Jonckheere Double Star Photometry – Part IX: Sagitta

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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 with magnitudes obviously far too bright. This report covers a part of the Jonckheere objects in the constellation Sagitta including a check if physical by means of UCAC5 proper motion data. In most cases only one image per object is taken for differential photometry as even a single image based measurement is better than the currently often given mere estimation. As by-product a new CPM candidate pair was discovered and as appendix the UCAC5 proper motion data quality was counter-checked with GAIA DR1 (TGAS)

Introduction

As follow up to the previous reports on J-objects I selected this time the Jonckheere double stars in Sagitta. To concentrate my efforts on the "most promising" objects I checked only a part of them based on the following selection criteria:

- Single digit precision WDS magnitude for the secondary (checked per begin of 2017) suggests estimation instead of measurement
- Separation large enough to allow for clear resolution (at least obvious elongation) with the available equipment
- Rather neglected object.

This does not mean that all other J-objects in Sagitta have to be listed in the WDS catalog with correct magnitudes but the probability for realistic values seems a good one.

Measurements

For most of the selected J-objects one single image was taken with iTelescope iT24 with V-filter and 3s exposure time, plate solved with Astrometrica using the URAT1 catalog with reference stars in the Vmag range of 8.5 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 and astrometry/photometry was then done by the rather comfortable Astrometrica procedure with point and click at the components delivering RA/Dec coordinates and Vmag measurements based on all reference stars used for plate solving. In a few cases I had to take additional images to avoid issues with image quality.

The results are given in Table 1 below with the following structure:

- J# gives the number of the J-object.
- RA/Dec gives the position in the HH:MM:SS/DD:MM:SS format for both components.
- dRA and dDEc give the average plate solving error for RA and Dec in arcseconds.
- Sep gives separation in arcseconds in the data lines calculated as

$$Sep = \sqrt{\left[\left(RA_2 - RA_1\right)\cos\left(Dec_1\right)\right]^2 + \left(Dec_2 - Dec_1\right)^2}$$

  in radians according to Buchheim 2008.
- Err Sep gives the calculated error range for Sep as

$$Err\_Sep = \sqrt{dRA^2 + dDec^2}$$

- PA gives position angle in degrees in the data lines calculated as

$$PA = \arctan\left[\frac{(RA_2 - RA_1)\cos(Dec_1)}{Dec_2 - Dec_1}\right]$$

in radians depending on quadrant according to Buchheim 2008

- Err_PA = position angle error estimation in degrees calculated as arctan(*Err_Sep/Sep*) assuming the worst case that Err_Sep points perpendicular to the separation vector
- Mag gives Vmag for both components according to plate solving
- Err_Mag = magnitude error estimation calculated as

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

- SNR as signal to noise ratio for the given object
- dVmag as average magnitude plate solving error
- Date gives the Julian observation epoch (instead of the Bessel epoch used so far in the WDS catalog)
- N gives the number of images used
- Notes indicate the telescope used, number of images with exposure time and additional comments if considered necessary.

In an additional step I then checked all objects for common proper motion by using the UCAC5 catalog PM data (see Appendix C for a counter-check of the UCAC5 proper motion data quality in comparison with GAIA DR1/TGAS). Table 2 lists the UCAC5 data for the J objects in question and the assessment if the UCAC5 proper motion data allows for common proper motion using the following structure:

- First row:
  - J# gives the number of the J-object
  - RA/Dec gives the GAIA DR1 position as given in the UCAC5 catalog in degrees for the primary
  - Sep gives separation in arcseconds in the data lines calculated as SQRT(((RA2-RA1) *cos(Dec1))^2+(Dec2-Dec1)^2) in radians
  - PA gives position angle in degrees in the data lines calculated as arctan((RA2-RA1) *cos(Dec1))/(Dec2-Dec1)) in radians depending on quadrant
  - M1(G) and M2(G) give the GAIA DR1 Gmag values for both components as given in the UCAC5 catalog
  - pmRA1, pmDec1/pmRA2, pmDec2 give the UCAC5 proper motion data and e_pm1/2 give the total pm data error for both components
  - Ap gives the GAIA aperture diameter (calculated for a corresponding surface with the used rectangular aperture)
  - Me gives the observation method
  - Date gives the GAIA DR1 observation epoch
  - CPM Rat gives the CPM rating according to Knapp and Nanson 2017 (see Appendix A)
  - Source/Notes gives the reference to the used catalog and additional comments on the objects
- Second row:
  - RA/Dec gives the UCAC5 position in degrees for the primary (from UCAC images re-reduced with TGAS reference stars)
  - Sep gives separation in arcseconds in the data lines calculated as SQRT(((RA2-RA1) *cos(Dec1))^2+(Dec2-Dec1)^2) in radians
  - PA gives position angle in degrees in the data lines calculated as arctan((RA2-RA1) *cos(Dec1))/(Dec2-Dec1)) in radians depending on quadrant
  - Ap gives the used UCAC5 aperture
  - Me gives the observation method
  - Date gives the UCAC5 observation epoch (average from the used images)
  - Source/Notes gives UCAC5 as used catalog and additional comments on the objects if necessary

Summary

Table 1 shows with few exceptions the expected quite large differences for the magnitudes compared with the WDS data.

Table 2 shows (compared with other constellations rather surprisingly) that only one object qualifies for a perfect common proper motion pair with a second one a bit shaky due to rather small proper motion values. For several objects no CPM assessment was possible due to missing UCAC5 (but also 2MASS and GAIA DR1) data. This demonstrates that UCAC5 and GAIA DR1 are less complete than assumed.

By chance a new CPM candidate was found near J3000 with the caveat of a rather large proper motion data error range for the secondary (see Appendix B for the observation history).

