

Jonckheere Double Star Photometry – Part II: Delphinus

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Abstract: If any double star discoverer is in urgent need of photometry then it is Jonckheere. There are over 3000 Jonckheere objects listed in the WDS catalog and a good part of them have magnitudes which are obviously far too bright. To keep the workload manageable only one image per object is taken and photometry is done with a software allowing a simple point and click procedure – even a single measurement is better than the currently usually given estimation

Introduction

As follow up to the first report on J-objects in Cygnus (Knapp; Nanson 2016) I selected for this report all J-objects in Delphinus (Del) (plus ROE14AB in combination with J563BC) given in Table 1 with all values based on WDS data as of April 2015.

Photometry

For each of the listed J-objects one single image was taken (in Bessel epoch 2015.683) with iTelescope iT24 with 3 second exposure time. The imaging sessions were not straight forward as in previous sessions in Cygnus, mostly due to uncooperative weather conditions. So, for several objects repeated imaging sessions were required and in a few cases I had to resort to another telescope location. In these cases, the different Bessel epochs and different scopes are indicated in the notes column. In all cases the initial plate solving was done by AAVSO VPhot and in the few cases with negative VPhot result, but positive with MaxIm PinPoint. Each image was then once more plate solved with Astrometrica, using the UCAC4 catalog with reference stars in the Vmag range of 10.5 to 14.5 giving not only RA/Dec coordinates but also photometry results for all reference stars used including an average dVmag error. The J-objects were then located in the center of the image with a few exceptions, indicating that the given RA/Dec coordinates are usually correct with the exceptions suggesting position problems. Photometry was then done using the Astrometrica procedure with point and click at the components delivering

Vmag measurements based on all reference stars used for plate solving. The only changing parameter was the aperture radius used for photometry aiming to keep it equal or at least near 1.5x FWHM. In cases with smaller separation the star disks touched or overlapped but, nevertheless individual photometry could be done though less reliable than with clearly separated disks. Several cases allowed only the measurement of the combined magnitude, but even in these cases it is possible to make a well-founded estimate for the components based on the initial observed Δm between the components based on the formula

$$m_{combined} = -2.5 \log_{10} \left(2.521^{-m_1} + 2.521^{-m_2} \right)$$

according to Greaney 2012.

Summary

Table 2 shows, with few exceptions, quite large differences for the magnitudes compared with the WDS data, often even in cases where double digit values suggest recent precise measurements. A few cases suggest errors in position, separation, and position angle. Several times the images suggest the non-existence of the objects in question.

References

Buchheim, Robert, 2008, "CCD Double-Star Measurements at Altimira Observatory in 2007", *Journal of Double Star Observations*, **4**, 27-31.

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Greaney, Michael, 2012, "Some Useful Formulae" in R.W. Argyle, *Observing and Measuring Visual Double Stars*, 2nd Edition 2012, Chapter 25, Page 359, Springer.

Knapp, Wilfried and Nanson, John, 2016, "Jonckheere Double Star Photometry – Part I: Cyg", *JDSO*, **12**, 168-179.

Acknowledgements

The following tools and resources have been used

for this research:

- AAVSO APASS (via the UCAC4 catalog)
- AAVSO VPhot
- Aladin Sky Atlas v8.0
- Astrometrica v4.8.2.405
- AstroPlanner v2.2
- iTelescope iT24 & iT27
- MaxIm DL6 v6.08
- SIMBAD, VizieR

Table 1: WDS April 2015 values for the Jonckheere objects in Del sorted by designation number

WDS ID	Name	C	RA	Dec	Sep	M1	M2	PA
WDS20329+1142	J1	AB	20:32:52.760	+11:44:37.200	2.0	10.04	10.57	57
WDS20316+1150	J3	AB	20:31:33.391	+11:50:24.800	2.0	10.00	10.00	129
WDS20157+1003	J135	AB	20:15:43.430	+10:02:08.901	3.6	11.42	11.58	322
WDS20345+1138	J142	AB	20:34:25.910	+11:37:17.500	6.5	10.35	12.50	241
WDS20403+0349	J156	AB	20:40:20.583	+03:50:04.000	2.3	10.95	11.64	21
WDS20559+0835	J157	AB	20:55:51.537	+08:34:17.901	3.8	11.32	10.93	172
WDS20409+1738	J191	AB	20:40:52.162	+17:37:59.203	1.2	9.30	9.60	141
WDS20416+1058	J192	AB	20:42:36.580	+11:00:55.100	5.5	9.40	13.10	133
WDS20420+1821	J193	AB	20:42:02.550	+18:21:02.302	5.3	9.11	12.10	83
WDS20494+1124	J194	AB	20:49:23.528	+11:24:09.601	0.6	10.32	9.97	155
WDS20494+1124	J194	AB,C	20:49:23.528	+11:24:09.601	11.2	10.32	13.94	33
WDS20509+1907	J195	AB	20:50:53.568	+19:06:42.697	3.4	11.40	11.40	26
WDS21033+1655	J284	AB	21:03:12.192	+16:53:25.900	2.8	9.50	11.10	235
WDS20298+1712	J510	AB	20:29:45.690	+17:11:55.697	3.5	9.91	13.70	242
WDS20181+1555	J553	AB	20:18:06.692	+15:54:09.498	3.6	9.40	10.50	21
WDS20271+0948	J559	AB	20:27:06.862	+09:48:52.100	2.0	11.65	11.45	279
WDS20311+1248	J562	AB	20:31:07.271	+12:46:52.799	2.2	10.80	11.70	145
WDS20311+1648	ROE14	AB	20:31:03.178	+16:48:41.299	7.1	11.00	12.00	213
WDS20311+1648	J563	BC	20:31:02.691	+16:48:40.399	5.0	12.00	12.30	213
WDS20351+1533	J566	AB	20:35:09.952	+15:32:10.099	4.2	10.90	12.20	120
WDS20527+0527	J572	AB	20:52:39.400	+05:26:20.900	3.4	10.20	11.30	138
WDS20534+1921	J573	AB	20:53:18.532	+19:22:30.199	3.9	11.30	11.70	187
WDS20151+1143	J604	AB	20:15:05.438	+11:42:41.500	0.7	10.23	10.44	235
WDS20527+1726	J605	AC	20:52:44.069	+17:26:12.700	38.2	11.55	12.16	161
WDS20527+1726	J605	AB	20:52:44.069	+17:26:12.700	1.7	11.40	11.90	241
WDS20571+1801	J607	AB	20:57:05.297	+18:00:59.903	3.1	10.80	12.40	305
WDS20348+1857	J790	AB	20:34:54.001	+18:56:42.397	2.3	9.50	10.00	88
WDS21056+1749	J797	AB	21:05:37.301	+17:49:46.503	3.4	12.30	13.80	214
WDS20198+1203	J837	AB	20:19:52.010	+12:03:10.400	2.0	11.10	11.70	297
WDS20210+1028	J838	AB	20:21:00.667	+10:28:20.999	6.5	11.52	12.00	118

