# Measurements of 427 Double Stars With Speckle Interferometry: The Winter/Spring 2017 Observing Program at Brilliant Sky Observatory, Part 1

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**Abstract**: In the winter and spring of 2017, an aggressive observing program of measuring close double stars with speckle interferometry and CCD imaging was undertaken at Brilliant Sky Observatory, my observing site in Cave Creek, Arizona. A total of 596 stars were observed, 8 of which were rejected for various reasons, leaving 588 pairs. Of these, 427 were observed and measured with speckle interferometry, while the remaining 161 were measured with a CCD. This paper reports the results of the observations of the 427 speckle cases. A separate paper in this issue will report the CCD measurements of the 161 other pairs.

## 1. Introduction

The winter and spring of 2017 marks the start of the third observing season at Brilliant Sky Observatory using speckle interferometry. Previous measurements have been reported in this journal by this author (Harshaw, A through G). This paper will continue the reports in that tradition.

## 2. Equipment Used

Brilliant Sky Observatory is equipped with a Celestron C-11 11-inch SCT telescope mounted on a Celestron CGEM-DX mount atop a PierTech adjustable pier. (See Figure 1.) The mount is controlled by a Lenovo desktop computer running TheSky 6.0.

The optical train consists of a Crayford focuser (locked in place so as not to affect focal length between observing sessions) which feeds into an Orion 1.25-inch flip mirror. One leg of the flip mirror unit—the acquisition leg—feeds a 25mm f/l illuminated reticle eyepiece with a single crosshair illuminated by a dimmable LED. The mount always places the target star within 5 arc minutes of the cross hair, so acquisition is fast and easy. The camera leg of the flip mirror unit feeds into a ZWO ASI290MM monochrome camera, known for its low read noise and excellent performance as a speckle camera. The camera has a 2x "Shorty Barlow" from Orion affixed to its mounting ring. Because only the lens and its mounting barrel from the Shorty

*Figure 1: The setup at Brilliant Sky Observatory*

Barlow are used, the actual multiplication of the Barlow is 1.5, resulting in a system focal ratio of 14.98.

The focal length of the system, as well as pixel scale and camera orientation with respect to north, are all determined by multiple drifts (20 or more drifts per session) of a star near declination 45°. The drift star is nudged to the east edge of the camera's field of view, the drive motor turned off, and the star allowed to drift across the camera's field of view while the computer is recording the file as a series of FITS frames. These files are then analyzed in The Speckle ToolBox (STB) using the Drift Analysis function of STB.

Focus is achieved and maintained by a Feathertouch focuser controlled by a MicroTouch temperature-compensated focus controller, both obtained from Starizona, a telescope supply and service center located in Tucson, Arizona.

Stars measured with speckle must have rho under 5" and be bright enough to permit both stars to appear with integration times at or under 40ms.

When doing speckle measurements, 1,000 frames are made of each star at as short an integration time as possible given the magnitudes of the two stars. Usually five such files are made of each star (especially for speckle). A nearby single star is then imaged (again, 1,000 frames) and is used for deconvolution of the speckle files captured.

Files are written to a 2TB portable USB3 hard drive, which is then taken into my office for analysis the next day using STB for data reduction and measurements.

Final results are then saved to a 5TB USB3 hard drive with a backup made to a second 5TB USB3 hard drive. The backup drive undergoes an incremental backup once a week.

## 3. Methodology

### *3a. Speckle or CCD?*

The decision to make a file as a speckle interferometry case depends on two factors: the separation (rho) of the two stars and the magnitudes of the two stars.

To qualify for speckle interferometry, the pair must have a rho value of 5" or less (but on nights of very good seeing, this can be pushed up a bit, perhaps to 6"). Also, the stars must be bright enough to register in 40 ms or less.

Any pair wider than 5" and/or requiring integration times over 40ms is then recorded and processed as a CCD file.

### *3b. Using The Speckle Toolbox in Manual Mode.*

Some of the stars in this report are described as "Manual solution with STB." When a pair is wide enough to produce three distinct star images in the autocorellogram (the primary flanked by symmetric images of the companion's power spectrum image), STB has no difficulty in automatically locating and selecting the companion star (although sometimes, the observer must use the complementary image 180° from the one chosen by STB if theta is greater than 180°). But in cases where the power spectrum images of the stars are not distinct, or the frame is noisy, STB may not be able to automatically find the companion's power spectrum. In such cases, STB allows the user to manually select the companion's power spectrum by right clicking on it. In this report, all the pairs measured with "Manual solution" had distinct companion power spectra to select, but noise near the primary misled STB's automatic selection process.

### *3c. Using the Most Accurate Proper Motions Available.*

Until recently, the most accurate data sources for parallax and proper motion were rather limited in depth and scope. Also, the WDS often reports proper motions for one or both of the stars in a system without referencing the source of the measurement. (See Harshaw 2017H) When reporting proper motions in this paper, I will indicate the source of the data by following the proper motion numbers with a letter — G for Gaia, U for UCAC5, or W for a proper motion listed in the WDS but for which the source is not known.

In Harshaw 2017H, I reported how the resultant of two proper motion vectors could be computed. I use that method in this paper to indicate when the proper motion vectors do not seem to agree with the observations of the pair.

For example, a pair with widely differing proper motions would be expected to exhibit a linear or nearly-linear track over time, and there are many examples of this in the WDS. However, there are also cases where pairs with widely differing proper motions show no apparent trend in the measurements at all — all of the data points tend to clump around a central point much like the random scattering of buckshot from a shotgun. When widely differing proper motion vectors are listed for a pair with a tight pattern of measurements like this, we may assume that one (or both) of the proper motion vectors is incorrect.

In correspondence with Norbert Zacharias, team leader for the UCAC5 catalog, Zacharias suggested that where data is available in both Gaia and UCAC5 that we use Gaia:

> "I recommend to use Gaia DR1 data, i.e. for those stars which are in the TGAS… Keep in mind the UCAC data still has issues with poor charge transfer efficiency of the detector leading to magnitude (and field) dependent systematic errors at the

> about 2000 epoch. This could translate into about 1 to 2 mas/yr systematic errors for individual stars. But if the UCAC5 random errors on proper motions are small (order 1-2 mas/yr) while the TGAS proper motions are larger, you might want to take UCAC5 or a mean between TGAS and UCAC5… For stars not in TGAS, UCAC5 is a good option, although there are several other attempts to get proper motions with Gaia data and some other earlier data. See for example HSOY (update of PPMXL) or the GPS1 (derived from Pan-STARRS, SDSS and 2MASS). Then there is also the PMA (proper motion absolute) catalog based on 2MASS. They all have their pros and cons and are on about the same level of formal errors - nobody knows which is better in an absolute sense."

In many cases, Gaia has good proper motion data on only one of the stars in a double star system. Since the UCAC5 catalog has a much larger sampling of proper motions, it is common for a star without a proper motion value in Gaia to be listed in the UCAC5 data. When this was the case, I looked at the proper motion data in both catalogs for the star that was listed in both catalogs. If the UCAC5 proper motion vector was within 5 milli-arc seconds (mas) of the Gaia value, I assumed that the UCAC5 data for the second star would be on a par with Gaia (had Gaia listed it). However, if the difference in proper motions exceeded 5 mas, the UCAC5 data for the second star was not used.

### *3d. Using the Most Accurate Parallax Data Available*

Like the proper motion data, parallax data will be listed with attribution to its source. The format will be XX.XX ± 0.XX S, where the X's are the numbers of the parallax value (with ± 0.XX being the stated error estimate of the parallax) and S the source—H for Hipparcos, G for Gaia.

Most of the time, we only have parallax data on one of the stars in a double star system. In this report, only 34 of the 417 speckle measurements (8%) have parallax on both stars.

Determining if two stars are close enough to be physical on the basis of parallax data alone is a bit tricky. Let's consider two of the stars in this report.

WDS 09371–1350 (BRT1909) has parallaxes for both stars shown in Gaia. For the primary, Gaia shows 1.76 ± 0.40 mas, while for the companion it shows 2.19 ± 0.93 mas. Thus the primary could have a parallax ranging from 1.36 up to 2.16 mas while the companion could range from 1.26 to 3.12 mas. So there is a considerable range of parallaxes where the stars could be at the same distance from the earth. If we draw a diagram showing the parallaxes with their error estimates, we get a picture like Figure 2.

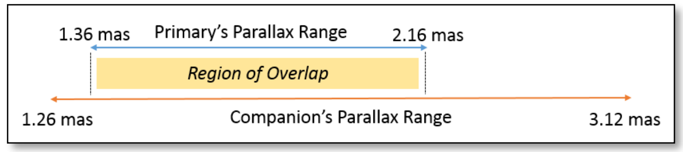


*Figure 2: Parallax overlap of BRT1909*

Whereas the two stars could clearly be at the same distance (as shown by the Region of Overlap), they could also be at quite different distances. The Region of Overlap is 0.80 mas whereas the entire parallax range is 3.12 – 1.26 or 1.86 mas. So the range of overlap is equivalent to 0.80 / 1.86 or 43% of the total parallax space. Does this mean the stars have a 43% chance of being at the same distance?

Unfortunately, no. The reason is that the probability of a star being at any given parallax value is not a linear function around the mean parallax value but rather a Gaussian distribution around the mean. The reported error estimate is one standard deviation. In a normal distribution, the first standard deviation from the mean contains 34.13% of the possible values, so there is a 68.26% chance that a star will be within its given parallax window (using 1 standard deviation on both sides of the mean). The actual math to compute a precise probability of two stars being at the same distance given their parallaxes is quite complicated. For our purposes, the percentage of overlap will serve as a reasonable indicator of a pair's likelihood of being at the same distance.

Let us consider a case where the stars clearly have no overlap in their parallaxes values. Let us look at WDS 10258+3237 (ES 432), a pair with given parallaxes of 4.00 ± 0.36 and 2.74 ± 0.49. Here is a diagram of the parallax data (Figure 3):

Clearly, there is no overlap between the parallax values of the stars in the system, so they are probably too far apart to be captured by their mutual gravitational forces.

In doing parallax calculations, if the error estimate of the parallax was 25% or more of the mean, the parallax was rejected as being unreliable.

Also, at the suggestion of William Hartkopf at the US Naval Observatory, I decided to use a weighted average of the parallax values for stars whose parallaxes

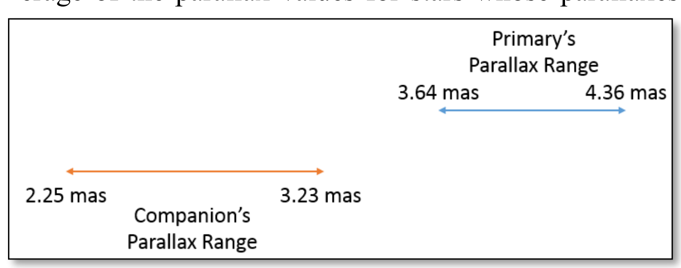


*Figure 3: Parallax range of ES 432*

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could place them close enough in physical proximity to be physical. In such cases, the weighted parallax was computed as shown in Equation 1.

$$PX_w = \frac{\left[\left(1 - PxA\ err\%\right) * PxA\right] + \left[\left(1 - PxB\ err\%\right) * PxB\right]}{\left[\left(1 - PxA\ err\%\right) + \left(1 - PxB\ err\%\right)\right]} \quad [1]$$

$PX_w$ is the weighted parallax. *PxA err%* is the error in parallax for the primary star expressed as a percentage (Error / Parallax). Likewise for *PxB err%.*

Let's take an example. Consider the case of WDS 11272+1908 (KU 38), a pair for which Gaia lists parallax for both stars. For the primary, Gaia shows 6.18 ± 0.38 mas and for the companion, 6.23 ± 0.42 mas. The weighted parallax then works out to

$$PX_w = \frac{\left[\left(1 - 0.38/6.18\right) * 6.18\right] + \left[\left(1 - 0.42/6.23\right) * 6.23\right]}{\left[\left(1 - 0.38/6.18\right) + \left(1 - 0.42/6.23\right)\right]}$$
$$= 6.20$$

Knowing the weighted parallax, it is a simple matter to divide 1 by the parallax in arc seconds (converting mas to arc seconds by multiplying the mas by 0.001). In this case, the distance would be 1 / 0.0062 = 161 parsecs.

### *3e. Estimating the minimum separation between the two stars.*

When we have a parallax for each star, we can then compute the *minimum* separation between the two stars once we have the distance in parsecs. This is found by simply multiplying the distance (in parsecs) by the latest value for rho (in arc seconds). In the case of KU 38, the last value for rho in the WDS was listed as 5.90". Hence, the minimum separation between the two stars is 5.90 * 161 or 950 astronomical units (AU)— roughly 32 times the distance from the Sun to Neptune. This is a vast distance to be sure, but well within the realm of possibility for a binary star system.

This method will yield only the *minimum* separation between the two stars since we do not know the orientation of the stars relative to our line of sight. We are only seeing a projection of their distance on the sky's plane, and in all likelihood, one of the stars lies closer to earth than the other. As a result, we see one leg of a right triangle, while the stars are truly separated by the hypotenuse of that triangle.

This same procedure can be applied, of course, to pairs where the parallax to only one of the stars is known. In such cases, the minimum separation is a rough guide to the physicality of the system.

A survey of 888 systems from the Sixth Orbit Catalog where we have the distance to the pair and can therefore compute the true separation of a binary system in AU, the true separations of stars (based on the semi-major axis of the orbit) run a range from 4.1 AU at the low end to 1,707 AU at the high end, with a mean of 281 AU.

The data available to date suggests that true separations in binary stars will be, at most, in the low thousands of astronomical units. Of course, this is not to say that a true binary could not have a separation of 30,000 astronomical units or more, but only that our research so far makes such a wide pair highly unlikely. Obviously, the 6$^{th}$ Orbit Catalog represents a selection bias due to the fact that we only have good distance data and orbits on binary stars that are relatively close to us and with short enough periods to detect a short arc in the data when plotted on a graph. Such visual clues can then lead to an orbital solution. Nonetheless, I would be highly suspicious of a given pair's odds of being a true binary if the separation between the two stars exceeds 3 or 4 thousand astronomical units.

## *4. Results*

### *4a. The Results Tables.*

The speckle results of the winter and spring 2017 observing season at Brilliant Sky Observatory are presented in 6 tables as shown in Table 1. (The numbers indicate the number of pairs listed in each table.)

In Table 1, the number before the colon indicates the table number. CPM means common proper motion pairs (pairs where the proper motion vectors are both within 5 mas of each other, except where the proper motions are large, in which case the differences can be extended). DPM means the pair has different proper motions (more than 5 mas difference in both vector values). LIN means the pair is showing a linear pattern. ORB are pairs that have known orbits. SAB signifies short arc binaries, pairs that are showing an arc but for which there are not yet orbital solutions. And UNK

*Table 1: Results by Type of System*

| Type | Speckle |
|---|---|
| CPM | 3: 278 |
| DPM | 4: 21 |
| LIN | 5: 13 |
| ORB | 6: 79 |
| SAB | 7: 12 |
| UNK | 8: 24 |

stands for unknown—cases that do not fit any of the other categories.

### *4b. A Quick Check of Measurement Consistency.*

A quick way to check consistency of one's measurements has traditionally been to compare the observer's measurement to the last measurement listed in the WDS (and obtained by a datarequest email to the USNO). The problem with this method is that if the last measurement was of uncertain value, the residual (difference between the observer's measurement and the last measurement on record) may be large, suggesting a poor measurement. Of course, the large residual may be due to a weak *prior* measurement. This will be seen in several cases in the tables that follow.

A more consistent method is to compute the average annual difference between the values of theta and rho from the last measurement on record to the observer's measurement, and then add all of the differences. The closer to zero each sum would be (theta and rho), the more consistent the measurements of the observer.

The reasoning is that for any large sample (and 427 pairs is probably a large enough sample), one would expect the changes in theta to be evenly divided between increasing theta (a + value for the difference) and decreasing theta (a – value); likewise for rho. In other words, there is a 50/50 chance that for any given pair, theta will increase over time or decrease, as will be the case for rho.

By computing the average *annual* change in theta and rho, one gets around those cases where the last measurement was made, say, 20 years ago and the residual seems very large. But if one computes the change in theta and rho per year over the 20 year window, the residuals become much smaller.

In computing annualized changes in theta and rho, I took the date of the observation minus the year of the last observation plus 0.5 (assuming an average measurement would be made mid-year), resulting in the number of years that have elapsed since the last measurement on file and the one I made. I then divided the raw residuals by this number of years to get the annual change.

I do this procedure for each night I observe and if the average annual change in theta exceeds 0.5° or rho exceeds 0.100", I assume there is a problem with the measurements that night (more than likely, a calibration issue). If the cause of the error can be determined (for example, doing a drift calibration the next night without moving the camera from the night before), the correction will be applied to the measurements obtained and results reported. If the cause cannot be determined, or if even after finding the cause, the errors still lie outside the parameters I have set, I reject all the work for that night and try to get the measurements on a later night.

*Table 2: Annual Differences in θ and ρ*

| Measurement Type | θ | ρ |
|---|---|---|
| Average Standard Error of the Means | | |
| Speckle | +0.4° | +0.2° |
| Average Raw Residuals | | |
| Speckle | -0.1° | +0.000" |
| Average Annual Change in θ, ρ | | |
| Speckle | -0.01° | -0.020" |

For all of the pairs in this report, the annual differences came to the values shown in Table 2. I also report in this table the average standard error of the mean and average raw residual.

### *4c. Table Format.*

The table column headings are as follows:

- Date: date of the observation (Julian)
- WDS No: the WDS number of the pair
- Disc/Comp: discoverer and components
- PM A: proper motion of the primary in mas per year. Source indicated by W for WDS, G for Gaia, or U for UCAC5
- PM B: proper motion of the companion as for A
- Last Yr: last year of measurement on file with the WDS
- Last θ: the last value for θ reported
- Last ρ: the last value for ρ reported
- Msrs: Number of measures made on the night of observation
- Measured θ ± err (°): the measured value of θ that night with the standard error of the mean, expressed in degrees
- Measured ρ ± err ("): the measured value of ρ that night with the standard error of the mean, expressed in arc seconds
- Resid θ: the difference between the observed value of θ and the last value on record
- Resid ρ: the difference between the observed value of ρ and the last value on record

In the plot diagrams that accompany the notes, the historical data has been corrected for precession and the axis values are expressed in arc seconds.

Every pair that I measure has a plot of its measurements generated from a WDS data request. Any measurement I make that lies far from the mean of the historical data is not reported, as there may be problems with calibration or even the measurement of the wrong star (surprisingly easy to do in a rich star field!).

In addition, some of the plots of the measurements presented in the "Notes" tables that follow each table of results contain a heavy orange line. This line is the PM vector that the stars should have followed if the displacement over its observed history is due only to a difference in proper motions. In some cases, the fit of the orange line to the data is so good as to virtually confirm the pair is linear. In other cases, the orange line is displayed on a small and dense packing of measurements, which would indicate a problem with one (or both) of the proper motion vectors.

*(Text continues on page 315)*

*Table 3: Common Proper Motion Pairs (CPM) Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.0822 | 02123+2357 | STF 226AB | +135-169 U | +130-160 W | 2009 | 231.9 | 1.76 | 5 | 230.9 ± 0.0 | 1.755 ± 0.002 | -1.0 | -0.005 | * |
| 2017.0822 | 02214+0853 | BU 8 | +000-015 W | +000-015 W | 2008 | 224.7 | 1.53 | 5 | 224.0 ± 0.1 | 1.632 ± 0.012 | -0.7 | 0.102 | * |
| 2017.0767 | 02233-0749 | HO 313AB | +013-024 W | +013-024 W | 2012 | 75.9 | 2.13 | 5 | 73.3 ± 0.2 | 2.279 ± 0.012 | -2.6 | 0.149 | |
| 2017.0795 | 02244+1130 | STF 261 | +000+003 G | -001+005 U | 2008 | 252.0 | 2.90 | 5 | 253.6 ± 0.3 | 2.831 ± 0.015 | 1.6 | -0.069 | * |
| 2017.0822 | 02327+0620 | STF 276 | +023-095 W | +023-095 W | 2011 | 274.0 | 1.70 | 5 | 275.6 ± 0.0 | 1.839 ± 0.002 | 1.6 | 0.139 | |
| 2017.0795 | 02389+1526 | AG 43 | -016-011 U | -018-012 U | 2008 | 61.8 | 2.97 | 5 | 63.3 ± 0.2 | 2.857 ± 0.023 | 1.5 | -0.113 | |
| 2017.0822 | 02411+1848 | STF 291AB | -003-013 G | -002-013 W | 2016 | 117.1 | 3.31 | 5 | 117.2 ± 0.1 | 3.366 ± 0.012 | 0.1 | 0.056 | * |
| 2017.0795 | 02429-0629 | A 452 | +066-057 G | +059-064 W | 2006 | 112.5 | 1.80 | 5 | 114.5 ± 0.1 | 1.891 ± 0.020 | 2.0 | 0.091 | * |
| 2017.0795 | 02447-0158 | STF 303 | -009-004 G | -010-005 U | 2003 | 180.9 | 5.79 | 5 | 182.8 ± 0.1 | 5.841 ± 0.010 | 1.9 | 0.051 | * |
| 2017.0795 | 02527+0628 | STF 323 | +022-013 W | +022-013 W | 2012 | 278.3 | 2.71 | 5 | 280.3 ± 0.1 | 2.719 ± 0.035 | 2.0 | 0.009 | * |
| 2017.0795 | 03051+2755 | STF 342 | -009-038 U | -002-027 W | 2008 | 303.9 | 3.20 | 5 | 304.2 ± 0.1 | 3.399 ± 0.006 | 0.3 | 0.199 | * |
| 2017.0822 | 03088+3528 | STF 352 | +032-031 G | +032-030 W | 2011 | 359.5 | 3.79 | 4 | 358.7 ± 0.0 | 3.898 ± 0.001 | -0.8 | 0.108 | * |
| 2017.0795 | 03242+1733 | STF 383 | +016-048 U | +014-053 W | 2010 | 120.2 | 5.33 | 5 | 120.8 ± 0.0 | 5.562 ± 0.010 | 0.6 | 0.232 | * |
| 2017.0767 | 03258-1304 | HU 21 | +008-000 G | +003+001 W | 1999 | 36.8 | 1.39 | 5 | 37.8 ± 0.5 | 1.458 ± 0.015 | 1.0 | 0.068 | * |
| 2017.0795 | 03312+1947 | STF 403 | +031+037 G | +034+024 W | 2012 | 171.4 | 2.29 | 5 | 172.7 ± 0.1 | 2.296 ± 0.010 | 1.3 | 0.006 | * |
| 2017.0822 | 03446+3551 | HO 504 | +009-011 W | +009-011 W | 2009 | 192.4 | 1.11 | 5 | 193.1 ± 0.1 | 1.105 ± 0.005 | 0.7 | -0.005 | |
| 2017.0767 | 03545-1243 | HLD 67 | -009-016 G | -017-011 W | 2009 | 149.8 | 2.78 | 5 | 146.8 ± 0.1 | 2.885 ± 0.006 | -3.0 | 0.105 | * |
| 2017.0795 | 03554+1738 | BU 85 | -000-005 G | -002-005 W | 2010 | 216.5 | 3.96 | 5 | 216.6 ± 0.0 | 4.037 ± 0.003 | 0.1 | 0.077 | * |
| 2017.0822 | 04024-0700 | STF 489 | -009+024 G | -010+027 U | 2010 | 197.2 | 3.08 | 5 | 196.5 ± 0.0 | 3.078 ± 0.005 | -0.7 | -0.002 | * |
| 2017.1507 | 04059+1058 | STF 491 | -002-074 G | -004-072 W | 2010 | 96.8 | 2.90 | 5 | 96.5 ± 0.0 | 2.843 ± 0.001 | -0.3 | -0.057 | * |
| 2017.1507 | 04160+0027 | STF 517 | +024-021 G | +024-022 W | 2012 | 8.0 | 3.29 | 5 | 6.6 ± 0.3 | 3.248 ± 0.002 | -1.4 | -0.042 | * |
| 2017.1507 | 04409+0058 | STF 583AB | +000-001 G | +000-001 W | 2012 | 327.5 | 5.45 | 5 | 326.9 ± 0.0 | 5.757 ± 0.001 | -0.6 | 0.307 | * |
| 2017.1507 | 04448+0517 | STF 589AB | -118-045 G | -122-058 W | 2011 | 277.0 | 4.70 | 5 | 276.1 ± 0.0 | 4.669 ± 0.001 | -0.9 | -0.031 | * |
| 2017.1507 | 04551-0033 | STF 614AB-C | +003+002 G | -001+002 W | 2010 | 69.1 | 4.39 | 5 | 68.5 ± 0.0 | 4.420 ± 0.001 | -0.6 | 0.030 | * |
| 2017.1507 | 04561+0908 | BU 405 | -005-004 W | -005-004 W | 2015 | 290.7 | 1.65 | 5 | 290.1 ± 0.1 | 1.772 ± 0.001 | -0.6 | 0.122 | * |

*Table 3 continues on next page.*

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*Table 3 (continued): Common Proper Motion Pairs (CPM) Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.1616 | 05030-0840 | STF 636 | -012-003 W | -012-003 W | 2013 | 103.2 | 3.60 | 5 | 103.6 ± 0.0 | 3.669 ± 0.001 | 0.4 | 0.069 | * |
| 2017.1644 | 05041+0257 | A 2632 | +000-006 W | +000-006 W | 2016 | 300.0 | 0.90 | 5 | 303.3 ± 0.3 | 0.901 ± 0.004 | 3.3 | 0.001 | |
| 2017.1644 | 05079+0824 | STF 643 | +023-061 G | +018-061 G | 2010 | 124.4 | 2.38 | 5 | 124.9 ± 0.0 | 2.448 ± 0.004 | 0.5 | 0.068 | * |
| 2017.1616 | 05110-0146 | BU 885 | +006-001 W | +006-001 W | 2006 | 196.1 | 0.64 | 5 | 198.3 ± 0.4 | 0.601 ± 0.013 | 2.2 | -0.039 | * |
| 2017.1671 | 05118+0102 | STF 652 | -001-017 W | -001-017 W | 2015 | 180.0 | 1.60 | 5 | 179.6 ± 0.1 | 1.668 ± 0.002 | -0.4 | 0.068 | * |
| 2017.1616 | 05125-0302 | A 51 | +000-008 W | +000-008 W | 2009 | 104.3 | 1.48 | 5 | 105.0 ± 0.2 | 1.486 ± 0.003 | 0.7 | 0.006 | |
| 2017.1616 | 05147-0704 | STF 667 | -008-008 G | -009-010 W | 2004 | 316.2 | 4.22 | 5 | 315.7 ± 0.0 | 4.284 ± 0.003 | -0.5 | 0.064 | * |
| 2017.1671 | 05152+0826 | STF 664 | +015-036 G | +011-039 W | 2011 | 177.2 | 4.66 | 5 | 176.3 ± 0.0 | 4.702 ± 0.001 | -0.9 | 0.042 | * |
| 2017.1671 | 05159+0345 | A 2638 | -006-021 W | -006-021 W | 2016 | 279.0 | 0.90 | 5 | 280.3 ± 0.1 | 0.961 ± 0.003 | 1.3 | 0.061 | |
| 2017.1616 | 05162-0329 | BU 318 | -002-001 W | -002-001 W | 1997 | 261.6 | 0.62 | 5 | 264.3 ± 1.1 | 0.643 ± 0.010 | 2.7 | 0.023 | * |
| 2017.1671 | 05177+0441 | STF 678AB | +017-032 G | +013-030 W | 2009 | 102.6 | 3.62 | 5 | 103.4 ± 0.0 | 3.594 ± 0.001 | 0.8 | -0.026 | * |
| 2017.1616 | 05204-0805 | BU 190AB | -000-063 G | +000-065 W | 2001 | 328.2 | 0.66 | 5 | 326.3 ± 0.5 | 0.706 ± 0.009 | -1.9 | 0.046 | * |
| 2017.1616 | 05217-0203 | STF 693 | -001+010 G | -002+010 W | 2008 | 10.5 | 3.49 | 5 | 10.7 ± 0.0 | 3.511 ± 0.003 | 0.2 | 0.021 | * |
| 2017.1671 | 05231+0103 | STF 700 | +001-006 G | +003-007 W | 2015 | 6.9 | 4.73 | 5 | 3.9 ± 0.0 | 4.788 ± 0.001 | -3.0 | 0.058 | * |
| 2017.1616 | 05231-0806 | A 486 | -003+005 W | -003+005 W | 1997 | 71.3 | 0.63 | 5 | 73.2 ± 0.7 | 0.750 ± 0.029 | 1.9 | 0.120 | * |
| 2017.1507 | 05236-1025 | STN 10 | -002+005 W | -002+005 W | 2006 | 120.6 | 0.85 | 5 | 120.4 ± 0.6 | 1.096 ± 0.025 | -0.2 | 0.246 | |
| 2017.1671 | 05252+0155 | STF 708 | +002-007 W | +002-007 W | 2010 | 321.1 | 2.69 | 5 | 321.1 ± 0.0 | 2.772 ± 0.001 | 0.0 | 0.072 | * |
| 2017.1671 | 05265+0256 | STF 712AB | -002-006 W | -002-006 W | 2012 | 66.4 | 3.16 | 5 | 65.9 ± 0.0 | 3.157 ± 0.001 | -0.5 | -0.003 | * |
| 2017.1644 | 05291-0201 | D 8AB | -001-020 W | +003-023 W | 2010 | 49.0 | 4.80 | 5 | 47.7 ± 0.1 | 5.711 ± 0.004 | -1.3 | 0.911 | |
| 2017.1671 | 05312+0318 | STF 729AB | +000-006 W | +000-006 W | 2015 | 27.0 | 1.90 | 5 | 25.5 ± 0.0 | 1.849 ± 0.002 | -1.5 | -0.051 | * |
| 2017.1644 | 05314-0206 | STF 731AB | +001+001 W | -001+000 W | 2006 | 327.2 | 4.94 | 5 | 327.0 ± 0.1 | 4.830 ± 0.008 | -0.2 | -0.110 | * |
| 2017.1644 | 05331-0143 | STF 734AB | -001-007 W | -001-007 W | 2008 | 357.3 | 1.65 | 5 | 355.3 ± 0.0 | 1.614 ± 0.003 | -2.0 | -0.036 | |
| 2017.1644 | 05345-0429 | BU 13 | -009-007 W | -009-007 W | 1991 | 141.9 | 0.96 | 5 | 144.1 ± 0.5 | 0.830 ± 0.002 | 2.2 | -0.130 | |
| 2017.1644 | 05347-0424 | STF 743 | -006-004 W | -006-004 W | 2012 | 282.0 | 1.80 | 5 | 283.2 ± 0.0 | 1.852 ± 0.003 | 1.2 | 0.052 | |
| 2017.1644 | 05355-0422 | STF 750 | +004+001 W | +004+001 W | 2014 | 60.1 | 4.10 | 5 | 59.6 ± 0.0 | 4.238 ± 0.002 | -0.5 | 0.138 | * |
| 2017.1671 | 05381-0011 | STF 757AB | -001-008 W | -001-008 W | 2010 | 239.4 | 1.45 | 5 | 239.3 ± 0.1 | 1.525 ± 0.003 | -0.1 | 0.075 | * |
| 2017.1507 | 05457-1447 | A 3018 | -002-048 W | -002-048 W | 1998 | 294.2 | 0.75 | 5 | 303.3 ± 0.6 | 0.707 ± 0.018 | 9.1 | -0.043 | * |
| 2017.1507 | 05484-1842 | HJ 3799 | -011+002 W | -011+002 W | 2008 | 152.4 | 3.79 | 5 | 151.4 ± 0.2 | 3.781 ± 0.008 | -1.0 | -0.009 | |
| 2017.1616 | 05495-1234 | HDS 783 | -001+005 W | -001+005 W | 2000 | 167.2 | 1.70 | 4 | 168.6 ± 0.1 | 1.944 ± 0.011 | 1.4 | 0.244 | |
| 2017.1616 | 05514-1139 | A 2512 | -008-004 W | -008-004 W | 1991 | 279.0 | 1.13 | 5 | 275.3 ± 0.3 | 0.999 ± 0.008 | -3.7 | -0.131 | * |
| 2017.1507 | 06041-1541 | SKI 2 | -010+014 W | -006+007 W | 1999 | 171.9 | 5.50 | 5 | 170.8 ± 0.3 | 5.293 ± 0.027 | -1.1 | -0.207 | |
| 2017.2137 | 06049-0243 | STF 839AB | -003-006 G | -002-005 G | 2004 | 289.1 | 4.94 | 5 | 288.1 ± 0.1 | 5.100 ± 0.005 | -1.0 | 0.160 | * |
| 2017.2137 | 06074-0400 | STF 850AB | -004-010 G | -004-010 G | 2008 | 17.8 | 2.02 | 5 | 15.2 ± 0.1 | 2.171 ± 0.004 | -2.6 | 0.151 | * |
| 2017.1616 | 06114-1650 | A 3022 | -013-006 W | -013-006 W | 2008 | 359.9 | 1.04 | 5 | 357.6 ± 0.4 | 1.098 ± 0.018 | -2.3 | 0.058 | |
| 2017.1507 | 06167-1203 | BU 18 | -012-035 G | -015-039 W | 1993 | 284.5 | 1.81 | 5 | 286.0 ± 0.2 | 1.872 ± 0.014 | 1.5 | 0.062 | * |