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Table 1. Measurement results for the selected J objects in Sge (twice for J3000 from two different images)

J#		RA	Dec	dRA	dDec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	SNR	dVmag	Date	N	Notes
784	A	20 01 17.177	19 17 09.60	0.09	0.11	2.162	0.142	165.201	3.762	11.711	0.102	56.26	0.10	2015.769	1	iT24 1x3s. Overlapping star disks
	B	20 01 17.216	19 17 07.51							12.126	0.104	37.50				
1201	A	19 47 36.738	17 06 56.04	0.10	0.11	1.843	0.149	84.707	4.612	12.296	0.093	44.61	0.09	2015.780	1	iT24 1x3s. Overlapping star disks
	B	19 47 36.866	17 06 56.21							12.577	0.097	29.04				
829	A	19 51 57.278	17 22 32.22	0.11	0.11	2.450	0.156	272.106	3.634	12.039	0.137	25.57	0.13	2015.766	1	iT24 1x3s. Overlapping star disks. SNR B <20
	B	19 51 57.107	17 22 32.31							12.850	0.152	13.17				
832	A	20 07 28.844	16 41 41.49	0.10	0.12	2.877	0.156	83.614	3.108	12.003	0.134	33.54	0.13	2015.766	1	iT24 1x3s. Touching star disks
	B	20 07 29.043	16 41 41.81							12.041	0.135	30.73				
1176	A	19 35 21.817	18 56 44.38	0.07	0.08	3.214	0.106	101.486	1.894	12.741	0.094	21.83	0.08	2015.766	1	iT24 1x3s
	B	19 35 22.039	18 56 43.74							12.779	0.094	21.64				
1317	A	19 51 54.558	17 24 48.78	0.08	0.09	2.592	0.120	58.867	2.660	12.865	0.094	40.47	0.09	2015.775	1	iT24 1x3s. Touching star disks
	B	19 51 54.713	17 24 50.12							13.445	0.098	27.35				
2602	A	20 15 50.844	18 20 43.94	0.08	0.10	2.828	0.128	348.382	2.593	12.953	0.087	32.45	0.08	2015.775	1	iT24 1x3s. Touching star disks
	B	20 15 50.804	18 20 46.71							12.965	0.089	28.08				
836	A	20 19 21.683	19 54 20.55	0.08	0.09	2.980	0.120	251.205	2.314	11.524	0.104	37.20	0.10	2015.766	1	iT24 1x3s. Touching star disks
	B	20 19 21.483	19 54 19.59							12.153	0.106	30.46				
3314	A	20 18 11.422	17 51 14.23	0.08	0.09	3.422	0.120	69.831	2.015	12.263	0.092	60.47	0.09	2015.780	1	iT24 1x3s
	B	20 18 11.647	17 51 15.41							12.947	0.094	37.89				
1174	A	19 15 13.010	18 09 51.75	0.09	0.13	3.203	0.158	297.121	2.826	10.814	0.092	51.98	0.09	2015.766	1	iT24 1x3s
	B	19 15 12.810	18 09 53.21							11.844	0.100	24.99				
506	A	20 10 48.535	18 26 45.53	0.12	0.11	3.080	0.163	309.516	3.025	12.364	0.090	26.17	0.08	2015.963	1	iT24 1x3s. Touching star disks. SNR B <20
	B	20 10 48.368	18 26 47.49							12.942	0.102	16.80				
1301	A	19 10 03.450	20 28 18.34	0.10	0.10	3.664	0.141	141.309	2.210	11.171	0.091	83.79	0.09	2015.775	1	iT24 1x3s. Touching star disks
	B	19 10 03.613	20 28 15.48							12.093	0.093	43.14				
2959	B	19 15 53.428	20 16 36.18	0.09	0.09	4.191	0.127	173.058	1.740	11.958	0.081	70.15	0.08	2015.775	1	iT24 1x3s. SNR C <20
	C	19 15 53.464	20 16 32.02							13.851	0.098	18.96				
3047	A	20 03 47.522	18 53 54.69	0.08	0.08	4.429	0.113	341.504	1.463	13.392	0.103	21.56	0.09	2015.780	1	iT24 1x3s
	B	20 03 47.423	18 53 58.89							13.805	0.103	21.25				
2946	A	19 09 53.304	21 08 41.51	0.08	0.09	3.953	0.120	57.393	1.745	12.201	0.072	61.31	0.07	2015.775	1	iT24 1x3s
	B	19 09 53.542	21 08 43.64							13.053	0.077	33.88				
2943	B	19 05 57.153	21 06 40.51	0.07	0.09	4.375	0.114	111.451	1.493	13.565	0.089	27.91	0.08	2015.775	1	iT24 1x3s. SNR C <20
	C	19 05 57.444	21 06 38.91							14.723	0.117	12.29				
2950	A	19 10 23.094	19 52 30.60	0.09	0.10	5.461	0.135	132.369	1.411	13.833	0.094	21.41	0.08	2015.775	1	iT24 1x3s. A fainter than B
	B	19 10 23.380	19 52 26.92							13.252	0.087	31.32				

Table 1 continues on next page.

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Table 1 (continued). Measurement results for the selected J objects in Sge (twice for J3000 from two different images)