Table 1 continues on next page.

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Table 1 (continued): WDS April 2015 values for the Jonckheere objects in Del sorted by designation number

WDS ID	Name	C	RA	Dec	Sep	M1	M2	PA
WDS20235+1811	J839	AB	20:23:35.739	+18:10:40.901	1.9	11.50	11.70	350
WDS20249+1124	J840	AB	20:24:46.958	+11:23:38.599	3.8	9.50	10.50	51
WDS20249+1309	J841	AB	20:24:56.070	+13:08:58.000	0.2	10.50	11.50	274
WDS20249+1309	J841	AB.C	20:24:56.070	+13:08:58.000	8.4	10.10	10.50	82
WDS20250+1451	J842	AB	20:24:57.972	+14:51:16.501	4.2	10.04	12.10	179
WDS20314+2054	J844	AB	20:30:50.688	+20:53:41.603	4.1	12.20	12.80	118
WDS20434+1712	J845	AB	20:43:21.981	+17:12:28.499	4.0	11.99	12.20	224
WDS20541+1402	J846	AB	20:54:07.202	+14:02:13.000	3.3	10.80	11.14	157
WDS20396+1310	J912	AB	20:39:39.021	+13:09:45.400	1.8	10.00	10.00	125
WDS20385+1118	J1073	AB	20:38:25.577	+11:16:24.701	5.3	9.70	14.00	113
WDS20209+1332	J1173	AB	20:20:50.478	+13:31:04.600	3.7	10.41	13.70	83
WDS20157+0957	J1234	AB	20:15:42.778	+09:56:37.900	4.4	12.51	15.00	43
WDS20280+1244	J1241	AB	20:28:00.112	+12:44:08.100	1.1	10.33	12.30	168
WDS20386+1120	J1242	AB	20:38:30.871	+11:18:39.201	5.1	9.60	11.00	204
WDS20298+1154	J1243	AB	20:30:22.240	+11:54:28.999	3.2	10.80	10.80	121
WDS20146+1116	J1296	AB	20:14:28.497	+11:17:34.602	3.3	11.90	12.40	236
WDS20276+0745	J1297	AB	20:27:33.147	+07:44:07.799	1.2	11.23	11.27	14
WDS20554+0836	J1318	AB	20:55:23.570	+08:35:38.200	0.8	10.30	10.77	142
WDS20247+0302	J1342	AB	20:24:44.823	+03:05:03.200	2.7	9.40	11.50	307
WDS20270+1008	J1343	AB	20:27:01.891	+10:11:16.301	2.4	9.60	10.00	54
WDS20348+1121	J1344	AB	20:34:45.562	+11:20:14.199	2.3	9.10	11.50	103
WDS20438+1440	J1345	AB	20:43:47.751	+14:39:14.501	3.7	9.60	10.50	280
WDS20560+0837	J1346	AB	20:56:00.223	+08:35:46.100	2.4	13.20	13.20	327
WDS20260+1212	J1704	AB	20:26:02.949	+12:11:07.001	6.0	10.16	10.80	202
WDS20586+0723	J1715	AB	20:58:36.422	+07:23:15.399	5.2	11.61	13.00	125
WDS20593+1744	J1716	AB	20:59:15.210	+17:43:17.099	6.4	10.00	11.00	224
WDS20169+1303	J1879	AB	20:16:56.723	+13:02:42.601	10.9	11.83	11.95	233
WDS20169+1303	J1879	AC	20:16:56.723	+13:02:42.601	13.7	11.83	14.40	272
WDS20172+1304	J1880	AB	20:17:08.121	+13:04:32.001	13.5	11.23	13.30	246
WDS20303+0917	J1883	AB	20:30:08.851	+09:20:52.201	6.4	11.53	12.00	115
WDS20315+1448	J1884	AB	20:31:23.290	+14:50:01.400	8.6	9.80	9.80	131
WDS20315+1446	J1885	AB	20:31:24.148	+14:47:04.200	11.9	12.00	12.00	353
WDS20351+1413	J1887	AB	20:35:04.623	+14:13:40.799	5.5	11.68	11.70	280
WDS20439+1255	J1888	AB	20:43:49.688	+12:53:40.501	9.8	9.70	12.50	159
WDS20441+1258	J1889	AB	20:44:04.073	+12:31:48.799	4.8	14.30	14.30	15
WDS20485+1448	J1890	AB	20:48:29.901	+14:50:57.100	6.8	11.20	11.50	140
WDS20360+0411	J2192	AB	20:36:31.120	+04:15:22.100	4.9	9.90	12.50	17
WDS20305+1829	J2313	AB	20:30:30.178	+18:29:07.801	6.0	9.50	11.90	133
WDS20327+0453	J2314	AB	20:32:40.229	+04:52:49.300	4.9	10.60	11.60	70
WDS20327+0453	J2314	AC	20:32:40.229	+04:52:49.300	17.6	10.60	14.00	154
WDS20415+1611	J2319	AB	20:41:16.627	+16:12:44.999	7.0	9.80	12.00	188
WDS20488+0512	J2321	AB	20:48:50.727	+05:11:58.101	6.6	9.61	10.80	151
WDS20518+1736	J2325	AB	20:51:50.799	+17:36:17.401	5.3	11.60	13.70	260
WDS20230+0929	J2572	AB	20:23:08.260	+09:28:43.700	4.1	9.80	13.20	281
WDS20321+0330	J2573	AB	20:32:27.519	+03:29:17.300	4.0	12.50	12.80	150

