

Double Star Measurements Using a Webcam, Annual Report of 2012

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Abstract: I report on the measurements of 355 double stars during 2012 using a standard webcam. The measured separations are in range between 1.3 and 493 arc seconds. The average separation in this report is about 76 arc seconds. Therefore, most measurements represent optical double stars or common proper motion stars. Only a small number are physical double stars. For some double stars I recommend companions which are not yet listed in the WDS catalog. I also give a short note about Christian Mayer's discovery of the structure of δ Bootis in 1776.

In January 2012 the 8 inch Newtonian telescope which was used for measurements from 2006 to 2011 (Schlimmer 2007a, Schlimmer 2012b) was replaced by a 12 inch Newtonian telescope. The primary focal length is 1500 mm, the aperture ratio is f/5. Because double star measurements in the past were also made with a focal length of 1500 mm (with help of a Barlow lens), the reproduction scale has not changed significantly. The 12 inch Newtonian telescope collects about 2.6 times more light than the replaced 8 inch telescope, so the sensitivity has increased by about 1 magnitude. For double stars with a distance less than 2 arc seconds, the focal length has to be enlarged. Therefore two Barlow lenses with a magnification of 2- and 5- times can be used.

The 12 inch Newtonian telescope is set on a Celestron CGEM-DX mount. This mount is designed for Schmidt-Cassegrain telescopes with short lens tube lengths with focus at the end of the lens tube. In case of a 12 inch Newtonian telescope, the focus is sited near the aperture and is often reachable only with a ladder. For better handling and also more stability, the tripod was replaced by a concrete column.

As a detector for measurements, a standard webcam described in a previous report (Schlimmer 2010), is used. The webcam and the Celestron GCEM-DX mount are connected with a computer. Windows XP (SP3) is used on the computer. Redshift 7 astronomy software

is used for star alignment. The analysis of the webcam data was done using the REDUC software package. This software was specially developed for double star analysis by Florent Losse.

During my observations in 2012, I found components which are not yet listed in the WDS catalog. These observations are discussed below.

1. WDS00324+5820, BU 1227AD

Companions B, C, and D were discovered in 1891 and 1897 by Burnham. Near CD a further star can be found. Its separation is about 43 arc seconds from A, its brightness is about 12 magnitudes.

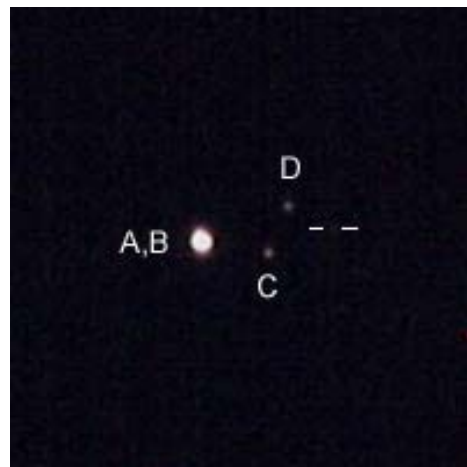


Figure 1: WDS00324+5820, companion marked with lines is not yet listed in WDS catalog

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2. WDS00365+5831, BU 1096AB,C

Companions B and C were discovered in 1889 by Burnham. During my own observations, I found two background stars at a distance of about 21 arc seconds and 39 arc seconds. Both background stars have a brightness of about 12 magnitudes.



Figure 2: WDS00365+5831, companions marked with lines are not yet listed in WDS catalog.

3. WDS05020+434, BU 554AB, Epsilon Aurigae

Epsilon Aurigae is a variable star of Algol type with period of about 27 years. There are a lot of companions but only C and E are brighter than 12 magnitudes. During my own observations in 2012, I found further background stars at distances between 28 and 132 arc seconds. The large number of faint stars is caused by its position near Milky Way. With help of the background stars, the common proper motion of Epsilon Aurigae can be observed.



Figure 3: WDS05020+434, background stars with numbers are not yet listed in WDS catalog

4. WDS05167+4600, Capella

Companions C to E, with brightness between 12 and 15 magnitudes, were discovered in 1878/79 by Burnham. These companions are background stars; only companion H has about the same proper motion as Capella. During my own observations in 2012, I found two further background stars at a distance of 92 and 134 arc seconds.

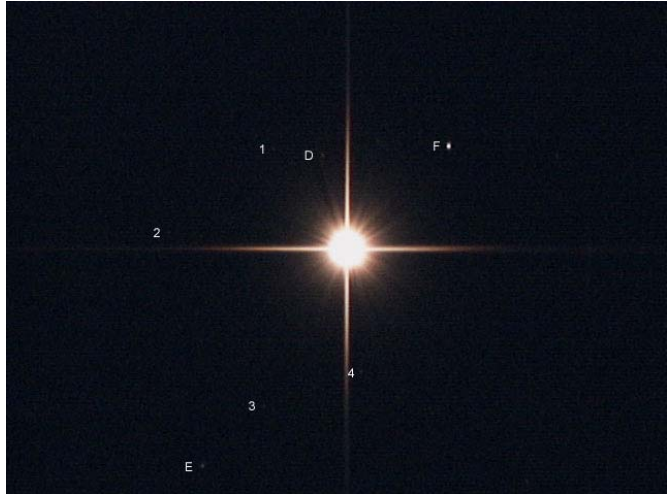


Figure 4: WDS05167+4600, Capella, background stars with numbers are not yet listed in WDS catalog

5. WDS05235+1602, STF 697AB

STF1254 was described in detail in my previous report (Schlimmer 2009b). Between components C and D a further background star can be found. Its brightness is about 12 magnitudes, distance from A is about 163 arc seconds.

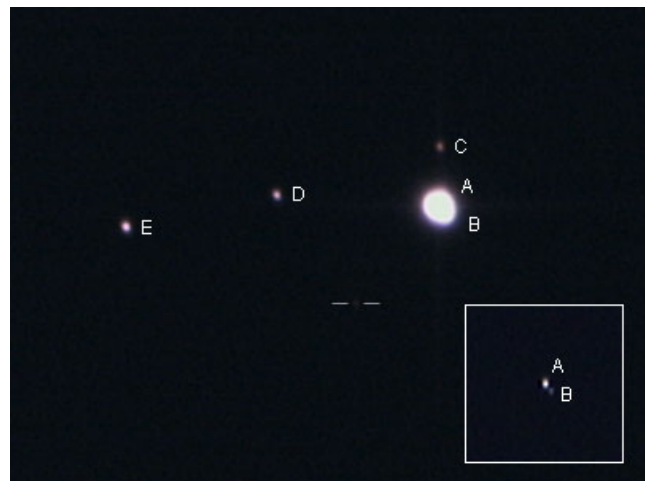


Figure 5: WDS05235+1602, background star with number is not yet listed in WDS catalog

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6. WDS05351+0956, STF 738AB, *Lambda Orionis*

Lambda Orionis is the brightest star of the open star cluster Collinder 69 and has some companions with brightness between 9 and 11 magnitudes. At a distance of 62 arc seconds an additional companion can be found.

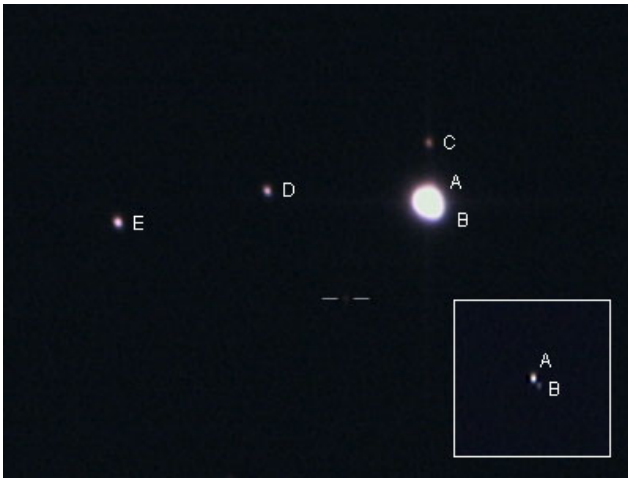


Figure 6: WDS05351+0956, background star marked with lines is not yet listed in WDS catalog

7. WDS05552+0724, H 6 39AB, *Betelgeuse*

Next to *Betelgeuse* are some background stars. The brightest one of them was discovered in 1786 by William Herschel. Currently the components A-H are listed in the WDS catalog. Companions B, C, and F to H were observed only one time before. In the same field there are two further components with a brightness of 13.5 magnitudes (like component D) which are not yet listed in the WDS catalog. The distances are

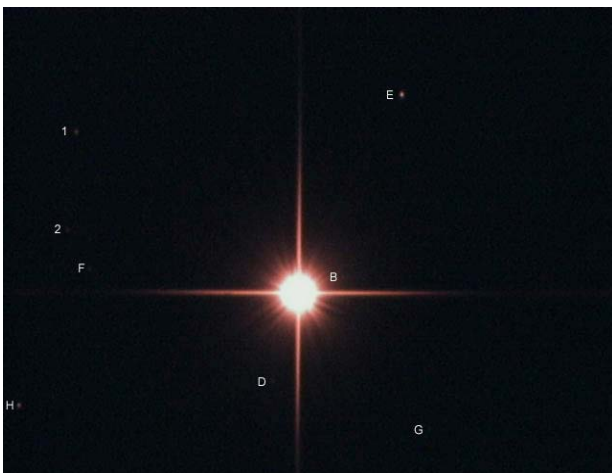


Figure 7: *Betelgeuse* with some background stars with brightness of 11.2 to 14.5 magnitude. Stars 1 and 2 are not yet listed in WDS catalog.