J#		RA	Dec	dRA	dDec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	SNR	dVmag	Date	N	Notes
3064	B	20 14 32.896	18 08 45.57	0.08	0.08	4.350	0.113	220.453	1.490	13.087	0.104	35.36	0.10	2015.780	1	iT24 1x3s. SNR C <10
	C	20 14 32.698	18 08 42.26							14.570	0.148	9.42				
3024	A	19 53 06.273	17 38 55.22	0.08	0.08	4.093	0.113	221.833	1.583	14.960	0.145	9.05	0.09	2015.780	1	iT24 1x3s. A fainter than B. SNR A <10 and SNR B < 20
	B	19 53 06.082	17 38 52.17							14.525	0.128	11.47				
3000	A	19 46 20.825	18 58 39.12	0.08	0.09	4.525	0.120	57.819	1.524	13.474	0.087	30.81	0.08	2015.775	1	iT24 1x3s
	B	19 46 21.095	18 58 41.53							13.755	0.090	26.19				
3000	A	19 46 20.823	18 58 39.20	0.07	0.06	4.410	0.092	56.091	1.198	13.374	0.101	84.69	0.10	2017.549	5	iT24 5x10s
	B	19 46 21.081	18 58 41.66							13.615	0.101	80.29				
1192	A	19 22 50.419	18 57 45.28	0.08	0.10	4.613	0.128	151.930	1.590	11.906	0.092	61.82	0.09	2015.780	1	iT24 1x3s
	B	19 22 50.572	18 57 41.21							13.133	0.102	22.27				
3028	A	19 53 47.472	18 46 51.17	0.08	0.09	4.760	0.120	306.628	1.449	12.187	0.092	61.73	0.09	2015.780	1	iT24 1x3s. Incredible dense star field suggests an Open Cluster but this object is cataloged as Globular Cluster M71
	B	19 53 47.203	18 46 54.01							12.853	0.094	41.13				
1303	A	19 15 42.788	16 54 03.51	0.08	0.09	4.712	0.120	209.769	1.464	12.720	0.083	49.92	0.08	2015.775	1	iT24 1x3s
	B	19 15 42.625	16 53 59.42							13.206	0.087	32.14				
3046	A	20 03 53.306	19 39 11.60	0.07	0.09	5.222	0.114	99.145	1.251	12.962	0.094	42.09	0.09	2015.780	1	iT24 1x3s
	B	20 03 53.671	19 39 10.77							13.922	0.100	24.40				
833	A	20 09 41.260	17 24 43.83	0.08	0.09	4.763	0.120	114.430	1.448	9.870	0.080	158.60	0.08	2015.766	1	iT24 1x3s
	B	20 09 41.563	17 24 41.86							12.256	0.084	40.45				
1185	A	19 45 02.160	19 01 26.29	0.08	0.08	5.168	0.113	99.916	1.254	9.839	0.121	89.85	0.12	2015.766	1	iT24 1x3s
	B	19 45 02.519	19 01 25.40							11.342	0.123	37.71				
3075	A	20 19 17.023	18 27 50.32	0.07	0.08	4.926	0.106	103.978	1.236	13.908	0.094	21.68	0.08	2015.780	1	iT24 1x3s
	B	20 19 17.359	18 27 49.13							13.917	0.090	25.22				
3037	A	19 56 51.497	19 34 00.99	0.07	0.09	5.134	0.114	129.567	1.272	13.324	0.087	31.26	0.08	2015.780	1	iT24 1x3s. SNR B <20
	B	19 56 51.777	19 33 57.72							14.375	0.107	14.68				
3052	A	20 07 33.538	16 10 26.65	0.07	0.09	5.170	0.114	99.463	1.263	12.080	0.101	64.91	0.10	2015.780	1	iT24 1x3s. SNR B <20
	B	20 07 33.892	16 10 25.80							14.702	0.138	11.01				
3010	A	19 48 22.457	18 42 59.56	0.08	0.09	5.539	0.120	313.033	1.245	13.435	0.119	13.44	0.09	2015.775	1	iT24 1x3s. SNR B <10
	B	19 48 22.172	18 43 03.34							15.025	0.142	9.44				
3017	A	19 50 05.635	17 47 33.22	0.08	0.08	5.450	0.113	50.865	1.189	13.554	0.098	27.72	0.09	2015.780	1	iT24 1x3s
	B	19 50 05.931	17 47 36.66							13.803	0.100	24.65				
3023	A	19 52 02.643	17 23 16.44	0.08	0.08	5.707	0.113	113.000	1.136	13.546	0.098	27.00	0.09	2015.780	1	iT24 1x3s. SNR B <20
	B	19 52 03.010	17 23 14.21							14.636	0.120	13.30				

Table 1 concludes on next page.

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Table 1 (conclusion). Measurement results for the selected J objects in Sge (twice for J3000 from two different images)

J#		RA	Dec	dRA	dDec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	SNR	dVmag	Date	N	Notes
3055	A	20 10 46.368	19 15 11.74	0.07	0.08	5.552	0.106	61.022	1.097	12.737	0.093	48.14	0.09	2015.780	1	iT24 1x3s
	B	20 10 46.711	19 15 14.43							13.703	0.097	29.90				
2307	A	20 16 42.431	18 03 05.23	0.08	0.10	6.098	0.128	116.700	1.203	12.230	0.092	63.32	0.09	2015.775	1	iT24 1x3s
	B	20 16 42.813	18 03 02.49							13.226	0.095	36.09				
3048	A	20 04 27.782	19 37 31.04	0.08	0.09	5.922	0.120	271.548	1.165	10.307	0.100	142.61	0.10	2015.780	1	iT24 1x3s
	B	20 04 27.363	19 37 31.20							12.177	0.102	53.97				
3012	A	19 49 09.653	18 51 27.36	0.08	0.08	6.603	0.113	271.649	0.982	13.922	0.101	66.64	0.10	2017.470	10	iT24 10x10s
	B	19 49 09.188	18 51 27.55							14.630	0.104	40.18				
3012	A	19 49 09.653	18 51 27.36	0.08	0.08	6.772	0.113	172.896	0.957	13.922	0.101	66.64	0.10	2017.470	10	iT24 10x10s. This is actually an optical quintuple with D and E components fainter than 15mag
	C	19 49 09.712	18 51 20.64							13.507	0.101	82.15				
1233	A	20 06 32.900	19 53 27.04	0.11	0.11	6.851	0.156	245.232	1.301	11.836	0.092	50.48	0.09	2015.780	1	iT24 1x3s. SNR B <10
	B	20 06 32.459	19 53 24.17							14.368	0.193	5.86				
3053	A	20 10 12.888	19 15 42.41	0.07	0.08	7.726	0.106	248.034	0.788	11.758	0.091	85.18	0.09	2015.780	1	iT24 1x3s
	B	20 10 12.382	19 15 39.52							13.955	0.105	19.85				
2303	A	20 12 46.907	18 06 17.20	0.08	0.10	23.643	0.128	49.769	0.310	10.319	0.090	153.57	0.09	2015.775	1	iT24 1x3s
	B	20 12 48.173	18 06 32.47							12.517	0.093	49.98				
2303	B	20 12 48.173	18 06 32.47	0.08	0.10	4.508	0.128	322.155	1.627	12.517	0.093	49.98	0.09	2015.775	1	iT24 1x3s
	C	20 12 47.979	18 06 36.03							13.273	0.097	30.21				
2308	A	20 17 44.544	20 25 22.92	0.09	0.10	37.040	0.135	282.347	0.208	8.131	0.080	350.76	0.08	2015.775	1	iT24 1x3s
	B	20 17 41.970	20 25 30.84							12.832	0.083	47.94				
2308	A	20 17 44.544	20 25 22.92	0.09	0.10	42.719	0.135	284.132	0.180	8.131	0.080	350.76	0.08	2015.775	1	iT24 1x3s
	C	20 17 41.597	20 25 33.35							14.054	0.095	20.92				