*Table 3 continues on next page.*

## Measurements of 427 Double Stars With Speckle Interferometry ...

*Table 3 (continued): Common Proper Motion Pairs (CPM) Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.1644 | 06217-1424 | HU 1241AB | -016+008 W | -016+008 W | 1996 | 81.4 | 0.83 | 5 | 79.7 ± 0.4 | 0.766 ± 0.004 | -1.7 | -0.064 | |
| 2017.1644 | 06238-1947 | BU 568 | -004+003 W | -004+003 W | 2005 | 153.0 | 0.79 | 5 | 155.2 ± 0.9 | 0.849 ± 0.015 | 2.2 | 0.059 | * |
| 2017.1644 | 06252-1056 | BU 569 | -002-013 W | -002-013 W | 1991 | 117.1 | 1.69 | 5 | 115.0 ± 0.1 | 1.675 ± 0.005 | -2.1 | -0.015 | * |
| 2017.1507 | 06372-1415 | HLD 80 | -002+002 G | -001+002 G | 2011 | 311.9 | 4.03 | 5 | 310.6 ± 0.0 | 4.090 ± 0.003 | -1.3 | 0.060 | * |
| 2017.1507 | 06420-1600 | BU 19 | -004+002 G | -002+004 W | 1999 | 168.5 | 3.95 | 5 | 166.9 ± 0.1 | 3.797 ± 0.009 | -1.6 | -0.153 | * |
| 2017.1644 | 06484-1326 | STF 971AB | -010-009 W | -010-009 W | 2008 | 323.0 | 1.20 | 5 | 323.0 ± 0.2 | 1.237 ± 0.001 | 0.0 | 0.037 | * |
| 2017.1644 | 06488-1613 | BU 20 | +009-049 G | +011-049 W | 2002 | 27.2 | 3.29 | 5 | 26.7 ± 0.1 | 3.315 ± 0.005 | -0.8 | 0.025 | * |
| 2017.2137 | 06573-1005 | A 514 | -025+014 W | -025+014 W | 1991 | 101.4 | 1.39 | 5 | 103.0 ± 0.2 | 1.465 ± 0.004 | 1.6 | 0.075 | * |
| 2017.2137 | 06584-1011 | A 515 | -009+004 W | -009+004 W | 1991 | 313.0 | 1.68 | 5 | 314.7 ± 0.1 | 1.708 ± 0.004 | 1.7 | 0.028 | |
| 2017.2712 | 08019-0333 | A 539 | -009-001 W | -009-001 W | 2005 | 19.6 | 0.75 | 5 | 21.3 ± 1.3 | 0.663 ± 0.005 | 1.7 | -0.087 | |
| 2017.2712 | 08042-0151 | BU 903 | -006-005 G | -002-012 W | 1991 | 33.6 | 1.72 | 5 | 34.0 ± 0.0 | 1.649 ± 0.001 | 0.4 | -0.071 | * |
| 2017.2986 | 08046+5445 | STF1172 | -018-017 G | -018-014 W | 1995 | 243.6 | 1.66 | 5 | 243.5 ± 0.0 | 1.746 ± 0.001 | -0.1 | 0.086 | * |
| 2017.2877 | 08091+3714 | HU 849 | -035-042 G | -035-040 W | 2008 | 283.1 | 1.17 | 5 | 282.5 ± 0.1 | 1.255 ± 0.002 | -0.6 | 0.085 | * |
| 2017.2712 | 08092-0642 | BU 583 | -003-009 W | -003-009 W | 2010 | 71.3 | 1.83 | 5 | 70.7 ± 0.0 | 1.844 ± 0.001 | -0.6 | 0.014 | |
| 2017.2740 | 08101+0403 | AG 150 | +022-001 G | +018-001 G | 2010 | 30.3 | 5.00 | 5 | 30.0 ± 0.1 | 5.085 ± 0.004 | -0.3 | 0.085 | * |
| 2017.2712 | 08109-0455 | A 335 | -011-003 G | -015-006 W | 1991 | 125.9 | 1.43 | 5 | 127.2 ± 0.1 | 1.512 ± 0.002 | 1.3 | 0.082 | * |
| 2017.2795 | 08127+2933 | STF1197 | -008+005 W | -008+005 W | 2015 | 99.5 | 1.83 | 5 | 99.9 ± 0.1 | 1.783 ± 0.001 | 0.4 | -0.047 | |
| 2017.2795 | 08136+1023 | BU 204 | -008+010 W | -008+010 W | 2004 | 292.0 | 0.80 | 5 | 291.0 ± 0.9 | 0.773 ± 0.003 | -1.0 | -0.027 | * |
| 2017.2740 | 08138+0159 | BU 1244 | +043-056 W | +043-056 W | 2005 | 10.8 | 0.98 | 5 | 5.8 ± 0.1 | 1.033 ± 0.001 | -5.0 | 0.053 | * |
| 2017.2795 | 08138+1538 | PRT 3 | -022+045 W | -022+045 W | 2015 | 339.7 | 1.50 | 5 | 338.7 ± 0.0 | 1.506 ± 0.002 | -1.0 | 0.006 | |
| 2017.2712 | 08140-1740 | HU 1249 | +026-028 W | +026-028 W | 2003 | 122.2 | 0.73 | 5 | 124.2 ± 1.7 | 0.910 ± 0.012 | 2.0 | 0.180 | * |
| 2017.2986 | 08296+5203 | HDS1213 AaAb | -087+025 W | -087+025 W | 2015 | 323.0 | 0.90 | 5 | 321.8 ± 0.0 | 1.019 ± 0.001 | -1.2 | 0.119 | * |
| 2017.2986 | 08298+5112 | STF1225 | +004+001 G | +003-002 G | 2008 | 189.4 | 3.68 | 5 | 192.3 ± 0.0 | 3.759 ± 0.001 | 2.9 | 0.079 | * |
| 2017.2740 | 08330+0958 | A 2895 | +007-037 W | +007-037 W | 1991 | 57.3 | 0.81 | 5 | 55.9 ± 1.3 | 0.768 ± 0.021 | -1.4 | -0.042 | |
| 2017.2712 | 08331-1257 | A 2365 | -005+006 W | -005+006 W | 2005 | 282.1 | 1.29 | 5 | 282.3 ± 0.7 | 1.363 ± 0.007 | 0.2 | 0.073 | |
| 2017.2740 | 08339+0135 | STF1243 | -002-004 W | -002-004 W | 2008 | 233.2 | 1.74 | 5 | 232.8 ± 0.0 | 1.724 ± 0.001 | -0.4 | -0.016 | |
| 2017.2986 | 08342+5655 | STF1235 | -014-029 G | -014-033 W | 1996 | 85.4 | 1.50 | 5 | 88.3 ± 0.2 | 1.529 ± 0.005 | 2.9 | 0.029 | * |
| 2017.2795 | 08421+2501 | J 1110 | -046-018 G | -042-021 G | 2012 | 41.6 | 3.36 | 5 | 41.5 ± 0.0 | 3.424 ± 0.001 | -0.1 | 0.064 | * |
| 2017.2877 | 08432+3849 | BU 209 | +036+016 G | +035+008 W | 2012 | 8.3 | 1.25 | 5 | 8.2 ± 0.1 | 1.278 ± 0.001 | -0.1 | 0.028 | * |
| 2017.2795 | 08437+1654 | A 2546 | +019-007 W | +019-007 W | 2010 | 215.5 | 1.70 | 5 | 218.6 ± 0.1 | 1.243 ± 0.001 | 3.1 | -0.457 | * |
| 2017.2795 | 08444+1555 | A 2472 | -002-016 W | -002-016 W | 2012 | 262.7 | 0.80 | 5 | 260.8 ± 0.2 | 0.810 ± 0.001 | -1.9 | 0.010 | * |
| 2017.2712 | 08453-0236 | STF1270 | +001-010 G | +004-013 W | 2013 | 264.4 | 4.61 | 5 | 264.5 ± 0.3 | 4.699 ± 0.004 | 0.1 | 0.089 | * |
| 2017.2740 | 08461+0748 | J 735 | -097+054 G | -099+053 W | 2014 | 339.7 | 2.79 | 5 | 339.2 ± 0.3 | 2.818 ± 0.013 | -0.5 | 0.028 | * |
| 2017.2877 | 08466+3829 | STF1259 | -049-059 G | -050-058 U | 2010 | 341.5 | 5.00 | 5 | 340.5 ± 0.0 | 5.102 ± 0.004 | -1.0 | 0.102 | * |
| 2017.2740 | 08482+0235 | BU 335 | -023-037 G | -023-038 W | 2013 | 265.5 | 2.74 | 5 | 264.6 ± 0.0 | 2.607 ± 0.004 | -0.9 | -0.133 | * |

*Table 3 continues on next page.*

**Measurements of 427 Double Stars With Speckle Interferometry ...**

*Table 3 (continued): Common Proper Motion Pairs (CPM) Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.2877 | 08500+3935 | STF1279 | +073-007 G | +073-015 W | 2013 | 87.0 | 1.25 | 5 | 87.4 ± 0.1 | 1.277 ± 0.002 | 0.4 | 0.027 | * |
| 2017.2877 | 08505+2308 | AG 157 | -047+013 U | -045+016 G | 2013 | 75.2 | 2.27 | 5 | 74.8 ± 0.0 | 2.295 ± 0.001 | -0.4 | 0.022 | * |
| 2017.2877 | 08508+3504 | STF1282AB | -174+114 W | -174+114 W | 2014 | 277.6 | 3.50 | 5 | 277.8 ± 0.0 | 3.518 ± 0.003 | 0.2 | 0.018 | * |
| 2017.2740 | 08512+0820 | PER 1 | -005-006 W | -005-006 W | 2015 | 353.7 | 0.84 | 5 | 350.0 ± 0.4 | 0.838 ± 0.017 | -3.7 | -0.002 | |
| 2017.2712 | 08516-0711 | BU 587AB | -053-017 W | -053-017 W | 2003 | 120.6 | 1.15 | 5 | 121.2 ± 0.6 | 1.186 ± 0.023 | 0.6 | 0.036 | * |
| 2017.2712 | 08518-1108 | SCJ 11 | -005-002 W | -005-002 W | 2008 | 353.2 | 2.16 | 5 | 353.0 ± 0.0 | 2.282 ± 0.002 | -0.2 | 0.122 | |
| 2017.2712 | 08538-0035 | STF1292AB | -043+044 G | -043+043G | 2004 | 188.1 | 5.93 | 5 | 188.5 ± 0.2 | 6.082 ± 0.003 | 0.4 | 0.152 | * |
| 2017.2740 | 08542-0846 | BU 24 | -009+001 G | -012-003 W | 2014 | 174.8 | 1.17 | 5 | 174.0 ± 0.2 | 1.179 ± 0.002 | -0.8 | 0.009 | * |
| 2017.2986 | 08548+4335 | STF1289 | -057-153 G | -055-154 W | 2015 | 7.0 | 3.70 | 5 | 6.6 ± 0.0 | 3.700 ± 0.001 | -0.4 | 0.000 | * |
| 2017.2740 | 08549-0749 | BU 103 | -008-002 G | -002-005 W | 2014 | 74.6 | 3.22 | 5 | 71.9 ± 0.1 | 3.008 ± 0.005 | -2.7 | -0.212 | * |
| 2017.2986 | 08561+4341 | STF3120 | +014-005 W | +014-005 W | 2015 | 1.0 | 1.40 | 5 | 0.7 ± 0.0 | 1.393 ± 0.001 | -0.3 | -0.007 | * |
| 2017.2795 | 08571+1045 | A 2968 | -034-027 W | -034-027 W | 2015 | 132.4 | 1.11 | 5 | 132.3 ± 0.0 | 1.177 ± 0.002 | -0.1 | 0.067 | |
| 2017.2740 | 08598-0607 | RST4427 | -001-017 W | -001-017 W | 1991 | 340.6 | 0.57 | 5 | 334.0 ± 0.3 | 0.588 ± 0.009 | -6.6 | 0.018 | * |
| 2017.2877 | 09016-0832 | A 3071 | -070-025 W | -070-025 W | 2004 | 335.3 | 1.27 | 5 | 336.1 ± 0.3 | 1.318 ± 0.006 | 0.8 | 0.048 | * |
| 2017.2877 | 09020+0240 | BU 211 | -006-003 G | -005-010 W | 2006 | 268.4 | 1.10 | 5 | 268.2 ± 0.1 | 1.125 ± 0.002 | -0.2 | 0.025 | * |
| 2017.3096 | 09033+4740 | HU 720 | -017-011 W | -017-011 W | 2015 | 140.0 | 0.70 | 5 | 135.6 ± 0.3 | 0.781 ± 0.011 | -4.4 | 0.081 | * |
| 2017.3096 | 09071+3037 | AG 162 | +029-039 G | +030-039 G | 2007 | 106.8 | 4.01 | 5 | 106.6 ± 0.1 | 4.114 ± 0.013 | -0.2 | 0.104 | * |
| 2017.3260 | 09080+8102 | STF1284 | -054-016 U | -050-031 W | 2012 | 167.8 | 2.58 | 5 | 168.3 ± 0.1 | 2.484 ± 0.003 | 0.5 | -0.096 | * |
| 2017.2877 | 09095+0256 | STT 197 | -016-037 W | -016-037 W | 2000 | 66.3 | 1.43 | 5 | 64.5 ± 0.1 | 1.438 ± 0.001 | -1.8 | 0.008 | * |
| 2017.2740 | 09101-1507 | A 3073 | -014-001 G | -026-010 W | 1991 | 347.0 | 1.80 | 5 | 348.9 ± 0.6 | 1.856 ± 0.005 | 1.9 | 0.056 | * |
| 2017.3096 | 09103+5223 | STF1312 | -012-014 G | -014-014 W | 2010 | 149.0 | 4.50 | 5 | 148.2 ± 0.0 | 4.766 ± 0.004 | -0.8 | 0.266 | * |
| 2017.2740 | 09118-1649 | BU 336 | -017+005 W | -017+005 W | 1991 | 239.3 | 1.79 | 5 | 240.0 ± 0.1 | 1.933 ± 0.003 | 0.7 | 0.143 | * |
| 2017.2877 | 09122-0729 | A 2972 | -037+014 U | -038+015 U | 2011 | 340.5 | 4.26 | 5 | 340.6 ± 0.1 | 4.363 ± 0.004 | 0.1 | 0.103 | |
| 2017.3014 | 09127+1632 | STF1322 | +002-006 G | +001-003 W | 2015 | 53.0 | 1.72 | 5 | 53.4 ± 0.2 | 1.748 ± 0.001 | 0.4 | 0.028 | * |
| 2017.2986 | 09149+0413 | BU 455 | +039-050 W | +039-050 W | 2002 | 69.3 | 1.84 | 5 | 68.1 ± 0.0 | 1.845 ± 0.000 | -1.2 | 0.005 | * |
| 2017.2877 | 09161-0821 | BU 212 | -047-000 G | -043-011 W | 2011 | 198.4 | 1.60 | 5 | 198.0 ± 0.0 | 1.627 ± 0.002 | -0.4 | 0.027 | * |
| 2017.2877 | 09168-0050 | RST4906 | -011-003 W | -011-003 W | 1991 | 153.4 | 0.73 | 5 | 154.0 ± 0.2 | 0.842 ± 0.013 | 0.6 | 0.112 | * |
| 2017.2740 | 09186-1712 | A 3076 | +000-001 W | +000-001 W | 2003 | 282.8 | 1.04 | 5 | 285.2 ± 0.3 | 1.071 ± 0.014 | 2.4 | 0.031 | |
| 2017.3096 | 09188+3648 | STF1334AB | -033-124 W | - | 2014 | 223.6 | 2.54 | 5 | 223.0 ± 0.1 | 2.620 ± 0.005 | -0.6 | 0.080 | |
| 2017.2795 | 09188-1025 | A 125AB | -022+004 G | -020+001 W | 2012 | 30.9 | 3.02 | 5 | 30.4 ± 0.0 | 3.048 ± 0.003 | -0.5 | 0.028 | * |
| 2017.3260 | 09208+6121 | STF1331AB | -016+010 W | -016+010 W | 2010 | 151.9 | 0.90 | 5 | 152.5 ± 0.4 | 0.941 ± 0.019 | 0.6 | 0.041 | * |
| 2017.3096 | 09210+3643 | STF1339 | -003+009 W | -003+009 W | 2015 | 65.0 | 1.40 | 5 | 64.9 ± 0.2 | 1.485 ± 0.008 | -0.1 | 0.085 | |
| 2017.3014 | 09233+2211 | AG 165 | -008+000 W | -008+000 W | 2015 | 15.2 | 1.27 | 5 | 15.5 ± 1.2 | 1.381 ± 0.071 | 0.3 | 0.111 | |
| 2017.3096 | 09235+3908 | STF1344 | -014-032 G | -020-030 W | 2014 | 103.2 | 3.72 | 5 | 102.9 ± 0.0 | 3.815 ± 0.002 | -0.3 | 0.095 | * |
| 2017.3014 | 09239+2754 | STT 201AB | -005-040 W | -005-040 W | 2015 | 207.0 | 1.24 | 5 | 206.1 ± 0.4 | 1.373 ± 0.021 | -0.9 | 0.133 | * |

*Table 3 continues on next page.*

## Measurements of 427 Double Stars With Speckle Interferometry ...

*Table 3 (continued): Common Proper Motion Pairs (CPM) Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.3096 | 09256+5401 | STF1346AB | -036-022 G | -038-023 W | 2014 | 315.3 | 5.77 | 5 | 314.0 ± 0.0 | 5.762 ± 0.004 | -1.3 | -0.008 | * |
| 2017.2877 | 09269-0315 | A 128 | -041-028 W | -041-028 W | 1997 | 262.5 | 1.30 | 5 | 262.1 ± 0.3 | 1.335 ± 0.004 | -0.4 | 0.035 | |
| 2017.3014 | 09277+1545 | STF1353 | -022-019 U | -020-019 U | 2010 | 126.0 | 3.26 | 5 | 125.1 ± 0.3 | 3.315 ± 0.020 | -0.9 | 0.055 | * |
| 2017.2877 | 09296-0307 | BU 591 | -002-004 G | +000-006 W | 1997 | 30.4 | 0.86 | 5 | 28.6 ± 0.2 | 0.967 ± 0.009 | -1.8 | 0.107 | * |
| 2017.3096 | 09300+4216 | A 1985 | -029-039 W | -029-039 W | 2015 | 24.0 | 1.60 | 5 | 23.2 ± 0.0 | 1.670 ± 0.002 | -0.8 | 0.070 | * |
| 2017.2795 | 09310-1544 | BU 339 | -047+025 W | -047+025 W | 2001 | 247.3 | 1.25 | 5 | 248.8 ± 0.1 | 1.211 ± 0.007 | 1.5 | -0.039 | * |
| 2017.2986 | 09315+0128 | STF1365 | -011-030 W | -011-030 W | 2012 | 157.1 | 3.44 | 5 | 156.4 ± 0.1 | 3.456 ± 0.002 | -0.7 | 0.016 | * |
| 2017.2795 | 09338-1020 | A 131AB | -091-001 W | -091-001 W | 2014 | 324.3 | 0.90 | 5 | 323.6 ± 0.5 | 0.954 ± 0.043 | -0.7 | 0.054 | |
| 2017.2795 | 09400-1710 | STN 19AB | +001-019 U | -002-022 U | 2012 | 263.9 | 2.71 | 5 | 261.9 ± 0.3 | 2.791 ± 0.035 | -2.0 | 0.081 | |
| 2017.2795 | 09415-1829 | BU 214AB | +007-010 W | +007-010 W | 2002 | 243.0 | 3.62 | 5 | 242.1 ± 0.1 | 3.749 ± 0.011 | -0.9 | 0.129 | * |
| 2017.3096 | 09450+4314 | STF1376AB | -009-119 W | -008-100 G | 2014 | 310.0 | 5.30 | 5 | 309.3 ± 0.1 | 5.371 ± 0.007 | -0.7 | 0.071 | |
| 2017.3260 | 09460+7643 | STF1373 | -009-119 W | -008-100 G | 2012 | 135.5 | 1.89 | 5 | 137.1 ± 0.2 | 2.168 ± 0.003 | 1.6 | 0.278 | * |
| 2017.3096 | 09476+5057 | HU 630 | +008-005 U | +005-001 U | 2013 | 72.6 | 2.24 | 5 | 74.0 ± 0.1 | 2.200 ± 0.001 | 1.4 | -0.040 | |
| 2017.3260 | 09509+5812 | KR 33 | -014-083 W | -014-083 W | 2005 | 213.4 | 2.06 | 5 | 214.0 ± 0.2 | 2.082 ± 0.006 | 0.6 | 0.022 | |
| 2017.3014 | 09521+1628 | STF1390AB | -004+002 W | -004+002 W | 2010 | 206.9 | 2.22 | 5 | 206.6 ± 0.3 | 2.223 ± 0.023 | -0.3 | 0.003 | |
| 2017.3260 | 09551+6854 | STF1386AB | -010-002 G | -006-001 W | 2012 | 110.5 | 2.10 | 5 | 110.7 ± 0.3 | 2.183 ± 0.013 | 0.2 | 0.083 | * |
| 2017.3096 | 09572+4554 | STF1394 | -024-086 G | -025-085 W | 2013 | 249.2 | 4.59 | 5 | 250.5 ± 0.0 | 4.525 ± 0.004 | 1.3 | -0.065 | * |
| 2017.3260 | 09591+8023 | STF1380 | +003-003 W | +003-003 W | 1991 | 25.8 | 1.65 | 5 | 21.6 ± 0.7 | 1.736 ± 0.028 | -4.2 | 0.086 | * |
| 2017.2959 | 10040+3239 | HU 631 | -039+005 W | -039+005 W | 2015 | 255.1 | 0.70 | 5 | 257.5 ± 0.1 | 0.800 ± 0.001 | 2.4 | 0.100 | * |
| 2017.2959 | 10056+3105 | STF1406 | -045-013 W | -045-013 W | 2015 | 221.0 | 0.80 | 5 | 219.1 ± 0.1 | 0.728 ± 0.009 | -1.9 | -0.072 | * |
| 2017.3315 | 10076+0621 | WEI 23 | +006+002 U | +010-001 U | 2011 | 314.6 | 3.33 | 5 | 314.3 ± 0.0 | 3.396 ± 0.001 | -0.3 | 0.066 | |
| 2017.2959 | 10114+7302 | STF1408 | +014+014 G | +013+015 U | 2011 | 13.3 | 3.71 | 5 | 12.7 ± 0.0 | 3.782 ± 0.002 | -0.6 | 0.072 | * |
| 2017.2822 | 10151+1907 | STF1417 | -031-005 W | -018+001 W | 2013 | 77.2 | 2.33 | 5 | 76.6 ± 0.0 | 2.376 ± 0.001 | -0.6 | 0.046 | * |
| 2017.3397 | 10163+3309 | HU 634 | +003+018 W | +003+018 W | 2010 | 169.3 | 1.95 | 5 | 169.4 ± 0.1 | 1.984 ± 0.003 | 0.1 | 0.034 | |
| 2017.2822 | 10180+1711 | A 2369 | -004+001 G | -003+002 W | 2010 | 296.7 | 1.09 | 5 | 295.7 ± 0.5 | 1.031 ± 0.007 | -1.0 | -0.059 | * |
| 2017.2822 | 10181+2731 | STF1421 | +001-020 G | +001-020 W | 2012 | 330.9 | 4.54 | 5 | 330.3 ± 0.0 | 4.601 ± 0.002 | -0.6 | 0.061 | * |
| 2017.2795 | 10206-1621 | HLD 103 | +023-024 G | -019-024 W | 2001 | 344.0 | 1.76 | 5 | 343.3 ± 0.1 | 1.738 ± 0.007 | -1.0 | -0.022 | * |
| 2017.2959 | 10234+2630 | A 1990 | -001+001 W | -001+001 W | 2015 | 290.5 | 1.48 | 5 | 290.1 ± 0.0 | 1.511 ± 0.000 | -0.4 | 0.031 | * |
| 2017.2795 | 10256+0847 | STF1431 | -013-002 G | -011-005 W | 2012 | 73.7 | 3.56 | 5 | 73.5 ± 0.0 | 3.586 ± 0.001 | -0.2 | 0.026 | * |
| 2017.2959 | 10260+5237 | STF1428 | -125-040 G | -131-044 W | 2012 | 87.4 | 2.88 | 5 | 88.3 ± 0.0 | 2.810 ± 0.003 | 0.9 | -0.066 | * |
| 2017.2959 | 10321+8136 | TDS 594 | -049-045 U | -051-043 U | 2011 | 104.2 | 2.86 | 5 | 103.0 ± 0.1 | 2.894 ± 0.002 | -1.2 | 0.034 | * |
| 2017.2959 | 10333+3740 | STF1443 | +011-075 G | +010-079 U | 2010 | 160.1 | 5.43 | 5 | 160.7 ± 0.0 | 5.313 ± 0.008 | 0.6 | -0.117 | * |
| 2017.2822 | 10336+1513 | STF1446 | +012-007 G | +012-008 U | 2013 | 250.5 | 5.50 | 5 | 249.6 ± 0.0 | 5.601 ± 0.003 | -0.9 | 0.101 | * |
| 2017.2959 | 10338+2321 | STF1447 | -046-005 G | -047-004 W | 2011 | 124.4 | 4.44 | 5 | 123.9 ± 0.0 | 4.463 ± 0.001 | -0.5 | 0.023 | * |
| 2017.2795 | 10391-1735 | HLD 108AB | -004-002 W | -004-002 W | 2005 | 26.5 | 0.97 | 5 | 22.8 ± 0.1 | 0.981 ± 0.004 | -3.7 | 0.011 | |