218 arc seconds and 190 arc seconds.

8. WDS06412+0928, STF 954AB

Around STF 954 some companions can be observed. Between companions A and G a further star can be found which is not yet listed in the WDS catalog. The distance is about 48 arc seconds, brightness is about 12 magnitudes.

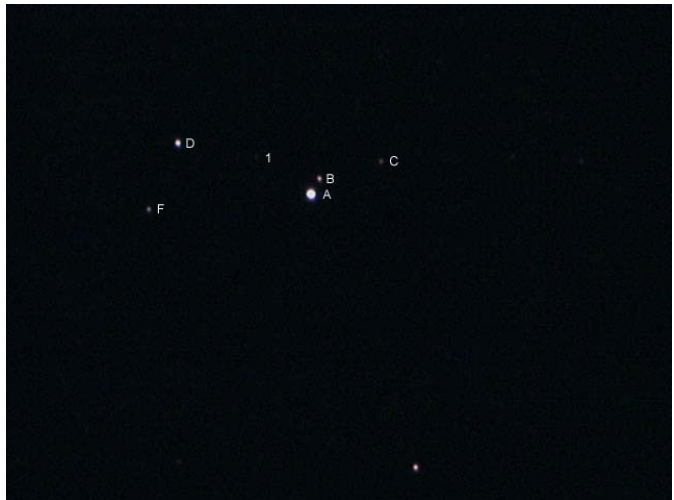


Figure 8: WDS06412+0928, background star 1 is not yet listed in WDS catalog.

9. WDS07393+0514, LAM 6AC, *Procyon*

Procyon is one of the brightest stars in winter sky. Some bright background stars can be observed. During my own observations in 2012, I found a further companion next to G. The distance to G is about 34 arc seconds.

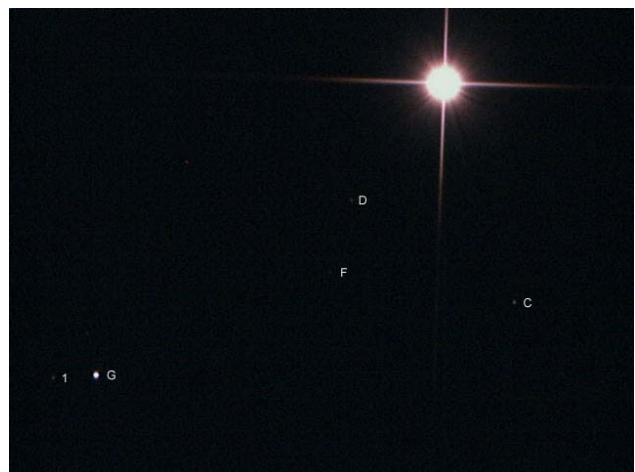


Figure 9: WDS07393+0514, *Procyon*, background star near component G is not yet listed in WDS catalog

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10. WDS08404+1940, STF1254 in Presepe, Messier 44

STF1254 is a multiple star in open star cluster Presepe (Messier 44). The B component was discovered in 1825, the C and D components were found in 1863. No motion between them has been observed since first observation. During my observations in 2012, I observed an additional component next to A, which is not yet listed in the WDS catalog. The distance is about 16 arc seconds, the angle is 154 degrees. Figure 10 shows a composite of two images which were made with a Canon EOS400D. The measurement was made with a stacked webcam picture. The brightness is estimated to be 12.5 magnitudes.



Figure 10: STF1254, the component near A is not yet listed in the WDS catalog. The figure shows a composite of two images which were made with a Canon EOS400D.

11. WDS15155+3319, STFA 27, Delta Bootis and G 167-29AB

STFA 27 has a companion at 105 arc seconds. Because of its brightness of 7.89 magnitudes, it was often observed. The German astronomer Christian Mayer observed the companion for the first time on June 10, 1776 from his new observatory at Mannheim. He described his observation in his book "Defense of New Observations of Fixed Star Satellites" which was published in 1778 (Mayer, 1778). Mayer found a distance of 102.0 arc seconds and an angle of 80 degrees. It is not known why Mayer did not add this observation to his double star catalog, *De novis in coelo sidereo*

phaenomenis in miris stellarum fixarum comitibus, published one year later in 1779 (Chr. Mayer 1779). This was the first double star catalog in history (Schlimmer 2007b). However, William Herschel observed Delta Bootis on July 23, 1780 and published his observation in his double star catalog in 1782 (Herschel 1782). Only this component of δ Bootis is listed in the WDS. During my own observations, I found a further component at a distance of 91.6 arc seconds and a position angle of about 5 degrees.

G 167-29AB is a high proper motion star next to Delta Bootis and was described in detail in my previous report (Schlimmer 2012). The proper motion is about 350 mill arc seconds per year. The image was made with a Canon EOS400D.

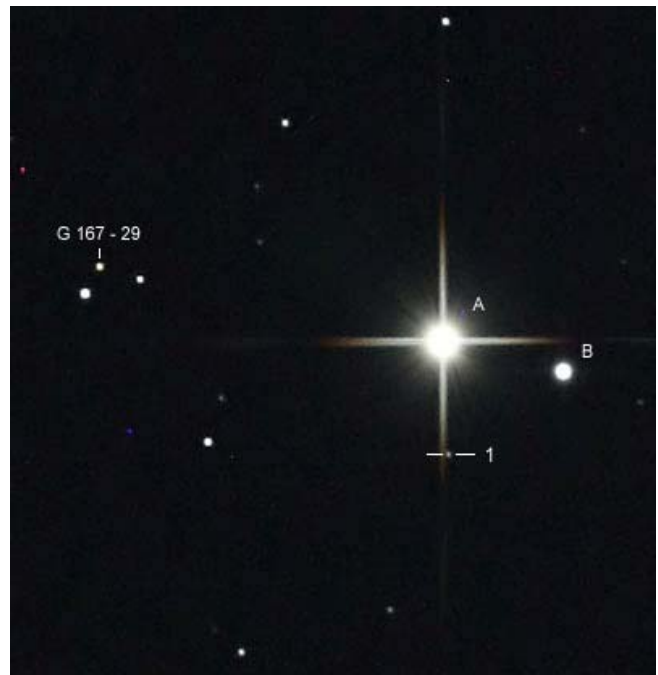


Figure 11: STFA 27, the component which is marked with lines is not yet listed in WDS catalog.

12. WDS18369+3846, H 5 39AB, Vega

Vega is the brightest star in the summer sky. Because of some brighter background stars with brightness between 9.5 to 11 magnitudes, the proper motion of Vega can be easily observed. In addition to the known background stars, I listed some fainter background stars with brightness of about 12 magnitudes in the table.

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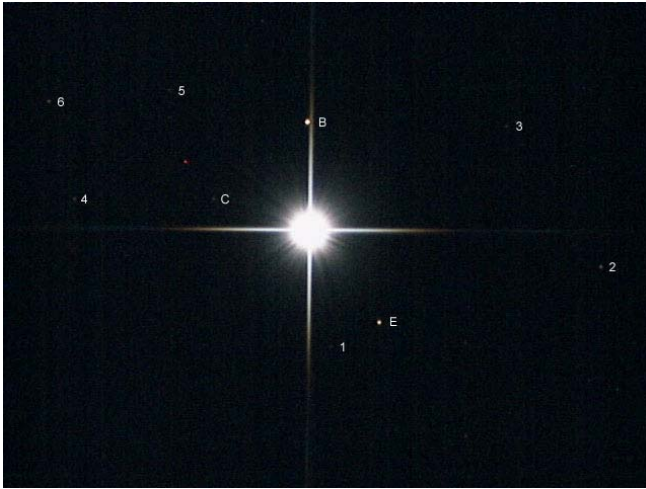


Figure 12: Vega, background stars which are marked with lines are not yet listed in WDS catalog.