Explanations regarding the Notes column:

1. “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
2. “Touching/Overlapping 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
3. “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 magnitude error range estimation
4. “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 magnitude error range estimation

Table 2: J objects in Sge (with GAIA DR1 and UCAC5 positions given) being checked for being potentially CPM pairs based on UCAC5 proper motion data

J#	RA	Dec	Sep"	PA°	M1(G)	M2(G)	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Ap	Me	Date	CPM Rat	Source/Notes
784																	Neither UCAC5 nor 2MASS object available for B
1201	296.9029386	17.1155456	2.33	80.43	12.379	12.540	-4.50	-8.20	1.980	2.30	-6.70	2.121	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	296.9029561	17.1155761	2.235	80.544									0.20	Eu	2001.557		UCAC5
829	297.9886319	17.3756392	2.69	277.22	11.354	12.400	9.10	-4.40	1.838	-5.60	-5.30	2.121	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	297.9885964	17.3756556	2.495	278.088									0.20	Eu	2001.548		UCAC5
832																	No UCAC5 object for B, 2MASS and GAIA DR1 data confusing
1176	293.8418139	18.9454428	3.14	287.22	12.465	12.497	1.40	0.80	1.556	0.70	0.50	1.556	0.96	Hg	2015.000	CCCC	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	293.8418083	18.9454397	3.134	287.342									0.20	Eu	2001.592		UCAC5
1317																	No UCAC5 object for B, 2MASS and GAIA DR1 data confusing
2602	303.9618536	18.3455108	3.07	350.06	12.845	12.859	4.40	1.00	1.697	2.90	1.60	1.769	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	303.9618361	18.3455069	3.057	350.394									0.20	Eu	2001.564		UCAC5
836	304.8403131	19.905745	3.27	244.96	11.250	11.743	-1.00	-7.90	1.697	3.50	1.50	1.697	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	304.8403169	19.9057744	3.380	243.447									0.20	Eu	2001.609		UCAC5
3314	304.5485586	17.8542986	3.47	249.51	12.045	12.115	-4.00	-3.10	1.697	-4.00	-3.10	1.697	0.96	Hg	2015.000	AACB	GAIA DR1. PM data from UCAC5 catalog. Potential CPM pair, but PM values too small to be significant
	304.5485742	17.8543103	3.471	249.494									0.20	Eu	2001.552		UCAC5
1174	288.8042108	18.1644086	3.30	298.17	10.448	11.431	-1.40	-6.30	1.697	-4.10	-5.10	3.111	0.96	Hg	2015.000	CACB	GAIA DR1. PM data from UCAC5 catalog. Rather optical pair
	288.8042161	18.1644319	3.263	298.238									0.20	Eu	2001.583		UCAC5
506	302.70223780	18.4459314	3.47	305.99	12.07	12.81	-4.60	-8.00	1.70	-4.80	-9.50	1.84	0.96	Hg	2015.000	BCCB	GAIA DR1. PM data from UCAC5 catalog. Rather optical pair
	302.7022558	18.4459614	3.479	306.287									0.20	Eu	2001.564		UCAC5
1301	287.51434390	20.4717525	3.92	139.78	10.94	11.91	-3.80	-2.50	1.70	-4.90	-3.10	1.70	0.96	Hg	2015.000	ACCB	GAIA DR1. PM data from UCAC5 catalog. Rather optical pair
	287.5143589	20.4717619	3.927	139.551									0.20	Eu	2001.608		UCAC5
2959																	No UCAC5 object for B, 2MASS and GAIA DR1 data confusing
3047	300.94801830	18.8986092	4.32	340.24	13.22	13.42	-2.90	-9.50	1.98	1.60	-7.20	2.12	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	300.94803	18.8986447	4.316	339.334									0.20	Eu	2001.568		UCAC5
2946	287.47207470	21.1448464	4.08	56.06	11.92	12.66	18.80	30.40	1.56	-0.30	-1.40	1.70	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	287.4719996	21.1447336	4.536	53.411									0.20	Eu	2001.635		UCAC5
2943	286.4881722	21.1111975	4.39	111.47	13.17	14.20	2.40	-0.50	1.77	0.60	-3.60	2.40	0.96	Hg	2015.000	CCCC	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	286.4881628	21.1111994	4.392	110.857									0.20	Eu	2001.630		UCAC5

Table 2 continues on next page.