Table 1 concludes on next page.

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Table 1 (conclusion): WDS April 2015 values for the Jonckheere objects in Del sorted by designation number

WDS ID	Name	C	RA	Dec	Sep	M1	M2	PA
WDS20418+1404	J2575	AB	20:41:55.059	+14:05:23.400	0.7	9.70	13.00	311
WDS20393+1101	J2603	AB	20:39:18.160	+10:59:36.201	1.8	11.39	13.40	354
WDS20398+1927	J2604	AB	20:39:44.109	+19:26:07.502	2.0	12.12	12.10	142
WDS21058+1939	J2702	AB	21:05:43.851	+19:40:09.899	5.4	11.20	11.60	178
WDS20152+1357	J3066	AB	20:15:23.751	+14:00:30.401	4.5	11.00	11.50	334
WDS20152+1357	J3066	AC	20:15:23.751	+14:00:30.401	9.1	11.00	15.00	215
WDS20227+1345	J3079	AB	20:22:29.808	+13:45:35.300	7.6	12.90	13.30	139
WDS20227+2023	J3080	AB	20:22:46.940	+20:22:23.401	7.4	12.00	13.00	292
WDS20228+2023	J3081	AB	20:22:51.403	+20:22:15.999	6.3	10.00	11.00	0
WDS20229+1346	J3082	AB	20:23:07.148	+13:47:43.401	6.1	14.20	15.80	19
WDS20259+0902	J3084	AB	20:25:53.487	+09:02:12.701	5.8	12.03	12.90	88
WDS20263+1445	J3085	AB	20:26:15.488	+14:45:35.201	6.1	9.80	9.80	204
WDS20275+1514	J3087	AB	20:27:27.633	+15:13:46.000	5.6	10.50	11.60	328
WDS20293+1029	J3088	AB	20:29:20.690	+10:27:58.399	7.4	10.50	11.30	80
WDS20295+1033	J3089	AB	20:29:21.321	+10:31:41.301	4.6	11.60	12.30	316
WDS20314+2049	J3091	AB	20:31:34.228	+20:51:20.402	5.7	11.20	11.50	116
WDS20326+1024	J3092	AB	20:32:36.301	+10:23:49.902	5.3	12.10	12.60	335
WDS20334+1359	J3093	AB	20:33:25.012	+13:58:46.299	4.2	12.80	12.80	43
WDS20339+1915	J3094	AB	20:33:54.002	+19:14:56.299	7.4	11.10	14.80	22
WDS20363+1636	J3095	AB	20:36:07.760	+16:35:11.002	5.3	12.40	12.40	179
WDS20365+2044	J3096	AB	20:36:33.647	+20:43:53.100	21.9	10.50	12.60	2
WDS20365+2044	J3096	BC	20:36:33.880	+20:44:20.902	8.3	12.60	13.10	9
WDS20370+1420	J3098	AB	20:36:59.822	+14:21:15.300	4.9	12.60	13.10	303
WDS20378+1936	J3099	AB	20:37:26.869	+19:38:08.898	5.5	12.50	12.70	147
WDS20385+1848	J3102	AB	20:38:44.027	+18:49:32.097	6.2	11.60	12.10	97
WDS20393+2003	J3103	AB	20:39:30.499	+20:03:30.903	5.7	12.05	12.42	224
WDS20397+1406	J3104	AB	20:39:44.061	+14:06:00.698	6.3	9.90	11.20	286
WDS20416+1738	J3107	AB	20:41:23.013	+17:39:12.502	5.9	11.70	11.70	120
WDS20436+1537	J3108	AB	20:43:43.041	+15:38:59.501	6.2	11.00	12.50	197
WDS20433+1728	J3109	AB	20:43:20.107	+17:27:50.203	7.9	12.50	13.10	245
WDS20466+1532	J3110	AB	20:46:29.353	+15:31:51.501	6.7	11.20	11.50	222
WDS20509+1517	J3113	AB	20:51:01.663	+15:19:44.999	4.8	11.50	11.50	112
WDS20513+1647	J3115	AB	20:51:14.387	+16:46:12.798	7.2	12.16	15.20	318
WDS20522+1656	J3116	AB	20:52:09.600	+16:56:13.002	73.3	8.77	12.88	39
WDS20522+1656	J3116	BC	20:52:12.841	+16:57:09.897	5.9	13.30	14.80	139
WDS20585+1607	J3118	AB	20:58:30.880	+16:06:43.899	5.8	9.40	11.20	74
WDS21081+1857	J3125	AB	21:08:17.131	+18:57:53.801	4.7	12.40	13.60	258
WDS20285+0443	J3220	AB	20:28:18.933	+04:41:49.300	3.9	10.75	12.50	181
WDS20314+0701	J3221	AB	20:31:15.792	+06:59:14.300	3.8	10.00	11.60	166
WDS20487+0706	J3223	AB	20:48:44.561	+07:05:43.700	3.5	10.69	11.40	310
WDS20311+1247	J3244	AB	20:31:07.999	+12:45:59.000	4.6	11.38	12.90	160
WDS20519+1203	J3245	AB	20:51:51.877	+12:01:57.598	3.8	11.80	12.60	249
WDS20289+1022	J3263	AB	20:28:49.413	+10:23:15.099	7.1	11.30	12.10	55
WDS20292+1019	J3264	AB	20:29:10.829	+10:19:27.699	6.3	11.64	12.30	358
WDS20502+1246	J3277	AB	20:50:05.372	+12:42:41.500	4.1	10.70	12.50	327
WDS20555+1730	J3328	AB	20:55:28.239	+17:29:14.997	3.9	11.99	14.70	122