*Table 3 continues on next page.*

**Measurements of 427 Double Stars With Speckle Interferometry ...**

*Table 3 (continued): Common Proper Motion Pairs (CPM) Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.2959 | 10402+3824 | STF1459 | -027-015 G | -028-016 W | 2014 | 152.1 | 5.33 | 5 | 152.2 ± 0.0 | 5.423 ± 0.004 | 0.1 | 0.093 | * |
| 2017.2822 | 10417+1044 | STT 227 | +020-001 W | +020-001 W | 2010 | 2.9 | 0.89 | 5 | 1.9 ± 0.2 | 0.903 ± 0.003 | -1.0 | 0.013 | * |
| 2017.2959 | 10447+2042 | STF1468 | +040-012 G | +038-012 U | 2010 | 334.5 | 4.24 | 4 | 333.5 ± 0.0 | 4.265 ± 0.001 | -1.0 | 0.025 | * |
| 2017.2795 | 10462-0546 | STF1470 | -015+005 G | -022+002 W | 2005 | 193.7 | 1.40 | 5 | 190.8 ± 0.2 | 1.459 ± 0.004 | -2.9 | 0.059 | * |
| 2017.2959 | 10473+2235 | STT 228 | -037-001 W | -037-001 W | 2015 | 170.4 | 0.62 | 5 | 169.9 ± 0.7 | 1.650 ± 0.003 | -0.5 | 1.035 | * |
| 2017.3315 | 10512-0906 | BU 111AB | -003-001 G | -004+001 G | 2013 | 4.8 | 3.40 | 5 | 4.2 ± 0.1 | 3.282 ± 0.004 | -0.6 | -0.118 | * |
| 2017.2795 | 10575-1105 | A 1770AB-C | -011+018 W | -011+018 W | 2012 | 8.7 | 4.51 | 5 | 8.0 ± 0.1 | 4.561 ± 0.002 | -0.7 | 0.051 | * |
| 2017.3397 | 11023+3049 | STF1501 | -047-042 W | -047-042 W | 2015 | 186.0 | 1.30 | 5 | 184.5 ± 0.1 | 1.317 ± 0.002 | -1.5 | 0.017 | * |
| 2017.3616 | 11024+8313 | STF1479 | -025-021 W | -022-013 W | 2011 | 25.4 | 4.46 | 5 | 24.7 ± 0.3 | 4.588 ± 0.013 | -0.7 | 0.128 | * |
| 2017.3397 | 11050+3825 | HO 378 | -065-031 W | -065-031 W | 2015 | 236.0 | 1.00 | 5 | 236.6 ± 0.0 | 1.092 ± 0.002 | 0.6 | 0.092 | * |
| 2017.3397 | 11137+4105 | HO 50 | -014+016 G | -014+016 W | 2003 | 35.1 | 3.03 | 5 | 35.0 ± 0.1 | 3.005 ± 0.001 | -0.1 | -0.025 | * |
| 2017.3397 | 11151+3735 | STT 232AB | +003-005 W | +003-005 W | 2014 | 246.0 | 0.70 | 5 | 243.2 ± 0.6 | 0.604 ± 0.004 | -2.8 | -0.096 | * |
| 2017.3315 | 11154+2734 | STF1521 | -035+001 G | -036+001 W | 2013 | 96.3 | 3.65 | 5 | 97.6 ± 0.0 | 3.705 ± 0.006 | 1.3 | 0.055 | * |
| 2017.3616 | 11156+5947 | STF1519 | -029-015 G | -027-018 W | 2015 | 290.0 | 1.40 | 5 | 289.0 ± 0.9 | 1.485 ± 0.019 | -1.0 | 0.085 | * |
| 2017.3562 | 11195+4728 | STF1525 | -003-008 G | -004-005 W | 2010 | 174.0 | 4.00 | 5 | 173.2 ± 0.1 | 2.285 ± 0.006 | -0.8 | -1.715 | * |
| 2017.3616 | 11328+6004 | KR 38 | +004+004 G | +009+005 U | 2014 | 52.3 | 2.78 | 5 | 52.6 ± 0.5 | 2.802 ± 0.013 | 0.3 | 0.022 | * |
| 2017.4027 | 11329+5525 | A 1593 | -025-003 G | -026-002 U | 2011 | 255.0 | 4.00 | 5 | 255.4 ± 0.0 | 4.177 ± 0.003 | 0.4 | 0.177 | * |
| 2017.3562 | 11332+4927 | HU 727 | -023-021 W | -023-021 W | 2014 | 205.0 | 1.20 | 5 | 205.2 ± 0.0 | 1.253 ± 0.001 | 0.2 | 0.053 | |
| 2017.3315 | 11367+2128 | STF1558AB | -061-030 W | -061-030 W | 2010 | 165.1 | 1.28 | 5 | 168.2 ± 0.1 | 1.265 ± 0.008 | 3.1 | -0.015 | * |
| 2017.3562 | 11371+4040 | A 1996 | -016+013 W | -016+013 W | 2014 | 190.0 | 2.00 | 5 | 188.9 ± 0.2 | 1.988 ± 0.001 | -1.1 | -0.012 | * |
| 2017.3616 | 11388+6421 | STF1559 | +018+006 W | +018+006 W | 2013 | 322.9 | 1.96 | 5 | 323.6 ± 0.0 | 1.974 ± 0.005 | 0.7 | 0.014 | * |
| 2017.2795 | 11438+1831 | BRT2412 | -147+010 G | -157-004 W | 2015 | 291.9 | 4.95 | 5 | 290.9 ± 0.1 | 4.886 ± 0.008 | -1.0 | -0.064 | * |
| 2017.3562 | 11517+4449 | HJ 842 | -067-010 G | -067-011 W | 2010 | 88.6 | 3.15 | 5 | 88.9 ± 0.0 | 3.104 ± 0.011 | 0.3 | -0.046 | * |
| 2017.3397 | 11529+3050 | STF1576 | -067+024 G | -066+026 W | 2013 | 241.1 | 5.18 | 5 | 241.2 ± 0.0 | 5.369 ± 0.002 | 0.1 | 0.189 | * |
| 2017.3562 | 11551+4629 | STF1579AB-C | -010-003 W | -010-003 W | 2014 | 42.0 | 3.90 | 5 | 41.8 ± 0.1 | 3.882 ± 0.005 | -0.2 | -0.018 | * |
| 2017.3726 | 11561+4533 | STF1581 | -024-006 G | -026-007 W | 2012 | 169.9 | 2.39 | 5 | 170.6 ± 0.0 | 2.459 ± 0.003 | 0.7 | 0.069 | * |
| 2017.3397 | 11563+3527 | STT 241 | -097+010 G | -085-023 W | 2011 | 145.5 | 1.83 | 5 | 146.6 ± 0.1 | 1.830 ± 0.006 | 1.1 | 0.000 | * |
| 2017.3616 | 11598+5324 | STT 243 | -044-020 W | -044-020 W | 2015 | 8.0 | 1.10 | 5 | 8.2 ± 0.0 | 1.169 ± 0.001 | 0.2 | 0.069 | |
| 2017.3397 | 12005-1517 | A 2162 | -026+023 G | -026+0221 W | 1999 | 151.9 | 1.41 | 5 | 149.4 ± 0.4 | 1.716 ± 0.019 | -2.5 | 0.306 | * |
| 2017.4055 | 12120+6836 | STF1611 | +006-003 G | +004-002 W | 2000 | 5.0 | 1.80 | 5 | 4.1 ± 0.0 | 1.890 ± 0.001 | -0.9 | 0.090 | * |
| 2017.3616 | 12137+7826 | HU 891 | -001-087 G | +002-075 W | 1999 | 13.0 | 2.73 | 5 | 12.0 ± 0.1 | 2.808 ± 0.002 | -1.0 | 0.078 | * |
| 2017.3726 | 12167+3004 | AG 176 | +010-068 G | +011-064 U | 2001 | 185.3 | 2.65 | 5 | 183.7 ± 0.1 | 2.336 ± 0.005 | -1.6 | -0.314 | * |
| 2017.3836 | 12189+5622 | STF1630 | -011-013 W | -011-013 W | 2004 | 169.0 | 2.40 | 5 | 171.1 ± 0.0 | 2.542 ± 0.001 | 2.1 | 0.142 | |
| 2017.3562 | 12207+2255 | STF1634 | -072-029 W | -072-029 W | 2014 | 147.2 | 5.08 | 5 | 147.3 ± 0.0 | 5.380 ± 0.011 | 0.1 | 0.300 | * |
| 2017.3397 | 12217+0333 | HU 737 | +028-057 G | +028-057 U | 2013 | 56.6 | 2.64 | 5 | 55.8 ± 0.1 | 2.648 ± 0.010 | -0.8 | 0.008 | * |

*Table 3 continues on next page.*

**Measurements of 427 Double Stars With Speckle Interferometry ...**

*Table 3 (continued): Common Proper Motion Pairs (CPM) Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.3836 | 12257+4444 | STF1642 | -071-005 G | -072-004 W | 2012 | 179.4 | 2.53 | 5 | 179.6 ± 0.1 | 2.488 ± 0.004 | 0.2 | -0.042 | * |
| 2017.3397 | 12311+0207 | AG 178 | -008-014 W | -008-014 W | 2005 | 284.2 | 1.33 | 5 | 285.5 ± 0.4 | 1.314 ± 0.005 | 1.3 | -0.016 | |
| 2017.3616 | 12321+7449 | STF1654 | -010-008 G | -010-007 W | 2006 | 22.8 | 3.77 | 5 | 22.5 ± 0.0 | 3.834 ± 0.000 | -0.3 | 0.064 | * |
| 2017.3589 | 12396+6440 | STF1667AB | +017-010 W | +017-010 W | 2015 | 38.0 | 1.10 | 5 | 40.2 ± 0.1 | 1.244 ± 0.003 | 2.2 | 0.144 | |
| 2017.3836 | 12406+4017 | HJ 2617AB | -020+062 G | -020+063 W | 2010 | 2.0 | 5.70 | 5 | 2.5 ± 0.0 | 5.762 ± 0.004 | 0.5 | 0.062 | * |
| 2017.3589 | 12427+3349 | STF1672 | +000-006 G | +004-004 U | 2013 | 313.0 | 4.30 | 5 | 312.7 ± 0.1 | 4.393 ± 0.015 | -0.3 | 0.093 | * |
| 2017.3397 | 12438+0733 | STF1674 | +001+009 W | +001+009 W | 2013 | 173.5 | 2.38 | 5 | 172.9 ± 0.0 | 2.322 ± 0.003 | -0.6 | -0.058 | * |
| 2017.3836 | 12460+4949 | STF1679AB | +013+003 G | +013+001 U | 2013 | 207.0 | 5.90 | 5 | 208.0 ± 0.0 | 5.909 ± 0.004 | 1.0 | 0.009 | * |
| 2017.3397 | 12533+1310 | HU 894 | +003-029 W | +003-029 W | 2011 | 145.2 | 1.19 | 5 | 143.1 ± 0.1 | 1.237 ± 0.002 | -2.1 | 0.047 | * |
| 2017.3589 | 12563+5406 | STF1695AB | -062-002 W | -087+003 W | 2015 | 282.0 | 3.60 | 5 | 280.6 ± 0.1 | 3.867 ± 0.004 | -1.4 | 0.267 | * |
| 2017.3616 | 12564-0057 | STT 256 | +027-092 W | +027-092 W | 2013 | 101.0 | 1.10 | 5 | 100.7 ± 0.0 | 1.057 ± 0.001 | -0.3 | -0.043 | * |
| 2017.3589 | 12574+3022 | STF1696 | -022-006 G | -020-006 W | 2014 | 203.2 | 3.53 | 5 | 203.7 ± 0.1 | 3.651 ± 0.004 | 0.5 | 0.121 | * |
| 2017.3644 | 12587+2728 | STF1699 | -122-104 G | -128-103 W | 2014 | 8.0 | 1.70 | 5 | 8.7 ± 0.1 | 1.650 ± 0.023 | 0.7 | -0.050 | * |
| 2017.3616 | 12592+8256 | STF1720 | -018+001 W | -018+001 W | 2009 | 329.3 | 1.62 | 5 | 329.4 ± 0.0 | 1.701 ± 0.001 | 0.1 | 0.081 | |
| 2017.4055 | 13007+7343 | HJ 2633 | -038-111 G | -043-112 G | 2013 | 90.3 | 4.67 | 5 | 91.4 ± 0.0 | 4.633 ± 0.001 | 1.1 | -0.037 | * |
| 2017.4027 | 13026+5625 | KR 41 | +022+012 G | -025+008 U | 2003 | 333.8 | 3.68 | 5 | 334.0 ± 0.0 | 3.614 ± 0.002 | 0.2 | -0.066 | * |
| 2017.4247 | 13034-0626 | BU 928AB | -021-023 W | - | 2011 | 318.8 | 2.41 | 5 | 318.7 ± 0.1 | 2.523 ± 0.006 | -0.1 | 0.113 | |
| 2017.4055 | 13048+7302 | BU 799AB | -019+010 W | -017+013 W | 2013 | 265.1 | 1.39 | 5 | 266.9 ± 0.3 | 1.343 ± 0.012 | 1.8 | -0.047 | * |
| 2017.4055 | 13128+4030 | A 1606 | -062+007 W | -062+007 W | 2012 | 16.8 | 1.27 | 5 | 16.8 ± 0.1 | 1.297 ± 0.003 | 0.0 | 0.270 | |
| 2017.4055 | 13166+5034 | STT 263 | -045+023 W | -051+031 W | 2011 | 135.8 | 1.72 | 5 | 137.9 ± 0.0 | 1.735 ± 0.004 | 2.1 | 0.015 | * |
| 2017.3562 | 13207+0257 | STF1734 | -060-012 W | -060-012 W | 2014 | 174.0 | 1.10 | 5 | 173.1 ± 0.6 | 1.069 ± 0.011 | -0.9 | -0.031 | * |
| 2017.3562 | 13243+0124 | STF1742 | -026-014 W | -026-014 W | 2012 | 356.0 | 0.90 | 5 | 357.0 ± 0.1 | 0.940 ± 0.001 | 1.0 | 0.040 | * |
| 2017.4164 | 13261+3509 | A 1855 | +005+020 G | +001+020 U | 2011 | 291.5 | 3.58 | 5 | 290.9 ± 0.1 | 3.691 ± 0.006 | -0.6 | 0.111 | * |
| 2017.4055 | 13288+5956 | STF1752AB | -084+031 W | -084+031 W | 2010 | 107.9 | 0.97 | 5 | 107.4 ± 0.3 | 0.973 ± 0.005 | -0.5 | 0.003 | * |
| 2017.4164 | 13324+3649 | STF1755 | -019-022 G | +018-020 W | 2012 | 129.9 | 4.21 | 5 | 129.6 ± 0.0 | 4.185 ± 0.005 | -0.3 | -0.025 | * |
| 2017.4055 | 13341+6746 | STF1767 | -180+021 G | -180+019 U | 2013 | 344.5 | 4.22 | 5 | 344.8 ± 0.0 | 4.143 ± 0.010 | 0.3 | -0.077 | * |
| 2017.3644 | 13344+2617 | STF1760 | +010+001 G | +009+001 U | 2007 | 64.0 | 8.70 | 5 | 64.2 ± 0.0 | 8.824 ± 0.001 | 0.2 | 0.124 | * |
| 2017.3644 | 13346+3308 | BU 933AB | +049-055 G | +049-054 W | 2011 | 22.0 | 2.70 | 5 | 22.7 ± 0.1 | 2.827 ± 0.003 | 0.7 | 0.127 | * |
| 2017.4027 | 13354+5955 | KR 42 | -071+023 G | -070+022 G | 2011 | 215.4 | 3.73 | 5 | 216.6 ± 0.0 | 3.723 ± 0.002 | 1.2 | -0.007 | * |
| 2017.4055 | 13356+4939 | AG 190 | +007-002 G | +007-006 G | 2011 | 12.8 | 2.56 | 5 | 13.3 ± 0.0 | 2.619 ± 0.003 | 0.5 | 0.059 | * |
| 2017.4055 | 13367+6947 | STF1771 | -019+032 W | -019+032 W | 2013 | 82.9 | 1.79 | 5 | 82.8 ± 0.1 | 1.786 ± 0.004 | -0.1 | -0.004 | * |
| 2017.4164 | 13368+0650 | A 1611 | -048+002 W | -048+002 W | 2010 | 121.7 | 0.86 | 5 | 120.7 ± 1.0 | 0.885 ± 0.011 | -1.0 | 0.025 | * |
| 2017.4055 | 13377+5043 | STF1770 | -012+004 G | -016+004 W | 2012 | 126.0 | 1.77 | 5 | 123.0 ± 0.2 | 1.669 ± 0.006 | -3.0 | -0.101 | * |
| 2017.4027 | 13509+4422 | A 1613AB | -075+031 U | -076+028 U | 2011 | 260.7 | 3.10 | 5 | 261.4 ± 0.1 | 3.136 ± 0.004 | 0.7 | 0.036 | * |
| 2017.4164 | 13563+0517 | STT 273AB | +045-059 W | +045-059 W | 2014 | 112.2 | 1.01 | 5 | 111.7 ± 0.4 | 0.972 ± 0.002 | -0.5 | -0.038 | * |

*Table 3 continues on next page.*

**Measurements of 427 Double Stars With Speckle Interferometry ...**

*Table 3 (continued): Common Proper Motion Pairs (CPM) Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.4055 | 13571+3426 | BU 937 | -040+020 W | -040+020 W | 2011 | 135.3 | 1.03 | 5 | 136.6 ± 0.1 | 1.052 ± 0.003 | 1.3 | 0.022 | * |
| 2017.4164 | 13591+2549 | STF1793 | +011-005 G | +004-003 W | 2015 | 241.3 | 4.64 | 5 | 242.0 ± 0.0 | 4.854 ± 0.002 | 0.7 | 0.214 | * |
| 2017.4164 | 14033+0557 | HWE 29AB | -103+009 W | -103+009 W | 2012 | 235.8 | 1.28 | 5 | 235.2 ± 0.1 | 1.421 ± 0.000 | -0.6 | 0.014 | * |
| 2017.4466 | 14101+2636 | STF1808AB | -173-055 W | -173-055 W | 2011 | 81.0 | 2.60 | 5 | 82.8 ± 0.1 | 2.624 ± 0.001 | 1.8 | 0.024 | * |
| 2017.4247 | 14116+2802 | STF1810 | -027+047 G | -026+044 W | 2013 | 183.7 | 2.36 | 5 | 183.7 ± 0.0 | 2.392 ± 0.000 | 0.0 | 0.032 | * |
| 2017.4411 | 14143+3356 | STF1818 | -108+029 G | -104+028 U | 2013 | 330.1 | 5.50 | 5 | 330.5 ± 0.0 | 5.473 ± 0.003 | 0.4 | -0.027 | * |
| 2017.4247 | 14158+1018 | STF1823AB-C | +119-193 U | +119-193 W | 2012 | 147.0 | 3.84 | 5 | 146.7 ± 0.0 | 3.933 ± 0.001 | -0.3 | 0.093 | |
| 2017.4164 | 14203+0835 | STT 281 | +014-022 W | +014-022 W | 2010 | 165.6 | 1.50 | 5 | 165.6 ± 0.4 | 1.456 ± 0.006 | 0.0 | -0.044 | |
| 2017.4164 | 14270+0341 | STF1842 | -052-069 W | -057-090 W | 2010 | 198.0 | 2.74 | 5 | 197.0 ± 0.0 | 2.743 ± 0.001 | -1.0 | 0.003 | * |
| 2017.4411 | 14279+2123 | HO 543 | +042-095 G | -044-095 U | 2010 | 236.9 | 4.59 | 5 | 237.5 ± 0.0 | 4.669 ± 0.000 | 0.6 | 0.079 | * |
| 2017.4027 | 14339+5514 | STF1860 | -011+014 W | -011+014 W | 2011 | 112.3 | 0.99 | 5 | 112.3 ± 0.1 | 1.045 ± 0.004 | 0.0 | 0.055 | * |
| 2017.4466 | 14363+1924 | STF3087 | -004-008 W | -004-008 G | 2005 | 222.1 | 2.25 | 5 | 222.9 ± 0.3 | 2.378 ± 0.007 | 0.8 | 0.128 | * |
| 2017.4466 | 14403+1206 | HWE 34 | -056-005 G | -054-005 G | 2012 | 12.8 | 2.58 | 5 | 12.4 ± 0.1 | 2.599 ± 0.008 | -0.4 | 0.019 | * |
| 2017.4247 | 14417+0932 | STF1866 | -050+024 W | -050+024 W | 2010 | 203.5 | 0.74 | 5 | 205.0 ± 0.3 | 0.742 ± 0.003 | 1.5 | 0.002 | * |
| 2017.4027 | 14436+3745 | STF1875 | -024+052 U | -024+050 G | 2012 | 128.1 | 3.04 | 5 | 129.4 ± 0.1 | 3.085 ± 0.001 | 1.3 | 0.045 | |
| 2017.4247 | 14471+0058 | STF1881 | -028-029 W | -028-029 W | 2011 | 0.3 | 3.44 | 5 | 0.0 ± 0.0 | 3.462 ± 0.001 | -0.3 | 0.022 | * |
| 2017.4466 | 14524+1757 | A 2071 | -029-012 W | -029-012 W | 2011 | 270.0 | 1.40 | 5 | 272.9 ± 0.1 | 1.295 ± 0.021 | 2.9 | -0.105 | * |
| 2017.4411 | 14531+7811 | HU 908AB | -013-002 G | -011-002 W | 2012 | 237.3 | 1.52 | 5 | 236.3 ± 0.3 | 1.590 ± 0.008 | -1.0 | 0.070 | * |
| 2017.4027 | 14545+3406 | STF1891 | -067+044 G | -067+045 W | 2010 | 246.6 | 3.58 | 4 | 247.8 ± 0.0 | 3.519 ± 0.001 | 1.2 | -0.061 | * |
| 2017.4027 | 14584+4403 | STF1896AB | -061-068 G | -058-069 W | 2013 | 277.0 | 4.05 | 5 | 277.6 ± 0.0 | 4.091 ± 0.002 | 0.6 | 0.041 | * |
| 2017.4493 | 15058+5841 | A 1114 | -020+034 W | -020+034 W | 2010 | 285.6 | 1.22 | 5 | 286.1 ± 0.4 | 1.225 ± 0.005 | 0.5 | 0.005 | |
| 2017.4247 | 15087-0059 | STF3090AB | +030-096 W | +030-096 W | 2010 | 286.3 | 0.62 | 5 | 287.2 ± 0.7 | 0.627 ± 0.024 | 0.9 | 0.007 | * |
| 2017.4438 | 15126+1523 | STF1917 | -005-009 G | -008-012 U | 2011 | 232.9 | 2.52 | 5 | 232.6 ± 0.1 | 2.448 ± 0.008 | -0.3 | -0.072 | * |
| 2017.4438 | 15138+1427 | STF1923AB | -056-012 G | -054-014 W | 2010 | 11.6 | 4.64 | 5 | 11.3 ± 0.2 | 4.841 ± 0.008 | -0.3 | 0.201 | * |
| 2017.4247 | 15227-1654 | HU 307 | -012-001 G | -014+000 W | 1999 | 2.7 | 2.94 | 5 | 2.4 ± 0.0 | 2.959 ± 0.001 | -0.3 | 0.019 | * |
| 2017.4466 | 15257+2638 | STF1941 | +016-005 G | -018-007 W | 2014 | 212.0 | 1.40 | 5 | 212.2 ± 0.0 | 1.397 ± 0.002 | 0.2 | -0.003 | * |
| 2017.4247 | 15264+0822 | A 1119 | -012-002 W | -012-002 W | 2012 | 178.5 | 1.57 | 5 | 179.7 ± 0.9 | 1.796 ± 0.026 | 1.2 | 0.226 | * |
| 2017.4247 | 15276+0522 | STF1943 | -031-028 G | -031-031 W | 2014 | 148.0 | 4.93 | 5 | 147.2 ± 0.2 | 5.093 ± 0.025 | -0.8 | 0.163 | * |
| 2017.4466 | 15300+2530 | STF1950 | -004+007 W | -005+008 W | 2013 | 91.3 | 3.37 | 5 | 91.8 ± 0.0 | 3.338 ± 0.002 | 0.5 | -0.032 | * |
| 2017.4493 | 15361+4849 | HU 652 | -020-012 W | -020-012 W | 2011 | 185.1 | 1.12 | 5 | 185.9 ± 0.0 | 1.158 ± 0.001 | 0.8 | 0.038 | * |
| 2017.4493 | 15361+5531 | A 1124 | -001+055 G | -003+056 W | 2012 | 143.2 | 1.38 | 5 | 143.3 ± 0.2 | 1.458 ± 0.003 | 0.1 | 0.078 | * |
| 2017.4247 | 15391-0834 | STF3094 | -102-016 G | -108-024 W | 2010 | 297.4 | 2.49 | 5 | 296.4 ± 0.0 | 2.575 ± 0.001 | -1.0 | 0.085 | * |
| 2017.4466 | 15398+2117 | AG 197 | +022-024 G | +021-026 U | 2010 | 126.7 | 3.11 | 5 | 126.8 ± 0.0 | 3.183 ± 0.006 | 0.1 | 0.073 | * |
| 2017.4247 | 15443-1943 | HU 654 | -029-024 W | -029-024 W | 1991 | 11.7 | 1.08 | 5 | 14.2 ± 0.8 | 1.079 ± 0.021 | 2.5 | -0.001 | |
| 2017.4438 | 15453+0432 | AG 198 | +003-015 W | +002-016 W | 2013 | 144.4 | 2.25 | 5 | 144.3 ± 0.1 | 2.249 ± 0.005 | -0.1 | -0.001 | * |

*Table 3 concludes on next page.*

## Measurements of 427 Double Stars With Speckle Interferometry ...

*Table 3 (conclusion): Common Proper Motion Pairs (CPM) Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.4247 | 15470-1908 | HU 656 | -004-009 U | -004-009 W | 2002 | 16.9 | 1.36 | 5 | 15.0 ± 0.8 | 1.484 ± 0.007 | -1.9 | 0.124 | |
| 2017.4247 | 15492-0314 | STF1974 | -007-002 G | -006-001 G | 2009 | 158.7 | 2.43 | 5 | 157.7 ± 0.2 | 2.467 ± 0.021 | -1.0 | 0.370 | * |
| 2017.4493 | 15499+4247 | STF1982 | -032+025 G | -033+027 U | 2008 | 298.0 | 4.94 | 5 | 299.5 ±0.1 | 4.903 ±0.002 | 1.5 | -0.037 | * |
| 2017.4466 | 15509+1911 | A 2078 | -015-016 W | -015-016 W | 2010 | 166.3 | 1.09 | 5 | 165.3 ± 0.2 | 1.14 ± 0.008 | -1.0 | 0.050 | * |
| 2017.4247 | 15589-0304 | STF3101 | -237+042 G | -237-042 W | 2009 | 73.4 | 2.22 | 5 | 72.7 ± 0.0 | 2.200 ± 0.001 | -0.7 | -0.020 | * |
| 2017.4438 | 16179-0724 | A 23 | -013-006 W | -013-006 W | 1999 | 69.6 | 1.89 | 5 | 71.6 ± 0.3 | 1.95 ± 0.011 | 2.0 | 0.060 | |
| 2017.4438 | 16394-0306 | BU 820AB | -060+039 G | -059+040 W | 2010 | 235.2 | 4.25 | 5 | 234.6 ± 0.1 | 4.414 ± 0.003 | -0.6 | 0.164 | * |
| 2017.4438 | 16462-1721 | SKI 10 | -023-017 G | -027-017 U | 2014 | 84.8 | 3.37 | 5 | 84.0 ± 0.3 | 3.434 ± 0.008 | -0.8 | 0.064 | * |

### Notes to Table 3 (CPM Pairs)

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 02123+2357AB | 27.3 ± 1.19 | H | 37 | 65 | 4 | The PM vector (331°, 1.8"), shown as an orange line on the plot, is a rough fit to data. |
| 02214+0853 | 8.31 ± 0.81 | H | 120 | 184 | - | |
| 02244+1130 | 5.39 ± 0.29 | G | 186 | 529 | - | |
| 02429-0629 | 8.13 ± 0.27 | G | 123 | 221 | 5 | A short arc might be forming. |
| 02447-0158 | 3.94 ± 0.26 | G | 254 | 1,469 | - | Very tight clustering of data on the plot. |
| 02527+0628 | 5.10 ± 0.90 | H | 196 | 531 | - | Tight grouping. |
| 03051+2755 | - | - | - | - | - | The PM vector (32°, 2.3") does not fit the observations. This suggests that one (or both) of the PM vectors may be wrong. All of the measurements (except one from 1914) fall within a 0.5" region. |
| 03088+3528 | 7.83 ± 0.34 | G | 128 | 484 | - | |
| 03242+1733 | 9.49 ± 3.48 | H | N/A | N/A | - | The Hipparcos parallax has an error that exceeds 25%. |
| 03258-1304 | 2.63 ± 0.42 | G | 380 | 529 | - | |
| 03312+1947 | 9.2 ± 0.32 | G | 109 | 249 | - | The PM vector (193°, 2.4") is right for theta, but twice the value for rho. The data plot is showing an emerging trend that may lead to a short arc binary. |
| 03545-1243 | 1.95 ± 0.73 | G | N/A | N/A | - | The Gaia parallax has an error that exceeds 25%. |
| 03554+1738 | 3.79 ± 0.25 | G | 264 | 1,045 | - | |
| 04024-0700 | 10.91 ± 0.23 | G | 92 | 282 | - | |
| 04059+1058 | 7.98 ± 0.42 | G | 125 | 363 | - | |
| 04160+0027 | 7.11 ± 0.35 | G | 141 | 462 | - | |
| 04409+0058AB | 3.71 ± 0.41 | G | 270 | 1,469 | - | |
| 04448+0517AB | 25.56 ± 0.24 | G | 39 | 178 | 6 | This pair is trending towards a short arc binary. |
| 04551-0033AB-C | 2.87 ± 0.27 | G | 648 | 1,530 | - | |
| 05030-0840 | 5.31 ± 0.69 | G | 188 | 678 | - | |

Notes to Table 3 (CPM Pairs) continued

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 05079+0824 | A: 18.91 ± 0.28<br>B: 18.67 ± 0.48 | G<br>G | 53 | 127 | - | A weighted parallax (18.79 mas) was used. The parallax bars overlap 51%. Given the nearly identical proper motions (of moderately high value), this pair is probably physical. |
| 05118+0102 | 5.12 ± 1.07 | H | 195 | 328 | - | |
| 05147-0704 | 2.59 ± 0.46 | G | 386 | 1,629 | - | |
| 05152+0826 | 10.32 ± 0.30 | G | 97 | 452 | - | |
| 05162-0329 | 5.09 ± 1.14 | H | 196 | 132 | - | |
| 05177+0441 AB | 5.21 ± 0.24 | G | 192 | 696 | - | |
| 05204-0805 AB | 6.10 ± 0.37 | G | 164 | 108 | - | Tight grouping of data points, but a trend may be starting to form. |
| 05217-0203 | 4.17 ± 0.26 | G | 240 | 839 | - | |
| 05231+0103 | 3.52 ± 0.51 | G | 284 | 1,403 | - | |
| 05231-0806 | 4.43 ± 0.89 | H | 2,326 | 142 | 7 | A very strong trend is emerging in the data. |
| 05252+0155 | 1.84 ± 1.10 | H | N/A | N/A | - | Hipparcos parallax is not usable (error too large). |
| 05265+0256 AB | 6.86 ± 0.89 | H | 146 | 461 | - | |
| 05312+0318 AB | 2.87 ± 0.84 | H | N/A | N/A | - | Hipparcos parallax is not usable (error too large). |
| 05314-0206 AB | 2.49 ± 0.27 | H | N/A | N/A | - | Hipparcos parallax is not usable (error too large). |
| 05355-0422 | 2.77 ± 0.82 | H | N/A | N/A | - | Hipparcos parallax is not usable (error too large). |
| 05381-0011 AB | 3.72 ± 1.25 | H | N/A | N/A | - | Hipparcos parallax is not usable (error too large). |
| 05457-1447 | | | | | 8 | Trend forming. |
| 05495-1234 | | | | | - | Only 4 measurements. |
| 05514-1139 | 2.71 ± 0.88 | H | N/A | N/A | - | Hipparcos parallax is not usable (error too large). |
| 06041-1541 | B: 3.28 ± 0.92 | H | N/A | N/A | - | Hipparcos parallax is not usable (error too large). |
| 06049-0243 AB | A: 2.27 ± 0.28<br>B: 2.52 ± 0.38 | G<br>G | 418 | 2,065 | - | A weighted parallax (2.39 mas) was used. The overlap in the parallaxes is 98%. This pair is probably physical. But no trend can yet be seen in the data plot; the past measurements are all very tightly clustered together. |
| 06074-0400 AB | A: 4.53 ± 0.27<br>B: 4.04 ± 0.27 | G<br>G | 233 | 471 | - | A weighted parallax (4.29 mas) was used. The overlap in the parallaxes is only 5%. Yet Gaia has identical proper motions for this pair. Despite the weak indicator provided by the parallaxes, the pair does indeed appear to be physical. |
| 06167-1203 | 6.98 ± 0.45 | G | 143 | 260 | - | |
| 06238-1947 | 2.43 ± 0.59 | H | 412 | 325 | - | |
| 06252-1056 | 5.37 ± 1.01 | H | 186 | 314 | - | |
| 06372-1415 | A: 5.63 ± 0.31<br>B: 5.69 ± 0.27 | G<br>G | 177 | 712 | - | A weighted parallax (5.66 mas) was used. There is an overlap of 98% in the parallax windows. Given that these two stars have the same (albeit small) proper motion, they are most likely a physical pair. However, the plot of the measurements shows a very tight clustering with no apparent trend showing. |
| 06420-1600 | 2.47 ± 0.40 | G | 405 | 1,599 | - | |
| 06484-1326 AB | 7.75 ± 0.78 | H | 129 | 156 | - | |

