STT Doubles with Large ΔM – Part V: Aquila, Delphinus, Cygnus, Aquarius

Wilfried R.A. Knapp
Vienna, Austria
wilfried.knapp@gmail.com

John Nanson
Star Splitters Double Star Blog
Manzanita, Oregon
jnanson@nehalemtel.net

Abstract: The results of visual double star observing sessions suggested a pattern for STT doubles with large ΔM of being harder to resolve than would be expected based on the WDS catalog data. It was felt this might be a problem with expectations on one hand, and on the other might be an indication of a need for new precise measurements, so we decided to take a closer look at a selected sample of STT doubles and do some research. We found that, as in the other constellations covered so far (Gem, Leo, UMa etc.), at least several of the selected objects in Aql, Del, Cyg and Aqr show parameters quite different from the current WDS data

1. Introduction

As a follow up to our STT reports so far, we continued in the constellations of Aquila, Delphinus, Cygnus, and Aquarius, which contained (with the exception of 3 multiples in Cyg covered in a separate report) 14 objects from our list (see Table 1). All values are based on WDS data as of the begin of 2016.

2. Further Research

Following the procedure for the earlier parts of our report we concluded again that the best approach would be to check historical data on all objects, observe them visually with the target of comparing with the existing data and obtain as many images as possible suitable for photometry.

2.1 Historical Research and Catalog Comparisons

Of the eleven stars in this survey, three of them have notable aspects worth further investigation. Three

Table 1. WDS Values for the Selected Objects at the Beginning of 2016

Name		ID	RA	Dec	Con	Sep	PA	M1	M2	ΔM
STT362	AC	18482+1039	18:48:13.819	+10:38:33.899	Aql	12	104	8.27	14.00	5.73
STT532	AB	19553+0624	19:55:18.791	+06:24:24.301	Aql	13.6	359	3.81	11.90	8.09
STT381	AB	19434+0410	19:43:21.089	+04:10:27.900	Aql	14.7	2	8.00	11.20	3.20
STT368	AC	19160+1610	19:16:01.839	+16:09:39.501	Aql	15.8	108	7.53	11.30	3.77
STT438	AB	21218+4309	21:21:45.801	+43:08:38.102	Cyg	2.3	357	8.27	10.30	2.03
STT427	AB	21037+3104	21:03:39.871	+31:03:44.698	Cyg	4.2	151	7.83	11.90	4.07
STT420	AB	20544+4042	20:54:22.253	+40:42:10.605	Cyg	5.4	0	6.70	10.70	4.00
STT374	AB	19310+5012	19:31:02.423	+50:11:48.701	Cyg	19.4	291	7.60	11.10	3.50
STT412	AB	20457+5040	20:45:43.080	+50:40:25.905	Cyg	25.9	279	7.10	13.10	6.00
STT412	BC	20457+5040	20:45:40.402	+50:40:30.093	Cyg	5.00	186	13.10	13.10	0.00
STT412	AC	20457+5040	20:45:43.080	+50:40:25.905	Cyg	26.20	268	7.27	11.22	3.95
STT409	AB	20403+0326	20:40:17.638	+03:26:28.500	Del	16.8	84	7.06	10.20	3.14
STT460	AB	22057+0147	22:05:39.203	+01:46:56.300	Aqr	13.8	340	8.40	12.80	4.40
STT460	AC	22057+0147	22:05:39.203	+01:46:56.300	Aqr	18.8	30	8.40	12.10	3.70

main research sources were used for this section of the paper, the first of which was W.J. Hussey's *Micrometrical Observations of the Double Stars Discovered at Pulkovo*, published in 1901, which provided preliminary historical information on each of the stars. Hussey's book includes his observations and measures of all the stars originally listed in Otto Wilhelm Struve's 1845 Pulkovo Catalog, as well as data beginning with the date of first measure and continuing through the following years up to 1900. That data, plus inclusion of the background for the Pulkovo Catalog, makes Hussey's book a valuable source of reference. Also consulted was S.W. Burnham's *A General Catalogue of Double Stars Within 121° of the North Pole, Part I* and *Part II*, for information on STT 381 and STT 460. In addition, Bill Hartkopf of the USNO graciously provided the text file for STT 460.

STT 381 (Aql) The intriguing aspect of STT 381 is Hussey's statement that that pair was dropped from the second edition of the Pulkovo catalog because "the companion was regarded as too faint for exact measurement with the 15-inch Pulkowa telescope." According to Hussey's account of STT 381, the pair was first measured by Johann Heinrich Mädler in 1847 at 8° and 15.74", but no magnitudes are shown. However Burnham, in Part I of his 1906 Catalog, lists an 1843 measure by Mädler of 7.5° and 15.79" with magnitudes of 7 and 11 (see Figure 2). Burnham also notes the exclusion of STT 381 from the second Pulkovo catalog, and includes a remark that the secondary wasn't seen by Dembowski in 1865, but notes he (Burnham) found it easy in 1876 with his six inch refractor. Hussey shows magnitudes of 8.0 and 12.0 for the pair in 1899, and Burnham lists them at 7.2 and 11.7 in 1900 (See Figure 2). The WDS shows a more narrow range of 8.0 and 11.20 for the pair. Our photometry resulted in a magnitude of 12.396 for B, but our result for A of 7.775 was hampered by the brightness of A relative to B. We can add that visual observations of B were difficult with a six inch refractor and a 9.25 inch SCT.

STT 409 (Del) This pair was first measured in 1843 by Mädler at 83.6° and 16.33". Hussey notes Otto Struve dropped STT 409 from the second edition of the Pulkovo catalog because the separation exceeded the 16" separation limit set for pairs with secondaries fainter than ninth magnitude. That limit was set by F.G.W. Struve, who began the survey in 1841 and a month later turned it over to his son, Otto (Hussey, 1901, p. 16). There's a tenth magnitude C companion which was added in 1894 by S. Glasenapp.

STT 460 (Aqr) The component of STT 460 which is now designated as C in the WDS was first measured in 1845 by Mädler at 53.9° and 15". The second component, now designated as B in the WDS, was added in 1849 by Otto Struve, with measures of 355.7° and 5.68". However, when the 1850 revision of the Pulkovo Catalog was published, it listed the two components of STT 460 at distances of 1.5" and 7.3". That set off a search by S.W. Burnham (Burnham, 1875) with his six inch refractor which failed to turn up a component at that distance. Hussey also searched for it with the 36 inch Lick refractor on two night in 1898 (Hussey, 1901, p. 182) and was unable to detect a component in the 1.5" range. It appears the 1.5" distance published in the 1850 catalog was very likely a misprint of 15".

The relative positions of the three components have changed rapidly since their discoveries in 1845 and 1849. The AB pair's initial measures (355.7° and 5.68") are virtually unrecognizable when compared to the current WDS measures (2003) of 340° and 13.80"; our measures for the pair are 339.8° and 14.47". The AC pair, first measured at 53.9° and 15", is listed in the WDS at 30° and 18.80" (also from 2003); our measures are 29.5° and 19.33". The WDS text file data for AB and AC displayed in Figure 2.2 highlights the consistent increases in the separations of both pairs, along with steady changes in their position angles.