Table 2 (cointinued). J objects in Sge (with GAIA DR1 and UCAC5 positions given) being checked for being potentially CPM pairs based on UCAC5 proper motion data

J#	RA	Dec	Sep"	PA°	M1(G)	M2(G)	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Ap	Me	Date	CPM Rat	Source/Notes
2950	287.59741110	19.8741828	5.35	310.97	12.90	12.91	-3.70	-4.70	1.70	-3.20	-2.30	1.70	0.96	Hg	2015.000	CCCC	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	287.5974258	19.8742003	5.331	310.664									0.20	Eu	2001.604		UCAC5
3064	303.63706720	18.1459925	4.49	220.01	12.66	14.05	-7.80	-7.90	1.70	-9.70	-8.30	2.26	0.96	Hg	2015.000	BCCB	GAIA DR1. PM data from UCAC5 catalog. Rather optical pair
	303.6370978	18.1460219	4.466	219.811									0.20	Eu	2001.564		UCAC5
3024	298.27612580	17.6487539	4.44	219.28	14.04	14.48	-5.80	-7.70	2.05	1.80	-3.50	2.55	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	298.2761483	17.6487828	4.549	219.809									0.20	Eu	2001.561		UCAC5
3000	296.58675670	18.9775444	4.46	55.79	13.21	13.40	-0.30	1.10	1.77	-9.60	-10.50	1.84	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	296.5867578	18.9775403	4.649	55.073									0.20	Eu	2001.571		UCAC5
KPP n+1	296.5878394	18.9782406	15.85	236.45	13.40	14.70	-9.60	-10.50	1.838	-10.0	-10.40	4.525	0.96	Hg	2015.000	AACC	GAIA DR1. PM data from UCAC5 catalog. Good CPM candidate found close to J3000 with J3000B as primary
	296.5878775	18.9782797	15.846	236.430									0.20	Eu	2001.571		UCAC5
1192	290.71007830	18.9625756	4.66	151.95	11.64	12.78	1.50	2.80	1.70	-0.70	1.00	1.84	0.96	Hg	2015.000	CCCC	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	290.7100725	18.962565	4.649	151.491									0.20	Eu	2001.586		UCAC5
3028	298.44778310	18.7808675	4.70	307.45	11.14	12.34	-5.80	-2.80	1.70	-1.20	5.80	1.70	0.96	Hg	2015.000	CBCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair - but a reasonable large number of objects in this star field show very similar PM values to J3028A suggesting an Open Cluster (but is catalogued as Globular Cluster M71)
	298.4478058	18.7808781	4.682	305.843									0.20	Eu	2001.565		UCAC5
1303	288.92828970	16.9009444	4.74	209.70	12.16	12.38	-71.80	-47.90	1.56	-73.20	-48.70	1.56	0.96	Hg	2015.000	AAAA	GAIA DR1. PM data from UCAC5 catalog. Perfect CPM candidate
	288.92857	16.9011233	4.720	209.562									0.20	Eu	2001.551		UCAC5
3046	300.97362060	19.6529772	5.19	279.39	13.27	12.80	-1.40	-8.30	1.84	-7.90	-6.00	1.70	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	300.9736261	19.6530081	5.099	279.206									0.20	Eu	2001.606		UCAC5
833	302.42191250	17.4121717	4.88	114.52	9.48	12.03	5.90	-2.70	2.26	2.70	-3.80	3.25	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	302.4218892	17.4121817	4.911	114.147									0.20	Eu	2001.552		UCAC5
1185																	Neither UCAC5 nor GAIA DR1 object for A available
3075	304.82091670	18.4640078	4.96	104.45	13.60	13.63	4.00	-14.50	1.98	3.70	-19.00	1.98	0.96	Hg	2015.000	BCCB	GAIA DR1. PM data from UCAC5 catalog. Rather optical pair
	304.8209008	18.4640619	4.950	103.753									0.20	Eu	2001.565		UCAC5
3037	299.21454080	19.5669400	5.09	128.48	12.66	13.88	-4.00	-5.70	1.56	-5.30	-1.90	1.84	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	299.2145569	19.5669611	5.129	128.802									0.20	Eu	2001.607		UCAC5
3052	301.88970640	16.1741053	5.22	101.64	11.91	13.90	-4.30	-6.10	1.41	-3.80	-1.60	2.12	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	301.8897233	16.1741283	5.224	102.311									0.20	Eu	2001.501		UCAC5
3010	297.09354190	18.7165325	5.50	318.16	13.20	14.56	-4.20	-4.90	1.70	-0.80	8.20	3.47	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	297.0935585	18.7165508	5.399	316.558									0.20	Eu	2001.571		UCAC5

Table 2 concludes on next page.

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Table 2 (conclusion) J objects in Sge (with GAIA DR1 and UCAC5 positions given) being checked for being potentially CPM pairs based on UCAC5 proper motion data