**Measurements of 427 Double Stars With Speckle Interferometry ...**

Notes to Table 3 (CPM Pairs) continued

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 06488-1613 | 5.57 ± 0.31 | G | 180 | 591 | - | |
| 06573-1005 | 18.29 ± 0.25 | G | 55 | 79 | - | |
| 08042-0151 | 3.54 ± 0.62 | G | 282 | 486 | - | Tightly grouped data plot. |
| 08046+5445 | 2.44 ± 0.29 | G | 410 | 680 | - | |
| 08091+3714 | 12.39 ± 0.37 | G | 81 | 100 | - | |
| 08101+0403 | A: 7.30 ± 0.63<br>B: 4.67 ± 0.30 | G<br>G | 137<br>214 | | | There is absolutely no overlap in the parallax windows. On the basis of parallax alone, this pair would not be physical, as the stars are (by parallax) 77 parsecs apart. Yet the proper motion data suggests a physical connection. This star needs more observations, but not on a frequent schedule. 114 years of observations yields a cluster of data that fits inside a 0.50" circle. |
| 08109-0455 | 2.96 ± .049 | G | 338 | 483 | 9 | A trend (perhaps short arc binary?) is emerging. |
| 08136+1023 | 5.70 ± 1.07 | H | 175 | 140 | - | |
| 08138+0159 | 7.02 ± 0.67 | H | 142 | 140 | 10 | This pair is one of those cases where the last measurement produces a high residual. The data plot shows an emerging short arc. |
| 08140-1740 | - | - | - | - | 11 | Very interesting case. This pair is showing a very strong linear pattern, but given the identical proper motions, we may be seeing a nearly edge-on short arc orbit (a large orbit would appear linear as the companion passes the primary). The $R^2$ value shown on the chart is generated by Excel using the Trend Line function and represents the fit of the trend line to the data. 1.00 is a perfect fit, and this system is showing an $R^2$ value of 0.9569, an extremely high correlation. Note, however, that Excel assigns equal weight to all of the data in the sample, something that would not actually be done when analyzing an orbit (or linear case). |
| 08296+5203AaAb | - | - | - | - | - | Only 5 measurements. |
| 08298+5112 | A: 4.62 ± 0.49<br>B: 3.85 ± 0.24 | G<br>G | 216<br>260 | - | - | There is no overlap in the parallax windows. |
| 08342+5655 | 5.17 ± 0.33 | G | 193 | 290 | 12 | This pair may be starting to exhibit a short arc. |
| 08421+2501 | A: 5.91 ± 0.37<br>B: 5.94 ± 0.38 | G<br>G | 169 | 567 | | A weighted parallax of 5.92 mas was used. There is a 98% overlap in the parallax windows. Given the nearly identical (and significant) proper motions, this pair is most likely physical. |
| 08432+3849 | 7.72 ± 0.93 | G | 130 | 161 | - | |
| 08437+1654 | - | - | - | - | 13 | Linear trend, $R^2$ = 0.8735. This pair could be an edge-on short arc binary. |
| 08444+1555 | - | - | - | - | - | Evn1980.159 appears to be a quadrant reversal. |
| 08453-0236 | 12.51 ± 0.32 | G | 80 | 369 | - | Very tight grouping of measurements. |
| 08461+0748 | 13.64 ± 0.34 | G | 73 | 205 | - | |
| 08466+3829 | 4.71 ± 0.26 | G | 212 | 1,062 | - | Very tight grouping of measurements. |
| 08482+0235 | 7.30 ± 0.33 | G | 133 | 375 | - | Very tight grouping of measurements. |
| 08500+3935 | 7.87 ± 0.54 | G | 127 | 159 | 14 | Trend forming. PM vector (180°, 1.5") does not fit observations. |
| 08505+2308 | B: 5.45 ± 0.50 | G | 183 | 417 | - | A trend is beginning to emerge. |

## Measurements of 427 Double Stars With Speckle Interferometry ...

Notes to Table 3 (CPM Pairs) continued

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 08508+3504 AB | 18.41 ± 0.26 | G | 54 | 190 | - | |
| 08516-0711 AB | 7.31 ± 0.60 | H | 137 | 157 | - | |
| 08538-0035 AB | A: 6.22 ± 0.50<br>B: 5.20 ± 0.32 | G<br>G | 161<br>192 | - | - | The stars are probably not physical. But the proper motions are identical. Puzzling case. |
| 08542-0846 | 2.44 ± 0.24 | G | 410 | 480 | - | |
| 08548+4335 | 18.55 ± 0.29 | G | 54 | 201 | - | |
| 08549-0749 | 3.97 ± 0.30 | G | 252 | 811 | - | Manual solution with STB. (Companion star had to be selected manually since STB's automatic detection rou-tine failed to find it.) |
| 08561+4341 | 4.80 ± 1.03 | H | 208 | 280 | - | |
| 08598-0607 | - | - | - | - | - | Only 5 measurements. |
| 09016-0832 | - | - | - | - | - | There appear to be several quadrant reversals among the measurements: A 1918.28, A 1922.98, A 1931.72, B 1937.27, Wor 1980.254 and Wor 1983.156. |
| 09020+0240 | 4.71 ± 0.53 | G | 212 | 234 | - | A vague trend seems to be shaping up. |
| 09033+4740 | 6.56 ± 1.49 | H | 152 | 111 | - | |
| 09071+3037 | A: 6.32 ± .038<br>B: 6.26 ± 0.44 | G<br>G | 159 | 638 | - | Weighted parallax (6.29 mas) used. 85% overlap in the parallax values. |
| 09080+8102 | 4.06 ± 0.61 | H | 246 | 635 | 15 | Trend emerging. PM vector (195°, 2.8") does not match the observations. |
| 09095+0256 | 6.07 ± 0.66 | H | 165 | 236 | - | |
| 09101-1507 | 3.39 ± 0.44 | G | 295 | 532 | - | |
| 09103+5223 | 2.47 ± 0.34 | G | 405 | 2,000 | 16 | Trend forming. |
| 09118-1649 | - | - | - | - | 17 | Trend forming. |
| 09127+1632 | 3.49 ± 0.35 | G | 287 | 516 | - | |
| 09149+0413 | 3.21 ± 1.16 | H | N/A | N/A | - | The error in the Hipparcos parallax is too large to make the measurement usable. |
| 09161-0821 | 4.78 ± 0.42 | G | 209 | 335 | - | |
| 09168-0050 | - | - | - | - | 18 | Short but pronounced linear trend. May be a nearly edge -on short arc binary? |
| 09188-1025 AB | 5.98 ± 0.46 | G | 167 | 505 | - | |
| 09208+6121 AB | 4.84 ± 1.15 | H | 207 | 185 | - | |
| 09235+3908 | 5.16 ± 0.49 | G | 194 | 721 | - | |
| 09239+2754 AB | 6.40 ± 1.01 | H | 156 | 191 | - | |
| 09256+5401 AB | 5.56 ± 0.32 | G | 180 | 1,038 | - | High residual due to CTT2014.282 having higher theta than the mean. My measurement plots well with the mean. |
| 09277+1545 | - | - | - | - | - | Phl1934.12 appears to be a quadrant reversal. |
| 09296-0307 | 2.94 ± 0.27 | G | 340 | 313 | - | |
| 09300+4216 | 7.39 ± 1.14 | H | 135 | 213 | 19 | Trending linear, but with identical proper motions, this may be a short piece of an arc. Cll1980 appears to be a quadrant reversal. |
| 09310-1544 | 7.59 ± 0.96 | H | 132 | 165 | - | This pair may be starting to show a short arc. Very rough and difficult to be sure. |
| 09315+0128 | 10.45 ± 1.29 | H | 96 | 329 | - | |

Notes to Table 3 (CPM Pairs) continued

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 09415-1829 | 18.09 ± 1.86 | H | 55 | 55 | - | Scattered grouping. Is Tok2010 a measurement of the wrong star? |
| 09450+7643 | A: 7.67 ± 1.11<br>B: 8.78 ± 0.29 | H<br>G | 121 | 229 | - | A weighted parallax of 8.26 mas was used, and the parallax windows have a 10% overlap. Probably a physical pair, despite the significant difference in proper motions. Cll 1979.999 looks like a quadrant reversal. |
| 09551+6854AB | 6.33 ± 0.26 | G | 158 | 332 | - | A weak trend is starting to show. |
| 09572+4554 | 14.05 ± 0.41 | G | 71 | 327 | - | |
| 09591+8023 | 4.57 ± 0.77 | H | 219 | 360 | - | |
| 10040+3239 | 13.08 ± 1.03 | H | 76 | 64 | - | |
| 10056+3105 | 4.66 ± 1.50 | H | N/A | N/A | 20 | The error is too large to make the Hipparcos parallax usable. A short arc is forming. |
| 10114+7302 | 7.48 ± 0.27 | G | 134 | 496 | - | |
| 10151+1907 | - | - | - | - | 21 | Tight grouping. The PM vector (65°, 2.6") does not fit the observations. |
| 10180+1711 | 1.78 ± 0.62 | G | N/A | N/A | - | The error in the parallax measurement makes the parallax unusable. |
| 10181+2731 | 3.77 ± 0.28 | G | 265 | 1,205 | - | Tight grouping with five wide outliers. |
| 10206-1621 | 4.76 ± 0.66 | G | 210 | 370 | - | |
| 10234+2630 | - | - | - | - | 22 | Definite trend developing. |
| 10256+0847 | 6.08 ± 0.29 | G | 164 | 587 | - | |
| 10260+5237 | 12.62 ± 0.51 | G | 79 | 221 | 23 | Definite trend forming. |
| 10321+8136 | - | - | - | - | - | Only 4 measurements. |
| 10333+3740 | 7.03 ± 0.24 | G | 142 | 772 | - | |
| 10336+1513 | 5.85 ± 0.79 | G | 171 | 940 | - | Tight grouping. |
| 10338+2321 | 6.70 ± 0.40 | G | 149 | 663 | - | |
| 10402+3824 | 3.14 ± 0.27 | G | 318 | 1,697 | - | Tight grouping. |
| 10417+1044 | - | - | - | - | - | May be trending to a short arc binary. |
| 10447+2042 | 7.81 ± 0.29 | G | 128 | 549 | - | |
| 10462-0546 | 2.62 ± 0.92 | G | N/A | N/A | 24 | The error is too large to make the parallax usable. The PM vector (247°, 1.3") matches observations closely. The may be a QR in BAB1933.26. |
| 10473+2235 | 6.32 ± 1.20 | H | 158 | 97 | 25 | Manual solution. The data may be starting to reveal a short arc. |
| 10512-0906AB | A: 5.20 ± 0.45<br>B: 4.42 ± 0.50 | G<br>G | 208 | 706 | - | Weighted parallax of 4.82 mas. There is a 10% overlap in the error windows. Given the CPM, this pair is probably physical. |
| 10575-1105AB-C | -1.10 ± 3.04 | H | N/A | N/A | - | The error is too large to make the parallax usable. |
| 11023+3049 | - | - | - | - | 26 | Strong trend developing. |
| 11024+8313 | 7.59 ± 1.13 | H | 132 | 588 | - | The PM vector (21°, 1.5") does not align well with the observations. The data cluster fits inside a 0.5" region. |
| 11050+3825 | 7.35 ± 1.05 | H | 136 | 147 | 27 | A strong trend is developing. |
| 11137+4105 | 8.24 ± 0.23 | G | 121 | 368 | - | |
| 11151+3735AB | 3.18 ± 1.17 | H | N/A | N/A | - | The error is too large to make the parallax usable. |
| 11154+2734 | 8.06 ± 0.59 | G | 124 | 453 | - | |
| 11156+5947 | 4.58 ± 0.23 | G | 218 | 317 | - | Starting to develop a loose trend in the data plot. |
| 11195+4728 | 3.97 ± 0.29 | G | 252 | 574 | - | |
| 11328+6004 | 3.45 ± 0.55 | G | 290 | 806 | - | |
| 11329+5525 | 4.23 ± 0.25 | G | 236 | 957 | - | |
| 11388+6421 | 4.74 ± 0.57 | H | 211 | 413 | 28 | |
| 11438+1831 | 19.78 ± 0.30 | G | 51 | 250 | - | |
| 11517+4449 | 6.06 ± 0.22 | G | 165 | 520 | - | |

**Measurements of 427 Double Stars With Speckle Interferometry ...**

Notes to Table 3 (CPM Pairs) continued

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 11529+3050 | 6.38 ± 0.25 | G | 157 | 812 | - | |
| 11551+4629AB-C | 4.72 ± 0.58 | H | 212 | 784 | - | |
| 11561+4533 | 3.55 ± 0.38 | G | 282 | 672 | - | |
| 11563+3527 | 7.41 ± 0.40 | G | 135 | 247 | - | Scattered data plot that is beginning to converge on a trend. |
| 12005-1517 | 7.89 ± 0.43 | G | 127 | 179 | - | Weak trend may be starting to emerge. |
| 12120+6836 | 4.9 ± 0.55 | G | 204 | 376 | - | |
| 12137+7826 | 8.12 ± 0.29 | G | 123 | 336 | 29 | The PM vector (14°, 1.2") does not match the observations. |
| 12167+3004 | 14.36 ± 0.30 | G | 70 | 185 | - | |
| 12207+2255 | 3.50 ± 1.16 | H | N/A | N/A | - | The error makes the parallax unusable. |
| 12217+0333 | 10.36 ± 0.32 | G | 97 | 255 | - | |
| 12257+4444 | 4.93 ± 0.30 | G | 203 | 513 | - | |
| 12321+7449 | 4.17 ± 0.23 | G | 240 | 904 | - | |
| 12406+4017AB | 15.39 ± 0.29 | G | 65 | 373 | - | |
| 12427+3349 | 3.66 ± 0.23 | G | 273 | 1,123 | - | |
| 12438+0733 | 5.01 ± 1.64 | H | N/A | N/A | - | The error makes the parallax unusable. |
| 12460+4949AB | 5.21 ± 0.26 | G | 192 | 1,138 | - | |
| 12533+1310 | - | - | - | - | 30 | Strong trend forming. |
| 12563+5406AB | 11.54 ± 0.51 | H | 87 | 329 | 31 | Tight grouping. The PM vector (281°, 4.9") is clearly off. |
| 12564-0057 | 12.56 ± 1.26 | H | 80 | 84 | - | The data plot shows a scattered early history that is beginning to converge on a trend. (This convergence is due to better measurement techniques over the years.) |
| 12574+3022 | 5.16 ± 0.23 | G | 194 | 684 | - | |
| 12587+2728 | 11.20 ± 0.41 | G | 89 | 148 | 32 | This pair may be starting to reveal an arc. |
| 13007+7343 | A: 7.67 ± 1.11<br>B: 8.78 ± 0.29 | G<br>H | 143 | 666 | - | A weighted parallax (7.01 mas) was used. However, the error windows only share a 29% overlap. Yet given the large and common proper motions, this pair is most likely physical. |
| 13026+5625 | 9.94 ± 0.26 | G | 101 | 372 | - | |
| 13048+7302 | 8.32 ± 0.49 | G | 120 | 167 | 33 | Strong trend emerging. |
| 13166+5034 | - | - | - | - | 34 | Solid trend emerging. |
| 13207+0257 | 7.38 ± 0.66 | H | 136 | 151 | - | The trend in the plot shows a tightening of the measurements. |
| 13243+0124 | 9.06 ± 0.81 | H | 110 | 104 | - | |
| 13261+3509 | 9.10 ± 0.26 | G | 110 | 393 | - | |
| 13288+5956 | 13.62 ± 0.65 | G | 73 | 71 | - | The data plot is showing a convergence, but an arc is not yet emerging. |
| 13324+3649 | 3.49 0.29 | G | 287 | 1,205 | - | The PM vector (87°, 6.7") is clearly not correct. |
| 13341+6746 | 13.48 ± 0.25 | G | 74 | 313 | - | |
| 13344+2617 | 8.02 ± 0.32 | G | 125 | 1,087 | - | |
| 13346+3308AB | 9.10 ± 0.30 | G | 110 | 301 | 35 | Short arc emerging? |

Notes to Table 3 (CPM Pairs) continued

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 13354+5955 | A: 11.11 ± 0.23<br>B: 11.19 ± 0.23 | G<br>G | 90 | 335 | - | A weighted average parallax (11.15 mas) was used. The parallax windows have a 50% overlap, with B's window being totally contained inside A's. Given the substantial common proper motion, this pair is likely physical. |
| 13356+4939 | A: 4.60 ± 0.27<br>B: 4.64 ± 0.44 | G<br>G | 216 | 554 | - | The weighted Gaia parallaxes (4.62 mas) were used. The parallax windows show a 39% overlap, with A's window being totally contained in B's. Given the small but almost identical proper motions, this pair is likely physical. |
| 13367+6947 | 10.19 ± 0.95 | H | 98 | 176 | - | |
| 13368+0650 | 4.18 ± 1.79 | H | N/A | N/A | - | The error is too large to make the parallax usable. A weak trend is beginning to emerge. |
| 13377+5043 | 2.05 ± 0.52 | G | N/A | N/A | - | The error is too large to make the parallax usable. |
| 13509+4422AB | 5.05 ± 0.23 | G | 198 | 614 | - | |
| 13563+0517 | 18.22 ± 3.81 | H | 55 | 55 | - | |
| 13571+3426 | 7.12 ± 1.56 | H | 140 | 144 | - | |
| 13591+2549 | 5.09 ± 0.30 | G | 196 | 912 | 36 | The PM vector (286°, 1.4") does not match the observations. |
| 14033+0557AB | - | - | - | - | 37 | Definite trend is showing. |
| 14101+2636 AB | B: 13.86 ± 0.28 | G | 72 | 187 | - | |
| 14116+2802 | 8.80 ± 0.26 | G | 114 | 368 | - | This pair may be starting to exhibit a short arc. |
| 14143+3356 | 11.82 ± 0.24 | G | 85 | 465 | - | |
| 14270+0341 | 10.92 ± 1.59 | H | 92 | 251 | 38 | Tight group. The PM vector (193°, 3.9") is far from the observations. |
| 14279+2123 | 10.69 ± 0.26 | G | 94 | 429 | - | |
| 14339+5514 | 6.57 ± 0.77 | H | 152 | 151 | - | |
| 14363+1924 | B: 7.46 ± 0.27 | G | 134 | 139 | - | Madler's 1854.31 measurement looks like an error. |
| 14403+1206 | A: 4.09 ± 0.27<br>B: 4.1 ± 0.35 | G<br>G | 244 | 630 | - | Weighted parallax (4.09 mas) used, with an overlap in the parallax windows of 79%. Combined with the rather high common proper motion, this pair is physical. |
| 14417+0932 | 2.19 ± 5.27 | H | N/A | N/A | - | The error makes the parallax unusable. |
| 14436+3745 | B: 4.10 ± 0.24 | G | 244 | 259 | - | |
| 14471+0058 | 7.52 ± 1.62 | H | 133 | 457 | - | |
| 14524+1757 | - | - | - | - | - | Definite trend is starting to emerge. |
| 14531+7811AB | 14.73 ± 0.23 | G | 68 | 103 | - | Weak trend may be forming. |
| 14545+3406 | 9.93 ± 0.61 | G | 101 | 361 | - | |
| 14584+4403AB | 9.30 ± 0.33 | G | 108 | 435 | - | |
| 15087-0059AB | 14.17 ± 2.78 | H | 71 | 44 | 39 | Strong trend emerging, but impossible to tell yet if it is linear or short arc. Given the CPM nature, it is probably a small segment of a long arc. |
| 15126+1523 | 7.89 ± 0.25 | G | 127 | 319 | - | |
| 15138+1427AB | 7.03 ± 0.27 | G | 142 | 660 | - | |
| 15227-1654 | 2.73 ± 0.25 | G | 366 | 1,075 | - | |
| 15257+2638 | 5.61 ± 0.69 | G | 178 | 244 | - | |
| 15264+0822 | - | - | - | - | 40 | May be in the early stages of showing a short arc. |
| 15276+0522 | A: 8.64 ± 0.69<br>B: 12.47 ± 0.50 | G<br>G | 116<br>80 | - | - | Based on parallax, the stars are 36 parsecs apart and thus clearly not physical. But with nearly identical proper motions, this pair presents an enigma. Is it physical or not? |
| 15300+2530 | 1.68 ± 0.28 | G | 595 | 2,006 | - | |
| 15361+4849 | 6.88 ± 1.11 | H | 145 | 163 | - | A weak pattern is starting to emerge. |
| 15361+5531 | 7.17 ± 0.25 | G | 139 | 193 | - | |

**Measurements of 427 Double Stars With Speckle Interferometry ...**

Notes to Table 3 (CPM Pairs) conclusion

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 15391-0834 | 7.28 ± 0.75 | G | 137 | 342 | 41 | The PM vector (217°, 1.8") does not fit the observations. |
| 15398+2117 | 3.54 ± 0.25 | G | 282 | 879 | - | |
| 15453+0432 | 4.98 ± 0.30 | G | 201 | 452 | - | A definite trend is emerging, but it is not possible yet to detect an arc. This pair may be involved in a large and nearly edge-on orbit. |
| 15492-0314 | A: 7.15 ± 0.27<br>B: 6.70 ± 0.33 | G<br>G | 144 | 351 | - | Weighted parallax (6.96 mas) used. The parallax windows overlap only 14%. Yet the proper motions are similar. Evidence suggests this is an optical pair, but more or better data is needed. |
| 15499+4247 | 4.24 ± 0.23 | G | 236 | 1,165 | - | |
| 15509+1911 | 2.69 ± 1.40 | H | N/A | N/A | - | The error makes the parallax unusable. |
| 15589-0304 | 13.85 ± 0.24 | G | 72 | 160 | - | |
| 16394-0306AB | 5.52 ± 0.26 | G | 181 | 770 | - | |
| 16462-1721 | 8.94 ± 0.28 | G | 112 | 377 | - | |
| Mean AB separation in AU | | | | 504 | | |

*Table 4: Different Proper Motion Pairs (DPM) Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.0822 | 02062+2507 | STF 212 | -020+029 U | -012-011 W | 2010 | 161.0 | 1.90 | 5 | 160.4 ± 0.0 | 1.961 ± 0.001 | -0.6 | 0.061 | |
| 2017.0767 | 02087-0026 | STF 218 | -042-013 W | -008-001 W | 2009 | 248.0 | 4.90 | 5 | 245.7 ± 0.1 | 4.983 ± 0.009 | -2.3 | 0.083 | * |
| 2017.0795 | 02341-0538 | STF 280 | +032+030 U | +004+095 U | 2012 | 346.0 | 3.70 | 5 | 347.3 ± 0.3 | 3.612 ± 0.013 | 1.3 | -0.088 | * |
| 2017.0767 | 03244-1400 | BU 12 | +031-016 U | +008+006 W | 2001 | 280.6 | 2.40 | 5 | 277.8 ± 0.3 | 2.302 ± 0.020 | -2.8 | -0.098 | * |
| 2017.0822 | 03354+3341 | STF 413 | -052+040 U | +019-006 G | 2010 | 124.7 | 2.38 | 5 | 124.3 ± 0.0 | 2.410 ± 0.001 | -0.4 | 0.030 | * |
| 2017.0822 | 03581-0454 | HLD 70 | +029-013 G | -045-010 W | 2008 | 273.5 | 3.47 | 5 | 272.0 ± 0.1 | 3.504 ± 0.005 | -1.5 | 0.034 | * |
| 2017.0822 | 04222-0441 | STF 536 | +008+001 G | -007-009 W | 2008 | 190.1 | 1.51 | 5 | 190.8 ± 0.2 | 1.561 ± 0.003 | 0.7 | 0.051 | * |
| 2017.2137 | 06512-1126 | HLD 83 | -017+037 W | +002-015 W | 1999 | 163.1 | 2.88 | 5 | 161.4 ± 0.2 | 2.883 ± 0.020 | -1.7 | 0.003 | * |
| 2017.2137 | 06561-1403 | STF 997 AB | +000-011 W | -002+007 W | 2011 | 343.9 | 2.88 | 5 | 343.0 ± 0.1 | 2.851 ± 0.015 | -0.9 | -0.029 | * |
| 2017.2740 | 08054+0550 | STF1182 | -011-006 G | -010-022 U | 2010 | 73.7 | 4.69 | 5 | 73.4 ± 0.1 | 4.767 ± 0.009 | -0.3 | 0.077 | * |
| 2017.2986 | 08298+5112 | STF1225 | +004+001 G | +003-002 G | 2008 | 189.4 | 3.68 | 5 | 192.3 ± 0.0 | 3.759 ± 0.001 | 2.9 | 0.079 | * |
| 2017.2740 | 08555-0758 | STF1295 | +006-026 G | -034+005 U | 2014 | 4.3 | 4.09 | 5 | 3.5 ± 0.0 | 4.068 ± 0.005 | -0.8 | -0.022 | * |
| 2017.3096 | 09051+3931 | AG 160 | +089+028 G | +018-025 W | 2009 | 60.0 | 3.95 | 5 | 59.4 ± 0.1 | 3.908 ± 0.007 | -0.6 | -0.042 | * |
| 2017.3096 | 09136+4659 | STF1318 | -008+001 W | -011-015 W | 2013 | 228.3 | 2.63 | 5 | 228.1 ± 0.0 | 2.632 ± 0.001 | -0.2 | 0.002 | * |
| 2017.2795 | 09318-1126 | HU 127 | +008+000 G | +022+003 W | 1991 | 85.6 | 0.89 | 5 | 84.9 ± 0.2 | 0.881 ± 0.002 | -0.7 | -0.009 | * |
| 2017.3014 | 09556+0806 | AG 170 | -058-069 G | -009-019 W | 2005 | 43.3 | 1.65 | 5 | 42.5 ± 0.5 | 1.692 ± 0.060 | -0.8 | 0.042 | * |
| 2017.4027 | 10406+4209 | STF1460 | -014+030 W | +003-002 W | 2013 | 162.0 | 3.80 | 5 | 162.6 ± 0.0 | 3.818 ± 0.002 | 0.6 | 0.018 | * |
| 2017.2795 | 10533-1045 | A 132 | -012+004 U | -012-007 U | 2011 | 201.0 | 4.41 | 5 | 200.3 ± 0.0 | 4.404 ± 0.008 | -0.7 | -0.006 | |
| 2017.4247 | 13376-0752 | STF1763 AB | -011+001 U | -026-010 W | 2010 | 39.1 | 2.66 | 5 | 38.6 ± 0.0 | 2.694 ± 0.000 | -0.5 | 0.034 | * |
| 2017.4247 | 14083+2112 | STF1804 | -004-004 W | +002-004 W | 2014 | 14.1 | 4.88 | 5 | 13.3 ± 0.2 | 4.843 ± 0.009 | -0.8 | -0.037 | |
| 2017.4411 | 14568+7050 | STF1905 | +032-025 G | -052 -077 U | 2012 | 160.0 | 2.80 | 5 | 161.3 ± 0.0 | 2.815 ± 0.004 | 1.3 | 0.015 | * |
| 2017.4466 | 15208+3459 | HO 62 | +016-005 W | -043+019 W | 2014 | 103.2 | 1.47 | 5 | 103.4 ± 0.1 | 1.526 ± 0.002 | 0.2 | 0.056 | * |

Notes to Table 4 (DPM Pairs)

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 02087-0026 | 7.98 ± 0.32 | G | 125 | 614 | - | |
| 02341-0538 | 5.62 ± 1.22 | H | 178 | 653 | 42 | The PM vector (337°, 12.8") clearly does not reflect the motion. |
| 03244-1400 | - | - | - | - | 43 | The PM vector (313°, 4.1") does not fit observations at all. One (or both) of the PM values is questionable. This pair looks to be CPM from the data plot. |
| 03354+3341 | 6.05 ± 0.44 | G | 165 | 393 | 44 | The PM vector (237°, 15.5") does not match the observations at all. |
| 03581-0454 | 6.66 ± 0.24 | G | 150 | 526 | 45 | The PM vector (272°, 9.3") is clearly not correct. |
| 04222-0441 | 8.21 ± 0.27 | G | 122 | 183 | 46 | Trend emerging. The PM vector (236°, 3.2") does not fit the observed motion. |
| 06512-1126 | - | - | - | - | 47 | The PM vector (200°, 6.48") is clearly incorrect. |
| 06561-1403 AB | 2.62 ± 0.58 | H | 382 | 1,503 | 48 | The PM vector (354°, 3.3") is clearly wrong. |
| 08054+0550 | 3.86 ± 0.49 | G | 259 | 1,215 | 49 | Weak trend. The PM vector (184°, 2.9") does not fit the observations. |
| 08555-0758 | 10.74 ± 0.58 | G | 93 | 381 | - | The PM vector (308°, 11.7") is far from the observations. |
| 09051+3931 | 6.44 ± 0.34 | G | 155 | 613 | 50 | Tight grouping. The PM vector (233°, 10.3") is clearly incorrect. |
| 09136+4659 | 19.07 ± 0.98 | H | 52 | 138 | 51 | Trend forming. The PM vector (191°, 3") does not fit the observations. |
| 09318-1126 | -0.88 ± 0.97 | G | N/A | N/A | - | The parallax is not usable. A short trend is forming. |
| 09556+0806 | -24.82 ± 0.63 | G | N/A | N/A | - | The parallax is not usable. |
| 10406+4209 | 5.38 ± 1.00 | H | 186 | 699 | - | A linear pattern is emerging. |
| 13376-0752 AB | 5.11 ± 0.80 | H | 196 | 521 | 52 | The PM vector (4.22" @ 234°) is clearly incorrect. |
| 14568+7050 | 13.14 ± 0.25 | G | 76 | 213 | 53 | Linear trend. The PM vector (201°, 10") is clearly incorrect. |
| 15208+3459 | 5.61 ± 0.69 | G | 178 | 238 | - | Trend may be emerging. |
| Mean AB separation in AU | | | | 564 | | |