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Table 2. Bessel epoch 2015.683 (exceptions see notes column) photometry results for the J objects in Del. “M1 WDS” and “M2 WDS” are the WDS catalog values. “M1 new” stands for measured M1, “dM1” stands for delta between “M1 WDS” and “M1 new”. “M2 new” stands for measured M2, “dM2” stands for delta “M1 WDS” and “M1 new”. “Err M1” stands for the estimated error range calculated from the average delta Vmag over all reference stars used in the image and the SNR value of the star with the formula $\sqrt{dV_{mag}^2 + (2.5 \log_{10}(1+1/SNR))^2}$.

WDS ID	Name		M1 WDS	M1 new	dM1	Err M1	M2 WDS	M2 new	dM2	Err M2	Notes
20329+1142	J1	AB	10.04	9.650	0.39	0.070	10.57	10.180	0.39	0.070	Overlapping star disks - no separate photometry possible. Combined magnitude 9.118 with SNR 238.97 gives estimated “M1 new” and “M2 new” values not confirming the current, seemingly a bit too faint, WDS values
20316+1150	J3	AB	10.00	11.946	-1.95	0.074	10.00	12.127	-2.13	0.074	Touching/overlapping star disks
20157+1003	J135	AB	11.42	11.216	0.20	0.102	11.58	11.455	0.13	0.103	Touching star disks
20345+1138	J142	AB	10.35	10.285	0.06	0.080	12.50	12.523	-0.02	0.084	
20403+0349	J156	AB	10.95	10.698	0.25	0.081	11.64	11.083	0.56	0.081	Touching/overlapping star disks
20559+0835	J157	AB	11.32	11.484	-0.16	0.083	10.93	11.130	-0.20	0.082	Touching star disks
20409+1738	J191	AB	9.30	10.880	-1.58	0.140	9.60	11.180	-1.58	0.140	Overlapping star disks - no separate photometry possible. Combined magnitude 10.268 with SNR 119.36 gives estimated “M1 new” and “M2 new” values suggesting much fainter magnitudes than currently WDS listed
20416+1058	J192	AB	9.40	11.381	-1.98	0.081	13.10	14.559	-1.46	0.158	Very low SNR <10 for B.
20420+1821	J193	AB	9.11	8.976	0.13	0.080	12.10	11.675	0.42	0.083	
20494+1124	J194	AB	10.32	10.270	0.05	0.090	9.97	9.920	0.05	0.090	Overlapping star disks - no separate photometry possible. Combined magnitude 9.325 with SNR 131.09 gives estimated “M1 new” and “M2 new” values confirming rather well the current WDS values
20494+1124	J194	AB. C	10.32	9.325	1.00	0.090	13.94	14.005	-0.07	0.126	WDS gives here obviously M1 for A and not AB combined. WDS value for C well confirmed
20509+1907	J195	AB	11.40	12.365	-0.97	0.114	11.40	12.385	-0.98	0.115	
21033+1655	J284	AB	9.50	11.236	-1.74	0.101	11.10	12.518	-1.42	0.107	Touching star disks
20298+1712	J510	AB	9.91	9.829	0.08	0.090	13.70	13.052	0.65	0.106	
20181+1555	J553	AB	9.40	10.641	-1.24	0.080	10.50	11.897	-1.40	0.082	
20271+0948	J559	AB	11.65	11.350	0.30	0.088	11.45	11.248	0.20	0.089	Overlapping/Touching star disks
20311+1248	J562	AB	10.80	10.104	0.70	0.132	11.70	10.654	1.05	0.139	Overlapping star disks
20311+1648	ROE14	AB	11.00	11.457	-0.46	0.091	12.00	12.630	-0.63	0.094	ROE14 AB as "bonus"
20311+1648	J563	BC	12.00	12.630	-0.63	0.094	12.30	13.193	-0.89	0.097	
20351+1533	J566	AB	10.90	10.126	0.77	0.130	12.20	11.252	0.95	0.131	
20527+0527	J572	AB	10.20	9.927	0.27	0.120	11.30	11.446	-0.15	0.126	Touching star disks
20534+1921	J573	AB	11.30	11.766	-0.47	0.081	11.70	12.925	-1.23	0.086	