13. WDS19307+2758, STFA 43, Albireo

Albireo is a very colorful double star. Because it is in the Milky Way a lot of background stars can be seen. I added known background stars to the list.

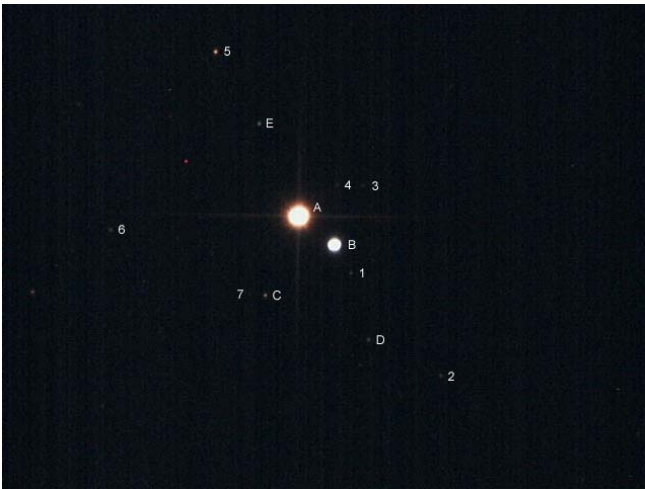


Figure 13: Albireo, background stars which are marked with lines are not yet listed in WDS catalog.

14. UNSO-B1.0 1006-0508835, near DS19411+1041, STF2558

At a distance of about 95 arc seconds from STF2558 (see table) a further double star can be found. The separation is 20 arc seconds, position angle is 330 degree. The brightness of both components is about 11 magnitudes. UNSO-B1.0 1006-0508835 is not yet listed as a double star in WDS catalog.



Figure 14: STF2558 and a possible optical pair in the neighborhood.

15. WDS19463+1037, 50 Aquarius

Companion B was discovered in 1836. Companions C and D were discovered in 1999 and 1907. The brightness of these companions is similar. Two further companions can be found.

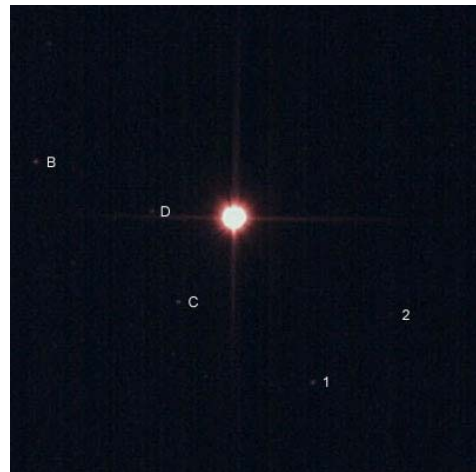


Figure 15: WDS19463+1037, background stars with numbers are not yet listed in WDS catalog.

16. WDS19508+0852, Altair

Altair is also a bright star in the summer sky. Companions were described in detail in my previous report (Schlimmer 2009). I found another companion next to the C companion.

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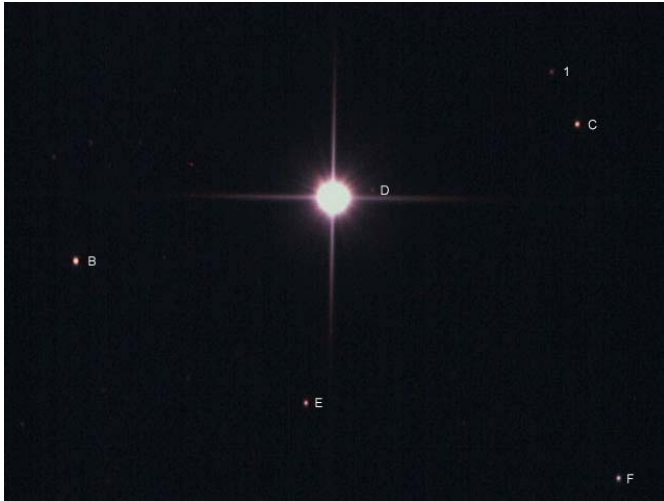


Figure 16: Altair, background d star with number is not yet listed in WDS catalog.

17. WDS19521+1138, BUP 200 and TYC1066-1390-1, 19524+1139

Only one companion at a distance of about 87 arc seconds was reported in the past. An additional companion of similar brightness can be found closer to component A at a distance of 26 arc seconds.

TYC1066-1390-1 can be seen in the same field of view as WDS19521+1138. It looks like a wide optical pair, but is not yet listed in the WDS catalog. The separation is about 33 arc seconds, position angle is 340 degrees.

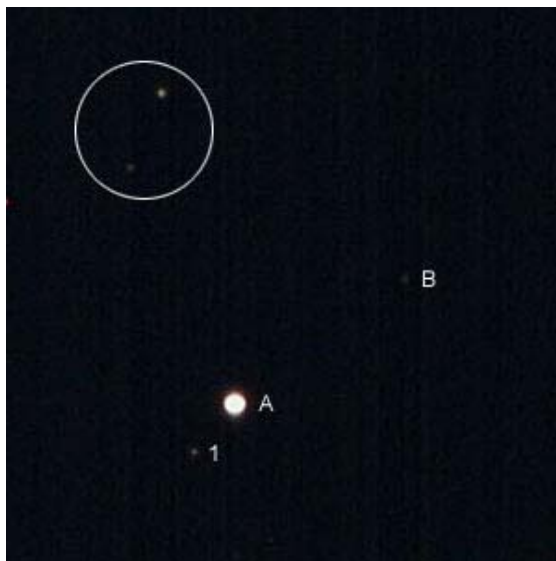


Figure 17: WDS19521+1138 and a possible optical pair in the neighborhood.

18. WDS20145+3648, 29 Cygni

29 Cygni is a multiple star. The distance between AB is about 215 arc seconds. Next to A companion E at a distance of about 35 arc seconds can be found. During my own observation in 2012, I found a further companion next to A, distance is about 32 arc seconds, position angle is about 36 degree. Together with A and E it forms an equilateral triangle.

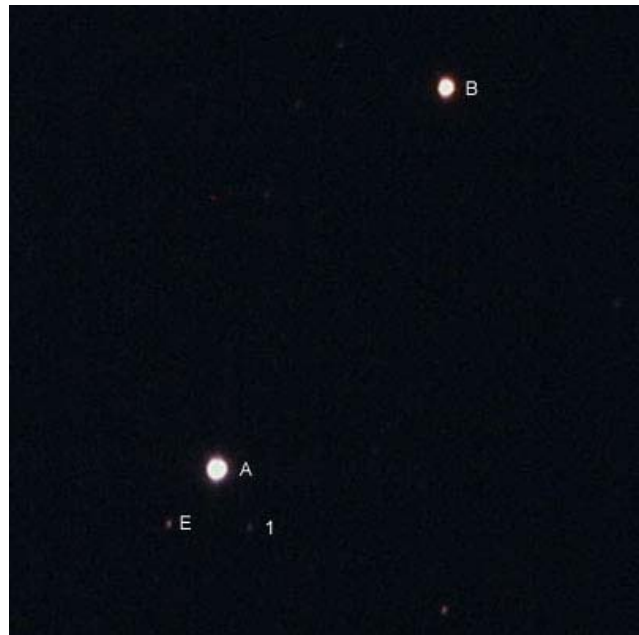


Figure 18: WDS20145+3648, background star with number is not yet listed in WDS catalog.

19. WDS21069+3845, 61 Cygni

61 Cygni is one of the famous binary stars and has been frequently observed. Around 61 Cygni there are a lot of background stars and its large proper motion can be easy observed. Some of these companions are described in my previous report of 61 Cygni (Schlimmer 2009a). Since 2005, I've observed other background stars near 61 Cygni which are not yet listed in one of my reports. The brightness of these stars is about magnitude 11.5, the separation is between 68 and 144 arc seconds.