**Measurements of 427 Double Stars With Speckle Interferometry ...**

*Table 5: Linear Pairs Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.0767 | 02493-1033 | STF 315 | +099-020 U | +099-039 W | 2013 | 164.9 | 1.30 | 5 | 164.2 ± 0.1 | 1.427 ± 0.005 | -0.7 | 0.127 | * |
| 2017.0767 | 03061-1326 | BU 527 AB | +000-018 U | -020+013 W | 1998 | 98.1 | 1.28 | 5 | 96.8 ± 0.2 | 1.406 ± 0.022 | -1.3 | 0.126 | * |
| 2017.0822 | 03401+3407 | STF 425 | -135-018 U | -070+006 G | 2012 | 60.4 | 1.94 | 5 | 58.2 ± 0.0 | 1.92 ± 0.001 | -2.2 | -0.020 | * |
| 2017.1507 | 04257-0214 | BU 403 | +058+003 W | +058+003 W | 2015 | 83.3 | 0.95 | 5 | 82.2 ± 0.4 | 0.916 ± 0.014 | -1.1 | 0.916 | * |
| 2017.1644 | 05245-0224 | DA 5 AB | +003-001 W | - | 2015 | 76.5 | 1.81 | 5 | 77.5 ± 0.1 | 1.827 ± 0.003 | 1.0 | 0.017 | * |
| 2017.1671 | 05269+0039 | LEO 2 | +006-013 G | +005-011 G | 2002 | 85.4 | 2.87 | 5 | 85.9 ± 0.5 | 3.243 ± 0.006 | 0.5 | 0.373 | * |
| 2017.2986 | 08194+5627 | STF1205 | +004+020 W | +004+020 W | 2016 | 166.0 | 1.70 | 5 | 166.2 ± 0.3 | 1.801 ± 0.005 | 0.2 | 0.101 | * |
| 2017.2712 | 08430-0242 | HO 355 | -016-028 W | -016-028 W | 2005 | 159.3 | 0.66 | 5 | 152.4 ± 0.1 | 0.805 ± 0.004 | -6.9 | 0.145 | * |
| 2017.2986 | 08593+3457 | STF1296 | +016+001 G | +011-002 G | 2015 | 76.0 | 1.80 | 5 | 76.3 ± 0.0 | 1.753 ± 0.001 | 0.3 | -0.047 | * |
| 2017.3014 | 09521+0249 | A 2561 AB | -058-007 G | -088+018 W | 2005 | 309.5 | 1.06 | 5 | 309.0 ± 0.1 | 1.138 ± 0.009 | -0.5 | 0.078 | * |
| 2017.2959 | 10029+6847 | STF1400 AB | -030-022 G | -031-022 W | 2011 | 225.8 | 3.25 | 5 | 224.8 ± 0.2 | 3.564 ± 0.006 | -1.0 | 0.314 | * |
| 2017.3315 | 11406+2102 | STF1566 | -009-020 G | -010-024 W | 2011 | 350.0 | 2.42 | 5 | 349.1 ± 0.0 | 2.366 ± 0.004 | -0.9 | -0.054 | * |
| 2017.4027 | 14497+4843 | STF1890 | -078+097 W | -078+097 W | 2013 | 46.3 | 2.58 | 5 | 46.7 ± 0.1 | 2.614 ± 0.004 | 0.4 | 0.034 | * |

Notes to Table 5 (Linear Pairs)

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 02493-1033 | 17.45 ± 0.95 | H | 57 | 74 | - | Linear solution by HRT2013. Ephemerides predict 165°, 1.337". Residuals: -0.8°, +0.090". |
| 03061-1326 AB | 8.04 ± 0.98 | H | 124 | 159 | 54 | Strong linear pattern, no solution yet. |
| 03401+3407 | A: 21.73 ± 0.84<br>B: 22.90 ± 0.73 | H<br>G | 45 | 87 | 55 and 56 | The distance and separation assume a weighted parallax of 22.32 mas, with a 16% overlap in the parallax windows. This pair could be physical, but a linear solution by FMR2014 yields ephemerides of 59.8°, 1.755". Curiously, another solution by GnR2015 yields the same ephemerides. The residuals for either case are -1.6°, +0.165". |
| 04257-0214 | 23.4 ± 1.04 | H | 43 | 40 | - | Linear solution by HRT2012 for which the ephemerides project 83.2°, 0.951". The residuals are -1.0°, -0.035". |
| 05245-0224 AB | 3.34 ± 0.07 | H | N/A | N/A | - | The error in the parallax makes it unusable. Linear solution by HRT2012. Ephemerides predict 77.2°, 1.815". Residuals are +0.3°, +0.012". |
| 05269+0039 | A: 4.30 ± 0.22<br>B: 3.94 ± 0.23 | G<br>G | 233<br>254 | 667<br>728 | - | There is no overlap in the parallax windows. There are only six measurements, but a definite linear trend is beginning to emerge. |
| 08194+5627 | - | - | - | - | 57 | No solution yet. A strong linear pattern is forming. |
| 08430-0242 | 6.37 ± 1.39 | H | 157 | 108 | - | A moderately strong linear pattern is emerging. The $R^2$ value is 0.6707. |
| 08593+3457 | A: 10.12 ± 0.26<br>B: 10.65 ± 0.44 | G<br>G | 96 | 179 | 58 | A weighted parallax of 10.38 mas was used. The parallax windows have a 19% overlap. |
| 09521+0249 AB | 27.71 ± 0.72 | G | 36 | 40 | 59 | The PM vector (310°, 3.6") is too long but it does have the correct theta. This is a strong linear case without a solution. |
| 10029+6847 AB | 13.9 ± 0.23 | G | 72 | 234 | - | Linear solution by HRT2011. Ephemerides predict 225.0°, 3.525". Residuals of -0.2°, +0.039". However, this pair has identical proper motions. Is this then a short arc binary? Manual solution with STB. |
| 11406+2102 | 8.38 ± 0.99 | G | 119 | 289 | - | Linear solution by HRT2011. The ephemerides predict 350.5°, 2.377". The residuals are -1.4°, -0.011". |
| 14497+4843 | 14.58 ± 0.51 | G | 69 | 177 | - | Linear solution by HRT2011. The ephemerides predict 45.8°, 2.576". The residuals are +0.9°, +0.038". |
| Mean AB separation in AU | | | | 139 | | |

**Measurements of 427 Double Stars With Speckle Interferometry ...**

*Table 6: Known Orbit Pairs Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.0795 | 02020+0246 | STF 202AB | +042-011 W | +042-011 W | 2012 | 266.0 | 1.70 | 5 | 264.5 ± 0.3 | 1.941 ± 0.007 | -1.5 | 0.241 | * |
| 2017.0822 | 02037+2556 | STF 208AB | +127+012 G | +134+010 W | 2012 | 343.0 | 1.38 | 5 | 343.8 ± 0.5 | 1.410 ± 0.009 | 0.8 | 0.030 | * |
| 2017.0767 | 02158-1814 | HTG 1 | -036-119 G | -052-135 W | 2014 | 162.5 | 1.97 | 5 | 164.1 ± 0.2 | 2.020 ± 0.024 | 1.6 | 0.050 | * |
| 2017.0822 | 02475+1922 | STF 305AB | +118-160 W | +118-159 G | 2012 | 306.5 | 3.60 | 5 | 306.5 ± 0.1 | 3.675 ± 0.004 | 0.0 | 0.075 | * |
| 2017.0822 | 03122+3713 | STF 360 | +069-017 U | -030-027 U | 2011 | 125.6 | 2.79 | 5 | 124.3 ± 0.0 | 2.931 ± 0.001 | -1.3 | 0.141 | * |
| 2017.0822 | 03356+3141 | BU 533AB | +067+003 W | +061-000 G | 2012 | 220.9 | 1.05 | 5 | 220.4 ± 0.1 | 1.048 ± 0.001 | -0.5 | -0.002 | * |
| 2017.1507 | 04199+1631 | STT 79 | +114-030 W | - | 2012 | 358.1 | 0.51 | 5 | 3.3 ± 1.5 | 0.525 ± 0.021 | 5.2 | 0.015 | * |
| 2017.1644 | 05005+0506 | STT 93 | +035-038 W | +035-038 W | 2014 | 243.5 | 1.61 | 5 | 243.6 ± 0.0 | 1.632 ± 0.003 | 0.1 | 0.022 | * |
| 2017.1644 | 05079+0830 | STT 98 | +022-061 W | +022-061 W | 2015 | 286.0 | 0.90 | 5 | 286.1 ± 0.2 | 0.952 ± 0.004 | 0.1 | 0.052 | * |
| 2017.1671 | 05135+0158 | STT 517AB | +007+002 W | +007+002 W | 2014 | 243.0 | 0.69 | 5 | 240.2 ± 0.6 | 0.693 ± 0.004 | 0.2 | 0.003 | * |
| 2017.1616 | 05239-0052 | WNC 2A-BC | -007+001 G | -005-009 W | 2016 | 159.6 | 3.00 | 5 | 158.3 ± 0.0 | 3.166 ± 0.003 | -0.5 | 0.166 | * |
| 2017.1671 | 05308+0557 | STF 728 | +005-042 W | +005-042 W | 2013 | 44.9 | 1.28 | 5 | 43.4 ± 0.1 | 1.279 ± 0.002 | -1.5 | -0.001 | * |
| 2017.1671 | 05407-0157 | STF 774AB | +004+003 W | +004+003 W | 2013 | 167.1 | 2.36 | 5 | 165.9 ± 0.2 | 2.377 ± 0.013 | -1.2 | 0.017 | * |
| 2017.1671 | 05417-0254 | BU 1052 | +054+017 W | +054+017 W | 2013 | 185.2 | 0.62 | 5 | 186.9 ± 0.5 | 0.636 ± 0.007 | 1.7 | 0.006 | * |
| 2017.1644 | 06336-1207 | HU 43 | -048-215 W | -048-215 W | 2010 | 307.6 | 0.79 | 5 | 308.1 ± 0.2 | 0.864 ± 0.005 | 0.5 | 0.074 | * |
| 2017.2740 | 08024+0409 | STF1175 | +066-103 G | +065-105 W | 2012 | 285.1 | 1.42 | 5 | 286.6 ± 0.0 | 1.477 ± 0.001 | 1.5 | 0.057 | * |
| 2017.2712 | 08061-0047 | A 1971 | +087-064 W | +087-064 W | 2014 | 2.8 | 0.96 | 5 | 2.2 ± 0.1 | 0.976 ± 0.001 | -0.6 | 0.016 | * |
| 2017.2877 | 08095+3213 | STF1187 | +016-096 U | +033-008 W | 2013 | 20.4 | 2.96 | 5 | 19.4 ± 0.0 | 3.103 ± 0.002 | -1.0 | 0.148 | * |
| 2017.2712 | 08213-0136 | STF1216 | -009-028 W | -009-028 W | 2013 | 304.8 | 0.53 | 5 | 306.7 ± 0.6 | 0.535 ± 0.017 | 1.9 | 0.005 | * |
| 2017.2795 | 08369+2315 | AG 154 | -109-107 W | -109-107 W | 2011 | 1.2 | 2.62 | 5 | 0.5 ± 0.0 | 2.688 ± 0.003 | -0.7 | 0.068 | * |
| 2017.2740 | 08507+0752 | VDK 3 | -069+009 W | - | 2010 | 168.4 | 1.39 | 5 | 185.0 ± 0.2 | 1.146 ± 0.004 | 16.6 | -0.244 | * |
| 2017.2986 | 09273+0614 | STF1355 | -178-151 W | -178-151 W | 2016 | 355.0 | 1.70 | 5 | 354.7 ± 0.0 | 1.808 ± 0.001 | -0.3 | 0.108 | * |
| 2017.3096 | 09414+3857 | STF1374AB | +083-136 W | - | 2014 | 310.0 | 2.70 | 5 | 311.0 ± 0.1 | 2.842 ± 0.002 | 1.0 | 0.142 | * |
| 2017.2822 | 10131+2725 | STT 213 | -050-123 W | -050-123 W | 2015 | 121.7 | 1.07 | 5 | 120.8 ± 0.3 | 1.091 ± 0.006 | -0.9 | 0.021 | * |
| 2017.2822 | 10200+1950 | STF1424AB | +311-153 W | +306-161 W | 2015 | 127.0 | 4.69 | 5 | 125.5 ± 0.1 | 4.776 ± 0.006 | -1.5 | 0.176 | * |
| 2017.2795 | 10205+0626 | STF1426AB | -007-044 W | -007-044 W | 2014 | 312.0 | 0.94 | 5 | 313.3 ± 0.4 | 0.903 ± 0.001 | 1.3 | -0.037 | * |
| 2017.2795 | 10217-0946 | BU 25 | +009-040 W | - | 2015 | 130.2 | 1.55 | 5 | 128.6 ± 0.0 | 1.535 ± 0.001 | -1.6 | -0.015 | * |
| 2017.2822 | 10269+1713 | STT 217 | -042-067 W | -042-067 W | 2015 | 146.3 | 0.73 | 5 | 146.5 ± 0.2 | 0.818 ± 0.001 | 0.2 | 0.088 | * |
| 2017.2822 | 10397+0851 | STT 224AB | -105+006 W | -105+006 W | 2014 | 135.2 | 0.49 | 5 | 135.4 ± 1.2 | 0.550 ± 0.014 | 0.2 | 0.060 | * |
| 2017.2959 | 10480+4107 | STT 229 | -021-003 W | -021-003 W | 2013 | 259.8 | 0.63 | 5 | 256.3 ± 0.9 | 0.714 ± 0.008 | -3.5 | 0.084 | * |
| 2017.2795 | 11000-0328 | STF1500 | +064+031 W | +064+031 W | 2014 | 300.0 | 1.35 | 5 | 298.8 ± 0.0 | 1.345 ± 0.002 | -1.2 | -0.005 | * |
| 2017.3808 | 11080+5249 | STF1510 | -062-003 G | -072+003 W | 2008 | 330.0 | 5.40 | 5 | 328.2 ± 0.0 | 5.586 ± 0.005 | -1.8 | 0.186 | * |
| 2017.3562 | 11136+5525 | A 1353 | -037+007 W | -037+007 W | 2013 | 209.8 | 0.57 | 5 | 210.9 ± 0.8 | 0.600 ± 0.010 | 1.1 | 0.030 | * |
| 2017.2795 | 11137+2008 | STF1517AB | -388-125 W | -388-125 W | 2015 | 315.7 | 0.71 | 5 | 314.4 ± 0.3 | 0.710 ± 0.002 | -1.3 | 0.000 | * |
| 2017.3562 | 11390+4109 | STT 237AB | -082-034 G | -081-038 W | 2015 | 245.0 | 2.10 | 5 | 242.8 ± 0.1 | 2.042 ± 0.007 | -2.2 | -0.058 | * |
| 2017.3562 | 11520+4805 | HU 731 | -217+047 W | -217+047 W | 2013 | 307.6 | 1.14 | 5 | 307.2 ± 0.5 | 1.211 ± 0.005 | -0.4 | 0.071 | * |

*Table 6 concludes on next page.*

**Measurements of 427 Double Stars With Speckle Interferometry ...**

*Table 6 (conclusion): Known Orbit Pairs Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.3562 | 11520+4805 | HU 731 | -217+047 W | -217+047 W | 2013 | 307.6 | 1.14 | 5 | 307.2 ± 0.5 | 1.211 ± 0.005 | -0.4 | 0.071 | * |
| 2017.3562 | 12244+2535 | STF1639AB | -013-013 W | -013-013 W | 2015 | 323.0 | 1.80 | 5 | 323.6 ± 0.0 | 1.851 ± 0.001 | 0.6 | 0.051 | * |
| 2017.3562 | 12272+2701 | STF1643AB | +096-229 W | +085-240 W | 2014 | 4.0 | 2.70 | 5 | 3.4 ± 0.2 | 2.747 ± 0.008 | -0.6 | 0.047 | * |
| 2017.3397 | 12306+0943 | STF1647 | +051-058 W | +051-058 W | 2015 | 248.0 | 1.20 | 5 | 248.7 ± 0.1 | 1.306 ± 0.005 | 0.7 | 0.106 | * |
| 2017.3562 | 12372+2112 | STF1663 | -012-023 W | -012-023 W | 2014 | 66.0 | 0.70 | 5 | 65.4 ± 1.6 | 0.537 ± 0.018 | -0.6 | -0.163 | * |
| 2017.3589 | 12533+2115 | STF1687AB | -048-027 W | -048-027 W | 2015 | 198.0 | 1.20 | 5 | 198.8 ± 0.3 | 1.145 ± 0.020 | 0.8 | -0.055 | * |
| 2017.4164 | 13120+3205 | STT 261 | +026-007 G | +015-006 W | 2014 | 337.6 | 2.53 | 5 | 337.9 ± 0.0 | 2.669 ± 0.004 | 0.3 | 0.139 | * |
| 2017.4164 | 13235+2914 | HO 260 | -468+245 W | -468+245 W | 2012 | 86.0 | 1.62 | 5 | 88.6 ± 0.0 | 1.684 ± 0.003 | 2.6 | 0.064 | * |
| 2017.4247 | 13237-0043 | A 2489 | -053-023 W | -053-023 W | 2010 | 189.9 | 0.84 | 5 | 188.1 ± 0.1 | 0.998 ± 0.018 | -1.8 | 0.158 | * |
| 2017.4247 | 13343-0019 | STF1757AB | -219+021 W | -219+021 W | 2014 | 137.3 | 1.70 | 5 | 141.1 ± 0.0 | 1.702 ± 0.000 | 3.8 | 0.002 | * |
| 2017.4164 | 13375+3618 | STF1768AB | -095+023 G | -085+002 W | 2014 | 97.4 | 1.81 | 5 | 94.9 ± 0.2 | 1.703 ± 0.010 | -2.5 | -0.107 | * |
| 2017.4164 | 13461+0507 | STF1781AB | -093-028 G | -103-035 W | 2014 | 193.1 | 0.99 | 5 | 195.1 ± 0.2 | 1.047 ± 0.009 | 2.0 | 0.057 | * |
| 2017.4164 | 13491+2659 | STF1785 | -427-090 W | -471-092 W | 2015 | 189.7 | 2.66 | 5 | 187.1 ± 0.1 | 2.902 ± 0.006 | -2.6 | 0.242 | * |
| 2017.4055 | 13577+5200 | A 1614 | +236-007 W | +236-007 W | 2013 | 300.4 | 1.43 | 5 | 299.5 ± 0.1 | 1.426 ± 0.003 | -0.9 | -0.004 | * |
| 2017.4027 | 14131+5520 | STF1820 | -342-002 W | -350-018 W | 2012 | 121.7 | 2.49 | 5 | 124.1 ± 0.0 | 2.799 ± 0.001 | 2.4 | 0.309 | * |
| 2017.4027 | 14203+4830 | STF1834 | -073-013 G | -073-014 W | 2013 | 102.6 | 1.64 | 5 | 104.5 ± 0.0 | 1.667 ± 0.000 | 1.9 | 0.037 | * |
| 2017.4411 | 14336+3535 | STF1858AB | -193+064 W | -192+058 W | 2013 | 37.9 | 3.05 | 5 | 38.4 ± 0.0 | 3.078 ± 0.002 | 0.5 | 0.028 | * |
| 2017.4027 | 14380+5135 | STF1863 | -056+007 W | -056+007 W | 2013 | 59.2 | 0.65 | 5 | 58.9 ± 0.1 | 0.665 ± 0.002 | -0.3 | 0.015 | * |
| 2017.4027 | 14407+3117 | STF1867 | -050-063 W | -050-063 W | 2013 | 353.7 | 0.70 | 5 | 354.9 ± 0.4 | 0.674 ± 0.004 | 1.2 | -0.026 | * |
| 2017.4247 | 14525+1844 | BU 31AB | -026+198 W | -026+198 W | 2013 | 220.3 | 2.06 | 5 | 221.7 ± 0.0 | 1.986 ± 0.000 | 1.4 | -0.074 | * |
| 2017.4027 | 14455+4223 | STT 285AB | -067+054 W | -067+054 W | 2013 | 83.6 | 0.50 | 5 | 78.6 ± 0.1 | 0.533 ± 0.003 | -5.0 | 0.033 | * |
| 2017.4247 | 14463+0939 | STF1879AB | +071-266 U | +071-266 W | 2014 | 84.6 | 1.73 | 5 | 81.1 ± 0.0 | 1.746 ± 0.001 | -3.5 | 0.016 | * |
| 2017.3808 | 14464-0723 | STF1876AB | -150+103 W | -150+103 W | 2013 | 113.3 | 1.27 | 5 | 115.2 ± 0.1 | 1.256 ± 0.010 | 1.9 | -0.014 | * |
| 2017.4247 | 14489+0557 | STF1883 | +027-125 U | -008-089 W | 2013 | 278.2 | 0.98 | 5 | 277.4 ± 0.0 | 1.045 ± 0.001 | -0.8 | 0.065 | * |
| 2017.4027 | 14515+4456 | STT 287 | -013-039 W | -013-039 W | 2013 | 0.0 | 0.65 | 5 | 4.9 ± 0.5 | 0.575 ± 0.028 | 4.9 | -0.075 | * |
| 2017.4247 | 14534+1542 | STT 288 | -020+030 W | -020+030 W | 2014 | 159.7 | 0.98 | 5 | 159.0 ± 0.0 | 1.008 ± 0.001 | -0.7 | 0.028 | * |
| 2017.4493 | 15038+4739 | STF1909 | -444+010 W | -374+039 W | 2014 | 66.1 | 1.13 | 5 | 74.9 ± 0.2 | 0.656 ± 0.002 | 8.8 | -0.474 | * |
| 2017.4466 | 15183+2650 | STF1932AB | +093+071 W | +088+077 W | 2014 | 264.0 | 1.56 | 5 | 266.9 ± 0.1 | 1.639 ± 0.001 | 2.9 | 0.079 | * |
| 2017.4438 | 15277+0606 | STF1944 | -002-036 W | -002-036 W | 2013 | 295.2 | 0.66 | 5 | 292.5 ± 1.1 | 0.702 ± 0.010 | -2.7 | 0.042 | * |
| 2017.4438 | 15348+1032 | STF1954AB | -005+000 U | +008-017 U | 2014 | 172.7 | 3.62 | 5 | 172.2 ± 0.1 | 4.097 ± 0.005 | -0.5 | 0.477 | * |
| 2017.4466 | 15360+3948 | STT 298AB | -483+028 W | -455+051 W | 2014 | 185.8 | 1.18 | 5 | 186.2 ± 0.0 | 1.22 ± 0.004 | 0.4 | 0.040 | * |
| 2017.4466 | 15405+1840 | A 2076 | -019+019 W | -019+019 W | 2012 | 185.1 | 0.73 | 5 | 186 ± 0.3 | 0.742 ± 0.005 | 0.9 | 0.012 | * |
| 2017.4493 | 15413+5959 | STF1969 | -223+160 G | -220+165 W | 2013 | 29.0 | 1.01 | 5 | 31.5 ± 0.2 | 1.073 ± 0.007 | 2.5 | 0.063 | * |
| 2017.4247 | 15559-0210 | STF1985 | -091-062 G | -089-061 W | 2013 | 353.1 | 5.92 | 5 | 354.1 ± 0.0 | 6.062 ± 0.003 | 1.0 | 0.142 | * |

**Measurements of 427 Double Stars With Speckle Interferometry ...**

Notes to Table 6 (Known Orbits)

*All ephemerides were computed with an Excel spreadsheet prepared by Jack Drummond (April, 2014). The number after the term "Orbit" is the orbit's grade. True Separation computed from orbital elements (semi-major axis).*

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | True Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 02020+0246 AB | 21.66 ± 1.06 | H | 46 | 340 | - | Orbit (4) by PRU2017. The ephemerides predict 262.1°, 1.834" and the residuals are +2.4°, +0.107". |
| 02037+2556 AB | 18.2 ± 0.46 | G | 55 | 76 | - | Orbit (3) by HEI1996. The ephemerides predict 346.5°, 1.492". The residuals are -2.7°, -0.082". |
| 02158-1814 | 42.52 ± 0.53 | G | 24 | 52 | - | Orbit (4) by TOK2015. The ephemerides are 163.1°, 1.736". The residuals are +1.0°, +0.284". |
| 02475+1922 AB | A: 29.8 ± 0.82<br>B: 29.88 ± 0.27 | H<br>G | 34 | 78 | - | Orbit (4) by MSN2014. There is a 50% overlap in the parallax windows. The ephemerides predict 306.0°, 3.726". The residuals are +0.5°, -0.051". |
| 03122+3713 | 25.05 ± 1.50 | H | 40 | 146 | 60<br>61 (Orb)<br>62 (Lin) | Orbit (5) by WSI2004. The ephemerides predict 125.7°, 2.857", while the residuals are -1.4°, -0.027". Curiously, there is also a linear solution by HRT2011. The ephemerides predict 124.9°, 2.919", while its residuals are -0.6°, +0.012". My measurement seems to favor the linear solution over the orbit. The PM vector (264°, 18.2") is far too long for the orbital solution. |
| 03356+3141 AB | B: 11.32 ± 0.37 | G | 88 | 87 | - | Orbit (5) by ZIR2015. The ephemerides predict 221°, 1.027" while the residuals are -0.6°, +0.021". |
| 04199+1631 | - | - | - | - | - | Orbit (2) by SOD1999. The ephemerides predict 4.3°, 0.561" while the residuals are -0.50°, -0.036". |
| 05005+0506 | 17.98 ± 1.51 | H | 56 | 102 | - | Orbit (4) by WSI2015. The ephemerides predict 1.550". The residuals are +0.0°, +0.082". |
| 05079+0830 | 15.47 ± 1.89 | H | 65 | 65 | 63 | Orbit (2) by SCA2008. The ephemerides predict 291.2°, 0.932". The residuals are -5.1°, +0.020". |
| 05135+0158 AB | 4.71 ± 0.85 | H | 212 | 163 | - | Orbit (4) by TOK2014. The ephemerides predict 240.4°, 0.687" while the residuals are -0.2°, +0.006". |
| 05239-0052 A-BC | 18.75 ± 0.47 | G | 53 | 153 | - | Orbit (5) by FMR2013. Ephemerides: 158.5°, 3.096". Residuals: -1.4°, +0.070". |
| 05308+0557 | 10.77 ± 0.64 | H | 93 | 149 | - | Orbit (4) by USN1999. Ephemerides: 44.4°, 1.315". Residuals: -1.0°, -0.036". |
| 05407-0157 AB | 4.43 ± 0.64 | H | 226 | 617 | - | Orbit (5) by HOP1967. Ephemerides: 166.4°, 2.197". Residuals: -0.5°, +0.180". |
| 05417-0254 | 12.39 ± 0.87 | H | 81 | 56 | - | Orbit (3) by HRT2010. Ephemerides: 183.7°, 0.584". Residuals: +3.2°, +0.052". |
| 06336-1207 | 11.8 ± 20.90 | H | N/A | N/A | - | The error makes the parallax unusable. Orbit (5) by HEI1993. Ephemerides: 312.0°, 0.860". Residuals: -3.9°, +0.004". |
| 08024+0409 | 24.21 ± 0.44 | G | 41 | 124 | - | Orbit (5) by OLE2001. Ephemerides: 290.4°, 1.386". Residuals: -3.8°, +0.091". |
| 08061-0047 | 9.86 ± 3.72 | H | N/A | N/A | - | The magnitude of the error makes the parallax unusable. Orbit (5) by TOK2015. Ephemerides: 359.0 °, 0.819". Residuals: +3.2°, +0.157". |
| 08095+3213 | 15.46 ± 1.23 | H | 65 | 198 | - | Orbit (5) by OLE2001. Ephemerides: 20.4°, 2.955". Residuals: -1.0°, +0.148". |
| 08213-0136 | - | - | - | - | - | Orbit (3) by TOK2014. Ephemerides: 307.6°, 0.521". Residuals: -0.9°, +0.014". Manual solution with STB. |
| 08369+2315 | 24.04 ± 2.97 | H | 42 | 131 | - | Orbit (5) by HRT2011. Ephemerides: 0.9°, 2.670". Residuals: -0.4°, +0.018". |
| 08507+0752 | - | - | - | - | 64 | Orbit (4) by WSI2006. Ephemerides: 181.4°, 1.063". Residuals: +3.6°, +0.083". The last few measures appear to be veering off the predictions. |
| 09273+0614 | 18.41 ± 1.23 | H | 54 | 94 | - | Orbit (4) by LIN2011. Ephemerides: 354.5°, 1.810". Residuals: +0.2°, -0.002". |
| 09414+3857 AB | 19.5 ± 0.83 | H | 51 | 163 | - | Orbit (5) by LIN2013. Ephemerides: 310.4°, 2.817". Residuals: +0.6°, +0.025". |
| 10131+2725 | 13.93 ± 1.22 | H | 72 | 71 | - | Orbit (4) by SCA2008. Ephemerides: 120.8°, 1.071". Residuals: +0.0°, -0.020". |
| 10200+1950 AB | 25.07 ± 0.52 | H | 40 | 124 | - | Orbit (4) by PKO2014. (Two orbits with the apparent motion parameters method.) Ephemerides: 126.2°, 4.627". Residuals: -0.7°, +1.149". |

**Measurements of 427 Double Stars With Speckle Interferometry ...**

Notes to Table 6 (Known Orbits) *continued*

*All ephemerides were computed with an Excel spreadsheet prepared by Jack Drummond (April, 2014). The number after the term "Orbit" is the orbit's grade. True Separation computed from orbital elements (semi-major axis).*