The proper motion overlay in Figure 3 clearly illustrates the disparate motion of each of the three stars which has resulted in the increasing separation of the components of STT 460. Apart from the B component, the proper motions are not especially high, but as the image shows, each of the three stars is moving away

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9540. OΣ 381 *rej.* Rejected in second edition of the *Poulkowa Catalogue.* Companion not visible to Δ in 1865; easy with 6-inch in 1876. No change shown by the later measures. 37 23

1899.50	5°.9	15".47	3n	Hu	8.0...12.0
1900.51	6.0	15.13	3n	β	7.2...11.7

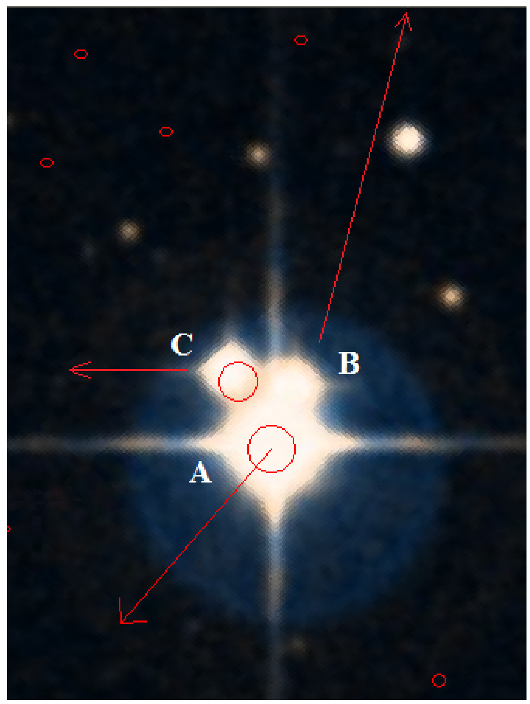
[Ma (**XI, XIII**)...Δ (I, p. 229)...Hu (*Pub. L. O.* **V**)...β5...]

Figure 2. From Burnham's 1906 Catalog of Double Stars, Part II, p. 855.

STT 460 AB

	PA	Sep
1849.69	355.7	5.68
1877.80	351.8	6.71
1886.82	351.7	8.05
1898.60	348.0	8.33
1898.67	349.0	8.18
1907.74	348.8	8.93
1907.74	347.5	8.60
1907.79	347.5	8.81
1908.56	347.6	8.83
1908.56	344.8	9.16
1909.65	346.5	8.29
1909.74	348.6	8.00
1909.84	351.9	8.28
1928.15	344.0	10.39
1929.88	343.6	9.98
1961.66	342.4	11.57
2000.60	340.3	13.72
2000.67	340.1	13.56
2003.78	340.1	13.78

WDS Text File Data



STT 460 AC

	PA	Sep
1845.67	53.9	15.00
1849.69	48.3	15.81
1866.53	46.7	15.77
1877.80	46.3	16.04
1886.82	43.6	16.51
1898.60	42.4	16.73
1898.67	44.3	17.02
1907.79	41.1	17.06
1907.79	41.0	16.84
1908.48	40.7	16.69
1908.56	40.7	16.74
1908.56	41.1	17.26
1909.65	41.0	16.76
1909.74	42.2	16.50
1909.84	42.0	16.75
1929.88	38.0	17.25
1961.66	34.6	17.97
2000.60	30.7	18.97
2000.67	31.1	18.86
2003.78	30.4	18.81

WDS Text File Data

	V	UCAC4	pmRA	pmDE
A	VizieR	459-122798	35.5	-40.1
B	VizieR	459-122797	-30.6	142.2
C	VizieR	459-122800	26.9	0.6

Figure 3. Proper Motion of STT 460 Components super-imposed on Aladin image using UCAC4 data.

from the others. (The arrows for B and C, which were added to the image, are not to scale. The arrow for A comes from Simbad's database).

2.2 Visual Observations

Both John Nanson and Wilfried Knapp made visual observations of the stars included in this report. John used a 152mm f/10 refractor, while Wilfried utilized a 140mm refractor and a 235mm SCT, as well as a masking device to evaluate what could be seen at lesser apertures.

STT 362 (Aql): John looked at STT 362 twice and found the B component to be more difficult than expected given the 7.60" separation and the 3.66 magnitudes of difference with the primary. B varied from an elongated smear to a definite point of light for very brief moments, making it impossible to estimate its magnitude. The general impression was B is fainter than the 11.93 shown for it in the WDS. Wilfried also looked at STT 362 twice and was able to split the AB pair on the second observation, but came to no conclusion on magnitude. Neither observer was able to catch sight of the C component. Wilfried was able to see nearby stars in the 13.5 magnitude range, which suggests C is fainter than that magnitude.

STT 368 (Aql): Wilfried observed STT 368 twice and apart from seeing an elongation of the AB pair, was unable to resolve the secondary. He caught a glimpse of C during the second observation at 100x, but was unable to catch sight of it again at higher magnifications, suggesting it may be significantly fainter than the WDS magnitude of 11.3. John resolved the AB pair at 253x and 380x with the six inch refractor during the one observation he made. He was able to see the C component clearly enough at 380x to compare it with three other stars, and found the star with a Vmag of 11.589 was closest in magnitude to C.

STT 381 (Aql): John observed STT 381 once and found the B component was tougher than expected for a pair with a separation of 14.7"and a magnitude difference of 3.2. The one comparison star he found had an incorrect Vmag of 10.298 (UCAC4 471-108123), but the f.mag for that star of 12.412 was more in line with the visual difficulty. Wilfried observed this pair twice and resolved B on the second attempt. He found a comparison star with an f.mag of 11.659 was a

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bit brighter than B, again suggesting B is fainter than the WDS magnitude of 11.2.

STT 409 (Del): Wilfried observed STT 409 once and was able to see B with a limiting aperture of 58mm, suggesting the WDS magnitude of 10.20 is correct. John also made one observation and found B was slightly brighter than a comparison star which was a magnitude fainter than the WDS value. Both observers were able to see C easily.

STT 460 (Aqr): John observed STT 460 several times and found it to be a real visual gem. Both the B and C components were very obvious on first sight, suggesting they're both brighter than the WDS values of 12.80 and 12.10, respectively. Nearby comparison stars suggested a magnitude for B of about 11.3. The C component appeared a bit brighter than B, which suggests a magnitude in the 10.6 range.

STT 532 (Aql): Wilfried observed STT 532 twice and was able to resolve B with averted vision during the first observation at a magnification of 470x. He found a nearby comparison star with an f.mag of 11.778 was similar in brightness to B, suggesting the WDS value of 11.90 is close. John observed STT 532 once and only managed a few fleeting glimpses of B, which were not enough to come to a conclusion on its magnitude.

STT 374 (Cyg): John observed STT 374 once and found the B component was very similar in magnitude to three comparison stars with Vmags ranging from 10.9 to 11.1, agreeing with the WDS value of 11.1. Wilfried looked at STT 374 twice and with the aid of the masking device also confirmed the WDS value.

