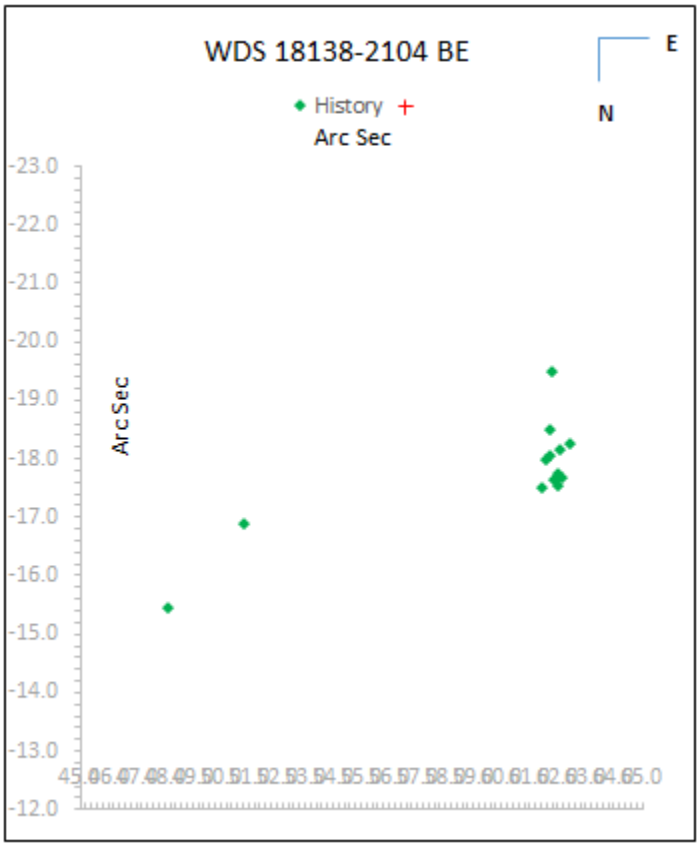

Figure 12. A plot of the historical data for WDS18138-2104 (SLV7BE).

Table 13. The historical data for WDS18138-2104 (SLV7BE)

Year	PA	SEP
1830.57	107.8	50.52
1835.58	108.4	53.54
1879.37	106.3	64.13
1892.56	106.7	64.41
1892.57	105.9	63.86
1901.57	105.9	64.36
1909.51	106.3	65.02
1919.27	106.3	64.718
1920.30	107.5	64.828
1923.28	106.3	64.275
1968.551	105.95	64.523
1998.41	105.8	64.43
2015.0	105.876	64.628
2020.797	105.907 ± 0.098	64.441 ± 0.094

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WDS 19399-2100 (SEE 390)

WDS 19399-2100 (SEE 390) was observed on the night of October 18, 2020. We found an average separation of ρ = 15.819 ± 0.056" and position angle of θ = 75.074 ± 0.235°. We plot our data along with the historical data supplied by Matson (2021) in Figure 13. The observations span a time form 1897.75, (See 1898), and 2020 and are given in Table 14. The position angle seems to be decreasing with a relatively constant separation.

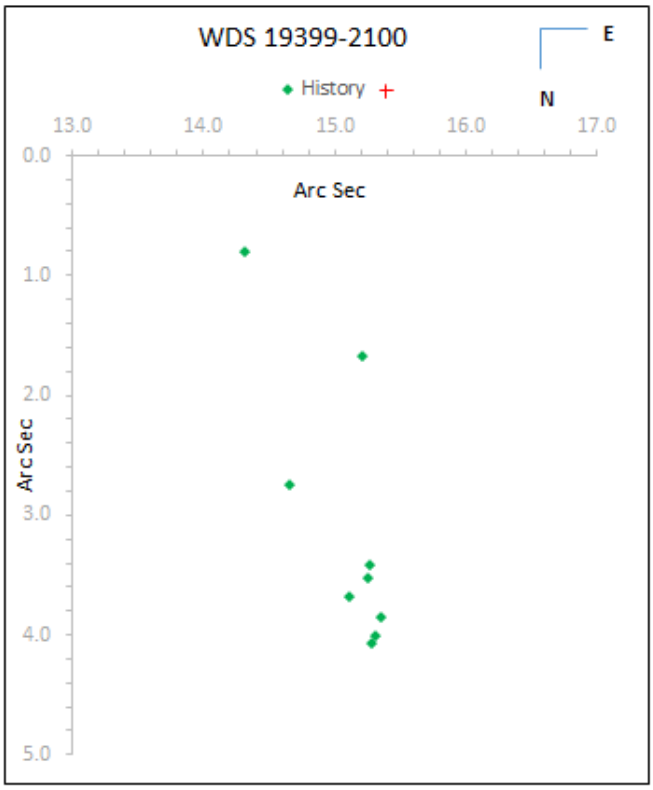

Figure 13. A plot of the historical data for WDS 19399-2100 (SEE 390).