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | True Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 10205+0626 AB | 6.68 ± 1.99 | H | N/A | N/A | - | The error makes the parallax unusable. Orbit (5) by NOV2006. Ephemerides: 312.5°, 0.912". Residuals: +0.8°, -0.009". |
| 10217-0946 | 16.68 ± 1.18 | H | 60 | 110 | - | Orbit (5) by ZIR2012. Ephemerides: 130.5°, 1.566". Residuals: -1.9°, -0.031". |
| 10269+1713 | 11.8 ± 1.44 | H | 85 | 40 | - | Orbit (3) by SCA2015. Ephemerides: 148.4°, 0.782". Residuals: -1.9°, +0.036". |
| 10397+0851 AB | - | - | - | - | - | Orbit (3) by HRT2010. Ephemerides: 135.3°, 0.496". Residuals: +0.1°, +0.054". Manual solution with STB. |
| 10480+4107 | 6.04 ± 0.96 | H | 166 | 104 | - | Orbit (4) by ALZ1998. Ephemerides: 257.4°, 0.637". Residuals: -1.1°, +0.077". Manual solution with STB. |
| 11000-0328 | 18.66 ± 0.86 | H | 54 | 182 | - | Orbit (5) by HRT2013. Ephemerides: 299.9°, 1.336". Residuals: -1.1°, +0.009". |
| 11080+5249 | 17.54 ± 0.26 | G | 57 | 450 | - | Orbit (5) by KIS2012. Ephemerides: 328.3°, 5.461". Residuals: -0.1°, +0.125". |
| 11136+5525 | - | - | - | - | - | Orbit (3) by DOC2015. Ephemerides: 209.0 °, 0.537". Residuals: +1.9°, +0.063". Manual solution with STB. |
| 11137+2008 AB | 18.35 ± 0.96 | H | 54 | 123 | - | Orbit (4) by FMR2011. Ephemerides: 316.3°, 0.694". Residuals: -1.9°, +0.016". |
| 11390+4109 AB | 12.24 ± 0.40 | G | 82 | 374 | - | Orbit (5) by USN2002. Ephemerides: 244.4°, 2.033". Residuals: -1.6°, +0.009". |
| 11520+4805 | 20.16 ± 3.04 | H | 50 | 59 | - | Orbit (4) by HRT2008. Ephemerides: 307.9°, 1.171". Residuals: -0.7°, +0.040". |
| 12244+2535 AB | 11.08 ± 0.59 | H | 90 | 110 | - | Orbit (4) by OLE2006. Ephemerides: 323.2°, 1.823". Residuals: +0.4°, +0.028". |
| 12272+2701 AB | 36.75 ± 0.90 | H | 27 | 73 | - | Orbit (4) by WSI2004. Ephemerides: 4.0°, 2.745". Residuals: -0.6°, +0.002". |
| 12306+0943 | 10.81 ± 0.90 | H | 93 | 405 | - | Orbit (4) by HOP1970. Ephemerides: 251.4°, 1.243". Residuals: -2.7°, +0.063".<br>There appear to be quadrant reversals on L 1902.35, FUR 1902.40, POS 1903.27, BOW 1904.30, and PHL 1923.07. |
| 12372+2112 | 5.34 ± 1.09 | H | 187 | 131 | - | Orbit (5) by ZIR2013. Ephemerides: 68.0°, 0.636". Residuals: -2.6°, -0.099". Manual solution with STB. |
| 12533+2115 AB | 11.52 ± 0.87 | H | 87 | 103 | - | Orbit (4) by DRU2014. Ephemerides: 197.4°, 1.158". Residuals: +1.4°, -0.013". |
| 13120+3205 | 13.68 ± 0.28 | G | 73 | 131 | 65 (Hsw)<br>66 (Kis)<br>67 (Hrt) | Interesting case - Kiselev derived an orbit whereas Hartkopf found a linear solution.<br>Orbit (4) by KIS2012. Ephemerides: 338.5°, 2.582". Residuals: +0.6°, +0.087".<br>Linear solution by HRT2011. Ephemerides not available. |
| 13235+2914 | 53.97 ± 2.13 | H | 19 | 40 | - | Orbit (3) by ZIR2013. Ephemerides: 87.1°, 1.626". Residuals: +1.5°, +0.058". |
| 13237-0043 | 10.96 ± 4.13 | H | N/A | N/A | - | The error makes the parallax unusable.<br>Orbit (5) by WSI2004. Ephemerides: 191.6°, 0.945". Residuals: -3.5°, +0.053". |
| 13343-0019 AB | 37.68 ± 1.30 | H | 27 | 75 | - | Orbit (4) by HEI1988. Ephemerides: 138.6°, 1.755". Residuals: +2.5°, -0.053" |
| 13375+3618 AB | 18.39 ± 0.99 | G | 54 | 55 | - | Orbit (3) by SOD1999. Ephemerides: 95.2°, 1.697". Residuals: -0.3°, +0.006". |
| 13461+0507 AB | 13.96 ± 0.58 | G | 72 | 72 | - | Orbit (3) by ALZ2007. Ephemerides: 194.5°, 0.975". Residuals: +0.6°, +0.072". |
| 13491+2659 | - | - | - | - | 68 | Orbit (2) by HEI 1988. Ephemerides: 185.5°, 2.937". Residuals: +1.6°, -0.035". |
| 13577+5200 | 18.92 ± .76 | H | 53 | 45 | - | Orbit (3) by RAO2014. Ephemerides: 301.6°, 1.486". Residuals: -2.1°, -0.060". |
| 14131+5520 | 26.14 ± 0.90 | G | 38 | 135 | - | Orbit (4) by KIY1998. Ephemerides: 122.4°, 2.265". Residuals: +1.7°, +0.146". |
| 14203+4830 | 14.06 ± 0.34 | G | 71 | 72 | - | Orbit (3) by WSI2015. Ephemerides: 103.8°, 1.580". Residuals: +0.7°, +0.097". |
| 14336+3535 AB | 25.34 ± 0.24 | G | 39 | 187 | - | Orbit (5) by ZIR2015. Ephemerides: 37.8°, 3.029". Residuals: +0.6°, +0.049". |

**Measurements of 427 Double Stars With Speckle Interferometry ...**

Notes to Table 6 (Known Orbits) *conclusion*

*All ephemerides were computed with an Excel spreadsheet prepared by Jack Drummond (April, 2014). The number after the term "Orbit" is the orbit's grade. True Separation computed from orbital elements (semi-major axis).*

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | True Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 14380+5135 | 11.67 ± 1.36 | H | 86 | 93 | - | Orbit (4) by ZIR2013. Ephemerides: 60.3°, 0.649". Residuals: -1.4°, +0.016". |
| 14407+3117 | 8.55 ± 1.73 | H | 117 | 141 | - | Orbit (5) by ZIR2013. Ephemerides: 353.7°, 0.662". Residuals: +1.2°, +0.012". |
| 14525+1844 | 20.65 ± 1.08 | H | 48 | - | - | Orbit (5) by HRT2014. Ephemerides: 221.2°, 2.012". Residuals: +0.5°, 0.026". |
| 14455+4223 AB | - | - | - | - | - | Orbit (2) by SCA2015. Ephemerides: 82.2°, 0.498". Residuals: -3.6°, +0.035". |
| 14463+0939 AB | 23.14 ± 1.26 | H | 43 | 48 | - | Orbit (3) by MSN1999. Ephemerides: 83.1°, 1.720". Residuals: -2.0°, -1.720". |
| 14464-0723 AB | - | - | - | - | - | Orbit (5) by USN2002. Ephemerides: 112.6°, 1.247". Residuals: +2.6°, +0.009". |
| 14489+0557 | 17.99 ± 1.82 | H | 56 | 45 | - | Orbit (2) by WSI2015. Ephemerides: 277.1 248/0.988". Residuals: +0.3°, +0.057". |
| 14515+4456 | 16.91 ± 0.86 | H | 59 | 54 | - | Orbit (4) by HEI1997. Ephemerides: 0.6°, 0.721". Residuals: +4.3°, -0.146". |
| 14534+1542 | 20.99 ± 0.93 | H | 48 | 65 | - | Orbit (4) by HEI1998. Ephemerides: 158.8°, 1.016". Residuals: +0.2°, +0.028". |
| 15038+4739 | 79.95 ± 1.56 | H | 13 | 48 | - | Orbit (2) by ZIR2011. Ephemerides: 66.7°, 1.02". Residuals: +8.2°, -0.364". |
| 15183+2650 AB | 27.29 ± 0.34 | G | 37 | 45 | - | Orbit (2) by SCA2015 . Ephemerides: 265.1°, 1.622". Residuals: +1.8°, +0.017". |
| 15277+0606 | 5.1 ± 1.29 | H | N/A | N/A | - | The error makes the parallax unusable. Orbit (5) by ZIR2015. Ephemerides: 294.0°, 0.620". Residuals: -1.5°, +0.082". Manual solution with STB. |
| 15348+1032 AB | 14.3 ± 0.75 | G | 70 | 268 | - | Orbit (4) by WSI2004. Ephemerides: 172.1°, 3.977". Residuals: +0.1°, +0.120". |
| 15360+3948 AB | - | - | - | - | - | Orbit (1) by SOD1999. Ephemerides: 183.6°, 1.194". Residuals: +2.6°, +0.026". |
| 15405+1840 | 3.23 ± 1.74 | H | N/A | N/A | - | The error makes the parallax unusable. Orbit (4) by ZIR2014. Ephemerides: 185.4°, 0.729". Residuals: +0.6°, +0.013". |
| 15413+5959 | 16.19 ± 0.25 | G | 62 | 63 | - | Orbit (4) by RAO1999. Ephemerides: 29.4°, 0.957". Residuals: +2.1°, +0.116". |
| 15559-0210 | 26.19 ± 0.40 | G | 38 | 264 | - | Orbit (5) by HOP1973. Ephemerides: 354.9°, 6.281". Residuals: -0.8°, -0.219". |
| Mean AB separation in AU | | | | 136 | | |

**Measurements of 427 Double Stars With Speckle Interferometry ...**

*Table 7: Short Arc Pairs Measured With Speckle*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.1507 | 04518+0115 | BU 748 | +009+004 G | +007+009 G | 2010 | 70.0 | 2.80 | 5 | 69.0 ± 0.0 | 3.019 ± 0.001 | -1.0 | 0.219 | * |
| 2017.1671 | 05181+0342 | A 2639 | -061+002 W | -061+002 W | 2016 | 273.0 | 0.90 | 5 | 277.2 ± 1.6 | 0.846 ± 0.002 | 4.2 | -0.054 | * |
| 2017.2795 | 08033+2616 | STT 186 | -014-009 W | -014-009 W | 2012 | 73.7 | 0.99 | 5 | 73.4 ± 0.1 | 1.004 ± 0.001 | -0.3 | 0.014 | * |
| 2017.2795 | 08136+1051 | STF1202 | +005-070 G | - | 2011 | 306.2 | 2.70 | 5 | 303.8 ± 0.0 | 2.700 ± 0.003 | -2.4 | 0.000 | * |
| 2017.2877 | 09193-0933 | A 126 | -050-001 W | -050-001 W | 2014 | 121.6 | 1.09 | 5 | 122.3 ± 0.1 | 1.164 ± 0.004 | 0.7 | 0.074 | * |
| 2017.3014 | 09290+1917 | COU 936 | +026+033 W | +026+033 W | 2012 | 226.3 | 0.88 | 5 | 225.8 ± 1.1 | 0.956 ± 0.017 | -0.5 | 0.076 | * |
| 2017.2986 | 09500+0148 | A 2560 | -034-010 W | -034-010 W | 2005 | 17.4 | 1.13 | 5 | 17.8 ± 0.1 | 1.122 ± 0.008 | 0.4 | -0.008 | * |
| 2017.3260 | 09513+6037 | STF1381 | -018+088 W | -018+088 W | 2015 | 186.2 | 0.80 | 5 | 187.3 ± 0.1 | 0.798 ± 0.005 | 1.1 | -0.002 | * |
| 2017.3315 | 10069-0143 | HDO 125 | -072+023 G | -078+019 W | 2012 | 190.0 | 2.70 | 5 | 190.3 ± 0.0 | 2.875 ± 0.003 | 0.3 | 0.267 | * |
| 2017.3397 | 11431+3715 | HU 1135 | -026-014 W | -026-014 W | 2014 | 336.0 | 0.70 | 5 | 334.1 ± 0.2 | 0.742 ± 0.001 | -1.9 | 0.042 | * |
| 2017.3589 | 12409+0850 | STF1668 | -013-030 W | -013-030 W | 2009 | 187.0 | 1.10 | 5 | 186.8 ± 0.0 | 1.129 ± 0.001 | -0.2 | 0.029 | * |
| 2017.4247 | 14165+2007 | STF1825 | -136-095 G | -131-084 W | 2012 | 153.6 | 4.33 | 5 | 152.7 ± 0.1 | 4.425 ± 0.020 | -0.9 | 0.095 | |

Notes to Table 7 (Short Arc Binaries, or SABs)

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 04518+0115 | A: 12.69 ± 0.35<br>B: 14.46 ± 0.47 | G<br>G | 79<br>69 | - | 69 | There is no overlap in the parallax windows. |
| 05181+0342 | 7.78 ± 1.76 | H | 129 | 100 | 70 | |
| 08033+2616 | 5.31 ± 1.04 | H | 188 | 187 | 71 | Trend line does not “orbit” the primary star. |
| 08136+1051 | 14.42 ± 0.35 | G | 69 | 187 | - | |
| 09193-0933 | - | - | - | - | 72 | Trend line does not “orbit” the primary star. |
| 09290+1917 | 12.03 ± 1.20 | H | 83 | 73 | 73 | Trend line does not “orbit” the primary star. |
| 09500+0148 | 4.40 ± 1.26 | H | N/A | N/A | - | The parallax error makes the parallax unusable. Early case of showing a weak arc. |
| 09513+6037 | 5.26 ± 2.19 | H | N/A | N/A | 74 | The parallax error makes the parallax unusable. |
| 10069-0143 | 10.4 ± 0.33 | G | 96 | 274 | - | Weak arc is forming. |
| 11431+3715 | - | - | - | - | - | Early case of a weak arc forming. The $R^2$ value is very high (0.9463), but the motion of the companion has only traversed 0.5". |
| 12409+0850 | 8.26 ± 0.85 | H | 121 | 137 | - | Weak arc forming. |
| 14165+2007 | 29.68 ± 0.47 | G | 34 | 146 | 75 | |
| Mean AB Separation in AU | | | | 158 | | |

**Measurements of 427 Double Stars With Speckle Interferometry ...**

*Table 8: Unknown Cases Measured With Speckle*
*Note: These cases are called "unknown" because no proper motions are known, or only one proper motion is known.*

| Date | WDS No | Disc/Comp | PM A | PM B | Last Yr | Last θ | Last ρ | Msrs | Measured θ ± err (°) | Measured ρ ± err (") | Resid θ | Resid ρ | Notes? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017.0795 | 02593-0615 | A 454 | +072+005 W | - | 2010 | 132.1 | 3.89 | 5 | 134.3 ± 0.3 | 3.957 ± 0.033 | 2.2 | 0.067 | |
| 2017.0822 | 03384+1736 | A 2420 | -009-005 G | - | 2008 | 268.9 | 2.08 | 5 | 267.6 ± 0.1 | 1.990 ± 0.004 | -1.3 | -0.090 | * |
| 2017.1507 | 04581+0141 | STF 622 | +058-003 G | +062-003 G | 2010 | 162.0 | 2.40 | 5 | 161.4 ± 0.0 | 2.537 ± 0.001 | -0.6 | 0.137 | * |
| 2017.1644 | 05063+0257 | AG 89 | +002-016 G | - | 2006 | 178.8 | 2.31 | 5 | 178.5 ± 0.1 | 2.325 ± 0.002 | -0.3 | 0.015 | * |
| 2017.1616 | 05099-0906 | A 483AB | +002+001 G | -003+002 G | 2009 | 58.0 | 3.95 | 5 | 58.5 ± 0.0 | 3.846 ± 0.002 | 0.5 | -0.104 | * |
| 2017.1616 | 05129-0347 | BRT 534 | -001-002 G | -001-003 G | 2000 | 171.9 | 4.16 | 5 | 171.8 ± 0.0 | 4.247 ± 0.004 | -0.1 | 0.087 | * |
| 2017.2137 | 05589-0120 | STF 826 | +001-007 W | - | 2010 | 132.6 | 1.99 | 5 | 132.2 ± 0.2 | 2.014 ± 0.011 | -0.4 | 0.024 | |
| 2017.2137 | 06025-0222 | STF 836 | -005-011 W | - | 2013 | 25.5 | 1.99 | 5 | 23.6 ± 0.1 | 1.967 ± 0.004 | -1.9 | -0.023 | |
| 2017.1644 | 06116-1727 | A 3023 | -010-020 G | - | 2002 | 327.3 | 2.20 | 5 | 328.4 ± 0.0 | 2.316 ± 0.001 | 1.1 | 0.116 | * |
| 2017.1507 | 06249-1943 | HO 339 | -034+018 G | - | 2005 | 191.8 | 5.29 | 5 | 191.2 ± 0.0 | 5.359 ± 0.007 | -0.6 | 0.069 | * |
| 2017.2795 | 08413+1916 | KU 32 | -036-012 G | - | 2000 | 165.4 | 2.16 | 5 | 164.7 ± 0.0 | 2.178 ± 0.001 | -0.7 | 0.018 | * |
| 2017.2795 | 08515+1208 | STF1287AB | -020-030 G | - | 2012 | 87.0 | 2.18 | 5 | 86.1 ± 0.0 | 2.187 ± 0.003 | -0.9 | 0.007 | * |
| 2017.2795 | 08521+0428 | STF1290 | -006-002 G | - | 2009 | 325.1 | 2.77 | 5 | 324.7 ± 0.0 | 2.775 ± 0.003 | -0.4 | 0.005 | * |
| 2017.2877 | 09012+0245 | STF1302AB | -062+021 G | - | 2009 | 236.3 | 2.71 | 5 | 233.3 ± 0.1 | 2.745 ± 0.005 | -3.0 | 0.035 | * |
| 2017.2795 | 09463-1627 | A 3079 | -008-012 W | - | 2000 | 122.4 | 2.73 | 5 | 123.8 ± 0.1 | 2.799 ± 0.011 | 1.4 | 0.069 | |
| 2017.3315 | 10314-0226 | A 1350 | -086-017 G | - | 2008 | 317.2 | 2.59 | 5 | 316.0 ± 0.1 | 2.600 ± 0.003 | -1.2 | 0.010 | * |
| 2017.2822 | 10350+0839 | STF1450 | -054-003 W | - | 2013 | 155.8 | 2.11 | 5 | 155.7 ± 0.1 | 2.160 ± 0.004 | -0.1 | 0.050 | * |
| 2017.3315 | 11245+2037 | STF1537 | -001+005 G | - | 2013 | 358.3 | 2.28 | 5 | 358.1 ± 0.1 | 2.298 ± 0.004 | -0.2 | 0.018 | * |
| 2017.3616 | 12168+7009 | STF1626 | +056+001 G | - | 2005 | 4.8 | 2.16 | 5 | 2.0 ± 0.0 | 2.133 ± 0.000 | -2.8 | -0.027 | * |
| 2017.4247 | 14301+0617 | STF1853 | -024+027 U | - | 2011 | 81.5 | 2.86 | 5 | 82.4 ± 0.0 | 2.858 ± 0.000 | 0.9 | -0.002 | |
| 2017.4411 | 14450+2704 | STF1877AB | -042+014 W | - | 2014 | 343.4 | 2.90 | 5 | 344.8 ± 0.1 | 2.930 ± 0.011 | 1.4 | 0.030 | * |
| 2017.4247 | 15479-0519 | STF3096 | +027+004 G | +028+007 G | 2011 | 77.2 | 3.73 | 5 | 76.1 ± 0.0 | 3.725 ± 0.001 | -1.1 | -0.005 | * |
| 2017.4247 | 15509-0902 | STF 3097 | -153-103 W | - | 2009 | 188.1 | 3.95 | 5 | 187.2 ± 0.0 | 4.001 ± 0.001 | -0.9 | 0.051 | |
| 2017.4438 | 16120-1928 | BU 120AB | -010-025 W | - | 2014 | 1.9 | 1.33 | 5 | 1.8 ± 0.5 | 1.514 ± 0.012 | -0.1 | 0.184 | * |

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Notes to Table 8 (Unknown Cases)

| WDS Number | Parallax | Parallax Source | Distance (Parsecs) | Min Sep (AU) | Plot Figure | Comments |
|---|---|---|---|---|---|---|
| 03384+1736 | 2.31 ± 0.32 | G | 433 | 902 | - | |
| 04581+0141 | A: 10.42 ± 0.32<br>B: 9.84 ± 0.42 | G<br>G | 99 | 254 | - | Weighted parallax (10.13 mas) used. There is a 16% overlap in the parallax windows. |
| 05063+0257 | 4.06 ± 0.27 | G | 246 | 569 | - | |
| 05099-0906 | A: 3.15 ± 0.28<br>B: 3.12 ± 0.27 | G<br>G | 319 | 1,260 | - | A weighted parallax of 3.13 mas was used. There is a 90% overlap in the parallax windows. |
| 05129-0347 | A: 2.56 ± 0.29<br>B: 2.97 ± 0.28 | G<br>G | 361 | 1,502 | - | Weighted parallax (2.77 mas) used. There is a 20% overlap in the parallax windows. |
| 06116-1727 | 1.64 ± 0.51 | G | N/A | N/A | - | The error makes the parallax unusable. |
| 06249-1943 | 16.54 ± 0.23 | G | 60 | 320 | - | |
| 08413+1916 | 5.00 ± 0.69 | G | 200 | 432 | - | DAL2005.274 looks like a quadrant flip (90° west). |
| 08515+1208 AB | 5.58 ± 0.35 | G | 179 | 391 | - | A trend appears to be forming. |
| 08521+0428 | 6.75 ± 0.49 | G | 148 | 410 | - | |
| 09012+0245 AB | 12.84 ± 0.30 | G | 78 | 211 | - | Linear trend forming. |
| 10314-0226 | 10.69 ± 0.94 | G | 91 | 242 | - | |
| 10350+0839 | 7.61 ± 0.67 | H | 131 | 277 | - | |
| 11245+2037 | 10.44 ± 0.27 | G | 96 | 218 | - | |
| 12168+7009 | 5.81 ± 0.22 | G | 172 | 372 | - | |
| 14450+2704 AB | 16.10 ± 0.66 | G | 62 | 180 | - | |
| 15479-0519 | A: 16.62 ± 0.3<br>B: 16.8 ± 0.24 | G<br>G | 60 | 223 | - | Weighted parallax of 16.71 mas. 100% overlap in the parallax windows. Pair is probably physical. |
| 16120-1928 AB | - | - | - | - | - | A linear trend is forming. |
| Mean AB Separation in AU | | | | 485 | | |

*(Continued from page 289)*

## 5. Discussion

### *5.1— The Impact of GAIA and UCAC5 data.*

The new data from GAIA (DR1) has already been of huge benefit in the analysis of double star systems. PM analysis can bolster a pair's odds of being physical, or dispel it (if the parallaxes are greatly different).

In addition, the latest high-quality PM data from GAIA and the UCAC5 catalog can support a pair's claim to physicality (if the PMs are nearly the same) or suggest a linear or optical nature (if the PMs are greatly different).

The Winter/Spring 2017 observing program at Brilliant Sky Observatory revealed the following possibilities flowing from GAIA and UCAC5 data. (Table 9).

### *5.2— The Mean Separations and Projected Orbital Periods of the Stars by Type.*

In addition to the possible new classifications arising from GAIA and UCAC5 data, it is also interesting to compare the mean separation of the two stars in cases where the distance is known (either for both stars, or it is assumed that both stars lie at the distance indicated by the one parallax on record). A survey of the data in the Notes to Tables 3 to 8 yields the data summarized in Table 10.

In the case of the known orbits, the mean orbital velocity may be calculated by using the orbital elements of the solution and solving for the perimeter of an ellipse, and then dividing that result by the orbital period.

$$p = \pi\left(a+b\right)\sum_{n=0}^{\infty}\binom{0.5}{n}^{2} h^{n} \qquad [2]$$

The perimeter of an ellipse is given by the infinite series (Equation 2):

$$b = ax\sqrt{1-e^{2}} \qquad [3]$$

In orbital solutions, we know the semi-major axis

*Table 10: Mean AB Separation in AU*

| Type of Pair | Mean AB Sep in AU |
|---|---|
| CPM | 504 |
| DPM | 564 |
| LIN | 139 |
| ORB | 136 |
| SAB | 158 |
| UNK | 485 |

*Table 9: Outcomes From GAIA/UCAC5*

| Physicality suggested by parallax | |
|---|---|
| Type | WDS Number |
| CPM | 05079+0824 |
| | 06049-0243 AB |
| | 06074-0400AB ? |
| | 06372-1415 |
| | 08421+2501 |
| | 09071+3037 |
| | 09300+4216 |
| | 09450+7643 ? |
| | 13007+7343 |
| | 13354+5955 |
| | 13356+4939 |
| | 14403+1206 |
| | 15087-0059 AB |
| | 15453+0432 ? |
| | 15492-0314 ? |
| LIN | 08593+3457 |
| UNK | 04581+0141 |
| | 05099-0906 |
| | 05129-0347 |
| | 15479-0519 |
| Proper Motion accounts for observations (probable optical pairs) | |
| CPM | 02123+2357 AB ? |
| | 03312+1947 ? |
| | 10462-0546 |
| *Proper Motion does NOT account for observations (one or both PM values are incorrect)* | |
| CPM | 08500+3935 |
| | 08538-0035 AB |
| | 09080+8102 |
| | 10151+1907 |
| | 11024+8313 |
| | 12137-7826 |
| | 13324+3649 |
| | 14270+0341 |
| | 15391-0834 |
| DPM | 02341-0538 |
| | 03244-1400 |
| | 03354+3341 |
| | 03581-0454 |
| | 04222-0441 |
| | 06512-1126 |
| | 06561-1403 |
| | 08054+0550 |
| | 08555-0758 |
| | 09051+3931 |
| | 09136+4659 |
| | 13376-0752 AB |
| | 14568+7050 |
| *Parallax suggests optical pair (different distances)* | |
| CPM | 08101+0403 |
| | 15276+0522 |
| LIN | 05269+0039 |
| SAB | 04518+0115 |
| *Probable Linear Cases without solutions* | |
| CPM | 08140-1740 |
| | 08437+1654 ? |
| LIN | 03061-1326 AB |
| | 08194+5627 |
| | 08430-0242 |
| | 09521+0249 AB |

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($a$) and the eccentricity ($e$). From these, we can compute the semi-minor axis ($b$) by using the expression (Equation 3):

If we substitute the expression $(a\text{-}b)^2/(a+b)^2$ for $h$ in

$$p=\pi\left(a+b\right)\left(1+\frac{1}{4}h+\frac{1}{64}h^2+\frac{1}{256}h^3+\frac{1}{16384}h^4\ldots\right) \quad [4]$$

Equation 2, this conveniently expands into a series Excel can handle and gives a very accurate answer after the fourth expansion (Equation 4):

By determining the length of the semi-major axis in AU, that value can then be used to convert the total perimeter from arc seconds to AU.

This exercise shows us that the average orbital velocity of the 51 known orbits in this observing program (for which we have good parallax data) is 35,267 km/hour or 9.80 km/sec. (The earth's mean orbital speed around the sun is 29.8 km/sec for comparison. The mean orbital speed of Neptune, a planet that is at a distance typical of many of the closer known binaries, is 5.43 km/sec.)

A plot of the results, showing the mean orbital velocity in red, is shown in Figure 4.(The y-axis maximum value is 40,000 km/hr and axis divisions are in 5,000 km/hr increments.)

The spread in orbital velocities spans a wide range, from 0.76 km/sec for the slowest pair (WDS 02020+0246 = STF 202AB) to the highest value of 51.70 km/sec for the fastest pair (WDS 10269+1713 = STT 217). The standard deviation of the 51 velocities was 8.43 km/sec, so this data is not of highly consistent quality. However, by matching the separation in the stars in AU from Table 10 to the nearest matching semi-major axis from the known orbits and using the orbital velocity of that pair as representative of the stars in the classes of Table 10, we can derive a rough estimate of periods of the stars of Table 10 to see if the velocity computations are consistent, and they are.

Considering only the CPM, SAB and UNK cases (since DPMs are most likely either pairs that are not physical or pairs with one or both proper motions in question, and LIN cases are linear and hence not likely to be physical), we get the following orbital period estimates (Table 11).

Since all of these estimates are well within the bounds of the 51 orbital cases, it would appear that the GAIA parallax data used to derive these projected periods is reasonably accurate. (The 51 orbital cases had a mean period of 1,104 years, with a minimum of 140 years and a maximum of 6,600 years.)

*Table 11: Orbital Velocity Estimates of the 2017 Program Stars*

| Type of Pair | Projected orbital period, years |
|---|---|
| CPM | 897 |
| SAB | 293 |
| UNK | 863 |

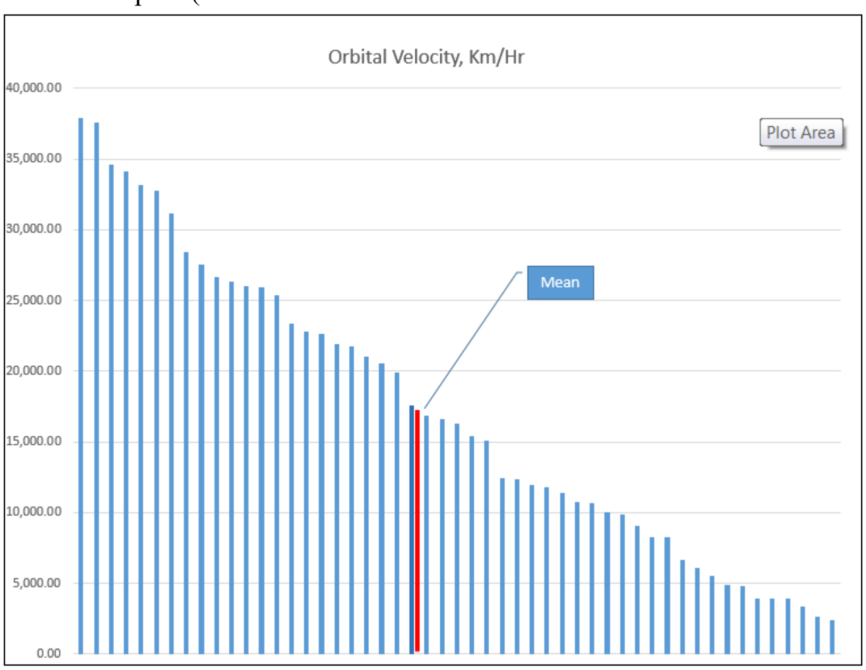


*Figure 4: Spread of orbital velocity (km/hr) for known orbits in the 2017 observing program.*

***5.3— Analysis of 888 Orbits from the Sixth Orbit Catalog.***

After the findings presented in section 5.2, I decided to investigate a larger sample of orbits. I downloaded the Sixth Orbit Catalog from the U. S. Navy's web site and selected only those pairs for which we had good parallax data ("good" defined as parallaxes from Hipparcos or GAIA). 888 pairs met this criterion.

I did the calculations detailed in section 5.2, and

$$Min\ Sep = (1-e)a$$

$$Max\ Sep = (1+e)a$$

added two new factors— the minimum separation of the stars (in AU) and the maximum separation (in AU). These values are derived from

The results of my analysis are shown in Table 12.

For comparison, the maximum velocity of the 51 orbits in this paper was 51.70 km/sec; the minimum velocity was 0.76 km/sec; and the mean velocity was 8.43 km/sec. The mean semi-major axis of the 51 orbits was 118.04 AU (slightly over twice that of the Sixth Catalog pairs); the mean semi-minor axis was 112.41 (roughly three times the Sixth Catalog); and the mean perimeter in AU was 955 (roughly three times the value of the Sixth Catalog pairs). Obviously, there are many pairs analyzed in the Sixth Orbit Catalog that are much closer than the pairs studied in this observing program (indeed, the closest pair being Mu Ori AaAb, a pair separated by only 0.08 AU, with a period of only 4.447585 days). In fact, many of the Sixth Orbit Catalog pairs in this analysis are far too close to resolve in an 11-inch telescope.