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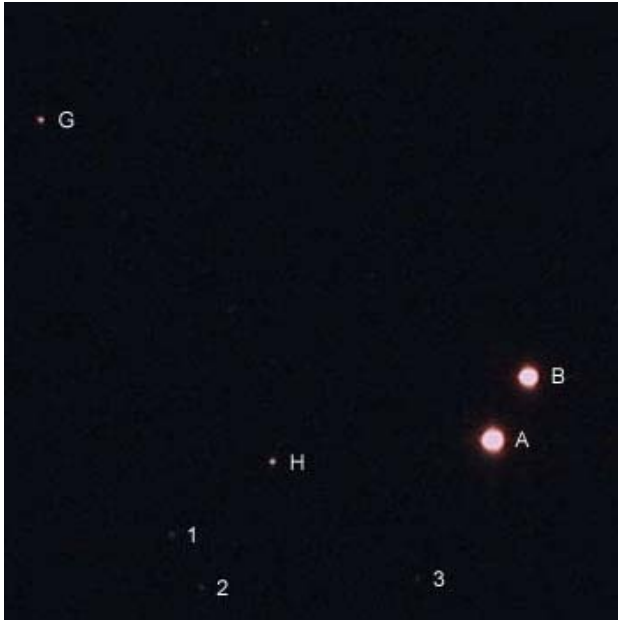


Figure 19: 61 Cygni, background stars with numbers are not yet listed in WDS catalog.

20. WDS22139+3943

With brightness between 10 and 13 magnitudes, not all companions are easy to observe. During my own observation, I found two further background stars around component A which form an equilateral triangle. Distances are about 38 arc seconds.

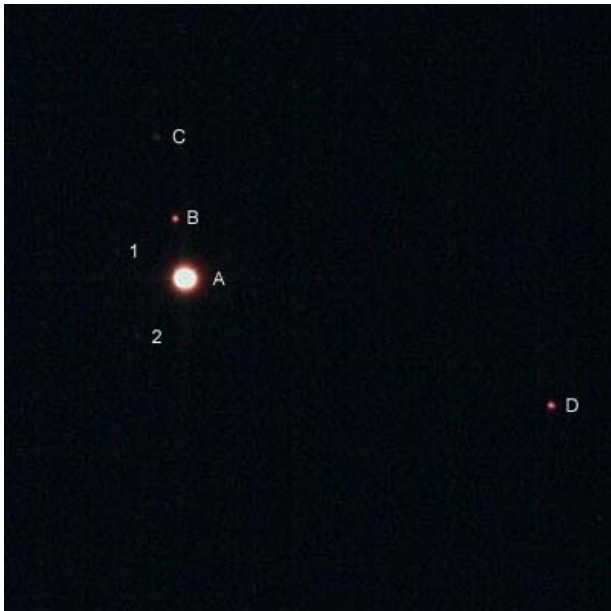


Figure 20: WDS22139+3943, background stars with numbers are not yet listed in WDS catalog.

21. WDS21435+5847, Herschel's Garnet star

Around Herschel's Garnet star some faint companions can be observed. Components B and C are listed in WDS catalog. Because of their brightness of 12.3 and 12.7 magnitudes they are not often observed. During my observation in 2012 I found further companions with brightness of magnitude 11 and 13.

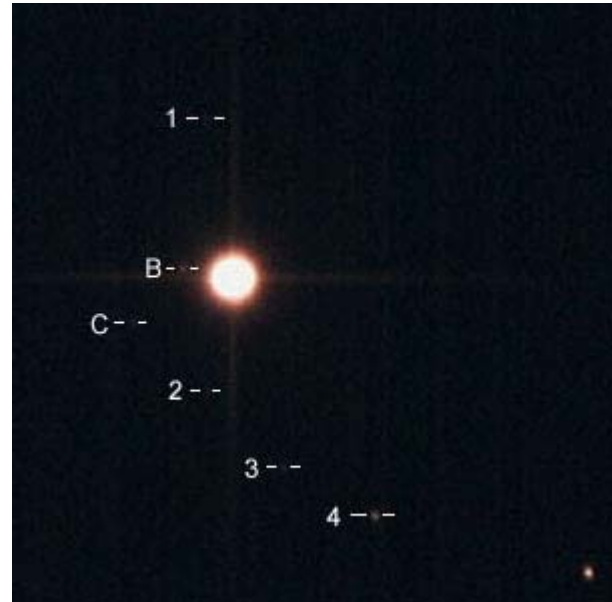


Figure 21: WDS21435+5847, background stars with numbers are not yet listed in WDS catalog.

The following table (next page) shows my measurements of 2012.

Acknowledgements

This research made use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory.

This research made use of the SIMBAD database, operated at CDS, Strasbourg, France

References

- Schlimmer 2007A, "Double Star Measurement Using a Webcam", *Journal of Double Star Observations*, **3**, Pages 131-134.
- Schlimmer 2007B, "Christian Mayer's Double Star Catalog of 1779", *JDSO*, **3**, 151-158.
- Schlimmer 2008A, "The Proper Motion of HLD120AB (WDS14527+0746)", *JDSO*, **4**, 56-58.

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NAME	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
ES 2	00311+5648	8.97 9.5	112.1	5.93	2012.801	1	
BU 1227AC	00324+5820	7.21 11.2	79.6	22.53	2012.801	1	
BU 1227AD	00324+5820	7.21 11.7	111.6	30.96	2012.801	1	
A1	00324+5820	7.21 12	94.9	43.10	2012.801	1	1
ES 3	00350+5636	8.65 9.5	158.6	8.10	2012.801	1	
STF 38	00355+5841	8.66 8.97	144.4	16.89	2012.801	1	
BU 1096AB-C	00365+5831	8.79 9.74	240.8	35.50	2012.801	1	
A1	00365+5831	8.79 12	132.6	20.86	2012.801	1	2
A2	00365+5831	8.79 12	145.4	38.58	2012.801	1	3
BU 1349AB	00405+5632	2.35 14.0	280.8	24.01	2012.801	1	α Cas
BU 1349AC	00405+5632	2.35 13.0	103.2	30.98	2012.801	1	
H 518AD	00405+5632	2.35 8.98	282.0	70.49	2012.801	1	
ES 2214	04584+3844	8.4 12.3	26.1	6.46	2012.801	1	
STF 616AB	04593+3753	5.00 8.21	0.8	4.87	2012.801	1	
STI1427	00473+5651	8.96 11.6	252.9	15.23	2012.801	1	
STF 60AB	00491+5749	3.52 7.36	323.3	13.22	2012.801	1	η Cas
STF 0AE	00491+5749	3.52 10.15	124.5	77.97	2012.801	1	
SMR 2AI	00491+5749	3.5 11.6	72.6	90.28	2012.801	1	
SMR 2AJ	00491+5749	3.5 12.3	261.6	237.14	2012.801	1	
BU 1AC	00528+5638	8.58 8.89	136.1	3.90	2012.727	1	NGC281
BU 1AD	00528+5638	8.58 9.66	194.8	8.96	2012.727	1	
BU 1AE	00528+5638	8.58 12.1	332.0	16.39	2012.727	1	
ABH 5AB-F	00528+5638	8.32 11.00	229.2	53.09	2012.727	1	
ABH 5AB-G	00528+5638	8.32 11.00	240.3	56.08	2012.727	1	
ABH 5AB-H	00528+5638	8.32 12.30	145.9	74.26	2012.727	1	
ABH 5AB-I	00528+5638	8.32 13.34	160.3	45.43	2012.727	1	
BKO 139AN	00528+5638	8.58 13.9	46.1	32.10	2012.727	1	
BKO 139AO	00528+5638	8.58 14.0	295.9	34.39	2012.727	1	
BKO 139FG	00528+5638	11.00 11.00	309.3	10.98	2012.727	1	
ES 552	00531+5713	7.1 13.1	85.6	14.51	2012.727	1	
ES 44	00570+5729	7.98 10.0	265.7	9.60	2012.727	1	
HJ 1114	02191+5708	6.55 11.8	322.9	16.44	2012.727	1	NGC869
STT 64AB	03500+2351	6.81 10.15	235.9	3.21	2012.932	1	
STT 64AC	03500+2351	6.81 10.54	234.9	10.29	2012.932	1	
STT 64BC	03500+2351	10.15 10.54	235.6	6.76	2012.932	1	
STT 92AB	05003+3924	6.02 9.50	283.6	4.07	2012.932	1	
BU 554AB	05020+4349	2.99 14.0	225.6	28.93	2012.938	1	ϵ Aur
BU 554AC	05020+4349	2.99 11.26	275.9	42.75	2012.938	1	
BU 554AD	05020+4349	2.99 13.4	316.8	45.33	2012.938	1	
BU 554AE	05020+4349	2.99 9.60	47.9	206.93	2012.938	1	
STU 19AF	05020+4349	2.99 11.02	272.1	221.93	2012.938	1	
A1	05020+4349	2.99 14	14.8	101.01	2012.938	1	4
A2	05020+4349	2.99 13.5	22.1	123.50	2012.938	1	5
A3	05020+4349	2.99 13.5	140.1	110.88	2012.938	1	6
A4	05020+4349	2.99 13.5	159.1	132.01	2012.938	1	7
A5	05020+4349	2.99 14	301.1	28.81	2012.938	1	8