STT 412 (Cyg): Wilfred viewed STT 412 twice and with the aid of the masking device concluded B is 1.5 magnitudes brighter than the WDS value of 13.1. John observed STT 412 once and found B was obviously brighter than the WDS value. A close comparison with the 11.22 magnitude C companion showed both B and C to be similar in magnitude, with C being slightly brighter than B. Comparison stars indicated the WDS magnitude for C is about right, leading to the conclusion that B is in the 11.5 to 11.8 magnitude range since it appears to about half a magnitude fainter than C.

STT 420 (Cyg): John observed this pair once and found B was very obvious at 190x in the six inch refractor, and also could see it at 152x. Given the 5.4" separation and 4.0 magnitude difference between primary and secondary, the WDS value for B of 10.7 seems to be about right. Wilfried looked at STT 420 twice but was unable to detect B due to poor seeing conditions.

STT 427 (Cyg): Wilfried observed this pair once but was unable to resolve the two stars with a 140mm refractor. John observed it once with a 152mm refractor and was able to see the secondary at 152x and 253x. The difficulty seemed to be about what would be expected given the 4.07 magnitudes of difference and 4.2" separation.

STT 438 (Cyg): John looked at STT 438 twice. Seeing was poor during the first observation, but the secondary was glimpsed briefly a couple of times. During the second attempt, with better seeing, the secondary could be seen as a bump on the edge of the primary at 152x and 253x. A magnitude estimate wasn't possible, but given the three magnitudes of difference and the 2.3" separation, the visual difficulty was about what would be expected. Wilfried also looked at this pair twice. During the first observation, the secondary could be seen at 200x with the aperture reduced to 117mm, which would seem to confirm the WDS magnitude of 10.3 for B. Poor seeing during the second attempt prevented catching sight of the secondary.

2.3 Photometry and Astrometry Results

Several hundred images taken with iTelescope remote telescopes were in a first step plate solved and stacked with AAVSO VPhot. The stacked images were then plate solved with Astrometrica with UCAC4 reference stars with Vmags in the range 10.5 to 14.5mag. The RA/Dec coordinates resulting from plate solving with UCAC4 reference stars in the 10.5 to 14.5mag range were used to calculate Sep and PA using the formula provided by R. Buchheim (2008). Err_Sep is calculated as SQRT(dRA^2+dSep^2) with dRA and dDec as average RA and Dec plate solving errors. Err_PA is the error estimation for PA calculated as arctan (Err_Sep/Sep) in degrees assuming the worst case that Err_Sep points in the right angle to the direction of the separation means perpendicular to the separation vector. Mag is the photometry result based on UCAC4 reference stars with Vmags between 10.5 and 14.5mag. Err_Mag is calculated as

$$Err\_Mag = \sqrt{dV_{mag}^2 + \left[2.5\log_{10}\left(1+\frac{1}{SNR}\right)\right]^2}$$

with *dVmag* as the average *Vmag* error over all used reference stars and *SNR* is the signal to noise ratio for the given star. The results are shown in Table 2 (dRA, dDec, dVmag and SNR not given due to space restrictions).

Summary

Tables 3 and 4 below compare the final results of

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Table 2. Photometry and astrometry results for the selected STT objects. Date is the Bessel epoch in 2015 and N is the number of images (usually with 1s exposure time) used for the reported values. iT in the Notes column indicates the telescope used with number of images and exposure time given (Specifications of the used telescopes: See Acknowledgements). The average results over all used images are given in the line below the individual stacks in red and bold. The error estimation over all used images is calculated as root mean square over the individual Err values. The N column in the summary line gives the total number of images used and Date the average Bessel epoch.

STT 362	RA	Dec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	Date	N	Notes
A	18 48 13.818	10 38 34.16	12.065	0.164	105.676	0.779	7.898	0.130	2015.565	5	1
C	18 48 14.606	10 38 30.90					14.357	0.163			
A	18 48 13.821	10 38 34.04	12.156	0.170	104.580	0.800	8.053	0.110	2015.557	5	2
C	18 48 14.619	10 38 30.98					13.983	0.132			
A	18 48 13.822	10 38 34.17	11.836	0.213	105.685	1.029	8.065	0.100	2015.555	5	3
C	18 48 14.595	10 38 30.97					14.292	0.143			
A	18 48 13.830	10 38 34.03	12.037	0.205	105.714	0.977	8.133	0.120	2015.617	5	4
C	18 48 14.616	10 38 30.77					14.128	0.131			
A	18 48 13.823	10 38 34.02	12.119	0.184	105.017	0.869	8.039	0.170	2015.555	5	5
C	18 48 14.617	10 38 30.88					14.267	0.176			
A	18 48 13.818	10 38 34.08	12.135	0.163	105.290	0.769	8.054	0.090	2015.557	5	6
C	18 48 14.612	10 38 30.88					14.291	0.100			
A	18 48 13.862	10 38 34.22	11.955	0.170	104.533	0.813	8.121	0.090	2015.617	5	7
C	18 48 14.647	10 38 31.22					14.214	0.100			
A	**18 48 13.828**	**10 38 34.103**	**12.043**	**0.182**	**105.212**	**0.866**	**8.052**	**0.119**	**2015.575**	**35**	8
C	**18 48 14.616**	**10 38 30.943**					**14.219**	**0.138**			
STT532	RA	Dec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	Date	N	Notes
A	19 55 18.839	06 24 16.67	13.311	0.226	0.577	0.974	5.345	0.141	2015.569	4	9
B	19 55 18.848	06 24 29.98					11.309	0.151			
A	19 55 18.838	06 24 16.35	13.801	0.184	0.619	0.765	4.646	0.150	2015.569	5	10
B	19 55 18.848	06 24 30.15					11.197	0.158			
A	19 55 18.857	06 24 16.53	13.662	0.297	358.937	1.245	4.480	0.121	2015.615	5	11
B	19 55 18.840	06 24 30.19					11.646	0.154			
A	19 55 18.847	06 24 16.66	13.271	0.240	0.772	1.038	5.452	0.121	2015.615	5	12
B	19 55 18.859	06 24 29.93					11.453	0.130			
A	19 55 18.871	06 24 16.84	13.226	0.205	358.256	0.889	5.857	0.113	2015.569	5	13
B	19 55 18.844	06 24 30.06					11.349	0.126			
A	19 55 18.865	06 24 16.77	13.222	0.191	359.096	0.828	6.093	0.134	2015.615	6	14
B	19 55 18.851	06 24 29.99					11.519	0.138			
A	**19 55 18.853**	**06 24 16.637**	**13.414**	**0.227**	**359.713**	**0.971**	**5.312**	**0.131**	**2015.592**	**30**	15
B	**19 55 18.848**	**06 24 30.05**					**11.412**	**0.143**			

Table 2 continues on next page.