Of equally great importance, however, is the distribution of true A-B separations (in AU) that can be derived from the Sixth Orbit Catalog analysis. A histogram of the data is shown in Figure 76 (at the end of this paper). The surprising thing about this graph is how fast the distance between stars in known binaries drops off with increasing rho. 87.38% of the 888 pairs are less than 100 AU apart, and the widest pair analyzed (WDS 05407-0157, ζ Ori) was 615.80 AU apart. This would suggest caution regarding any computed separation that exceeds a few thousand AU.

*Table 12: Orbital Velocity Estimates of 888 Known Orbits*

| **Max Velocity, km/sec** | **211.17** |
|---|---|
| Min Velocity, km/sec | 0.13 |
| Mean Velocity, km/sec | 9.80 |
| Mean semi-minor axis, AU | 43.30 |
| Mean semi-major axis, AU | 54.57 |
| Mean minimum sep, AU | 62.32 |
| Mean maximum sep, AU | 83.22 |
| Mean perimeter, " | 6.432 |
| Mean perimeter, AU | 312.00 |

Of course, the Sixth Orbit Catalog also represents a heavily biased sample to date— it contains, almost by default, pairs that have short enough orbital periods to display meaningful data that leads to orbital solutions. It may well be that there are binaries with periods in the tens of thousands (or even hundreds of thousands) of years, but for such pairs, the change in relative position of the two stars will be barely detectable even over time frames of centuries.

It would make an interesting student project to run a set of simulations of hypothetical binaries in which pairs of different masses are compared, probable orbital velocities computed, and the binding force of gravity between the two is estimated. If the orbital velocity results in a centripetal force that exceeds the binding energy, it would be highly unlikely for the two stars to be a true binary.

Finally, Figure 5 shows the strong relationship between the semi-major axis (in AU) and the orbital peri-

$$Period = 1.3444 \times Sep^{0.6827}$$

od. An equal-weight trend line has been established by Excel and shows a best-fit correlation of 0.8331. The equation of that trend line is shown as

where S*ep* is the semi-major axis in AU and *Period* is the orbital period in years.

***5.4— Comparison of AB Separation for the DPM pairs to All Other Classes.***

When we compare the minimum AB separation for the stars for the DPM classes to all other classes, an obvious fact emerges: the mean separations for these stars is the greatest for any class of double star observed in the Winter/Spring 2017 program (564 AU). This is only slightly higher than the mean separation for the CPM pairs (504 AU), but considerably higher than those for the known orbits (136) and the short arc binaries (which may become orbits eventually, at 158 AU).

The widest DPM pair (WDS 06561-1403) came in at 1,503 AU, while the closest pair (WDS 09136+4659) was at 138 AU. The minimum AB separation for the orbital pairs in the observing program was 14 AU while the maximum was 533. Granted, this is a biased selection as we are dealing with close pairs (under 5"), but it would seem that pairs with separations in the thousands

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*Figure 5. The relationship between the Semi-major axis (in AU) and the Orbital Period (in years)*

of AU may not be very stable, if they exist as true binaries at all.

## 6. Conclusion

We have already established in the pages of this Journal that small telescopes can do speckle interferometry of close pairs with a high degree of precision.

The results of the 2017 Winter and Spring observing program at Brilliant Sky Observatory show great promise for the addition of the new GAIA DR1 and UCAC5 parallax and proper motion data to our research as we continue to work on the WDS to determine which of its 140,000+ pairs are true binaries and which are optical or non-binary but physical pairs. I can only assume that when GAIA DR2 is released in April of 2018, our pursuit of true binaries will literally explode. We are in for some exciting times!

## 7. Acknowledgements

This paper has made extensive use of the Washington Double Star Catalog and the Sixth Orbit Catalog, both maintained by the U. S. Naval Observatory in Washington, D.C. The author is also indebted to Norbert Zacharias and William Hartkopf (both of the U. S. Naval Observatory) for their help and suggestions in private email communications.

## 8. References

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## Appendix: Plots of Special Cases Detailed in the Notes

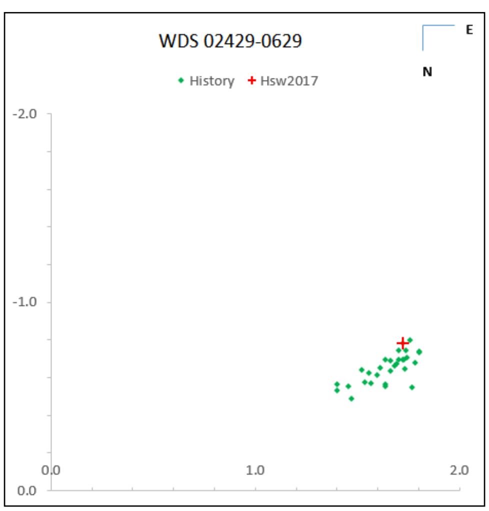


*Figure 4: Plot of WDS 02429-0629.*

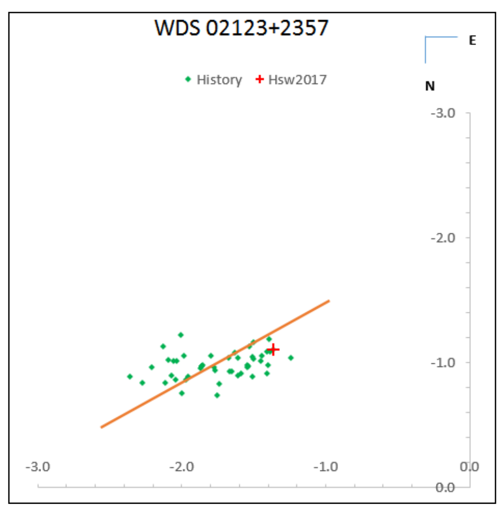


*Figure 5: Plot of WDS 02123+2357.*

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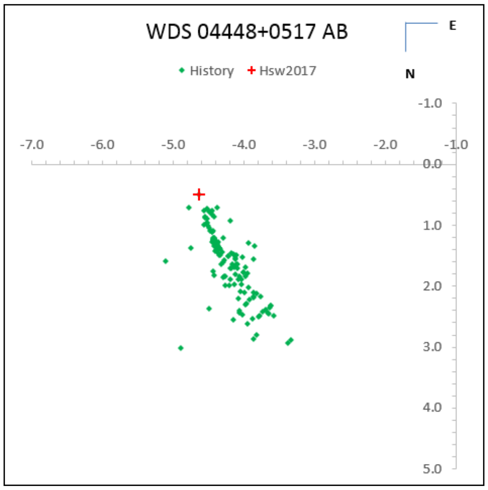


*Figure 6. Plot of WDS 04448+0517 AB.*

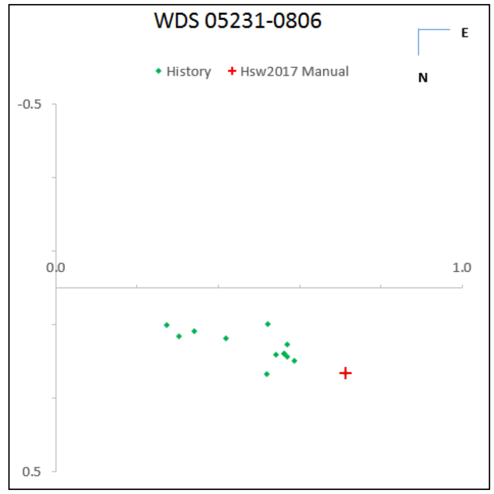


*Figure 7. Plot of WDS 05231-0806..*

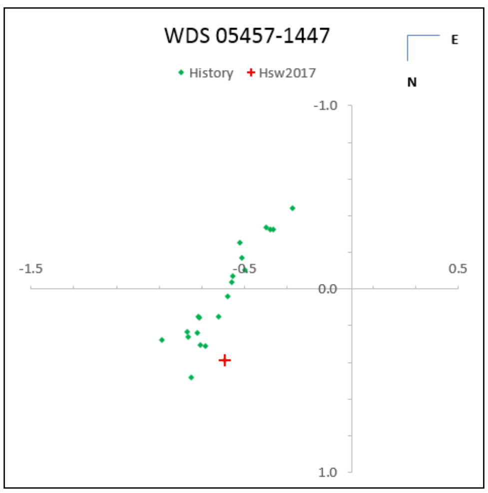


*Figure 8. Plot of WDS 05231-0806..*

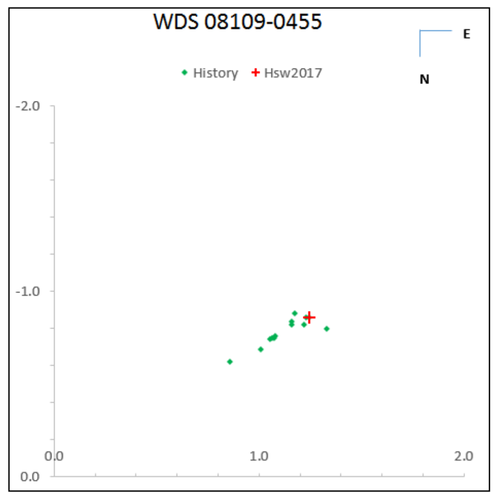


*Figure 9. Plot of WDS 08109-0455.*

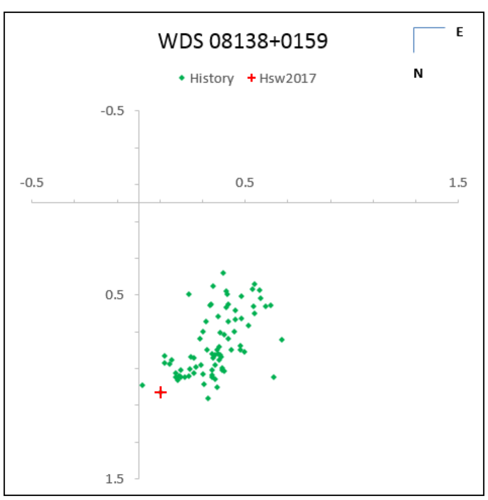


*Figure 10. Plot of WDS 08138+0159*

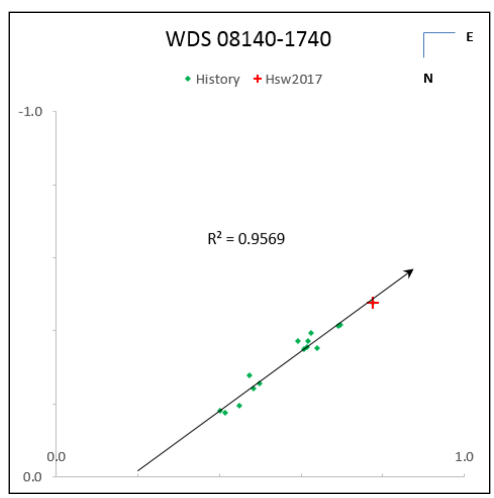


*Figure 11. Plot of WDS 08140-1740.*

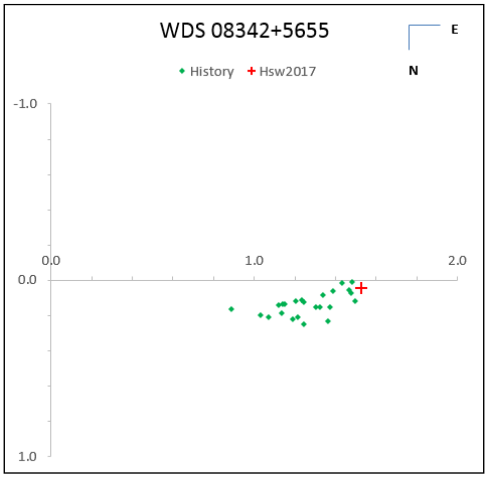


*Figure 12. Plot of WDS 08342+5655.*

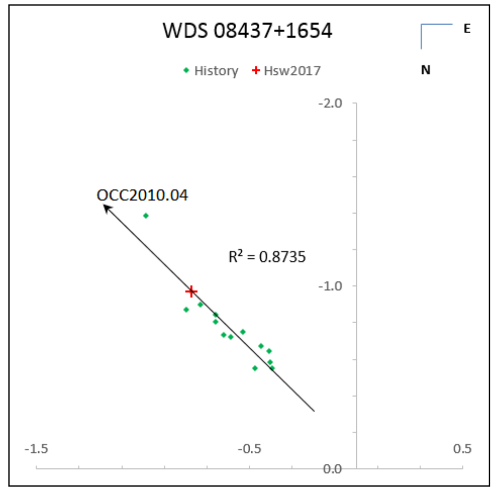


*Figure 13. Plot of WDS 08437+1654.*

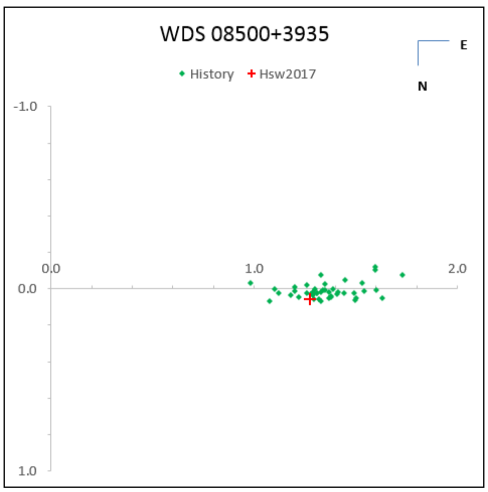


*Figure 14. Plot of WDS 08500+3935.*

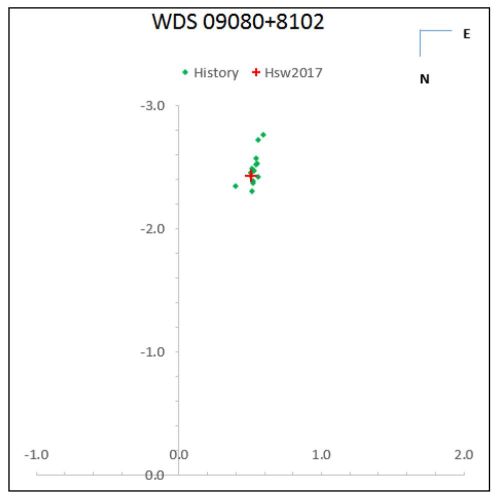


*Figure 15. Plot of WDS 09080+8102.*

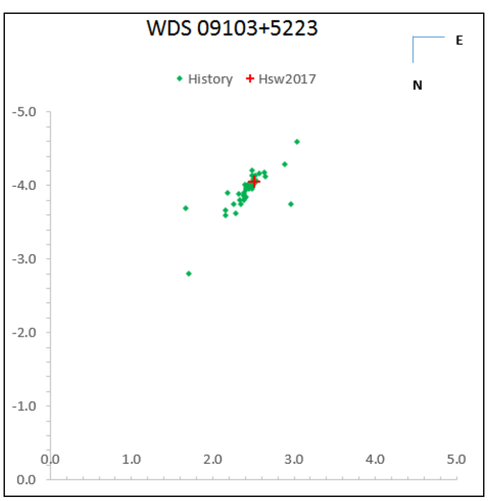


*Figure 16. Plot of WDS 09103+5223*

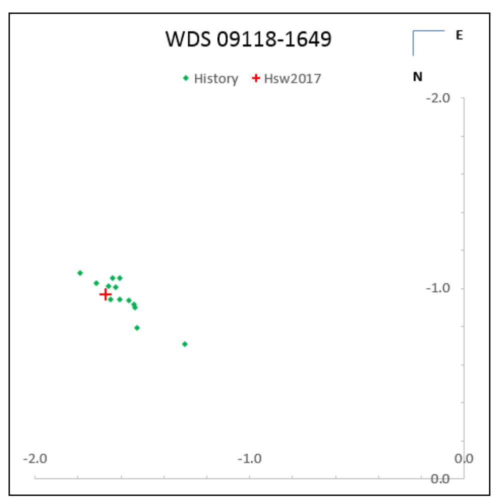


*Figure 17. Plot of WDS 09118-1649.*

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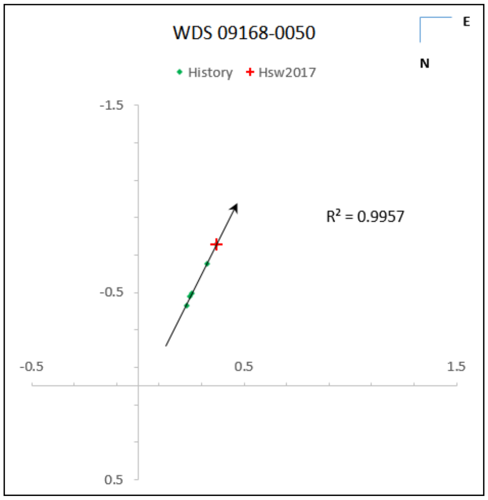


*Figure 18. Plot of WDS 09168-0500.*

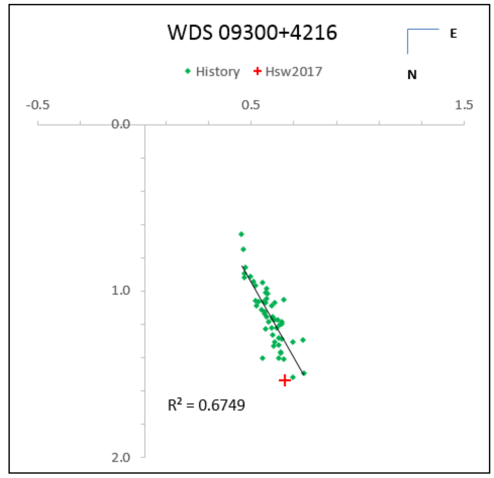


*Figure 19. Plot of WDS 09300+4216.*

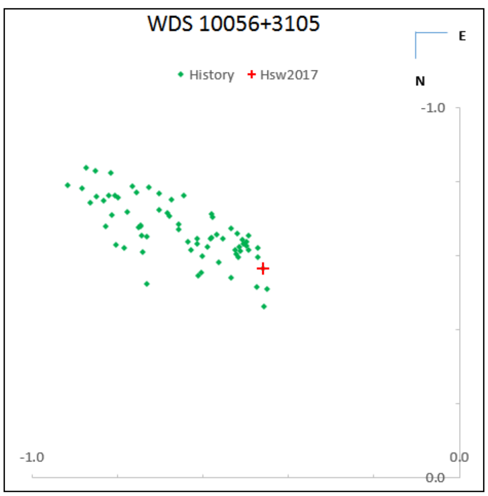


*Figure 20. Plot of WDS 10056+3105.*

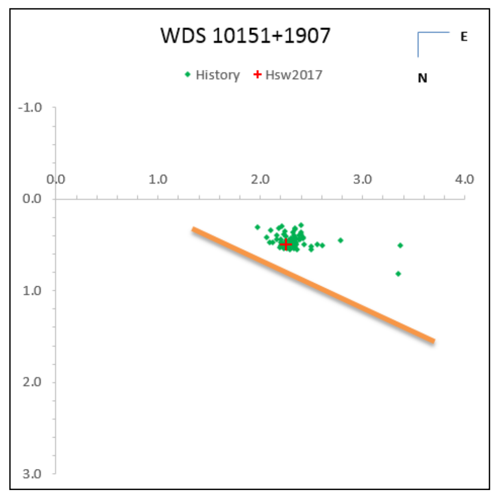


*Figure 21. Plot of WDS 10151+1907.*

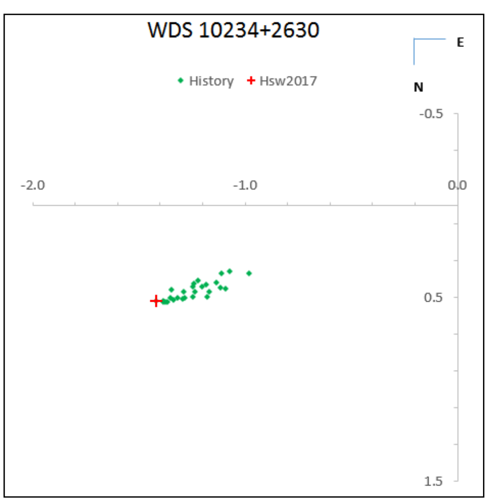


*Figure 22. Plot of WDS 10234+2630*

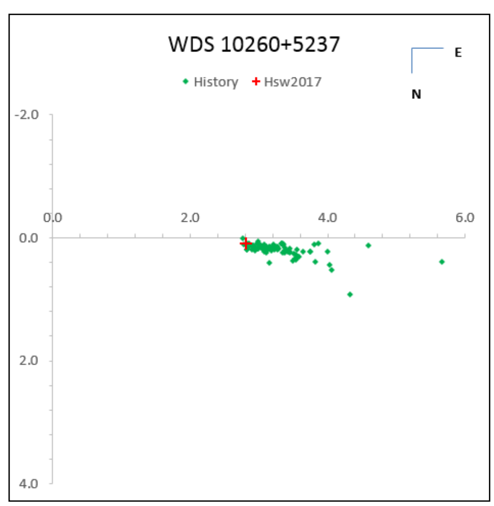


*Figure 23. Plot of WDS 10260+5237.*

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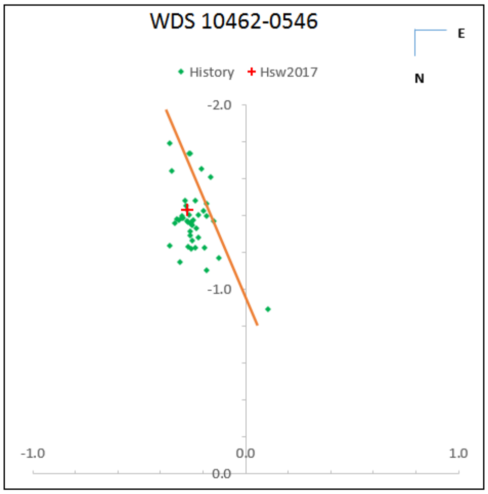


Figure 24. Plot of WDS 10642-0546.

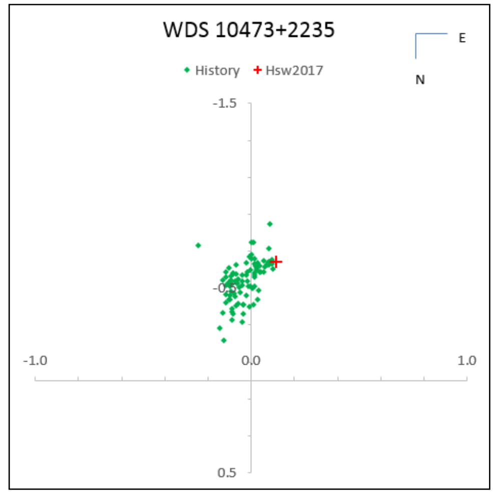


Figure 25. Plot of WDS 10473+2235.

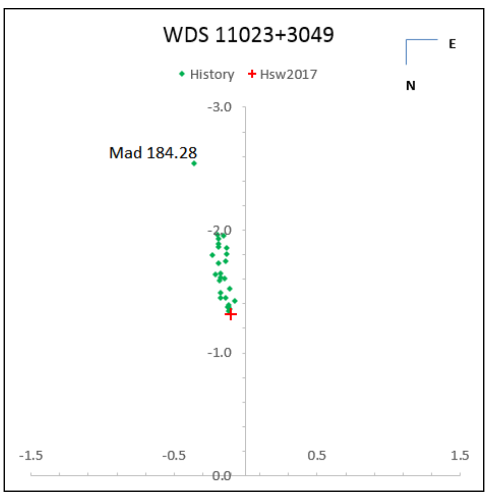


Figure 26. Plot of WDS 11023+3049.

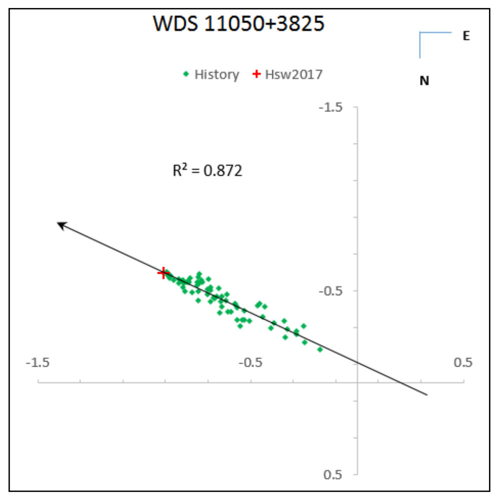


Figure 27. Plot of WDS 11050+3825.

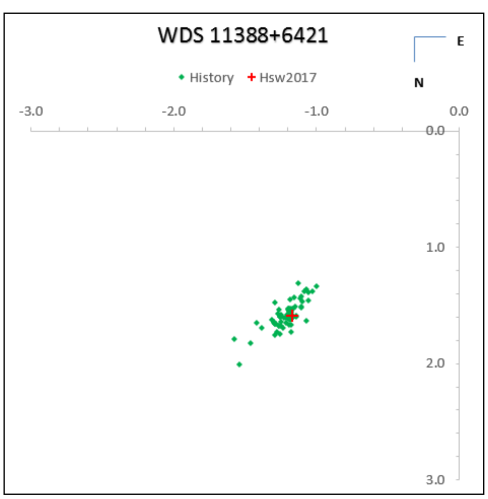


Figure 28. Plot of WDS 11388+6421.

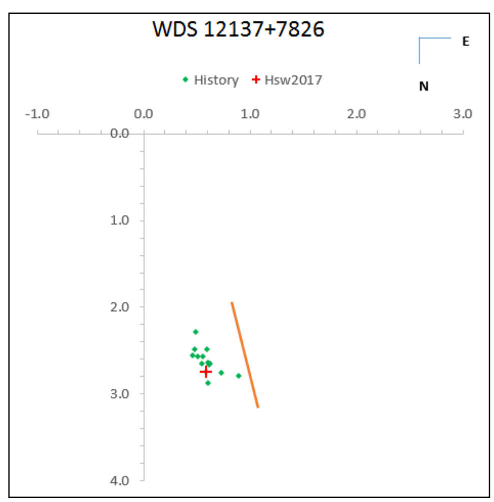


Figure 29. Plot of WDS 12137+7826.