J#	RA	Dec	Sep"	PA°	M1(G)	M2(G)	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Ap	Me	Date	CPM Rat	Source/Notes
3017	297.52346580	17.7925778	5.46	51.06	12.68	13.58	-2.60	-1.70	1.70	-1.20	4.50	1.84	0.96	Hg	2015.000	CCCC	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	297.5234761	17.7925842	5.392	51.620									0.20	Eu	2001.561		UCAC5
3023	298.01100470	17.3878997	5.59	109.91	13.07	14.53	-3.50	-2.10	1.70	-4.40	-7.40	2.76	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	298.0110186	17.3879075	5.576	109.183									0.20	Eu	2001.547		UCAC5
3055	302.69317530	19.2532297	5.53	61.01	12.25	13.33	4.50	-9.00	1.41	-3.90	-9.20	1.56	0.96	Hg	2015.000	CACB	GAIA DR1. PM data from UCAC5 catalog. Probably optical
	302.6931578	19.2532633	5.627	61.541									0.20	Eu	2001.597		UCAC5
2307	304.17679690	18.0515197	6.10	117.56	11.98	12.95	0.80	-10.70	1.70	-0.30	-2.30	1.77	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	304.1767939	18.0515597	6.167	118.429									0.20	Eu	2001.565		UCAC5
3048	301.11575310	19.6252936	5.90	271.47	10.25	11.68	-2.20	-5.50	1.70	-5.50	-11.50	3.39	0.96	Hg	2015.000	BCCB	GAIA DR1. PM data from UCAC5 catalog. Rather optical pair
	301.1157618	19.6253139	5.857	272.268									0.20	Eu	2001.606		UCAC5
3012 AB	297.29019310	18.8576136	6.59	271.85	12.87	14.09	-6.20	-1.90	2.12	-6.30	-9.00	2.69	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	297.2902175	18.8576206	6.588	272.687									0.20	Eu	2001.570		UCAC5
3012 AC	297.29019310	18.8576136	6.85	173.00	12.87	13.30	-6.20	-1.90	2.12	-2.40	-3.00	2.05	0.96	Hg	2015.000	CCCC	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	297.2902175	18.8576206	6.830	173.404									0.20	Eu	2001.571		UCAC5
1233	301.63712530	19.8909158	7.01	245.62	11.71	13.71	2.50	-0.20	1.70	-11.90	21.80	2.26	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	301.6371156	19.8909167	6.961	242.752									0.20	Eu	2001.606		UCAC5
3053	302.55369030	19.2617736	7.65	247.79	10.86	13.58	-2.40	-8.80	1.41	-11.00	-14.60	1.84	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	302.5536997	19.2618064	7.510	248.002									0.20	Eu	2001.592		UCAC5
2303 AB	303.19543310	18.1047794	23.70	49.75	10.16	12.26	14.70	-13.90	1.70	-8.20	-15.00	1.70	0.96	Hg	2015.000	CCBC	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	303.1953753	18.1048314	23.948	50.201									0.20	Eu	2001.564		UCAC5
2303 BC	303.20072000	18.1090336	4.35	322.08	12.26	12.98	-8.20	-15.00	1.70	-4.80	-4.20	1.70	0.96	Hg	2015.000	CCCB	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	303.2007523	18.1090894	4.266	320.398									0.20	Eu	2001.564		UCAC5
2308 AB	304.43557780	20.4230961	36.95	282.24	7.84	12.29	3.40	0.30	3.11	-6.10	-4.30	1.70	0.96	Hg	2015.000	CCCC	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	304.4355642	20.423095	36.840	282.372									0.20	Eu	2001.611		UCAC5
2308 AC	304.43557780	20.4230961	42.51	284.18	7.84	13.44	3.40	0.30	3.11	-2.90	-2.50	2.12	0.96	Hg	2015.000	CCCC	GAIA DR1. PM data from UCAC5 catalog. Obviously optical pair
	304.4355642	20.423095	42.441	284.258									0.20	Eu	2001.611		UCAC5

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- AAVSO VPhot
- Aladin Sky Atlas v8.0
- Astrometrica v4.10.1.432
- AstroPlanner v2.2
- iTelescope
    - iT24: 610mm CDK with 3962mm focal length. Resolution 0.625 arcsec/pixel. V-filter. No transformation coefficients available. Located in Auberry, California. Elevation 1405m
- MaxIm DL6 v6.08
- SIMBAD, VizieR, UCAC4, URAT1, GAIA DR1, UCAC5
- Washington Double Star Catalog

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Appendix A

CPM rating scheme according to Knapp/Nanson 2017 with extensions:

Four rating factors are used: Proper motion vector direction, proper motion vector length, size of position error in relation to proper motion vector length and relationship separation to average proper motion speed:

- Proper motion vector direction rating: "A" for within the error range identical direction, "B" for similar direction within the double error range and "C" for outside.
- Proper motion vector length rating: "A" for within the error range identical length, "B" for similar length within the double error range and C for outside.
- Error size rating: "A" for error size of less than 5% of the proper motion vector length, "B" for less than 10% and "C" for a larger error size.
- Rating for relation separation to average proper motion speed: "A" for less than 100 years, "B" for 100 to 1000 years and "C" for above.

To compensate for (depending on the selected objects and available catalogs) excessively large position errors resulting an "A" rating despite Rather high deviations absolute upper limits are applied regardless calculated error size:

- Proper motion vector direction: Max. 2.86° difference for an "A" and 5.72° for a "B".
- Proper motion vector length: Max. 5% difference for an "A" and 10% for a "B".

Modification for cases of very small position errors (when for example using SDSS9 instead of 2MASS or directly proper motion data from GAIA DR1 or UCAC5 – the latter done here) with the consequence that the requirements to get an A or even B CPM rating get unreasonable hard:

- The from the position error resulting error estimation for proper motion vector direction and length is in this case calculated as root mean square from both position errors (instead of so far only the larger 2MASS one).
- If the PM vector direction difference is larger than this calculated "allowed" error but still less than 0.5° then an "A" is given, a "B" is given for larger than 0.5 but less than 1 degree, and a "C" is given if above.
- If the PM vector length difference is larger than this calculated "allowed" error but still less than 0.5% then an "A" is given, a "B" is given for larger than 0.5 but less than 1 percent, and a "C" is given if above.

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Appendix B

Observation history for KPP n+1

Name	RA	Dec	Sep	PA	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Ap	Me	Date	CPM Rat	Source/Notes
KPP n+1	19 46 21.081	18 58 41.66	15.837	236.591	13.615	15.952	-9.60	-10.50	1.838	-10.0	-10.40	4.525				AACC	Good CPM candidate
	296.58770833	18.9787778	16.314	234.817									1.2	Pp	1950.540		POSSI.O estimation
	296.58779167	18.9783889	15.629	236.615									1.2	Pp	1985.710		POSSII.J estimation
	296.587858	18.978289	15.902	236.361	13.4								1.3	E2	2000.854		2MASS. M1 estimate from 2MASS J and K magnitudes
	296.5878775	18.9782797	15.846	236.430									0.2	Eu	2001.571		UCAC5
	296.5878314	18.9782369	15.785	236.511									0.2	Eu	2014.075		URAT1
	296.5878395	18.97824042	15.849	236.448	13.402	14.698	-9.60	-10.50	1.838	-10.0	-10.40	4.525	0.96	Hg	2015.000	AACC	GAIA DR1.M1 and M2 are GAIA Gmags. PM data from UCAC5
	296.5878375	18.978238889	15.837	236.591	13.615	15.952							0.61	C	2017.549		iT24 5x10s V-filter