Table 14. The historical data for WDS 19399-2100 (SEE 390).

Year	PA	SEP
1897.75	83.7	15.3
1899.72	86.8	14.34
1954.65	79.4	14.91
1998.41	76.3	15.55
1999.597	77.4 ± 0.7	15.646 ± 0.030
2000.457	77.0 ± 0.5	15.653 ± 0.021
2010.5	75.9 ± 0.6	15.83 ± 0.15
2015.0	75.338	15.831
2020.800	75.074 ± 0.235	15.819 ± 0.056

WDS 18147-1939 (J 1623)

We obtained five 20 second unfiltered exposures of WDS 18147-1939 (J 1623) on the night of Oct 18, 2020. We found an average separation of ρ = 5.692 ± 0.399" and average position angle of θ = 29.264 ± 1.082°. Figure 14 shows a plot of the four historical measurements, which are given in Table 15.

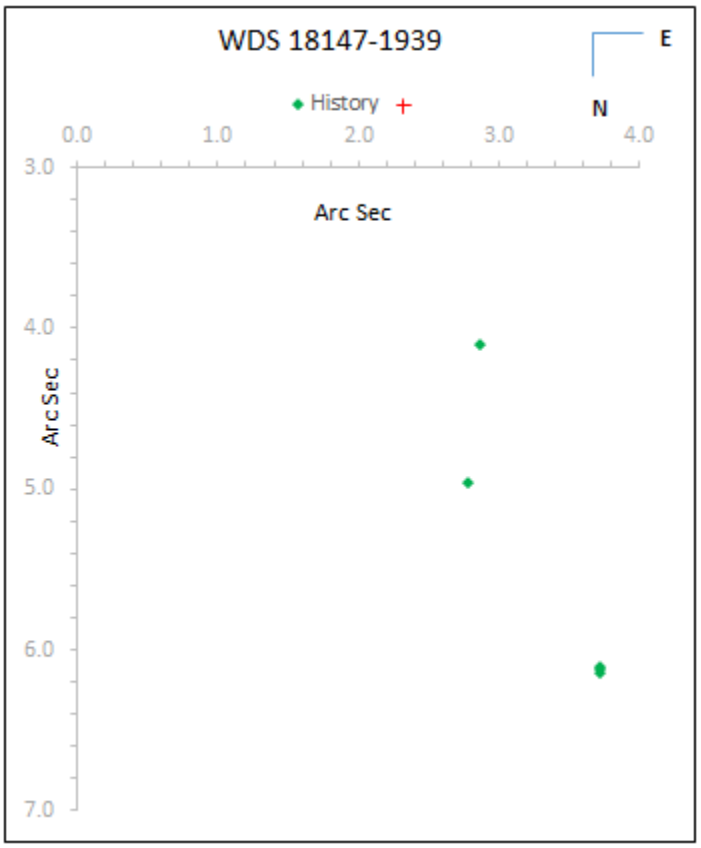

Figure 14. A plot of the historical data for WDS 18147-1939 (J 1623).

Table 15. The historical data for WDS 19399-2100 (SEE 390).

Year	PA	SEP
1941.39	35	5.
1999.40	31.2	7.18
1999.5064	31.3	7.15
1999.589	31.3 ± 0.2	7.165 ± 0.012
2020.800	29.264 ± 1.082	5.692 ± 0.399

WDS 18114-2205 (ARA1850)

WDS 18114-2205 [ARA1850] was observed on October 18, 2020. Five unfiltered exposures of 5 seconds were obtained. We found an average separation of ρ = 8.380 ± 0.232" and position angle of θ = 286.707 ± 0.211°. There are eight previous measurements, given in Table 16, which are plotted in Figure 15. The position angle seems to be increasing as the separation decreases.