STT Doubles with Large ΔM – Part V: Aquila, Delphinus, Cygnus, Aquarius

Table 2 (continued). Photometry and astrometry results for the selected STT objects. Date is the Bessel epoch in 2015 and N is the number of images (usually with 1s exposure time) used for the reported values. iT in the Notes column indicates the telescope used with number of images and exposure time given (Specifications of the used telescopes: See Acknowledgements). The average results over all used images are given in the line below the individual stacks in red and bold. The error estimation over all used images is calculated as root mean square over the individual Err values. The N column in the summary line gives the total number of images used and Date the average Bessel epoch.

STT381	RA	Dec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	Date	N	Notes
A	19 43 21.085	04 10 27.96	14.519	0.198	2.067	0.781	7.482	0.190	2015.557	5	16
B	19 43 21.120	04 10 42.47					12.106	0.192			
A	19 43 21.077	04 10 27.97	14.528	0.163	1.888	0.642	7.936	0.150	2015.555	5	17
B	19 43 21.109	04 10 42.49					12.550	0.152			
A	19 43 21.092	04 10 27.80	14.556	0.255	1.708	1.003	7.807	0.170	2015.563	5	18
B	19 43 21.121	04 10 42.35					12.443	0.174			
A	19 43 21.088	04 10 27.91	14.701	0.213	2.216	0.829	7.874	0.130	2015.617	5	19
B	19 43 21.126	04 10 42.60					12.483	0.131			
A	**19 43 21.085**	**04 10 27.91**	**14.576**	**0.210**	**1.970**	**0.824**	**7.775**	**0.162**	**2015.573**	**20**	20
B	**19 43 21.119**	**04 10 42.478**					**12.396**	**0.164**			

STT368	RA	Dec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	Date	N	Notes
A	19 16 01.848	16 09 39.85	15.825	0.241	108.609	0.872	7.167	0.110	2015.617	5	21
C	19 16 02.889	16 09 34.80					13.245	0.119			
A	19 16 01.870	16 09 39.51	15.406	0.212	107.646	0.789	7.193	0.090	2015.555	5	22
C	19 16 02.889	16 09 34.84					13.178	0.099			
A	19 16 01.868	16 09 39.73	15.635	0.106	108.689	0.390	7.188	0.120	2015.557	5	23
C	19 16 02.896	16 09 34.72					13.314	0.127			
A	19 16 01.868	16 09 39.52	15.593	0.213	107.889	0.781	7.143	0.090	2015.563	5	24
C	19 16 02.898	16 09 34.73					13.142	0.101			
A	19 16 01.860	16 09 39.83	15.522	0.205	107.936	0.757	7.199	0.080	2015.617	5	25
C	19 16 02.885	16 09 35.05					13.178	0.085			
A	19 16 01.860	16 09 39.63	15.674	0.191	107.948	0.698	7.162	0.070	2015.555	5	26
C	19 16 02.895	16 09 34.80					13.225	0.074			
A	19 16 01.863	16 09 39.76	15.639	0.177	108.568	0.648	7.172	0.070	2015.557	5	27
C	19 16 02.892	16 09 34.78					13.238	0.074			
A	19 16 01.858	16 09 39.37	15.658	0.233	107.238	0.854	7.158	0.070	2015.563	5	28
C	19 16 02.896	16 09 34.73					13.212	0.075			
A	19 16 01.848	16 09 39.85	15.825	0.241	108.609	0.872	7.167	0.070	2015.617	5	29
C	19 16 02.889	16 09 34.80					13.245	0.084			
A	**19 16 01.86**	**16 09 39.672**	**15.641**	**0.206**	**108.128**	**0.755**	**7.172**	**0.087**	**2015.578**	**45**	30
C	**19 16 2.892**	**16 09 34.806**					**13.220**	**0.095**			

Table 2 continues on next page.

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Table 2 (continued). Photometry and astrometry results for the selected STT objects. Date is the Bessel epoch in 2015 and N is the number of images (usually with 1s exposure time) used for the reported values. iT in the Notes column indicates the telescope used with number of images and exposure time given (Specifications of the used telescopes: See Acknowledgements). The average results over all used images are given in the line below the individual stacks in red and bold. The error estimation over all used images is calculated as root mean square over the individual Err values. The N column in the summary line gives the total number of images used and Date the average Bessel epoch.

STT438	RA	Dec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	Date	N	Notes
A	21 21 45.771	43 08 37.54	2.210	0.220	0.284	5.691	8.089	0.100	2015.639	5	31
B	21 21 45.772	43 08 39.75					9.719	0.101			
A	21 21 45.772	43 08 37.97	2.060	0.198	359.087	5.489	8.150	0.070	2015.621	5	32
B	21 21 45.769	43 08 40.03					9.916	0.072			
A	**21 21 45.772**	**43 08 37.755**	**2.135**	**0.209**	**359.706**	**5.602**	**8.120**	**0.086**	**2015.630**	**10**	33
B	**21 21 45.77**	**43 08 39.89**					**9.818**	**0.087**			
STT427	**RA**	**Dec**	**Sep**	**Err Sep**	**PA**	**Err PA**	**Mag**	**Err Mag**	**Date**	**N**	**Notes**
A	21 03 39.890	31 03 44.55	3.898	0.264	155.252	3.875	7.682	0.100	2015.639	4	34
B	21 03 40.017	31 03 41.01					10.768	0.102			
A	21 03 39.893	31 03 44.53	4.612	0.172	155.298	2.136	7.455	0.110	2015.700	4	35
B	21 03 40.043	31 03 40.34					10.558	0.111			
A	21 03 39.898	31 03 44.63	4.212	0.198	151.181	2.692	7.641	0.070	2015.615	5	36
B	21 03 40.056	31 03 40.94					11.019	0.072			
A	21 03 39.893	31 03 44.52	3.918	0.184	152.030	2.687	7.674	0.070	2015.621	5	37
B	21 03 40.036	31 03 41.06					10.874	0.071			
A	21 03 39.891	31 03 44.67	4.017	0.170	150.907	2.419	7.663	0.070	2015.632	5	38
B	21 03 40.043	31 03 41.16					10.779	0.072			
A	**21 03 39.893**	**31 03 44.58**	**4.129**	**0.201**	**152.976**	**2.781**	**7.623**	**0.086**	**2015.641**	**23**	39
B	**21 03 40.039**	**31 03 40.902**					**10.800**	**0.087**			
STT420	**RA**	**Dec**	**Sep**	**Err Sep**	**PA**	**Err PA**	**Mag**	**Err Mag**	**Date**	**N**	**Notes**
A	20 54 22.261	40 42 10.57	5.276	0.234	2.841	2.543	6.622	0.130	2015.637	3	40
B	20 54 22.284	40 42 15.84					10.364	0.133			
A	20 54 22.261	40 42 10.57	5.784	0.283	2.141	2.803	6.586	0.090	2015.639	4	41
B	20 54 22.280	40 42 16.35					10.689	0.095			
A	20 54 22.265	40 42 10.54	5.370	0.186	359.757	1.984	6.411	0.120	2015.700	5	42
B	20 54 22.263	40 42 15.91					10.030	0.121			
A	20 54 22.265	40 42 10.63	5.441	0.177	1.198	1.862	6.616	0.060	2015.615	5	43
B	20 54 22.275	40 42 16.07					10.549	0.062			
A	20 54 22.263	40 42 10.57	5.605	0.191	2.326	1.952	6.612	0.060	2015.620	5	44
B	20 54 22.283	40 42 16.17					10.794	0.090			
A	20 54 22.268	40 42 10.59	5.753	0.191	1.699	1.902	6.603	0.070	2015.632	5	45
B	20 54 22.283	40 42 16.34					10.673	0.077			
A	**20 54 22.264**	**40 42 10.578**	**5.537**	**0.214**	**1.667**	**2.210**	**6.575**	**0.093**	**2015.640**	**27**	46
B	**20 54 22.278**	**40 42 16.113**					**10.517**	**0.099**			

Table 2 continues on next page.