Table 2 continues on next page.

Jonckheere Double Star Photometry – Part II: Delphinus

Table 2 (continued). Bessel epoch 2015.683 (exceptions see notes column) photometry results for the J objects in Del. ...

WDS ID	Name		M1 WDS	M1 new	dM1	Err M1	M2 WDS	M2 new	dM2	Err M2	Notes
20151+1143	J604	AB	10.23	10.210	0.02	0.080	10.44	10.420	0.02	0.080	Overlapping star disks - no separate photometry possible. Combined magnitude 9.552 with SNR 210.02 gives estimated "M1 new" and "M2 new" values confirming rather well the current WDS values
20527+1726	J605	AC	11.55	11.665	-0.11	0.111	12.16	12.160	-	0.112	WDS values for A with 11.4 and 11.55 not consistent
20527+1726	J605	AB	11.40	11.665	-0.26	0.111	11.90	11.982	-0.08	0.112	Overlapping star disks
20571+1801	J607	AB	10.80	10.714	0.09	0.130	12.40	12.440	-0.04	0.136	Touching star disks
20348+1857	J790	AB	9.50	11.554	-2.05	0.091	10.00	12.080	-2.08	0.092	Touching star disks
21056+1749	J797	AB	12.30	12.053	0.25	0.101	13.80	13.259	0.54	0.106	
20198+1203	J837	AB	11.10	10.848	0.25	0.100	11.70	11.905	-0.21	0.102	Overlapping/Touching star disks
20210+1028	J838	AB	11.52	12.543	-1.02	0.093	12.00	12.579	-0.58	0.093	
20235+1811	J839	AB	11.50	11.138	0.36	0.121	11.70	11.156	0.54	0.121	Overlapping/Touching star disks
20249+1124	J840	AB	9.50	11.314	-1.81	0.081	10.50	12.835	-2.34	0.085	
20249+1309	J841	AB	10.50	10.400	0.10	0.100	11.50	11.400	0.10	0.100	Overlapping star disks - no separate photometry possible. Combined magnitude 10.045 with SNR 174.65 gives estimated "M1 new" and "M2 new" values confirming rather well the current WDS values
20249+1309	J841	AB.C	10.10	10.045	0.05	0.100	10.50	10.664	-0.16	0.100	
20250+1451	J842	AB	10.04	9.926	0.11	0.090	12.10	11.713	0.39	0.092	
20314+2054	J844	AB	12.20	11.863	0.34	0.141	12.80	12.825	-0.02	0.146	
20434+1712	J845	AB	11.99	12.658	-0.67	0.094	12.20	13.137	-0.94	0.100	
20541+1402	J846	AB	10.80	10.622	0.18	0.071	11.14	11.060	0.08	0.071	
20396+1310	J912	AB	10.00	12.618	-2.62	0.096	10.00	12.701	-2.70	0.097	Touching star disks
20385+1118	J1073	AB	9.70	11.492	-1.79	0.081	14.00	14.170	-0.17	0.108	Low SNR <20 for B
20209+1332	J1173	AB	10.41	10.551	-0.14	0.071	13.70	12.164	1.54	0.079	Touching star disks
20157+0957	J1234	AB	12.51	11.892	0.62	0.095	15.00	13.392	1.61	0.137	Very low SNR <10 for B
20280+1244	J1241	AB	10.33	10.090	0.24	0.110	12.30	12.060	0.24	0.110	Overlapping star disks - no separate photometry possible. Combined magnitude 9.925 with SNR 102.93 gives estimated "M1 new" and "M2 new" values confirming rather the current WDS values
20386+1120	J1242	AB	9.60	11.546	-1.95	0.113	11.00	12.538	-1.54	0.121	
20298+1154	J1243	AB	10.80	12.608	-1.81	0.102	10.80	12.628	-1.83	0.102	iT27. Bessel epoch 2015.799
20146+1116	J1296	AB	11.90	12.619	-0.72	0.102	12.40	13.408	-1.01	0.106	iT27. Bessel epoch 2015.799

Table 2 continues on next page.

Jonckheere Double Star Photometry – Part II: Delphinus

Table 2 (continued). Bessel epoch 2015.683 (exceptions see notes column) photometry results for the J objects in Del. ...