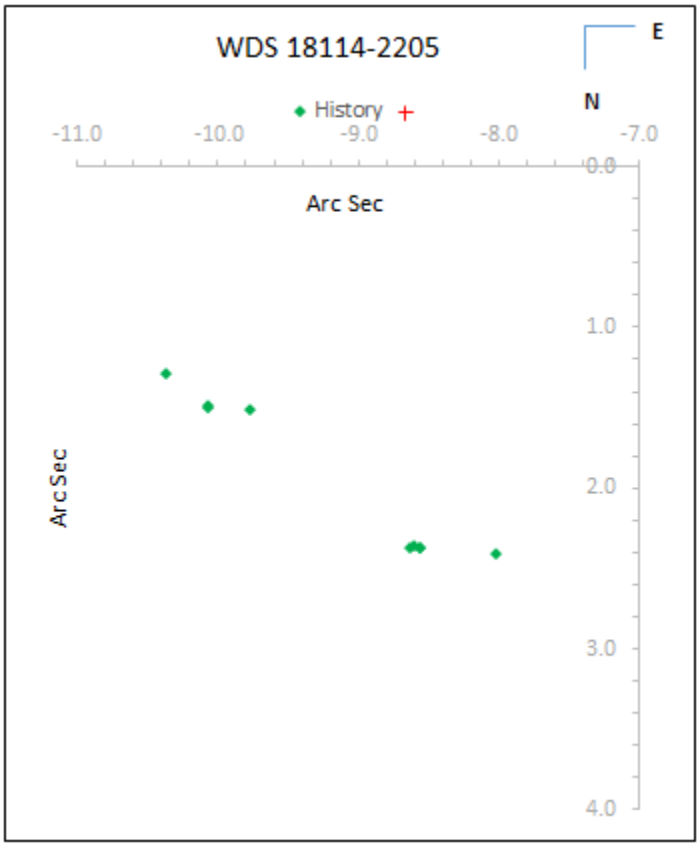

Figure 15. A plot of the historical data for WDS 18114-2205 (ARA1850).

Table 16. The historical data for WDS 18114-2205 (ARA1850).

Year	PA	SEP
1920.30	277.1	10.452
1922.29	278.5	10.18
1923.28	278.4	10.186
1923.28	278.8	9.985
1998.41	285.4	8.95
1998.6300	285.3	8.92
1999.552	285.5 ± 0.1	8.886 ± 0.019
2000.249	285.5 ± 0.1	8.892 ± 0.013
2020.800	286.707 ± 0.211	8.380 ± 0.232

WDS19592-2155 (LDS 697)

WDS 19592-2155 (LDS 697) was observed on October 18, 2020. We obtained five unfiltered 5 second exposures of the system. We found an average separation of ρ = 41.723 ± 0.043" and position angle of θ = 314.584 ± 0.0314°. There are ten observations in the WDS database, from 1920, (Luyten 1941) to 2015.5, (Knapp and Nanson 2019). Figure 16 shows a plot of the historical data, given in Table 17, along with our measurement.