Appendix C

Counter-check of UCAC5 proper motion data quality based on the TGAS objects from Knapp 2017 (Physical Double Stars in TGAS)

Name	RA	Dec	Sep	PA	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Ap	Me	Date	CPM Rat	Source/Notes
ARG 10																	No UCAC5 object for B
ES 929	2.47774295	54.1551978	3.30	117.40	10.10	11.45	-17.80	-16.39	1.21	-20.23	-15.39	2.04	0.96	Hg	2015	BABB	GAIA DR1. Potential CPM pair
	2.4778378	54.1552458	3.30	117.63			-17.50	-15.20	2.05	-16.40	-14.70	4.67	0.2	Eu	2003.593	ABCB	UCAC5. Good CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5+GAIA DR1 error range							-0.30	-1.19	OK	-3.83	-0.69	OK	Delta for pmRA2 rather large. Yet overall delta smaller than given UCAC5 pm error. CPM rating similar				
ES 1214	29.26939274	46.8989164	3.89	220.00	10.27	11.05	-5.45	-31.98	1.32	-4.84	-30.48	1.85	0.96	Hg	2015	AABB	GAIA DR1. Solid CPM candidate
	29.2694128	46.8990272	3.89	219.25			-4.00	-32.70	1.84	-7.30	-30.20	3.82	0.2	Eu	2002.788	CBCB	UCAC5. Probably not CPM
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5 error range							-1.45	0.72	OK	2.46	-0.28	OK	Delta for pmRA2 rather large. Yet overall delta smaller than given UCAC5 pm error. Yet CPM rating quite different				
FRK 2	29.11204677	30.4395869	53.56	306.60	7.83	8.98	-24.08	-27.73	0.08	-24.41	-28.62	0.88	0.96	Hg	2015	ABAC	GAIA DR1. Good CPM candidate
	29.1121458	30.4396847	53.57	306.63			-23.1	-26.40	1.838	-23.90	-28.00	1.56	0.2	Eu	2001.678	AABC	UCAC5. Good CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5 error range							-0.98	-1.33	OK	-0.51	-0.62	OK	Overall delta smaller than given UCAC5 pm error. CPM rating similar. GAIA DR1 pm error for A seems ridiculously small				
GRV 29	8.28484438	7.5858827	80.99	129.70	9.23	10.43	42.27	39.93	0.13	43.76	40.28	2.19	0.96	Hg	2015	AAAC	GAIA DR1. Solid CPM candidate
	8.284665	7.5857328	81.02	129.76			44.70	37.60	2.687	44.20	40.3	1.84	0.2	Eu	2000.669	AAAC	UCAC5. Solid CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5+GAIA DR1 error range							-2.43	2.33	No	-0.44	-0.02	OK	PM Delta for A larger than given UCAC5+GAIA DR1 pm error. But tiny GAIA DR1 pm error for A seems in error. Yet CPM rating ident				
GRV 704	359.586827	2.2893049	59.84	58.60	9.37	10.09	21.46	-14.67	1.02	22.84	-13.94	1.64	0.96	Hg	2015	BABC	GAIA DR1. Potential CPM candidate
	359.5867469	2.2893706	59.83	58.64			20.10	-16.50	2.69	20.00	-14.00	1.697	0.2	Eu	2000.652	BBCC	UCAC5. Potential CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5+GAIA DR1 error range							1.36	1.83	OK	2.84	0.06	OK	PM Delta smaller than given UCAC5+GAIA DR1 pm error. CPM rating similar				
HLD 6	23.97943998	33.0555955	2.15	293.90	9.75	9.85	-32.75	63.63	1.78	-31.38	66.41	0.98	0.96	Hg	2015	BAAA	GAIA DR1. Good CPM candidate
	23.9795767	33.055365	2.17	292.94			-31.40	63.10	1.98	-28.90	65.20	4.95	0.2	Eu	2001.858	AABA	UCAC5. Solid CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5 error range							-1.35	0.53	OK	-2.48	1.21	OK	Overall delta smaller than given UCAC5 pm error. CPM rating with UCAC5 better due to the larger pm error				
HU 14	31.03231971	-11.0164324	3.58	16.10	9.98	10.05	-48.95	-37.18	1.37	-52.88	-35.62	1.62	0.96	Hg	2015	BBAA	GAIA DR1. Potential CPM
	31.0325289	-11.0162736	3.56	16.50			-48.6	-37.6	1.414	-49.8	-35.40	3.25	0.2	Eu	1999.795	AABA	UCAC5. Solid CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5 error range							-0.35	0.42	OK	-3.08	-0.22	OK	Overall delta smaller than given UCAC5 pm error. CPM rating somewhat "better" than with GAIA due to the larger UCAC5 pm error				
HU 418	21.13357757	-16.2402014	4.11	102.10	10.49	10.67	8.05	9.43	0.93	7.90	9.19	1.48	0.96	Hg	2015	AACB	GAIA DR1. Solid CPM candidate
	21.1335428	-16.2402483	4.11	102.26			7.80	11.00	1.556	8.40	11.50	3.11	0.2	Eu	1999.648	ABCB	UCAC5. Good CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5+GAIA DR1 error range							0.25	-1.57	OK	-0.50	-2.31	OK	PM Delta smaller than given UCAC5+GAIA DR1 pm error. CPM rating similar				
J 1245																	No UCAC5 object for B
KR 3	3.75916285	55.7071589	3.45	222.40	9.54	9.59	52.91	31.47	1.00	53.66	27.08	1.04	0.96	Hg	2015	CBAA	GAIA DR1. Rather optical pair
	3.7588611	55.7070703	3.44	222.64			53.70	28.00	2.97	53.90	26.00	3.39	0.2	Eu	2003.598	AABA	UCAC5. Solid CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5+GAIA DR1 error range							-0.79	3.47	OK	-0.24	1.08	OK	PM Delta smaller than given UCAC5+GAIA DR1 pm error. CPM rating "better" than GAIA DR1 due to the generous UCAC5 pm error range				
KR 22	64.65695726	60.8330002	3.52	185.70	9.92	10	16.60	-30.06	1.32	15.52	-29.52	1.27	0.96	Hg	2015	AAAB	GAIA DR1. Solid CPM candidate
	64.6568598	60.8330964	3.50	185.88			15.20	-30.70	1.84	16.00	-32.90	4.24	0.2	Eu	2003.719	ABCA	UCAC5. Good CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5 error range							1.40	0.64	OK	-0.48	3.38	OK	Overall delta smaller than given UCAC5 pm error. CPM rating similar				

Table continues on next page.