WDS ID	Name		M1 WDS	M1 new	dM1	Err M1	M2 WDS	M2 new	dM2	Err M2	Notes
20276+0745	J1297	AB	11.23	11.180	0.05	0.111	11.27	11.220	0.05	0.111	Overlapping star disks - no separate photometry possible. Combined magnitude 10.448 with SNR 95.51 gives estimated "M1 new" and "M2 new" values confirming rather well the current WDS values
20554+0836	J1318	AB	10.30	10.270	0.03	0.140	10.77	10.740	0.03	0.140	Overlapping star disks - no separate photometry possible. Combined magnitude 11.425 with SNR 44.81 gives estimated "M1 new" and "M2 new" values confirming rather well the current WDS values
20247+0302	J1342	AB	9.40	12.090	-2.69	0.076	11.50	12.801	-1.30	0.072	Overlapping/Touching star disks
20270+1008	J1343	AB	9.60	11.889	-2.29	0.121	10.00	12.039	-2.04	0.121	Overlapping/Touching star disks. Bessel epoch 2015.713
20348+1121	J1344	AB	9.10	10.646	-1.55	0.070	11.50	10.878	0.62	0.071	Overlapping/Touching star disks. Bessel epoch 2015.713
20438+1440	J1345	AB	9.60	11.712	-2.11	0.143	10.50	12.682	-2.18	0.151	Low SNR <20 for B
20560+0837	J1346	AB	13.20	12.477	0.72	0.102	13.20	12.524	0.68	0.102	iT27. Touching star disks. Bessel epoch 2015.801
20260+1212	J1704	AB	10.16	10.320	-0.16	0.190	10.80	11.324	-0.52	0.191	Bessel epoch 2015.809
20586+0723	J1715	AB	11.61	12.232	-0.62	0.084	13.00	13.748	-0.75	0.124	Low SNR <20 for B
20593+1744	J1716	AB	10.00	11.781	-1.78	0.112	11.00	13.071	-2.07	0.122	
20169+1303	J1879	AB	11.83	11.972	-0.14	0.095	11.95	12.811	-0.86	0.110	Low SNR <20 for B. Bessel epoch 2015.809
20169+1303	J1879	AC	11.83	11.972	-0.14	0.095	14.40	13.959	0.44	0.165	Very low SNR <10 for B. Bessel epoch 2015.809
20172+1304	J1880	AB	11.23	11.113	0.12	0.101	13.30	12.910	0.39	0.110	
20303+0917	J1883	AB	11.53	11.665	-0.14	0.102	12.00	12.250	-0.25	0.103	
20315+1448	J1884	AB	9.80	11.782	-1.98	0.152	9.80	12.355	-2.56	0.154	
20315+1446	J1885	AB	12.00	13.283	-1.28	0.128	12.00	13.693	-1.69	0.136	Low SNR <20 for B
20351+1413	J1887	AB	11.68	11.934	-0.25	0.135	11.70	12.319	-0.62	0.139	
20439+1255	J1888	AB	9.70	12.023	-2.32	0.092	12.50	13.897	-1.40	0.107	Low SNR <10 for B. Bessel epoch 2015.809
20441+1258	J1889	AB	14.30	14.386	-0.09	0.106	14.30	15.405	-1.11	0.198	Low SNR <20 for A and very low SNR <10 for B. Bessel epoch 2015.809
20485+1448	J1890	AB	11.20	11.670	-0.47	0.182	11.50	12.056	-0.56	0.183	
20360+0411	J2192	AB	9.90	11.440	-1.54	0.051	12.50	12.882	-0.38	0.054	Bessel epoch 2015.713
20305+1829	J2313	AB	9.50	11.542	-2.04	0.122	11.90	13.209	-1.31	0.132	Low SNR <20 for B
20327+0453	J2314	AB	10.60	12.475	-1.88	0.113	11.60	12.800	-1.20	0.119	Low SNR <20 for B
20327+0453	J2314	AC	10.60	12.475	-1.88	0.052	14.00				No resolution, C fainter than 14mag
20415+1611	J2319	AB	9.80	12.035	-2.24	0.102	12.00	13.711	-1.71	0.122	
20488+0512	J2321	AB	9.61	9.700	-0.09	0.091	10.80	12.402	-1.60	0.097	

Table 2 continues on next page.

Jonckheere Double Star Photometry – Part II: Delphinus

Table 2 (continued). Bessel epoch 2015.683 (exceptions see notes column) photometry results for the J objects in Del. ...