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NAME	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
STT 96	05091+4907	6.67 11.1	104.6	20.57	2012.938	1	
SMR 15	05122+1611	10.3 10.5	151.9	31.35	2012.138	1	
SMR 16AB	05123+1614	9.7 10.5	122.0	36.67	2012.138	1	
SMR 16AC	05123+1614	9.7 10.1	113.4	185.27	2012.138	1	
SMR 16AD	05123+1614	9.7 11.4	76.7	159.28	2012.138	1	
SMR 16AE	05123+1614	9.7 12.3	59.3	12.14	2012.138	1	
STT 101	05138+4658	7.59 10.64	183.3	5.71	2012.938	1	
BAR 25AB	05167+4600	0.08 17.1	5.8	91.89	2012.938	1	Capella
BU 1392AC	05167+4600	0.08 13	331.7	132.94	2012.938	1	
BU 1392AD	05167+4600	0.08 13.6	194.6	71.30	2012.938	1	
BU 1392AE	05167+4600	0.08 12.1	326.0	193.72	2012.938	1	
HJ 2256AF	05167+4600	0.08 10.21	135.0	106.51	2012.938	1	
A1	05167+4600	0.08 13	216.0	91.90	2012.938	1	9
A2	05167+4600	0.08 13	264.4	133.69	2012.938	1	10
STF 666	05172+3320	7.85 7.89	75.5	3.13	2012.938	1	
STF 681	05207+4658	6.61 9.21	181.8	23.14	2012.938	1	
STT 104	05232+4701	7.1 11.1	189.8	21.18	2012.938	1	
STF 697AB	05235+1602	7.27 8.10	285.6	26.05	2012.138	1	Ori
WAL 38AC	05235+1602	7.27 10.83	284.1	97.90	2012.138	1	Ori
SMR 3AD	05235+1602	7.3 10.1	284.6	249.27	2012.138	1	Ori
A1	05235+1602	7.3	288.9	163.00	2012.138	1	11
STFA 14AC	05320-0018	2.41 6.83	0.1	52.38	2012.086	1	Mintaka
STF 738AB	05351+0956	3.51 5.45	41.3	4.31	2012.086	1	l ori
STF 738AC	05351+0956	3.51 10.72	185.5	29.25	2012.086	1	l ori
STF 738AD	05351+0956	3.51 9.63	271.7	78.46	2012.086	1	l ori
GUI 9AE	05351+0956	3.51 9.22	279.4	151.14	2012.086	1	l ori
A1	05351+0956	3.51	325.0	61.61	2012.086	1	l ori
STF 761AB	05386-0233	7.86 8.39	202.6	68.08	2012.086	1	
STF 761AC	05386-0233	7.86 8.55	208.9	71.70	2012.086	1	
STF 761BC	05386-0233	8.39 8.55	268.0	8.56	2012.086	1	
STF 762AB-C	05387-0236	3.76 8.79	240.0	10.68	2012.086	1	s ori
STF 762AB-D	05387-0236	3.76 6.56	82.9	12.91	2012.086	1	s ori
STF 762AB-E	05387-0236	3.76 6.34	61.4	41.49	2012.086	1	s ori
STF 774AC	05407-0157	1.88 9.55	9.6	58.41	2012.086	1	z ori
H 6 39AB	05552+0724	0.9 14.5	112.7	36.81	2012.138	1	Betel.
H 6 39AD	05552+0724	0.9 13.5	345.3	70.99	2012.138	1	Betel.
H 6 39AE	05552+0724	0.9 11.0	154.3	175.20	2012.138	1	Betel.
SLE 31AF	05552+0724	0.9 12.1	265.7	168.34	2012.138	1	Betel.
SLE 831AG	05552+0724	0.9 12.8	46.8	147.93	2012.138	1	Betel.
SLE 831AH	05552+0724	0.9 11.2	293.7	239.79	2012.138	1	Betel.
A1	05552+0724	0.9 13.5	237.0	217.79	2012.138	1	12
A2	05552+0724	0.9 13.5	257.3	189.93	2012.138	1	13
STF 926AB	06317+0546	7.23 8.62	287.0	10.86	2012.138	1	14
SLE 291	06318+0529	10.0 10.2	282.2	12.80	2012.138	1	15
GAN 3AC	06319+0457	6.79 11.8	312.8	6.76	2012.138	1	
GAN 3AD	06319+0457	6.79 12.24	287.4	12.24	2012.138	1	
GAN 3AE	06319+0457	6.79 11.64	198.4	13.52	2012.138	1	

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NAME	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES	
SLE 293AF	06319+0457	6.79 11.63	352.3	45.03	2012.138	1		
SLE 293AG	06319+0457	6.79 11.75	246.7	48.94	2012.138	1		
SLE 293AH	06319+0457	6.79 12.77	254.3	65.83	2012.138	1		
SLE 293AI	06319+0457	6.79 9.39	234.9	64.17	2012.138	1		
SLE 293AJ	06319+0457	6.79 11.18	109.9	53.64	2012.138	1		
SLE 293AK	06319+0457	6.79 10.74	137.1	74.43	2012.138	1		
STF 927AB	06321+0458	8.86 9.3	83.5	5.01	2012.138	1		
A 2820	06365+0548	8.57 12.7	51.4	4.01	2012.138	1		
	06365+0548	8.57	312.1	19.31	2012.138	1		
STF 950AC	06410+0954	4.66 9.9	14.2	16.43	2012.138	1	s Mon	
STF 950AD	06410+0954	4.66 9.7	308.4	40.66	2012.138	1	s Mon	
STF 950AE	06410+0954	4.66 8.86	139.8	73.79	2012.138	1	s Mon	
STF 950AF	06410+0954	4.66 9.0	222.4	155.48	2012.138	1	s Mon	
STF 950AG	06410+0954	4.66 10.01	230.3	187.63	2012.138	1	s Mon	
STF 950AH	06410+0954	4.66 9.81	166.9	89.00	2012.138	1	s Mon	
STF 950AK	06410+0954	4.66 8.2	56.0	104.90	2012.138	1	s Mon	
STF 950AM	06410+0954	4.66 9.75	104.0	177.90	2012.138	1	s Mon	
STF 950AO	06410+0954	4.66 9.7	260.9	136.17	2012.138	1	s Mon	
D 11EP	06410+0954	8.86 10.4	42.6	3.52	2012.138	1	s Mon	
STF 952MN	06410+0954	9.75 10.05	115.5	13.94	2012.138	1	s Mon	
SMR 9AQ	06410+0954	9.75 11.5	6.2	95.30	2012.138	1		
SMR 9AR	06410+0954	9.75 11.5	143.7	142.53	2012.138	1		
SMR 9AS	06410+0954	9.75 11.5	155.3	124.04	2012.138	1		
STF 954AB	06412+0928	7.18 10.23	153.2	12.98	2012.138	1	x-mas	
SLE 558AC	06412+0928	7.15 10.93	117.1	56.89	2012.138	1		
ARN 40AD	06412+0928	7.18 9.09	251.1	104.74	2012.138	1		
SMR 10AF	06412+0928	7.18	277.5	119.57	2012.138	1		
SMR 10AG	06412+0928	7.18	237.8	48.21	2012.138	1	16	
STF1110AB	07346+3153	1.93 2.97	56.7	4.82	2012.215	1	Castor	
STF1110AC	07346+3153	1.93-9.83	165.4	70.52	2012.095	1	Castor	
STF1110AD	07346+3153	1.93-10.07	222.0	181.85	2012.095	1	Castor	
LAM 6AC	07393+0514	0.38-11.7	21.7	180.21	2012.237	1	Procyon	
DIC 1AD	07393+0514	0.38-	325.5	116.68	2012.237	1	Procyon	
SLE 439AF	07393+0514	0.38-	332.7	172.34	2012.237	1	Procyon	
SMR 11AG	07393+0514	0.38-8.8	313.8	355.65	2012.237	1	Procyon	
	G1	07393+0514	8.8-12	277.4	33.51	2012.237	1	17
STF1196AB-C	08122+1739	5.30-6.20	67.5	6.25	2012.222	2	ζ Cnc	
STF1196AB-D	08122+1739	5.31-8.89	107.0	275.60	2012.222	2	ζ Cnc	
STF1254AB	08404+1940	6.44-10.37	54.2	20.34	2012.207	1		
STF1254AC	08404+1940	6.52-7.61	342.7	63.20	2012.207	1		
STF1254AD	08404+1940	6.52-9.20	43.8	82.39	2012.207	1		
	AE	08404+1940	6.52-	153.9	16.19	2012.207	1	18
S 571AC	08399+1933	7.31-7.47	156.5	45.15	2012.207	1		
S 571AD	08399+1933	7.31-6.67	241.7	92.45	2012.207	1		
BKO 34DE	08399+1933	6.67-11.0	2.8	34.97	2012.207	1		
HJ 110	08585+1151	4.25-11.8	323.7	10.48	2012.207	1		