Table 2 (continued). Photometry and astrometry results for the selected STT objects. Date is the Bessel epoch in 2015 and N is the number of images (usually with 1s exposure time) used for the reported values. iT in the Notes column indicates the telescope used with number of images and exposure time given (Specifications of the used telescopes: See Acknowledgements). The average results over all used images are given in the line below the individual stacks in red and bold. The error estimation over all used images is calculated as root mean square over the individual Err values. The N column in the summary line gives the total number of images used and Date the average Bessel epoch.

STT374	RA	Dec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	Date	N	Notes
A	19 31 02.427	50 11 48.92	19.491	0.220	289.949	0.647	7.486	0.050	2015.639	4	47
B	19 31 00.519	50 11 55.57					11.204	0.054			
A	19 31 02.435	50 11 48.67	19.574	0.177	290.204	0.518	7.267	0.110	2015.700	2	48
B	19 31 00.522	50 11 55.43					11.113	0.111			
A	19 31 02.429	50 11 48.89	19.488	0.184	290.014	0.540	7.506	0.050	2015.621	9	49
B	19 31 00.522	50 11 55.56					11.235	0.051			
A	19 31 02.431	50 11 48.90	19.516	0.177	289.985	0.519	7.480	0.060	2015.632	5	50
B	19 31 00.521	50 11 55.57					11.219	0.061			
A	**19 31 02.43**	**50 11 48.845**	**19.517**	**0.190**	**290.038**	**0.559**	**7.435**	**0.072**	**2015.648**	**20**	51
B	**19 31 00.521**	**50 11 55.532**					**11.193**	**0.073**			
STT412	**RA**	**Dec**	**Sep**	**Err Sep**	**PA**	**Err PA**	**Mag**	**Err Mag**	**Date**	**N**	**Notes**
A	20 45 43.086	50 40 25.93	25.898	0.262	279.243	0.579	7.209	0.130	2015.637	3	52
B	20 45 40.397	50 40 30.09					11.815	0.132			
A	20 45 43.097	50 40 25.94	25.995	0.205	278.986	0.452	7.161	0.130	2015.639	5	53
B	20 45 40.396	50 40 30.00					11.767	0.133			
A	20 45 43.105	50 40 25.88	26.048	0.170	279.056	0.375	6.951	0.140	2015.700	5	54
B	20 45 40.399	50 40 29.98					11.615	0.141			
A	20 45 43.107	50 40 25.96	26.082	0.184	279.133	0.405	7.168	0.110	2015.615	5	55
B	20 45 40.398	50 40 30.10					11.742	0.111			
A	20 45 43.101	50 40 26.10	26.039	0.198	278.926	0.437	7.156	0.100	2015.620	5	56
B	20 45 40.395	50 40 30.14					11.724	0.101			
A	20 45 43.106	50 40 26.01	25.926	0.170	279.099	0.375	7.171	0.100	2015.632	5	57
B	20 45 40.413	50 40 30.11					11.718	0.101			
A	**20 45 43.1**	**50 40 25.97**	**25.998**	**0.201**	**279.074**	**0.442**	**7.136**	**0.119**	**2015.640**	**28**	58
B	**20 45 40.4**	**50 40 30.07**					**11.730**	**0.121**			
STT412	**RA**	**Dec**	**Sep**	**Err Sep**	**PA**	**Err PA**	**Mag**	**Err Mag**	**Date**	**N**	**Notes**
B	20 45 40.397	50 40 30.09	5.110	0.262	187.160	2.932	11.815	0.132	2015.637	3	59
C	20 45 40.330	50 40 25.02					11.909	0.132			
B	20 45 40.396	50 40 30.00	5.030	0.205	185.096	2.336	11.767	0.133	2015.639	5	60
C	20 45 40.349	50 40 24.99					11.798	0.133			
B	20 45 40.399	50 40 29.98	4.926	0.170	185.870	1.980	11.615	0.141	2015.700	5	61
C	20 45 40.346	50 40 25.08					11.677	0.141			
B	20 45 40.398	50 40 30.10	5.029	0.184	184.988	2.100	11.742	0.111	2015.615	5	62
C	20 45 40.352	50 40 25.09					11.858	0.111			
B	20 45 40.398	50 40 30.10	4.966	0.198	185.823	2.289	11.724	0.101	2015.620	5	63
C	20 45 40.345	50 40 25.16					11.800	0.101			
B	20 45 40.413	50 40 30.11	5.083	0.170	186.550	1.912	11.718	0.101	2015.632	5	64
C	20 45 40.352	50 40 25.06					11.804	0.101			
B	**20 45 40.4**	**50 40 30.063**	**5.023**	**0.201**	**185.919**	**2.288**	**11.730**	**0.121**	**2015.640**	**28**	65
C	**20 45 40.346**	**50 40 25.067**					**11.808**	**0.121**			

Table 2 continues on next page.

STT Doubles with Large ΔM – Part V: Aquila, Delphinus, Cygnus, Aquarius

Table 2 (continued). Photometry and astrometry results for the selected STT objects. Date is the Bessel epoch in 2015 and N is the number of images (usually with 1s exposure time) used for the reported values. iT in the Notes column indicates the telescope used with number of images and exposure time given (Specifications of the used telescopes: See Acknowledgements). The average results over all used images are given in the line below the individual stacks in red and bold. The error estimation over all used images is calculated as root mean square over the individual Err values. The N column in the summary line gives the total number of images used and Date the average Bessel epoch.