WDS ID	Name		M1 WDS	M1 new	dM1	Err M1	M2 WDS	M2 new	dM2	Err M2	Notes
20518+1736	J2325	AB	11.60	11.777	-0.18	0.142	13.70	13.254	0.45	0.151	Low SNR <20 for B. Similar pair UCAC4-538-140054/UCAC4-538-140056 nearby
20230+0929	J2572	AB	9.80	12.206	-2.41	0.172	13.20	14.208	-1.01	0.213	Very low SNR<10 for B. Image quality questionable
20321+0330	J2573	AB	12.50	12.945	-0.45	0.102	12.80	13.323	-0.52	0.117	Low SNR<20 for B
20418+1404	J2575	AB	9.70				13.00				Overlapping star disks - no separate photometry possible. Combined magnitude 11.768 with SNR 58.88 - questionable object, Bogus assumed. If double at all than A could be not brighter than 11.8mag
20393+1101	J2603	AB	11.39				13.40				Overlapping star disks - no trace of a secondary, no separate photometry possible. Combined magnitude 11.376 with SNR 52.42 - questionable object, potential bogus
20398+1927	J2604	AB	12.12				12.10				Overlapping star disks - no trace of a secondary, no separate photometry possible. Combined magnitude 12.338 with SNR 21.91 - questionable object, potential bogus
21058+1939	J2702	AB	11.20	11.038	0.16	0.081	11.60	11.268	0.33	0.082	
20152+1357	J3066	AB	11.00	12.789	-1.79	0.106	11.50	13.641	-2.14	0.113	
20152+1357	J3066	AC	11.00	12.789	-1.79	0.106	15.00	15.834	-0.83	0.345	Very low SNR<5 for C
20227+1345	J3079	AB	12.90	12.645	0.26	0.063	13.30	13.366	-0.07	0.067	Bessel epoch 2015.702
20227+2023	J3080	AB	12.00	12.058	-0.06	0.221	13.00	12.732	0.27	0.221	Large dVmag 0.22. Bessel epoch 2015.702
20228+2023	J3081	AB	10.00	12.111	-2.11	0.171	11.00	12.741	-1.74	0.172	Large dVmag 0.17. Bessel epoch 2015.702
20229+1346	J3082	AB	14.20				15.80				Most probably position error. Only very faint single star with 14.634mag and SNR 14.01 in the given position. But nearby UCAC4-519-126369 20:23:07.099 +13:47:41.640 +14.264Vmag with companion UCAC4-519-126370 15.616mag model fit, no Vmag. Bessel epoch 2015.702
20259+0902	J3084	AB	12.03	13.208	-1.18	0.114	12.90	14.052	-1.15	0.127	Low SNR<20 for B. Bessel epoch 2015.702
20263+1445	J3085	AB	9.80	11.608	-1.81	0.081	9.80	12.258	-2.46	0.082	Bessel epoch 2015.702

Table 2 continues on next page.

Jonckheere Double Star Photometry – Part II: Delphinus

Table 2 (continued). Bessel epoch 2015.683 (exceptions see notes column) photometry results for the J objects in Del. ...

WDS ID	Name		M1 WDS	M1 new	dM1	Err M1	M2 WDS	M2 new	dM2	Err M2	Notes
20275+1514	J3087	AB	10.50	11.928	-1.43	0.241	11.60	13.040	-1.44	0.245	Large dVmag 0.24. Bessel epoch 2015.702
20293+1029	J3088	AB	10.50	12.865	-2.37	0.181	11.30	13.033	-1.73	0.184	Low SNR<20 for A and B. Bessel epoch 2015.702
20295+1033	J3089	AB	11.60	12.441	-0.84	0.222	12.30	14.097	-1.80	0.341	Low SNR<20 for A and very low SNR<5 for B. Bessel epoch 2015.702
20314+2049	J3091	AB	11.20	13.367	-2.17	0.226	11.50	13.407	-1.91	0.225	Bessel epoch 2015.702
20326+1024	J3092	AB	12.10				12.60				No resolution, no photometry possible. Both components probably much fainter than WDS value. UCAC4-502-130763 13.156mag, UCAC4-502-130762 13.652mag. Given Vmag 12.705 for A seems questionable, especially as the same value is given for B and similar bright stars nearby are listed with 13.764 Vmag. Bessel epoch 2015.702
20334+1359	J3093	AB	12.80				12.80				No resolution, no photometry possible. Both components probably much fainter than WDS value. UCAC4-520-130741 13.538mag, 4UCAC4-520-130739 13.176mag. Vmag 12.79mag for A seems questionable, especially as similar bright stars nearby are listed with 14.240Vmag. Bessel epoch 2015.702
20339+1915	J3094	AB	11.10	10.456	0.64	0.272	14.80				Companion too faint for resolution, thus rather confirming WDS value. Image quality questionable. Bessel epoch 2015.702
20363+1636	J3095	AB	12.40	12.462	-0.06	0.280	12.40	12.766	-0.37	0.286	Low SNR<20 for A and B, image quality questionable. Bessel epoch 2015.702
20365+2044	J3096	AB	10.50	10.676	-0.18	0.171	12.60	12.825	-0.23	0.192	Low SNR<20 for B. Bessel epoch 2015.702
20365+2044	J3096	BC	12.60	12.825	-0.23	0.192	13.10				Low SNR<20 for B, no resolution for C, thus probably much fainter than 13.1mag. Questionable image quality. Bessel epoch 2015.702
20370+1420	J3098	AB	12.60	13.506	-0.91	0.159	13.10	13.529	-0.43	0.154	Low SNR<20 for A and B. Bessel epoch 2015.702

Table 2 concludes on next page.

Jonckheere Double Star Photometry – Part II: Delphinus

Table 2 (conclusion). Bessel epoch 2015.683 (exceptions see notes column) photometry results for the J objects in Del. ...