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NAME	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
HJ 110	08585+1151	4.25 11.8	323.7	10.48	2012.207	1	
STF1300AB	09013+1516	9.47 9.73	180.6	4.98	2012.207	1	
ENG9001AC	09013+1516	9.47 9.8	13.4	201.42	2012.207	1	
ENG9001AD	09013+1516	9.47 10.2	61.6	197.22	2012.207	1	
STFB 6AB	10084+1158	1.40 8.24	307.9	174.65	2012.207	1	Regulus
STF1424AB	10200+1950	2.37 3.64	127.0	4.73	2012.207	1	Algieba
STF1424AC	10200+1950	2.37 9.64	288.4	337.78	2012.207	1	AD Leo
STF1424AD	10200+1950	2.60 10.0	302.0	369.56	2012.207	1	
STF1523AB	11182+3132	4.33 4.80	191.1	1.68	2012.284	1	ξ UMa
SHJ 143AB	12225+2551	4.86 11.8	57.1	36.73	2012.396	1	12 Com
SHJ 143AC	12225+2551	4.86 8.90	167.0	65.02	2012.396	1	
ARN 6AD	12225+2551	4.86 10.10	132.0	213.08	2012.396	1	
STF1643AB	12272+2701	9.03 9.45	5.0	2.30	2012.396	1	
STFA 21AB	12289+2555	5.23 6.64	250.1	144.86	2012.396	1	17 Com
STF1651	12317+2701	8.65 10.07	214.1	6.99	2012.396	1	
STF1670AB	12417-0127	3.48 3.53	13.2	1.76	2012.284	1	
STF1744AB	13239+5456	2.23 3.88	154.1	14.47	2012.221	1	Mizar
SMR 4AD	13239+5456	2.23 7.6	99.8	492.47	2012.221	1	
STF1835A-BC	14234+0827	5.03 6.78	195.1	6.32	2012.462	1	ξ Boo
STF1877AB	14450+2704	2.58 4.81	345.7	2.76	2012.396	1	e Boo
STF1888AB	14514+1906	4.76 6.95	305.7	5.91	2012.462	1	
HLD 120AB	14527+0746	8.05 10.84	225.0	15.83	2012.396	1	
STF1909	15038+4739	5.20 6.10	62.1	1.31	2012.456	1	44 Boo
STF1919	15127+1917	6.71 7.38	10.4	23.37	2012.462	1	
STFA 27	15155+3319	3.56 7.89	77.9	104.56	2012.426	2	d Boo
A1	15155+3319	3.56	4.7	91.64	2012.396	1	19
G 167-29AB	15151+3318	12.7	331.9	25.41	2012.426	2	20
G 167-29AC	15151+3318	12.7	74.5	35.24	2012.426	2	
ENG 52AB	15073+2452	4.97 10.8	40.4	103.46	2012.462	1	
STF2055AB-C	16309+0159	3.82 11.0	170.4	118.49	2012.560	1	7 Her
STFA 31AB	16406+0413	5.76 6.92	230.2	69.45	2012.560	1	36/37 Her
STF2074BC	16406+0413	6.92 11.4	316.0	25.74	2012.560	1	
BAL2421	16409+0338	8.51 11.1	226.0	8.91	2012.560	1	
STF2081AB	16430+0327	7.8 10.5	322.0	20.04	2012.560	1	
BU 9015AC	16430+0327	7.8 12.0	174.8	42.88	2012.560	1	
STF2086	16443-0033	7.43 10.22	156.7	14.00	2012.560	1	
STF2088AB	16447+0220	8.0 12.0	331.6	21.21	2012.560	1	
STF2088AC	16447+0220	8.0 13.4	354.0	16.08	2012.560	1	
STF2088BC	16447+0220	12.0 13.4	104.8	8.58	2012.560	1	
ENG 58AB	16469+0215	6.75 8.83	218.0	148.84	2012.560	1	
STF2096AB	16472+0204	6.09 9.68	89.4	23.59	2012.560	1	
ENG 59AB	17011-0413	4.99 9.71	67.6	99.94	2012.560	1	
ARN 16AC	17011-0413	4.99 8.75	85.2	221.10	2012.560	1	
STF2130AB	17053+5428	5.66 5.6	4.5	2.42	2012.568	1	μ Dra
STF2140AB	17146+1423	3.48 5.40	101.2	4.99	2012.675	1	α Her
STF2166	17279+1123	7.15 8.58	282.3	27.19	2012.555	1	

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NAME	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
STF2170AB	17287+1029	9.38 10.01	58.1	3.30	2012.555	1	
GUI 18AC	17287+1029	9.38 7.08	18.7	189.44	2012.555	1	
STF2176AB	17311+1027	9.53 10.32	17.0	16.72	2012.555	1	
GUI 19AC	17311+1027	9.53 9.46	71.6	89.50	2012.555	1	
STFA 35	17322+5511	4.87 4.90	310.9	61.85	2012.568	1	
STF2184AB	17344+1310	6.7 11.6	64.9	22.82	2012.555	1	
STF2184AC	17344+1310	6.7 12.6	293.5	127.79	2012.555	1	
STFA 34AB	17346+0935	5.80 7.50	190.3	41.11	2012.555	1	
STFA 34AC	17346+0935	5.80 11.90	343.7	96.83	2012.555	1	
STFA 34AD	17346+0935	5.80 10.5	213.3	126.92	2012.555	1	
STF2212	17464+0542	9.51 9.60	341.2	3.09	2012.555	1	
STF2216	17470+0542	8.01 10.09	26.9	27.22	2012.555	1	
STF2223	17490+0458	7.56 9.66	211.2	18.40	2012.555	1	
BU 633AB	17566+5129	2.23 13.4	152.0	20.95	2012.568	1	
BU 633AC	17566+5129	2.23 12.9	234.1	41.20	2012.568	1	
BU 633AD	17566+5129	2.23 12.9	11.3	57.88	2012.568	1	
BU 633AE	17566+5129	2.23 11.9	234.4	94.88	2012.568	1	
BU 633AF	17566+5129	2.23 11.2	114.1	124.83	2012.568	1	
BU 633AG	17566+5129	2.23 11.9	27.2	141.80	2012.568	1	
STF2271AB	18003+5251	8.17 9.24	267.5	3.36	2012.568	1	
H 6 2AC	18006+0256	3.96 8.06	142.3	54.18	2012.555	1	
BU 634AE	18006+0256	3.96 11.0	180.2	45.25	2012.555	1	
BU 634CD	18006+0256	8.06 12.5	123.0	7.21	2012.555	1	
BU 634CE	18006+0256	8.06 11.0	266.0	33.26	2012.555	1	
STF2272AB	18055+0230	4.22 6.17	129.7	6.15	2012.555	1	
STF2272AC	18055+0230	4.22 12.05	325.4	94.02	2012.555	1	
STF2272AR	18055+0230	4.22 12.87	26.1	164.83	2012.555	1	
STF2272AT	18055+0230	4.22 12.25	44.5	127.69	2012.555	1	
STF2272AV	18055+0230	4.22 10.83	275.5	145.38	2012.555	1	
STF2272VX	18055+0230	10.83 15.	252.1	17.35	2012.555	1	
STF2323AB	18239+5848	5.06 8.07	345.2	3.64	2012.612	1	39 Dra
STF2323AC	18239+5848	5.06 7.95	19.7	88.64	2012.612	1	
H 5 39AB	18369+3846	0.09 9.5	183.8	81.63	2012.612	1	Vega
STFB 9AC	18369+3846	0.09 11.0	254.5	76.04	2012.612	1	
STFB 9AE	18369+3846	0.09 9.5	39.4	87.24	2012.612	1	
A1	18369+3846	0.09 12	12.8	89.50	2012.612	1	21
A2	18369+3846	0.09 11	85.3	221.48	2012.612	1	22
A3	18369+3846	0.09 12	120.4	167.83	2012.612	1	23
A4	18369+3846	0.09 12	265.0	179.15	2012.612	1	24
A5	18369+3846	0.09 12	227.6	149.96	2012.612	1	25
A6	18369+3846	0.09 12	246.2	219.36	2012.612	1	26
HJ 2836AB	18384+6043	6.7 9.9	316.4	32.41	2012.612	1	
HJ 2836AC	18384+6043	6.7 9.9	252.1	56.08	2012.612	1	
SLE 235AD	18384+6043	6.7 8.9	313.2	154.35	2012.612	1	
STF2382AB	18443+3940	5.15 6.10	347.1	2.16	2012.631	1	ϵ Lyr
STF2383CD	18443+3940	5.25 5.38	77.7	2.38	2012.659	2	