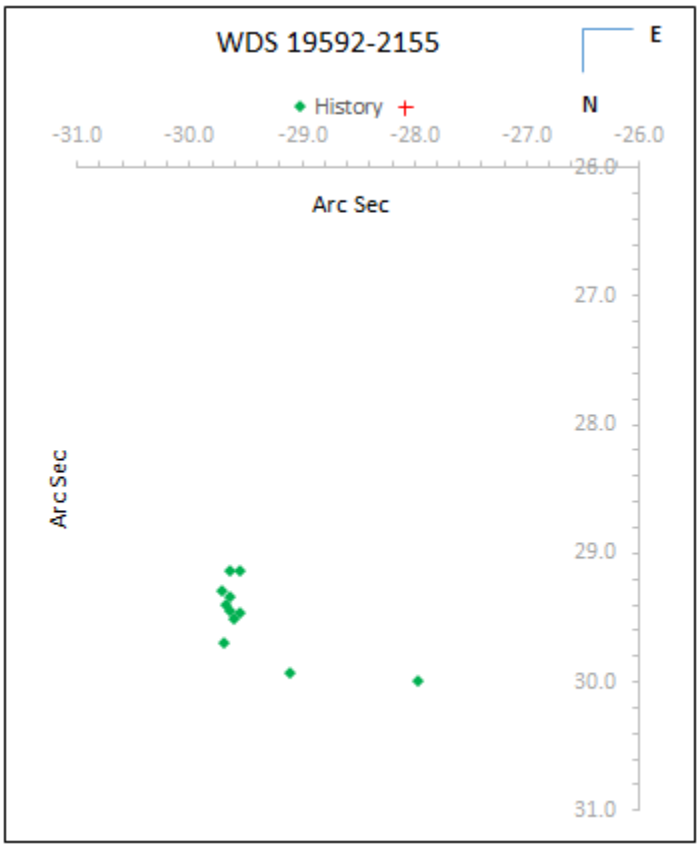

Figure 16. A plot of the historical data for WDS 19592-2155 (LDS 697).

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Table 17. the historical data for WDS 19592-2155 (LDS 697).

Year	PA	SEP
1920.	315.	42.
1921.75	315.8	41.753
1923.84	314.6	41.502
1960.	317	41.
1991.82	314.9	41.739
1998.48	314.8	41.78
1999.588	314.5 ± 0.2	41.567 ± 0.158
2000.	314.9	41.8
2010.5	314.7 ± 0.2	41.71 ± 0.13
2015.5	314.739 ± 0.000	41.77907 ± 0.00014
2020.800	314.584 ± 0.031	41.723 ± 0.043

WDS19027-0027 (J 475 AB, C, D)

We obtained five 20 second unfiltered exposures of WDS19027-0027 (J 475 AB,C, D) on Oct 22, 2020. The system has four components in the WDS, but we are unable to resolve the B component from the A component, which at the last measurement is only 1 arcsecond from A. On the images Star A does appear to be elongated, (Figure 17), and so this may affect its centroid position, and therefore the relative positions of the other two stars. Interestingly, star B seems to have changed position angle from Star A by 33 degrees in the WDS values obtained from Matson (2013), and here star A seems to be elongated towards an angle of more than 270 degrees judging from its direction as compared to star D, which is at 271 degrees. With these difficulties in mind, we do not report relative positions for these pairs. The WDS19027-0027 (J475AB) pair may be a good target for speckle imaging.

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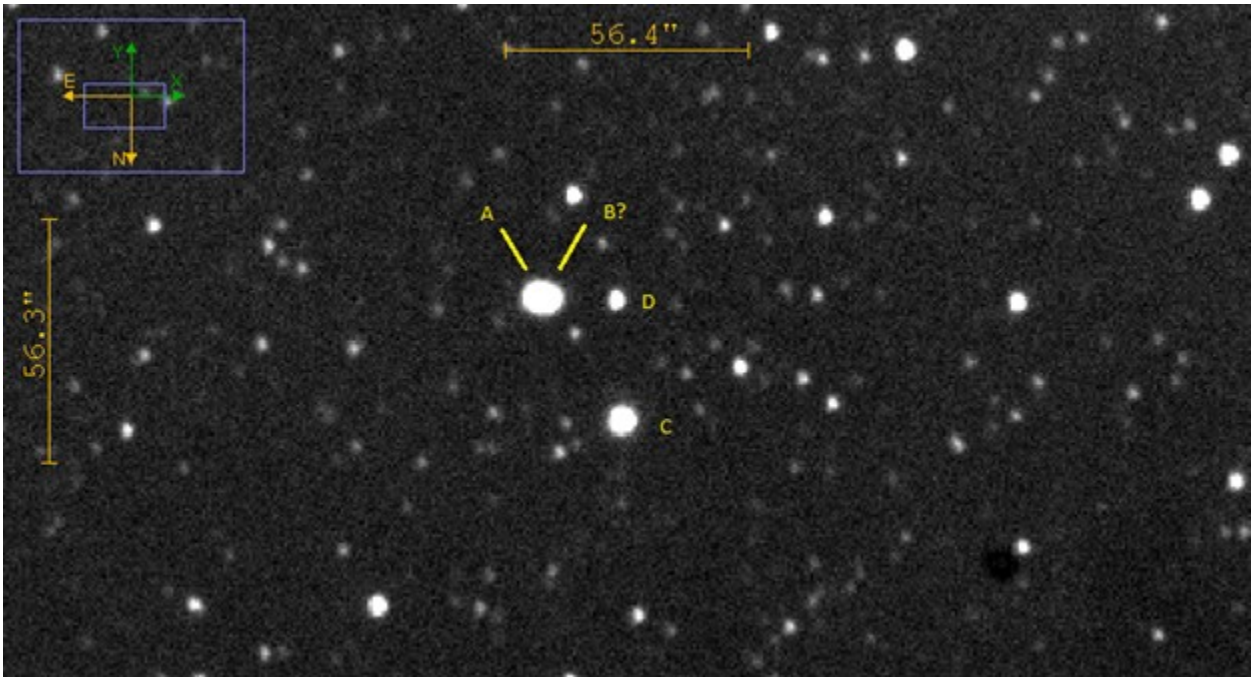