WDS ID	Name		M1 WDS	M1 new	dM1	Err M1	M2 WDS	M2 new	dM2	Err M2	Notes
20378+1936	J3099	AB	12.50	13.012	-0.51	0.116	12.70	13.558	-0.86	0.121	Bessel epoch 2015.702
20385+1848	J3102	AB	11.60	11.678	-0.08	0.171	12.10	12.845	-0.75	0.173	Bessel epoch 2015.702
20393+2003	J3103	AB	12.05	10.494	1.56	0.170	12.42	12.618	-0.20	0.174	Bessel epoch 2015.702
20397+1406	J3104	AB	9.90	11.717	-1.82	0.111	11.20	13.103	-1.90	0.115	Bessel epoch 2015.702
20416+1738	J3107	AB	11.70	13.205	-1.51	0.132	11.70	13.295	-1.60	0.130	Bessel epoch 2015.702
20436+1537	J3108	AB	11.00	11.214	-0.21	0.101	12.50	12.133	0.37	0.102	Bessel epoch 2015.702
20433+1728	J3109	AB	12.50	12.577	-0.08	0.134	13.10	12.659	0.44	0.135	Bessel epoch 2015.702
20466+1532	J3110	AB	11.20	11.105	0.09	0.111	11.50	11.751	-0.25	0.112	Bessel epoch 2015.702
20509+1517	J3113	AB	11.50	12.829	-1.33	0.107	11.50	12.880	-1.38	0.106	Bessel epoch 2015.702
20513+1647	J3115	AB	12.16	11.714	0.45	0.104	15.20	13.673	1.53	0.128	Low SNR<20 for B. Bessel epoch 2015.702
20522+1656	J3116	AB	8.77	8.687	0.08	0.080	12.88	13.155	-0.27	0.115	A too bright for reliable photometry, low SNR<20 for B. Bessel epoch 2015.702
20522+1656	J3116	BC	13.30	13.155	0.15	0.115	14.80				C too faint to be resolved, inconsistent WDS data for B (12.88 vs 13.3mag). Bessel epoch 2015.702
20585+1607	J3118	AB	9.40	9.607	-0.21	0.110	11.20	11.978	-0.78	0.113	Bessel epoch 2015.702
21081+1857	J3125	AB	12.40	12.490	-0.09	0.119	13.60	13.588	0.01	0.137	Low SNR<20 for B. Bessel epoch 2015.702
20285+0443	J3220	AB	10.75	10.811	-0.06	0.102	12.50	11.972	0.53	0.111	Bessel epoch 2015.702
20314+0701	J3221	AB	10.00	11.543	-1.54	0.148	11.60	12.733	-1.13	0.183	Very low SNR <10 for B. Bessel epoch 2015.702
20487+0706	J3223	AB	10.69	10.538	0.162	0.112	11.40				No resolution, not even an elongation. Probably WDS catalog mismatch. Bessel epoch 2015.828
20311+1247	J3244	AB	11.38	12.847	-1.47	0.105	12.90	15.732	-2.83	0.305	Very low SNR <10 for B. Same image as for J562. Bessel epoch 2015.702
20519+1203	J3245	AB	11.80	12.835	-1.04	0.131	12.60	13.222	-0.62	0.139	Low SNR<20 for A and B. Bessel epoch 2015.828
20289+1022	J3263	AB	11.30	12.489	-1.19	0.141	12.10	13.801	-1.70	0.183	Low SNR<20 for A and very low SNR<10 B. Bessel epoch 2015.828
20292+1019	J3264	AB	11.64	12.900	-1.26	0.128	12.30	14.295	-2.00	0.185	Very low SNR <10 for B. Bessel epoch 2015.828
20502+1246	J3277	AB	10.70	11.562	-0.86	0.134	12.50	13.469	-0.97	0.249	Very low SNR <10 for B. Bessel epoch 2015.828
20555+1730	J3328	AB	11.99	11.740	0.25	0.133	14.70	13.037	1.66	0.181	Low SNR<20 for A and very low SNR<10 B. Bessel epoch 2015.831

Table 2 notes on next page.

Jonckheere Double Star Photometry – Part II: Delphinus

Notes regarding the notes column:

- “iT27” indicates the use of telescope iT27 instead of iT24.
- “Bessel epoch” indicates an epoch given different from 2015.683.
- “Touching star disks” indicates that the rims of the star disks are touching and that the measurement results might be a bit less precise than with clearly separated star disks.
- “Overlapping/Touching star disks” indicates that the star disks overlap to the degree of an elongation and that the measurement results is probably less precise than with clearly separated star disks.
- “Overlapping star disks” indicates star disk overlap to the degree that photometry for the separated components was no longer possible and that it was necessary to resort to the measurement of the combined magnitude.
- “Low SNR <20” indicates that the measurement result might be a bit less precise than desired due to a low SNR value but this is already included in the calculation of the error range estimation.
- “Very low SNR <10” indicates that the measurement result is probably a bit less precise than desired due to a very low SNR value but this is already included in the calculation of the error range estimation.
- “Image quality questionable” indicates a rather large average magnitude error for the reference stars used for plate solving either due to not this perfect weather conditions during imaging or may be erroneous Vmag values for the stars used for plate solving. But this is already included in the calculation of the error range estimation.
- “too bright for reliable photometry” indicates a star far brighter than the for plate solving used range 10.5 to 14.5mag – despite this most such cases showed a reasonable measurement result anyway
- In case of J3223 separation is calculated based on the RA/Dec coordinates of the components. This is done using the formulae provided by Buchheim, 2008.

Specifications of the used telescopes:

- iT24: 610.mm CDK with 3962 mm focal length. Resolution 0.625 arcsec/pixel. V-filter. No transformation coefficients available. Located in Auberry, California. Elevation 1405 m.
- iT27: 700.mm CDK with 4531.mm focal length. CCD: FLI PL09000. Resolution 0.53 arcsec/pixel. V-filter. No B-V transformation coefficients available. Located in Siding Spring, Australia. Elevation 1122 m.