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NAME	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
STFA 37AD	18443+3940	5.15 5.38	172.2	208.71	2012.622	2	ϵ Lyr
STFA 37AI	18443+3940	5.15 10.43	137.7	150.04	2012.622	2	
STF2383CE	18443+3940	5.25 11.71	332.9	63.07	2012.622	2	
STFA 37CI	18443+3940	5.25 10.43	37.1	120.35	2012.622	2	
SHJ 277EF	18443+3940	11.71 11.2	37.4	45.29	2012.622	2	
SHJ 277GH	18443+3940	13.83 13.22	358.4	35.58	2012.612	1	
CD-F	18443+3940	5.25 11.2	359.5	92.18	2012.622	2	
CD-G	18443+3940	5.25 13.83	292.4	75.60	2012.612	1	
CD-H	18443+3940	5.25 13.22	312.2	95.78	2012.612	1	
STF2420AB	18512+5923	4.77 8.26	319.0	37.29	2012.612	1	
BU 137AC	18540+3723	8.69 12.0	146.8	24.38	2012.631	1	
ES 2028AB	18545+3654	4.30 11.2	349.8	86.49	2012.631	1	d Lyr2
SMR 13AD	18545+3654	4.30 8.8	210.2	193.02	2012.631	1	
SMR 13AE	18545+3654	4.30 10.3	238.4	400.15	2012.631	1	
SMR 13AF	18545+3654	4.30	245.5	368.72	2012.631	1	
SM 13AG	18545+3654	4.30	261.4	335.27	2012.631	1	
SMR 13AH	18545+3654	4.30	284.6	229.03	2012.631	1	
SMR 13AJ	18545+3654	4.30	249.7	278.99	2012.631	1	
SMR 13AK	18545+3654	4.30	236.8	303.75	2012.631	1	
SMR 13HI	18545+3654	4.30	251.8	25.85	2012.631	1	
HO 90	18545+3719	8.72 12.7	222.5	3.57	2012.631	1	
STF2427AB	18581+3813	9.61 9.93	59.4	55.05	2012.631	1	
STF2427AC	18581+3813	9.61 10.20	61.7	61.69	2012.631	1	
CTT 11AD	18581+3813	9.61 11.8	290.5	56.44	2012.631	1	
SP 2AE	18581+3813	9.61 5.87	350.4	160.50	2012.631	1	
STF2427BC	18581+3813	9.93 10.20	78.9	7.13	2012.631	1	
SMR 14EF	18581+3813	5.9 11.2	332.8	83.30	2012.631	1	
STF2487AB	19138+3909	4.38 8.58	80.5	28.28	2012.713	1	20 Lyr
STT 366AB	19142+3413	7.67 10.55	229.9	21.80	2012.713	1	
ES 2675AC	19142+3413	7.67 11.7	139.4	26.49	2012.713	1	
WAL 106AD	19142+3413	7.67 13.16	116.6	21.79	2012.713	1	
STT 367A-BC	19145+3434	7.31 10.26	227.0	33.40	2012.713	1	
HO 648AD	19145+3434	7.31 12.9	92.9	15.58	2012.713	1	
SEI 585	19148+3820	8.91 11.7	120.5	14.58	2012.713	1	
SHJ 292AB	19164+3808	4.48 10.14	70.3	99.16	2012.713	1	21 Lyr
SHJ 292AC	19164+3808	4.48 11.1	128.5	101.60	2012.713	1	
STFA 43AB	19307+2758	3.19 4.68	53.8	34.62	2012.686	1	Albireo
WAL 114AC	19307+2758	3.19 10.99	339.9	64.80	2012.686	1	
CTT 17AD	19307+2758	3.2 11.	32.1	107.22	2012.686	1	
CTT 18AE	19307+2758	3.2 11.	205.8	75.79	2012.686	1	
A1	19307+2758	3.2 12	45.3	58.29	2012.686	1	27
A2	19307+2758	3.2 12.5	44.4	161.44	2012.686	1	28
A3	19307+2758	3.2 12.5	118.2	53.96	2012.686	1	29
A4	19307+2758	3.2 12.5	131.9	37.56	2012.686	1	30
A5	19307+2758	3.2 10	209.5	138.95	2012.686	1	31
A6	19307+2758	3.2 11.5	276.9	142.22	2012.686	1	32

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NAME	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
C7	19307+2758	3.2 11.5	269.3	11.96	2012.686	1	33
STF2558	19411+1041	8.0 10.5	308.0	27.77	2012.686	1	
New	19424+1041	11.4 11.4	330.3	20.11	2012.686	1	34
STF2567AB	19441+1222	7.93 9.96	310.7	17.92	2012.686	1	
STF2570AB-C	19449+1047	7.62 9.81	279.7	4.47	2012.686	1	
BUP 198AB	19463+1037	2.72 10.8	256.7	134.06	2012.686	1	50 Aqu
DAL 44AC	19463+1037	2.7 10.9	329.0	65.72	2012.686	1	
DAL 44AD	19463+1037	2.7 11.4	267.9	53.47	2012.686	1	
A1	19463+1037	2.7 11.5	28.2	118.95	2012.686	1	35
A2	19463+1037	2.7 12	60.7	119.65	2012.686	1	36
STF2583AC	19487+1149	6.34 12.9	297.6	36.15	2012.686	1	
STFB 10AB	19508+0852	0.95 9.82	284.8	194.99	2012.686	1	Altair
STFB 10AC	19508+0852	0.95 10.3	107.6	187.95	2012.686	1	Altair
DAL 27AD	19508+0852	0.95 11.9	101.0	29.22	2012.686	1	Altair
SMR 5AE	19508+0852	0.95 11.0	353.4	152.39	2012.686	1	Altair
SMR 5AF	19508+0852	0.95 10.3	46.6	294.68	2012.686	1	Altair
A1	19508+0852	0.95	120.9	185.08	2012.686	1	37
J 124AB	19510+1025	5.11 13.5	251.3	19.46	2012.686	1	54 Aqu
J 124AC	19510+1025	5.11 13.7	220.0	21.69	2012.686	1	
POP1228AD	19510+1025	5.11 13.2	121.2	49.61	2012.686	1	
POP1228AE	19510+1025	5.11 13.0	148.0	81.61	2012.686	1	
BUP 200AB	19521+1138	6.13 11.7	128.8	87.23	2012.686	1	
A1	19521+1138	6.13 11.0	322.1	25.97	2012.686	1	38
New	19524+1139	11.08 11.5	339.8	33.28	2012.686	1	39
STF2593AB	19533+1150	8.7 10.1	342.1	12.03	2012.686	1	
STF2593AC	19533+1150	8.7 11.4	256.5	13.94	2012.686	1	
STF2593BC	19533+1150	10.1 11.4	307.0	3.67	2012.686	1	
SMR 7	20000+1736	10.1 11.4	264.3	4.17	2012.622	2	
S 730AB	20001+1737	7.16 8.45	14.5	112.79	2012.622	2	
S 730AC	20001+1737	7.16 10.21	337.8	78.58	2012.622	2	
S 730AD	20001+1737	7.16 9.9	198.4	41.04	2012.622	2	
ES 25AB	20060+3546	7.89 12.0	119.2	8.83	2012.713	1	
ES 25AC	20060+3546	7.89 14.8	296.5	11.76	2012.713	1	
SHJ 315AD	20060+3546	7.89 8.73	235.9	20.16	2012.713	1	
WAL 127AE	20060+3546	7.89 11.71	94.3	33.86	2012.713	1	
BU 440AB	20060+3547	6.78 12.0	64.6	6.77	2012.713	1	
BU 429AC	20060+3547	6.78 11.0	28.6	12.59	2012.713	1	
SHJ 314AD	20060+3547	6.78 9.49	300.2	11.15	2012.713	1	
BU 429AE	20060+3547	6.78 11.42	107.4	27.91	2012.713	1	
DOO 78AH	20060+3547	6.78 13.8	57.4	29.61	2012.713	1	
SHJ 314AF	20060+3547	6.78 7.30	28.3	35.82	2012.713	1	
BU 429FG	20060+3547	7.30 13.8	111.2	10.19	2012.713	1	
SEI 858AB	20060+3545	11.2 11.4	28.5	19.79	2012.713	1	
SEI 857AC	20060+3545	11.2 12.96	323.1	27.62	2012.713	1	
SEI 865	20061+3546	11.5 11.5	17.4	14.45	2012.713	1	
SEI 867AB	20062+3544	11.0 13.0	243.2	12.81	2012.713	1	

Table concludes on next page.