STT412	RA	Dec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	Date	N	Notes
A	20 45 43.086	50 40 25.93	26.214	0.262	268.011	0.572	7.209	0.130	2015.637	3	66
C	20 45 40.330	50 40 25.02					11.909	0.132			
A	20 45 43.097	50 40 25.94	26.140	0.205	267.917	0.450	7.161	0.130	2015.639	5	67
C	20 45 40.349	50 40 24.99					11.798	0.133			
A	20 45 43.105	50 40 25.88	26.239	0.170	268.253	0.372	6.951	0.140	2015.700	5	68
C	20 45 40.346	50 40 25.08					11.677	0.141			
A	20 45 43.107	50 40 25.96	26.203	0.184	268.097	0.403	7.168	0.110	2015.615	5	69
C	20 45 40.352	50 40 25.09					11.858	0.111			
A	20 45 43.101	50 40 26.10	26.215	0.198	267.945	0.434	7.156	0.100	2015.620	5	70
C	20 45 40.345	50 40 25.16					11.800	0.101			
A	20 45 43.106	50 40 26.01	26.197	0.170	267.922	0.371	7.171	0.100	2015.632	5	71
C	20 45 40.352	50 40 25.06					11.804	0.101			
A	**20 45 43.100**	**50 40 25.97**	**26.201**	**0.201**	**268.024**	**0.439**	**7.136**	**0.119**	**2015.640**	**28**	72
C	**20 45 40.346**	**50 40 25.067**					**11.808**	**0.121**			
STT409	**RA**	**Dec**	**Sep**	**Err Sep**	**PA**	**Err PA**	**Mag**	**Err Mag**	**Date**	**N**	**Notes**
A	20 40 17.693	03 26 28.70	16.803	0.255	83.507	0.868	6.930	0.110	2015.637	4	73
B	20 40 18.808	03 26 30.60					10.701	0.111			
A	20 40 17.712	03 26 28.64	16.769	0.304	83.598	1.039	6.907	0.090	2015.639	3	74
B	20 40 18.825	03 26 30.51					10.635	0.092			
A	20 40 17.715	03 26 28.52	16.728	0.184	83.478	0.632	6.698	0.090	2015.700	5	75
B	20 40 18.825	03 26 30.42					10.527	0.091			
A	20 40 17.711	03 26 28.76	16.852	0.213	83.834	0.723	6.847	0.060	2015.615	5	76
B	20 40 18.830	03 26 30.57					10.610	0.061			
A	20 40 17.709	03 26 28.76	16.739	0.213	83.620	0.728	6.961	0.050	2015.620	5	77
B	20 40 18.820	03 26 30.62					10.650	0.050			
A	20 40 17.708	03 26 28.56	16.812	0.177	83.682	0.603	6.885	0.050	2015.632	5	78
B	20 40 18.824	03 26 30.41					10.696	0.051			
A	**20 40 17.708**	**03 26 28.657**	**16.784**	**0.228**	**83.620**	**0.780**	**6.871**	**0.078**	**2015.640**	**27**	79
B	**20 40 18.822**	**03 26 30.522**					**10.637**	**0.079**			
STT460	**RA**	**Dec**	**Sep**	**Err Sep**	**PA**	**Err PA**	**Mag**	**Err Mag**	**Date**	**N**	**Notes**
A	22 05 39.244	01 46 56.04	14.360	0.248	339.719	0.991	8.219	0.120	2015.637	5	80
B	22 05 38.912	01 47 09.51					12.322	0.124			
A	22 05 39.235	01 46 55.80	14.499	0.213	339.606	0.840	8.196	0.080	2015.639	5	81
B	22 05 38.898	01 47 09.39					12.196	0.088			
A	22 05 39.239	01 46 55.56	14.517	0.212	339.758	0.837	8.022	0.110	2015.700	5	82
B	22 05 38.904	01 47 09.18					12.191	0.113			
A	22 05 39.235	01 46 55.83	14.496	0.198	339.980	0.785	8.165	0.100	2015.615	5	83
B	22 05 38.904	01 47 09.45					12.144	0.102			
A	22 05 39.230	01 46 55.82	14.484	0.177	339.647	0.700	8.168	0.080	2015.620	5	84
B	22 05 38.894	01 47 09.40					12.128	0.081			
A	22 05 39.234	01 46 55.77	14.465	0.163	339.620	0.645	8.205	0.050	2015.632	5	85
B	22 05 38.898	01 47 09.33					12.179	0.053			
A	**22 05 39.236**	**01 46 55.803**	**14.470**	**0.204**	**339.722**	**0.807**	**8.163**	**0.093**	**2015.640**	**30**	86
B	**22 5 38.902**	**01 47 09.377**					**12.193**	**0.096**			

Table 2 concludes on next page.

STT Doubles with Large ΔM – Part V: Aquila, Delphinus, Cygnus, Aquarius

Table 2 (conclusion). Photometry and astrometry results for the selected STT objects. Date is the Bessel epoch in 2015 and N is the number of images (usually with 1s exposure time) used for the reported values. iT in the Notes column indicates the telescope used with number of images and exposure time given (Specifications of the used telescopes: See Acknowledgements). The average results over all used images are given in the line below the individual stacks in red and bold. The error estimation over all used images is calculated as root mean square over the individual Err values. The N column in the summary line gives the total number of images used and Date the average Bessel epoch.

STT460	RA	Dec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	Date	N	Notes
A	22 05 39.244	01 46 56.04	19.247	0.248	30.109	0.739	8.219	0.120	2015.637	5	87
C	22 05 39.888	01 47 12.69					11.975	0.123			
A	22 05 39.235	01 46 55.80	19.295	0.213	29.462	0.631	8.196	0.080	2015.639	5	88
C	22 05 39.868	01 47 12.60					11.928	0.087			
A	22 05 39.239	01 46 55.56	19.423	0.212	29.351	0.626	8.022	0.110	2015.700	5	89
C	22 05 39.874	01 47 12.49					11.860	0.112			
A	22 05 39.235	01 46 55.83	19.321	0.198	29.419	0.589	8.165	0.100	2015.615	5	90
C	22 05 39.868	01 47 12.66					11.873	0.102			
A	22 05 39.230	01 46 55.82	19.362	0.177	29.452	0.524	8.168	0.080	2015.620	5	91
C	22 05 39.865	01 47 12.68					11.868	0.081			
A	22 05 39.234	01 46 55.77	19.354	0.163	29.467	0.482	8.205	0.050	2015.632	5	92
C	22 05 39.869	01 47 12.62					11.910	0.052			
A	**22 05 39.236**	**01 46 55.803**	**19.334**	**0.204**	**29.543**	**0.604**	**8.163**	**0.093**	**2015.640**	**30**	93
C	**22 5 39.872**	**01 47 12.623**					**11.902**	**0.096**			

Table 2 Notes:

1. iT21 stack 5x3s. A too bright for reliable photometry. SNR for C<15. Mag B measured with 11.945 with SNR 23.38
2. iT24 stack 5x3s. A too bright for reliable photometry. SNR for C<20. Mag B measured with 11.973 with SNR 44.48
3. iT24 stack 5x3s_3. A too bright for reliable photometry. SNR for C<15. Mag B measured with 11.958 with SNR 42.34
4. iT24 stack 5x3s. A too bright for reliable photometry. SNR for C<20. Mag B measured with 12.138 with SNR 43.31
5. iT24 stack 5x3s_2. A too bright for reliable photometry. Mag B measured with 11.983 with SNR 67,62
6. iT24 stack 5x3s_3. A too bright for reliable photometry. Mag B measured with 11.972 with SNR 76,22
7. iT24 stack 5x6s. A too bright for reliable photometry. Mag B measured with 12.089 with SNR 45.97
8. A too bright for reliable photometry. Average mag for B is 12.008
9. iT24 stack 4x2s. SNR B<20
10. iT24 stack 5x1s
11. iT24 stack 5x1s_2. SNR B<20
12. iT24 stack 5x2s
13. iT24 stack 5x3s. SNR B<20
14. iT24 stack 3x3s_2
15. SNR for B in some images <20 with B sitting directly in a telescope spike. A far too bright for reliable photometryiT24 stack 3x3s_2
16. iT24 stack 5x1s
17. iT24 stack 5x1s_2
18. iT24 stack 5x1s_3
19. iT24 stack 5x3s
20. A too bright for reliable photometry. High dVmag despite good image quality indicates not his good UCAC4 Vmag data quality in this FoV iT24 stack 5x3s
21. iT24 stack 5x1s
22. iT24 stack 5x1s_2
23. iT21 stack 5x1s_3
24. iT24 stack 5x1s_4
25. iT24 stack 5x3
26. iT24 stack 5x3s_2
27. iT24 stack 5x3s_3
28. iT24 stack 5x3s_4
29. iT24 stack 5x3s_5
30. A too bright for reliable photometry. Values for A are probably rather for AB
31. iT18 stack 5x3s. Heavily overlapping star disks, photometry and astrometry unreliable
32. iT24 stack 5x3s. Heavily overlapping star disks, photometry and astrometry unreliable
33. Heavily overlapping star disks, photometry and astrom-

etry unreliable. See Figure 4.
34. iT18 stack 4x3s. Overlapping star disks
35. iT21 stack 4x3s. Overlapping star disks
36. iT24 stack 5x3s. Overlapping star disks
37. iT24 stack 5x3s_2. Overlapping star disks
38. iT24 stack 5x3s_3. Overlapping star disks
39. A too bright for reliable photometry. Overlapping star disks. See Figure 5.
40. iT11 stack 3x3s. Overlapping star disks
41. iT18 stack 4x3s. Overlapping star disks
42. iT21 stack 5x3s. Overlapping star disks
43. iT24 stack 5x3s. Overlapping star disks
44. iT24 stack 5x3s_2. Overlapping star disks. SNR B<20
45. iT24 stack 5x3s_3. Overlapping star disks
46. A too bright for reliable photometry. Overlapping star disks
47. iT18 stack 4x3s
48. iT21 stack 5x3s
49. iT24 stack 5x3s
50. iT24 stack 5x3s
51. A too bright for reliable photometry
52. iT11 stack 3x3s
53. iT18 stack 5x3s
54. iT21 stack 5x3s
55. iT24 stack 5x3s
56. iT24 stack 5x3s_2
57. iT24 stack 5x3s_3
58. A too bright for reliable photometry
59. iT11 stack 3x3s
60. iT18 stack 5x3s
61. iT21 stack 5x3s
62. iT24 stack 5x3s
63. iT24 stack 5x3s_2
64. iT24 stack 5x3s_3
65. Summary line
66. iT11 stack 3x3s
67. iT18 stack 5x3s
68. iT21 stack 5x3s
69. iT24 stack 5x3s
70. iT24 stack 5x3s_2
71. iT24 stack 5x3s_3
72. A too bright for reliable photometry
73. iT11 stack 4x3s
74. iT18 stack 3x3s
75. iT21 stack 5x3s
76. iT24 stack 5x3s
77. iT24 stack 5x3s_2
78. iT24 stack 5x3s_3
79. A too bright for reliable photometry
80. iT11 stack 5x3s
81. iT18 stack 5x3s
82. iT21 stack 5x3s
83. iT24 stack 5x3s
84. iT24 stack 5x3s_2
85. iT24 stack 5x3s_3
86. A too bright for reliable photometry
87. iT11 stack 5x3s
88. iT18 stack 5x3s
89. iT21 stack 5x3s
90. iT24 stack 5x3s
91. iT24 stack 5x3s_2
92. iT24 stack 5x3s_3
93. A too bright for reliable photometry

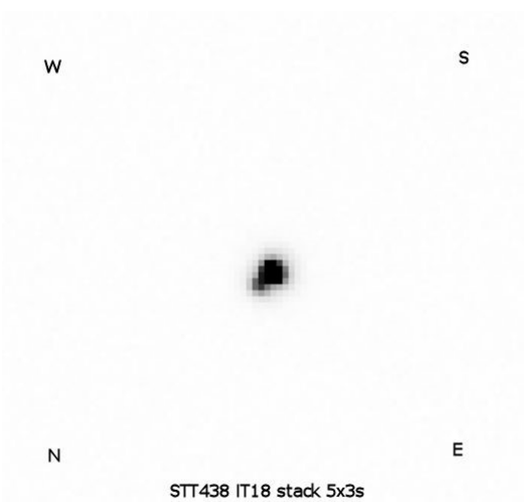

Figure 4. To our surprise, iT18 provided despite rather modest technical specifications, at least a hint of resolution of this close pair with a very bright primary

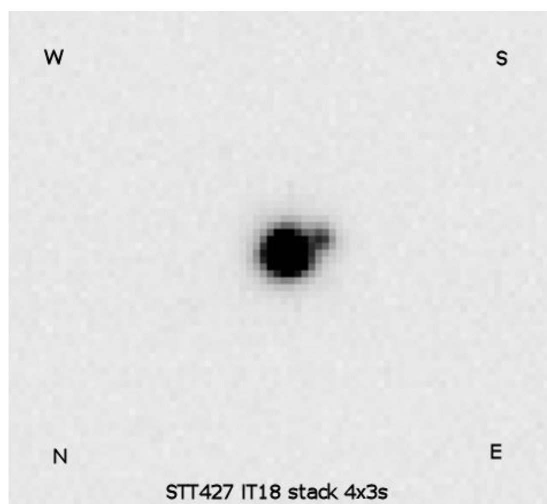

Figure 5. Not as close as STT438, but still difficult to resolve with the equipment currently available to us - again iT18 provided a hint of resolution of this pair with a very bright primary

STT Doubles with Large ΔM – Part V: Aquila, Delphinus, Cygnus, Aquarius

(Continued from page 477)

our research with the WDS data that was current at the time we began working on our current group of stars.

In Table 3 the results of our photometry have been averaged for each star. Because we're aware that both the NOMAD-1 and the UCAC4 catalogs are frequently consulted when making WDS evaluations of magnitudes changes, the data from those catalogs has also been included for each of the stars.

Red type has been used in Tables 3 and 4 to call attention to significant differences from the WDS data. With regard to Table 3, those magnitudes that differ by two tenths of a magnitude or more from the WDS values have been highlighted. In Table 4, differences in separation in excess of two-tenths of an arc second are highlighted, as are all position angles which differ by more than a degree.

Subsequent to our measures, as a quality check for our astrometry results we turned to the URAT1 catalog for the most recent precise professional measurements available. We used its coordinates to calculate the Sep and PA for all objects in this report for which URAT1 data was available and compared these values with our results, which are shown in Table 5.