Appendix C *(continued)*

Counter-check of UCAC5 proper motion data quality based on the TGAS objects from Knapp 2017 (Physical Double Stars in TGAS)

Name	RA	Dec	Sep	PA	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Ap	Me	Date	CPM Rat	Source/Notes
NI 8	56.20463585	57.0275591	16.49	315.10	10.73	10.73	114.56	-159.62	1.63	111.43	-159.51	1.41	0.96	Hg	2015	BAAA	GAIA DR1. Good CPM candidate
	56.2039365	57.0280881	16.46	315.21			114.90	-159.6	1.70	111.50	-159.4	1.697	0.2	Eu	2003.072	BAAA	UCAC5. Good CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5 error range							-0.34	-0.02	OK	-0.07	-0.11	OK	Overall delta smaller than given UCAC5 pm error. CPM rating ident				
SKF 845	44.34831207	0.9716313	99.28	16.20	10.47	10.59	-45.76	-46.76	1.97	-46.2	-47.02	2.30	0.96	Hg	2015	AAAC	GAIA DR1. Solid CPM pair
	44.3485092	0.9718311	99.26	16.18			-47.3	-48.00	1.98	-46.6	-46.2	1.556	0.2	Eu	2000.006	AAAC	UCAC5
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5 error range							1.54	1.24	OK	0.40	-0.82	OK	Overall delta smaller than given UCAC5 pm error. CPM rating ident				
SKF 927	306.4576645	0.9719352	65.94	229.60	8.9	10.35	20.78	36.12	1.01	23.67	36.43	2.29	0.96	Hg	2015	BABC	GAIA DR1. Good CPM candidate
	306.4575764	0.9717981	65.96	229.60			22.10	34.40	3.253	23.00	35.60	1.70	0.2	Eu	2000.641	AABC	UCAC5. Solid CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5 error range							-1.32	1.72	OK	0.67	0.83	OK	Overall delta smaller than given UCAC5 pm error. CPM rating somewhat "better" than with GAIA DR1				
STI 416	44.64337177	59.4671077	3.53	86.10	11.08	11.19	10.69	-18.56	1.25	9.79	-19.05	1.23	0.96	Hg	2015	AABB	GAIA DR1. Solid CPM candi-date
	44.6433069	59.4671656	3.52	85.96			10.50	-18.40	1.70	11.30	-19.30	1.70	0.2	Eu	2003.66	ABBB	UCAC5. Good CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5 error range							0.19	-0.16	OK	-1.51	0.25	OK	Overall delta smaller than given UCAC5 pm error. CPM rating similar				
TYC0587-132-1	359.6940575	0.2487344	376.29	103.85	10.8	10.72	-11.09	-77.03	1.21	-12.98	-77.44	2.26	0.96	Hg	2015	AAAC	GAIA DR1. Solid CPM candi-date
	359.6941047	0.2490406	376.29	103.84			-11.80	-76.50	1.27	-12.70	-78.10	1.27	0.2	Eu	2000.601	AAAC	UCAC5. Solid CPM candidate
Delta between TGAS and UCAC5 proper motion data with check if within UCAC5 error range							0.71	-0.53	OK	-0.28	0.66	OK	Overall delta smaller than given UCAC5 pm error. CPM rating ident				

Appendix C *(continued)*

Counter-check of UCAC5 proper motion data quality based on the TGAS objects from Knapp 2017 (Physical Double Stars in TGAS)

Summary: The proper motion values of UCAC5 are based on comparison of UCAC5 to GAIA DR1 positions. The UCAC5 positions are derived from a subset of UCAC images re-reduced with TGAS objects as reference stars. The given UCAC5 proper motion error is generally somewhat larger than the given TGAS pm error but in most cases the difference between UCAC5 and TGAS proper motion data is within the given UCAC5 error range and in all other cases (but one) within the added UCAC5 and TGAS error range. This one exception is GRV 29 probably due to an extraordinary small TGAS pm error range to be considered as suspect as it is by a factor 10 smaller than the average TGAS pm error. With FRK 2 we have a second object with a similar small TGAS pm error range but in this case the given UCAC5 error range is sufficient to cover the proper motion data delta between UCAC5 and TGAS. Such TGAS pm error outliers are may be a side effect of the sometimes questionable Tycho-2 position data quality (just see the large number of bogus Tycho Double Stars). Rather surprisingly the UCAC5 catalog does not offer objects for the secondary for two out of 17 TGAS objects. Overall the CPM rating based on UCAC5 is with few exceptions ident to very similar with TGAS and due to the given larger pm error range often a bit more generous. Only in one case (ES 1214) we have a negative UCAC5 CPM assessment after a "Solid CPM candidate" assessment with TGAS – this is caused by a rather large difference in pmRA2 (although within the given error range) with the UCAC5 pmRA2 value rather confirmed by comparing the positions 2MASS to GAIA DR1 (but with an even larger pm error range) so in the end the cause for this difference remains unclear. The overall impression is that UCAC5 proper motion data is of reasonable good quality second to TGAS but with the benefit of a much larger object coverage. A side result is that proper motion values of TGAS objects with an overly small error range might be better taken with some caution.