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NAME	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
BKO 82AC	20062+3544	11.0 15.0	34.6	6.59	2012.713	1	
ENG 72AB	20145+3648	4.96 6.71	155.1	215.54	2012.713	1	29 Cyg
BUP 207AE	20145+3648	4.96 12.2	324.8	35.20	2012.713	1	
A1	20145+3648	4.96 12.5	35.5	32.42	2012.713	1	40
STF2758AB	21069+3845	5.35 6.10	151.8	31.29	2012.612	1	61 Cyg
STF2758AG	21069+3845	5.35 10.84	237.3	239.73	2012.670	2	
STF2758AH	21069+3845	5.35 10.89	278.4	95.86	2012.670	2	
A1	21069+3845	5.35 11.5	289.2	144.96	2012.670	2	41
A2	21069+3845	5.35 11.5	299.6	141.30	2012.670	2	42
A3	21069+3845	5.35 11.5	332.7	68.85	2012.612	1	43
HJ 1746AB	22139+3943	4.65 10.6	189.5	30.34	2012.691	1	
HJ 1746AC	22139+3943	4.65 12.14	191.5	72.34	2012.691	1	
WAL 141AD	22139+3943	4.65 13.07	71.0	193.87	2012.691	1	
A1	22139+3943	4.65 13	248.4	36.33	2012.691	1	44
A2	22139+3943	4.65 13	321.0	37.81	2012.691	1	45
STF2922AB	22359+3938	5.66 6.29	185.5	22.27	2012.691	1	8 Lac
A 1469AC	22359+3938	5.66 10.38	167.8	48.51	2012.691	1	
A 1469AD	22359+3938	5.66 9.08	143.9	81.64	2012.691	1	
COM 8BF	22359+3938	6.29 10.97	175.3	127.60	2012.691	1	
A 1469DI	22359+3938	9.08 11	227.2	10.14	2012.691	1	
S 813AB	22393+3903	4.84 10.30	49.2	62.42	2012.691	1	
S 815	22415+4014	5.21 10.80	14.7	67.91	2012.691	1	
BU 690AB	21435+5847	4.2 12.3	258.7	19.31	2012.801	1	
BU 690AC	21435+5847	4.2 12.7	293.8	41.86	2012.801	1	
A1	21435+5847	4.2 13	189.0	61.73	2012.801	1	46
A2	21435+5847	4.2 13	347.1	44.46	2012.801	1	47
A3	21435+5847	4.2 13	14.7	75.07	2012.801	1	48
A4	21435+5847	4.2 11	30.4	105.94	2012.801	1	49
STT 479	22441+4149	5.21 10.90	130.4	14.36	2012.691	1	
BU 451AB	22520+4319	4.94 11.9	158.6	23.53	2012.691	1	
BU 451AC	22520+4319	4.94 12.1	305.2	105.98	2012.691	1	
BU 451AD	22520+4319	4.94 12.5	230.2	140.12	2012.691	1	
STF3050AB	23595+3343	6.46 6.72	338.3	2.35	2012.801	1	Mayer 80

Notes:

- Not yet listed in WDS catalog, brightness about 12.0 magnitudes
- Not yet listed in WDS catalog, brightness about 12.0 magnitudes
- Not yet listed in WDS catalog, brightness about 12.0 magnitudes
- Background star near Epsilon Aurigae, not yet listed in WDS catalog
- Background star near Epsilon Aurigae, not yet listed in WDS catalog
- Background star near Epsilon Aurigae, not yet listed in WDS catalog
- Background star near Epsilon Aurigae, not yet listed in WDS catalog
- Background star near Epsilon Aurigae, not yet listed in WDS catalog
- Background star near Capella, not yet listed in WDS catalog
- Background star near Capella, not yet listed in WDS catalog
- Not yet listed in WDS catalog, brightness about 12.0 magnitudes
- Next to Betelgeuse, not yet listed in WDS catalog, brightness about 13.5 magnitudes
- Also next to Betelgeuse, not yet listed in WDS

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- | | |
|---|---|
| catalog, brightness about 13.5 magnitudes | WDS catalog |
| 14. Inside open star cluster Collinder 97 | 32. Background star near Albireo, not yet listed in the WDS catalog |
| 15. Inside open star cluster Collinder 97 | 33. Background star near Albireo, not yet listed in the WDS catalog |
| 16. Not yet listed in WDS catalog, brightness about 12.0 magnitudes | 34. UNSO-B1.0 1006-0508835, not yet listed in WDS catalog, can be found in a distance of only 94.5 arc seconds and 88 degree from STF2558 not listed as double star in SIMBAD astronomical database |
| 17. Next to SMR 11AG, brightness about 12.0 magnitudes | 35. Not yet listed in WDS catalog |
| 18. Not yet listed in WDS catalog, brightness about 12.5 magnitudes | 36. Not yet listed in WDS catalog |
| 19. Not yet listed in WDS catalog | 37. Not yet listed in WDS catalog |
| 20. See article (Schlimmer 2012) | 38. Bright companion, Not yet listed in WDS catalog |
| 21. Background star near Vega, brightness about 12 magnitudes | 39. TYC1066-1390-1, not yet listed in WDS catalog |
| 22. Background star near Vega, brightness about 11 magnitudes | 40. 29 Cyg, not yet listed in WDS catalog, brightness about 12.5 magnitudes |
| 23. Background star near Vega, brightness about 12 magnitudes | 41. Background star near 61 Cygni |
| 24. Background star near Vega, brightness about 12 magnitudes | 42. Background star near 61 Cygni |
| 25. Background star near Vega, brightness about 12 magnitudes | 43. Background star near 61 Cygni |
| 26. Background star near Vega, brightness about 12 magnitudes | 44. Not yet listed in WDS catalog, brightness about 13.0 magnitudes |
| 27. Background star near Albireo, not yet listed in the WDS catalog | 45. Not yet listed in WDS catalog, brightness about 13.0 magnitudes |
| 28. Background star near Albireo, not yet listed in the WDS catalog | 46. Near Herschel's Garnet Star, not yet listed in WDS catalog |
| 29. Background star near Albireo, not yet listed in the WDS catalog | 47. Near Herschel's Garnet Star, not yet listed in WDS catalog |
| 30. Background star near Albireo, not yet listed in the WDS catalog | 48. Near Herschel's Garnet Star, not yet listed in WDS catalog |
| 31. Background star near Albireo, not yet listed in the | 49. Near Herschel's Garnet Star, not yet listed in WDS catalog |

(Continued from page 236)

Schlimmer 2008B, "Double Star Measurement Using a Webcam - Annual Report of 2007", *JDSO*, **4**, 81-83.

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SIMBAD Astronomical Database, <http://simbad.u-strasbg.fr/simbad/>

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WDS catalog, The Washington Double Star Catalog,
Mason, Wycoff, Hartkopf, Astrometry Department,
U.S. Naval Observatory

*Gründliche Vertheidigung neuer Beobachtungen von
Fixsterntabanten, welche zu Mannheim auf der
kurfürstlichen Sternwarte entdeckt worden sind,
[Defense of new Observations of Fixed Star
Satellites], Christian Mayer, 1778.*

*De novis in coelo sidereo phaenomenis in miris stel-
larum fixarum comitibus, Christian Mayer, 1779*

Herschel, William, 1782, Catalog of Double Stars, *Phi-
losophical Transactions of the Royal society of
London*, Vol. **72**.