Acknowledgements:

The following tools and resources have been used for this research:

- Washington Double Star Catalog as data source for the selected objects
- iTelescope: Images were taken with
  - iT24: 610mm CDK with 3962mm focal length. CCD: FLI-PL09000. Resolution 0.62 arcsec/pixel. V-filter. Located in Auberry, California. Elevation 1405m
  - iT11: 510mm CDK with 2280mm focal length. CCD: FLI ProLine PL11002M. Resolution 0.81 arcsec/pixel. B- and V-Filter. Located in Mayhill, New Mexico. Elevation 2225m
  - iT18: 318mm CDK with 2541mm focal length. CCD: SBIG-STXL-6303E. Resolution 0.73

(Continued on page 487)

Table 3. Photometry and Visual Results Compared to WDS

	WDS Mag	NOMAD-1 VMag	UCAC4 VMa	UCAC4 f. mag	Average of Photometry Measures	Results of Visual Observations
STT 362 C	14.00	-	-	13.627	14.219	Neither observer was able to detect C.
STT 532 B	11.90	-	-	-	11.412	One observation of B, which suggested WDS magnitude is close.
STT 381 B	11.20	-	-	12.062	12.396	Two observations, one suggesting a magnitude near 12.4 and one suggesting a magnitude fainter than 11.7.
STT 368 C	11.30	-	-	13.159	13.220	One observation suggesting C is significantly fainter than the WDS value, one suggesting a magnitude near 11.6.
STT 438 B	10.30	-	9.802	-	9.818	Two observations which suggested B was close the WDS value.
STT 427 B	11.90	-	-	-	10.800	One observation which suggested the WDS value was about right based on difficulty.
STT 420 B	10.70	-	-	-	10.517	One observation which suggested the WDS value was about right based on difficulty.
STT 374 B	11.10	11.520	-	10.976	11.193	Three observations confirming or suggesting the WDS value is close.
STT 412 B	13.10	10.760	-	11.594	11.730	Three observations, all indicating B is about 1.5 magnitudes brighter than WDS value.
STT 412 C	11.22	-	11.220	11.639	11.808	One observation which suggested C is slightly brighter than B.
STT 409 B	10.20	10.104	10.199	9.856	10.637	One observation found B equal to WDS value, one found it about half a magnitude fainter.
STT 460 B	12.80	-	-	12.057	12.193	One observation indicating B is clearly brighter than WDS value, estimate of a magnitude of 11.3 based on comparison star.
STT 460 C	12.10	-	-	11.974	11.902	One observation indicating C is clearly brighter than WDS value and a bit brighter than B - estimate magnitude of 10.6 based on comparison star.

Table 4. Astrometry Results Compared to WDS

	WDS Coordinates	WDS Sep	WDS PA	Astrometry Coordinates	Astrometry Sep	Astrometry PA
STT 362 AC	18:48:13.819 +10:38:33.899	12.0	104	18 48 13.828 +10 38 34.103	12.043	105.212
STT 532 AB	19:55:18.791 +06:24:24.301	13.6	359	19 55 18.853 +06 24 16.637	13.414	359.713
STT 381 AB	19:43:21.089 +04:10:27.900	14.7	2	19 43 21.085 +04 10 27.910	14.576	1.970
STT 368 AC	19:16:01.839 +16:09:39.501	15.8	108	19 16 01.86 +16 09 39.672	15.641	108.128
STT 438 AB	21:21:45.801 +43:08:38.102	2.3	357	21 21 45.772 +43 08 37.755	2.135	359.706
STT 427 AB	21:03:39.871 +31:03:44.698	4.2	151	21 03 39.893 +31 03 44.58	4.129	152.976
STT 420 AB	20:54:22.253 +40:42:10.605	5.4	0	20 54 22.264 +40 42 10.578	5.537	1.667
STT 374 AB	19:31:02.423 +50:11:48.701	19.4	291	19 31 02.430 +50 11 48.845	19.517	290.038
STT 412 AB	20:45:43.080 +50:40:25.905	25.9	279	20 45 43.10 +50 40 25.97	25.998	279.074
STT 412 BC	20:45:40.402 +50:40:30.093	5.0	186	20 45 40.40 +50 40 30.063	5.023	185.919
STT 412 AC	20:45:43.080 +50:40:25.905	26.2	268	20 45 43.100 +50 40 25.97	26.201	268.024
STT 409 AB	20:40:17.638 +03:26:28.500	16.8	84	20 40 17.708 +03 26 28.657	16.784	83.620
STT 460 AB	22:05:39.203 +01:46:56.300	13.8	340	22 05 39.236 +01 46 55.803	14.470	339.722
STT 460 AC	22:05:39.203 +01:46:56.300	18.8	30	22 05 39.236 +01 46 55.803	19.334	29.543

Table 5. Astrometry Results Compared with URAT1 Coordinates

Object	URAT1 Sep	iTelescope Sep	Err Sep	Within Error Range?	URAT1 PA	iTelescope PA	Err PA	Within Error Range?
STT 362 AC	12.070	12.043	0.182	Yes	105.247	105.212	0.866	Yes
STT 381 AB	14.579	14.576	0.210	Yes	2.100	1.970	0.824	Yes
STT 368 AC	15.650	15.641	0.206	Yes	108.214	108.128	0.755	Yes
STT 420 AB	5.697	5.537	0.214	Yes	1.076	1.667	2.210	Yes
STT 374 AB	19.515	19.517	0.190	Yes	290.098	290.038	0.559	Yes
STT 412 AB	26.040	25.998	0.201	Yes	279.048	279.074	0.442	Yes
STT 412 BC	5.011	5.023	0.201	Yes	185.523	185.919	2.288	Yes
STT 412 AC	26.214	26.201	0.201	Yes	268.048	268.024	0.439	Yes
STT 409 AB	16.736	16.784	0.228	Yes	83.640	83.620	0.780	Yes
STT 460 AB	14.407	14.470	0.204	Yes	339.814	339.722	0.807	Yes
STT 460 AC	19.339	19.334	0.204	Yes	29.610	29.543	0.604	Yes

(Continued from page 485)

arcsec/pixel. V-filter. Located in Nerpio, Spain. Elevation 1650m
- iT21: 431mm CDK with 1940mm focal length. CCD: FLI-PL6303E. Resolution 0.96 arcsec/pixel. V-filter. Located in Mayhill, New Mexico. Elevation 2225m

- AAVSO VPhot for initial plate solving
- AAVSO APASS providing Vmags for faint reference stars (indirect via UCAC4)
- UCAC4 catalog (online via the University of Heidelberg website and Vizier and locally from USNO DVD) for counterchecks and for high precision plate solving
- Aladin Sky Atlas v8.0 for counterchecks
- SIMBAD, VizieR for counterchecks
- 2MASS All Sky Catalog for counterchecks
- URAT1 Survey (preliminary) for counterchecks
- AstroPlanner v2.2 for object selection, session planning and for catalog based counterchecks
- MaxIm DL6 v6.08 for plate solving on base of the UCAC4 catalog
- Astrometrica v4.8.2.405 for astrometry and photometry measurements.

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