Figure 17. A screen shot image of one of our images of WDS19027-0027 (J 475 AB, C, D) identifying the four components. We are unable to resolve star A and B.

WDS18093-1827 (ARA 455)

We obtained five 20 second unfiltered images of WDS18093-1827 (ARA 455) on the night of Oct 27, 2020. We found average separation is ρ = 11.517 ± 0.057" and position angle is θ = 96.880 ± 0.0290°. As can be seen in Table 18, there has been little change in position in the 114-year record of the stars.

Table 18. The historical data for WDS18093-1827 (ARA 455).

Year	PA	SEP
1916.67	96.2	11.76
1916.67	96.0	11.765
1987.59	96.12	11.693
1998.6218	96.1	11.61
1999.608	95.8	11.72
2020.825	96.1 ± 0.1	11.627 ± 0.029
2020.800	96.880 ± 0.029	11.517 ± 0.057

4. Discussion of the Nature of the Systems

Given that many of the systems do not show a clear orbital motion, it is useful to consider if they are physical systems or not. If they are long period systems then we might not expect orbital motion over the times covered by the observations, but it is also possible that they are optical doubles. Harshaw (2018) cross-referenced the WDS catalog with the GAIA 2 (Brown et al. 2018) data release and estimated the likelihood of the double stars being physical systems using the parallax, proper motion and velocity data in the GAIA database. For our systems, in Table 19 we give his rating as to the likelihood of the systems being physical. For the majority of these systems there was no conclusion about the likelihood that the systems were physical or not. For WDS19134-1803 (HJ 1373) it was concluded that the system was probably a physical system, and for WDS 19399-2100 (SEE 390) it was concluded that the system was not a physical system.

Table 19. Estimates of the likelihood of the systems being physical binaries (from Harshaw 2018).

Star	Likelihood
WDS 18150-1955TOB 275AB	Uncommented
WDS 18150-1955TOB 275AC	Unknown
WDS 18150-1955TOB 275AD	Unknown
WDS 18150-1955TOB 275CF	Unknown
WDS 18150-1955TOB 275DE	Unknown
WDS19057-1540HJ 5507AB	Unknown
WDS 19104-2118ARA1564	Maybe
WDS 18314-2259ARA2234	??
WDS18151-2503B 2860A,BC	Maybe
WDS19134-1803HJ 1373	Yes
WDS18138-2104SLV 7BD	Unknown
WDS18138-2104SLV 7BE	Unknown
WDS 19399-2100SEE 390	No
WDS 18147-1939J 1623	Maybe
WDS 18114-2205ARA1850	Unknown
19592-2155LDS 697	Unknown
WDS18082-2216BU243AB,C	Unknown
WDS19027-0027J 475AB,C	Unknown
WDS19027-0027J 475AB,D	Unknown
WDS18093-1827ARA 455	Unknown

Conclusions and Future Work

We present the relative positions of 12 double star systems measured during the course of an introductory observational astronomy class and plot our measurements along with the historical data for the systems in the WDS database. It is not clear for the majority of these systems if they are physical systems or not. The project shows the utility of incorporating the observation of double stars as a first project in an introductory observational astronomy course for upper-level students. Next we plan to add such research into an introductory astronomy class for non-science majors, and to conduct outreach to high schools.

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This research has made use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory. We appreciate the access to the historical data for our systems supplied by R. Matson. This research has made use of the SIMBAD database, operated at CDS, Strasbourg,

France (Wenger et al. 2000). We also express appreciation to the staff of our facilities and maintenance department for their hard work in the renovation of our observatory, without which this work would not have been possible. Finally, we express appreciation for the comments and suggestions of the anonymous referee which greatly improved this work.

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