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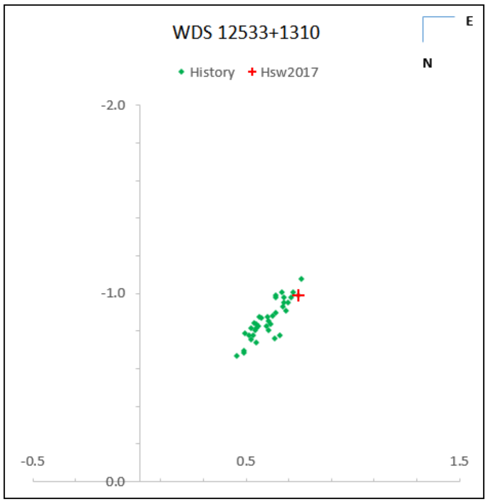


*Figure 30. Plot of WDS 12533+1310.*

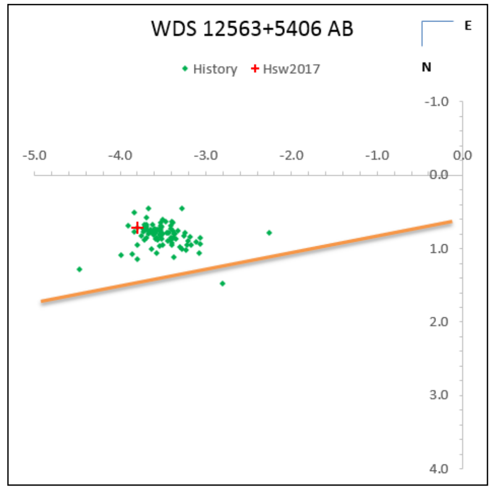


*Figure 31. Plot of WDS 12563+5460 AB.*

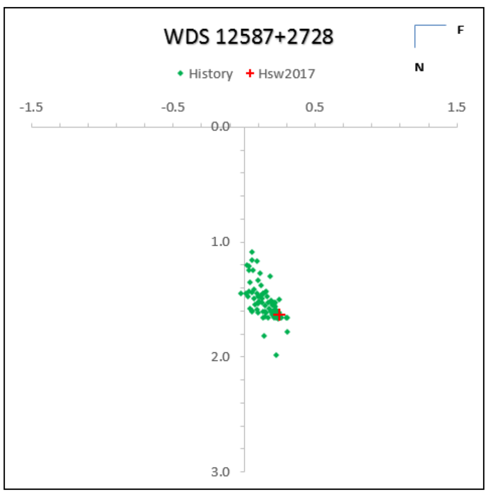


*Figure 32. Plot of WDS 12587+2728.*

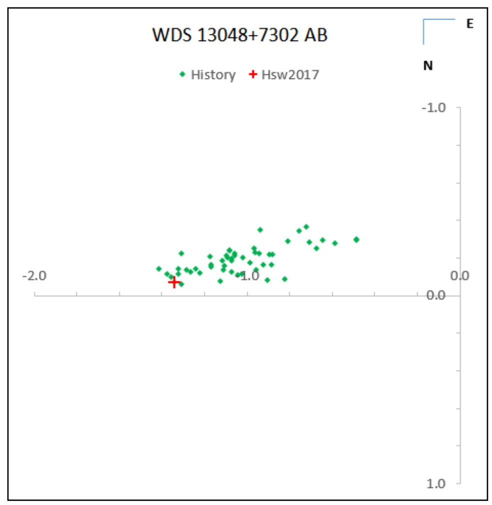


*Figure 33. Plot of WDS 13048+7302.*

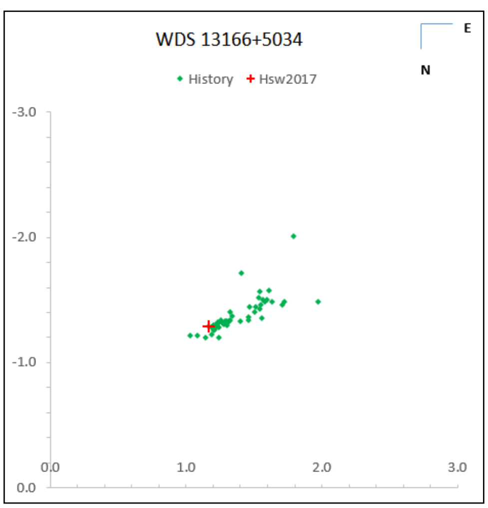


*Figure 34. Plot of WDS 13166+5034.*

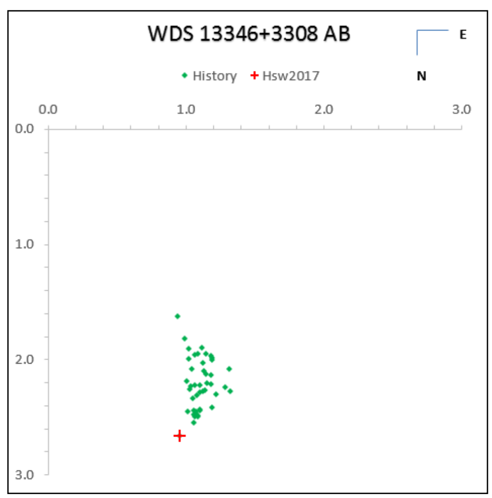


*Figure 35. Plot of WDS 13346+3308.*

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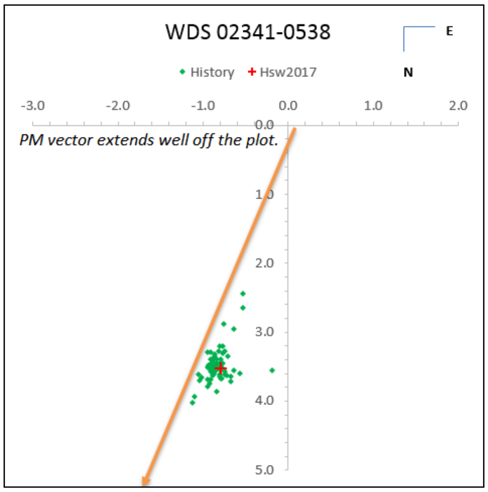


*Figure 42. Plot of WDS 02341-0538*

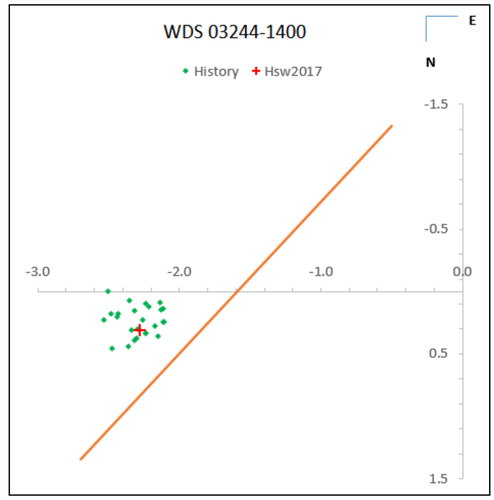


*Figure 43. Plot of WDS 03244-1400.*

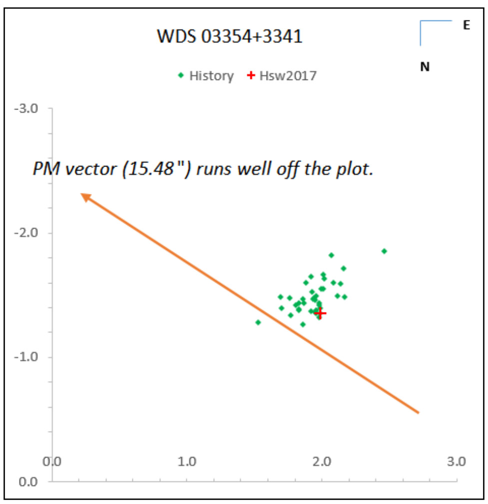


*Figure 44. Plot of WDS 03354+3341.*

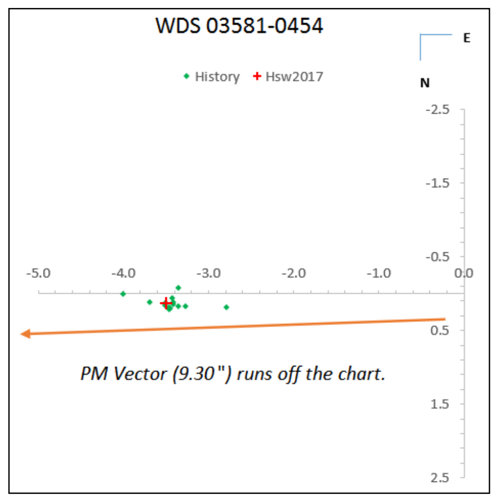


*Figure 45. Plot of WDS 03581-0454.*

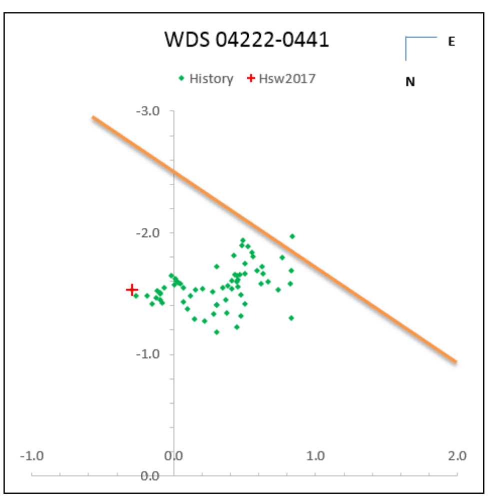


*Figure 46. Plot of WDS 04222-0441.*

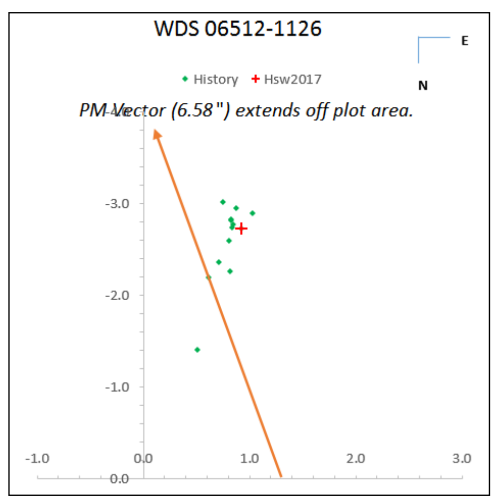


*Figure 47. Plot of WDS 06512-1126.*

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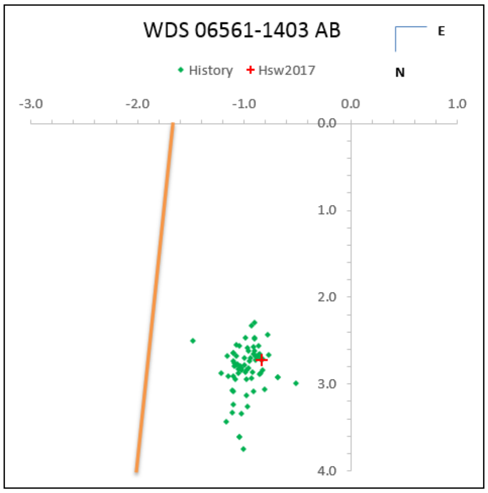


*Figure 48. Plot of WDS 06561-1403*

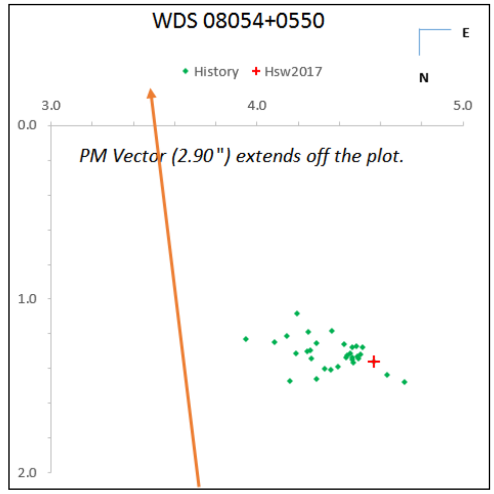


*Figure 49. Plot of WDS 08054+0550.*

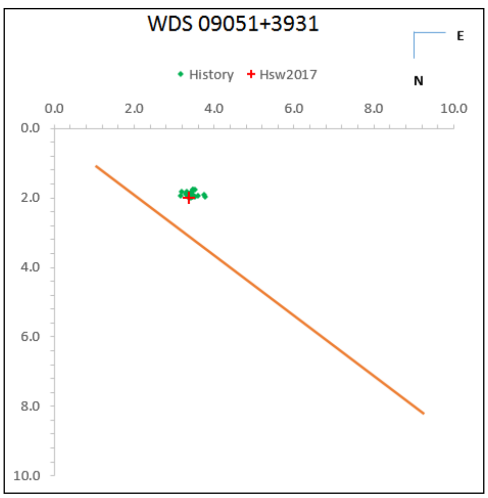


*Figure 50. Plot of WDS 03354+3341.*

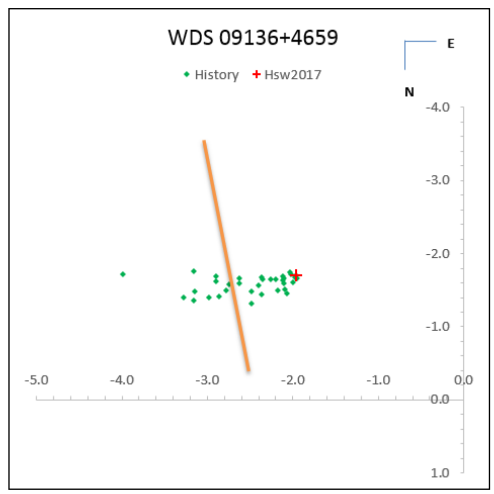


*Figure 51. Plot of WDS 09136+4659.*

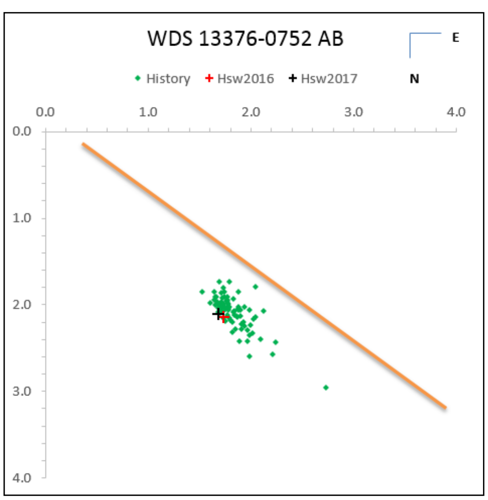


*Figure 52. Plot of WDS 13376-0752.*

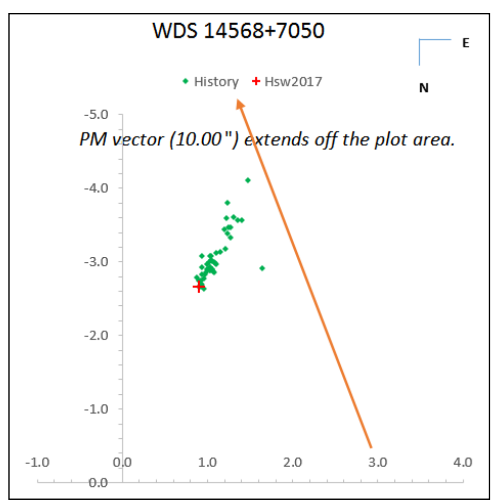


*Figure 53. Plot of WDS 14568+7050.*

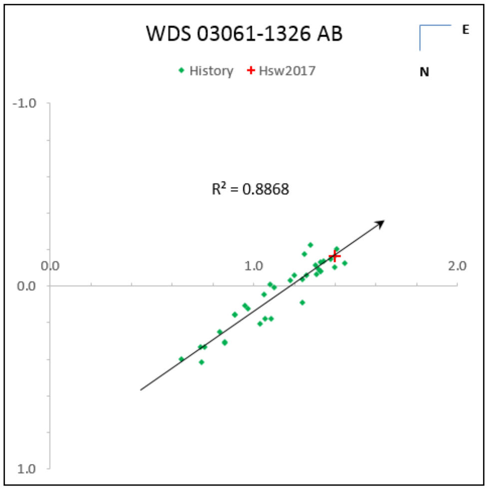


Figure 54. Plot of WDS 03061-1326 AB.

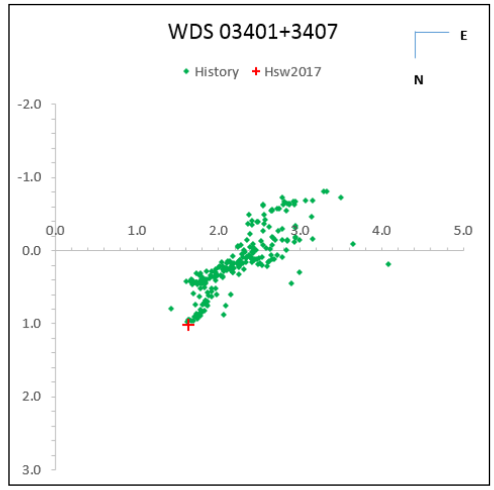


Figure 55. Plot of WDS 03401+3407.

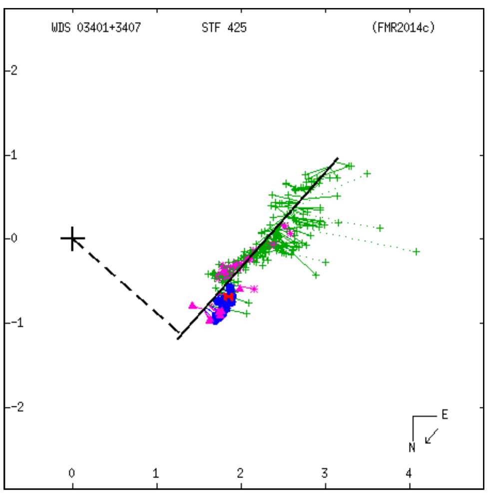


Figure 56. Linear solution of WDS 03401+3407 by FMR2014..

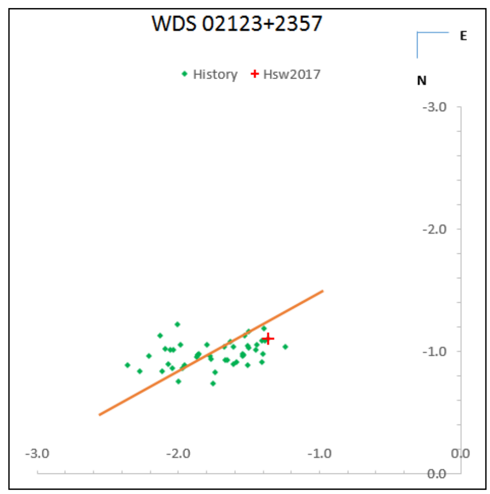


Figure 57. Plot of WDS 02123+2357.

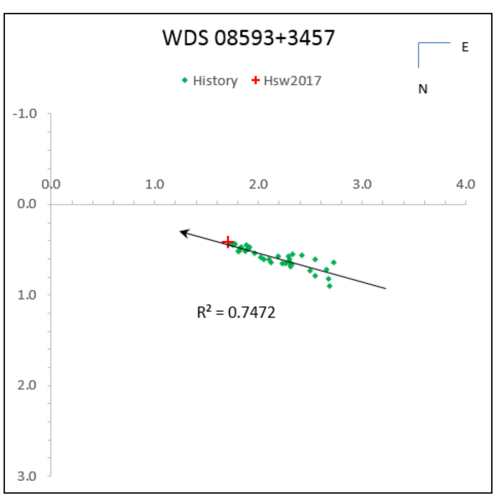


Figure 58. Plot of WDS 08593+3457.

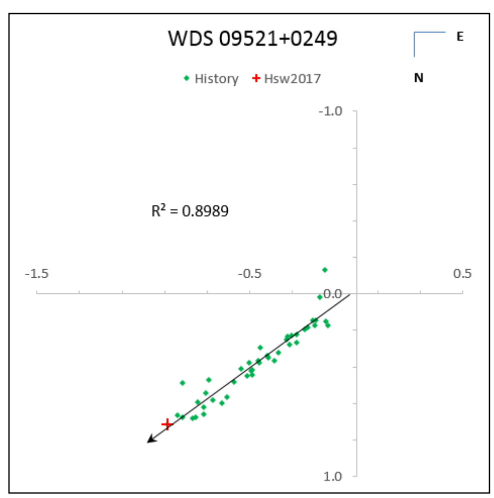


Figure 59. Plot of WDS 09521+0249.

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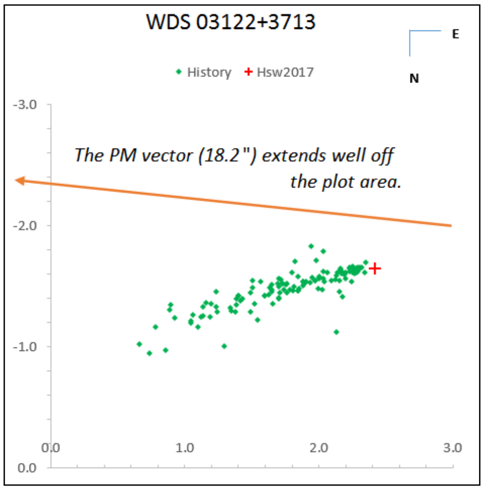


*Figure 60. Plot of WDS 03122+3713.*

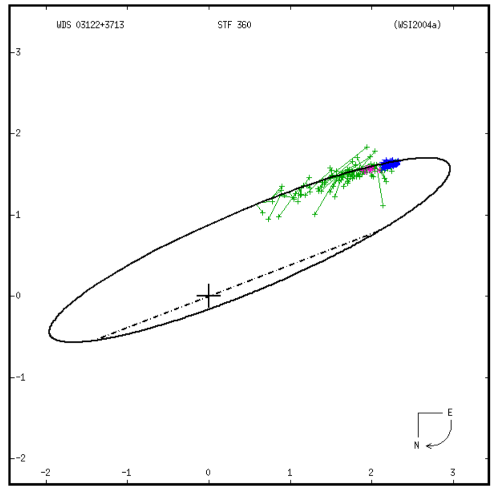


*Figure 61. Orbital solution of WDS 03122+3713.*

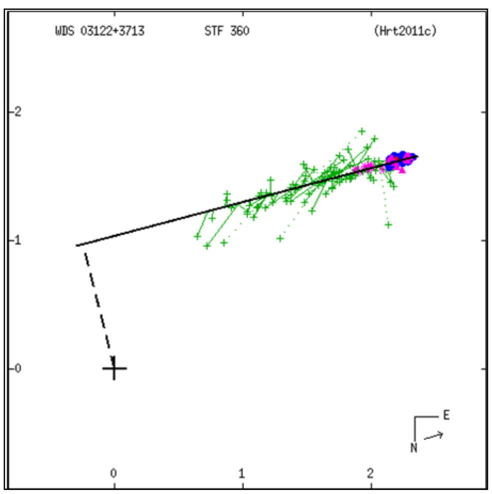


*Figure 62: Linear solution of WDS 03122+3713.*

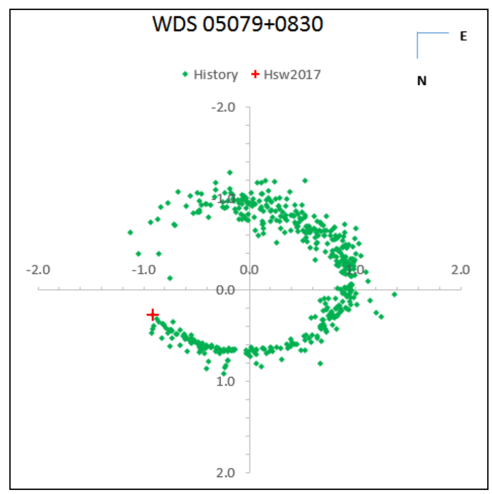


*Figure 63. Plot of WDS 05079+0830.*

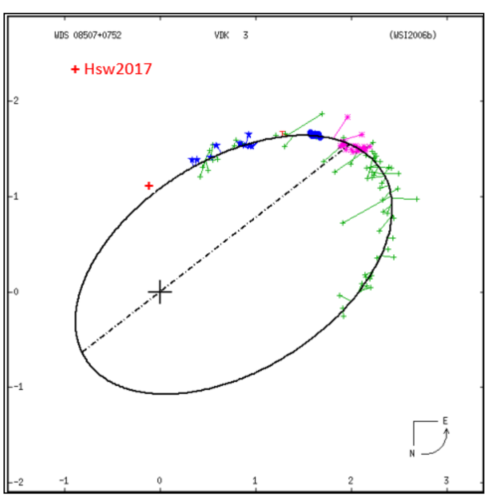


*Figure 64. Plot of WDS 08507+0752.*

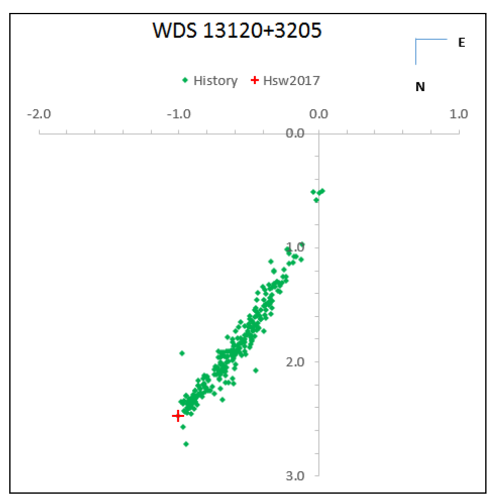


*Figure 65. Plot of WDS 13120+0830.*

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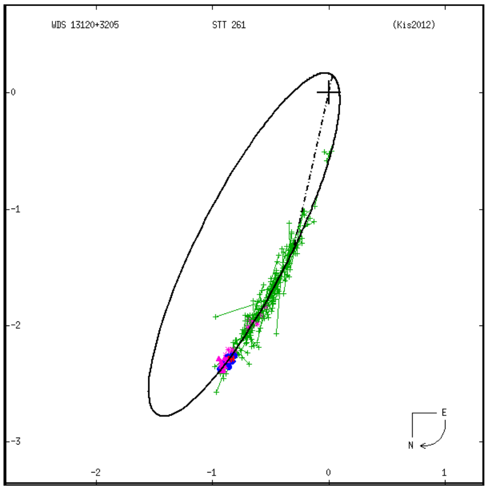


*Figure 66: Kiselev's orbit for WDS 13120+3205.*

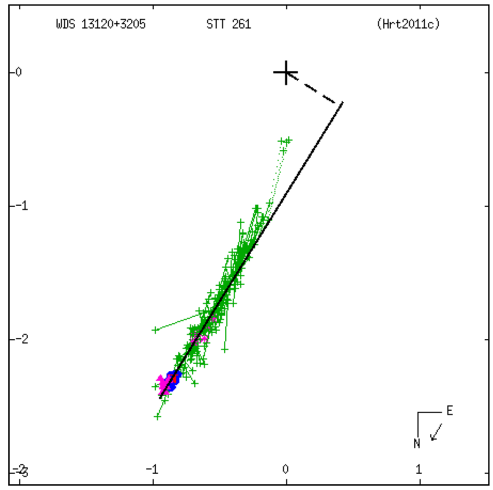


*Figure 67: Hartkopf's linear solution for WDS 13120+3205 .*

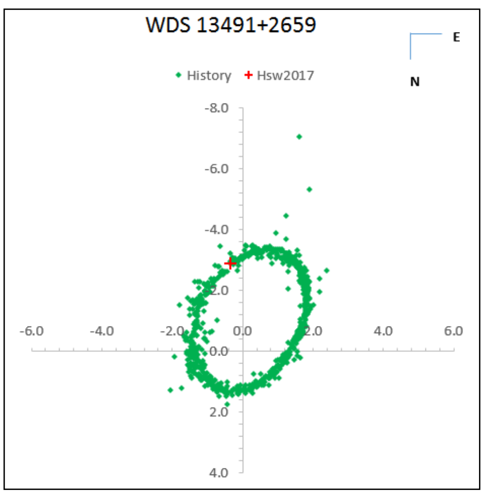


*Figure 68: Plot of WDS 13491+2659.*

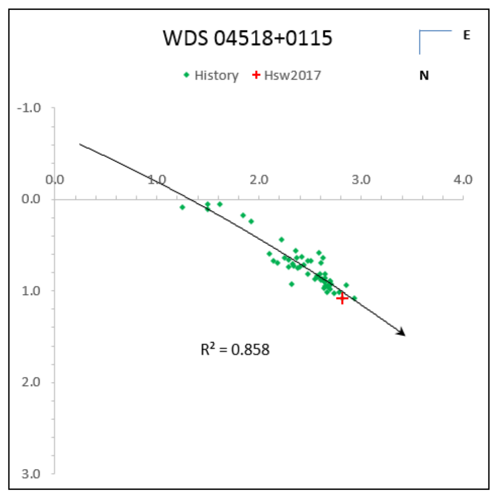


*Figure 69. Plot of WDS 04518+3205.*

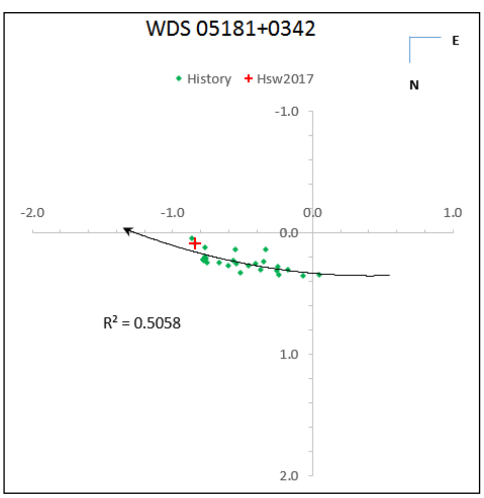


*Figure 70. Plot of WDS 05181+0342.*

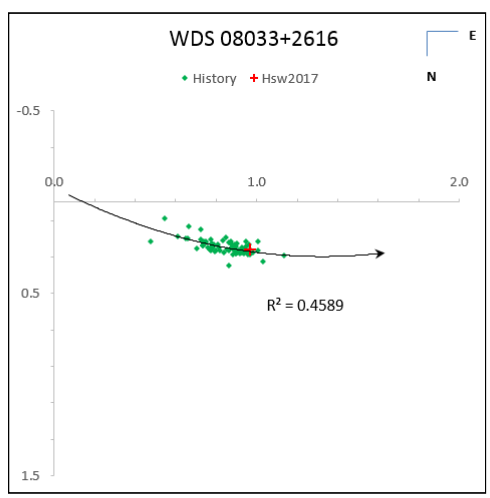


*Figure 71. Plot of WDS 08033+2616.*

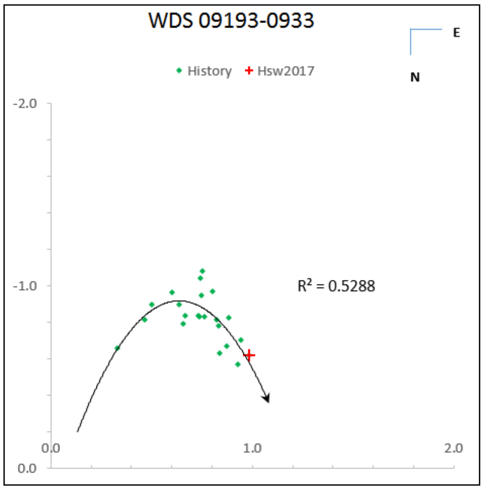


*Figure 72: Plot of WDS 09193-0933.*

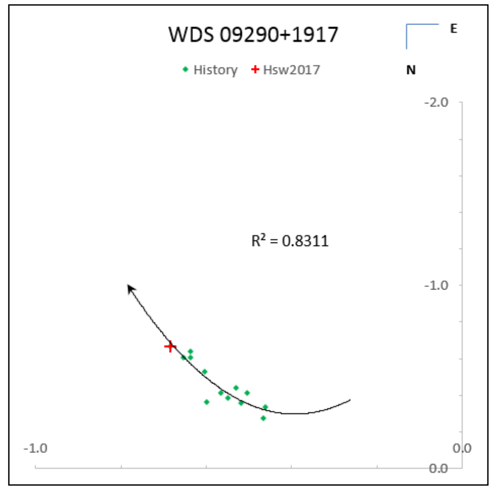


*Figure 73. Plot of WDS 09290+1917.*

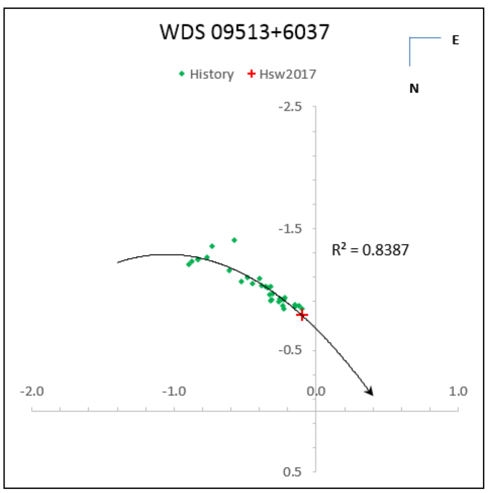


*Figure 74. Plot of WDS 09513+6037.*

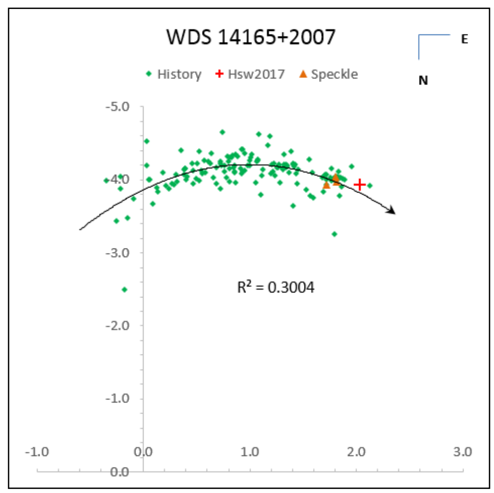


*Figure 75. Plot of WDS 14165+2007.*

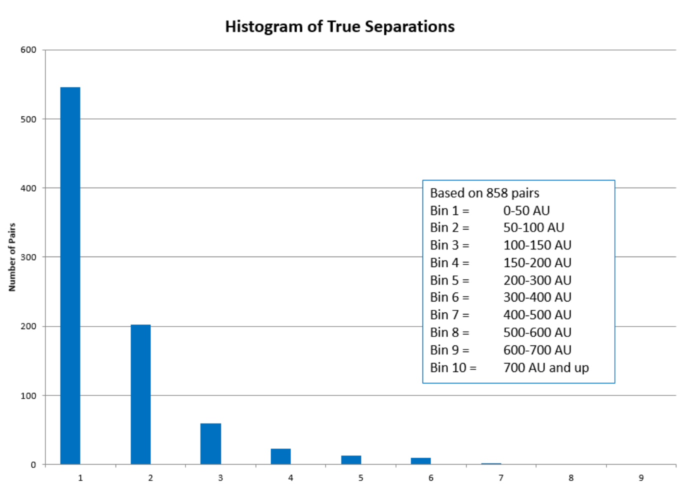


*Figure 76: Histogram of A-B Separations (in AU) from the Sixth Orbit Catalog*