New Common Proper-Motion Pairs from the IPHAS-POSS-I Survey

Rafael Caballero

Agrupación Astronómica Hubble
Martos, Jaen, Spain

rafa@sip.ucm.es

Abstract: The aim of this paper is to examine the IPHAS-POSS-I survey looking for previously uncataloged common proper motion pairs. This is done by selecting pairs of stars with separation under 90 arc seconds and also similar and significant proper motion. Different criteria are applied to reduce the set of pairs increasing the probability of a physical bound between the two components. The result of this research is a set of 34 new common proper motion pairs.

Introduction

In this paper we data mine the recently released IPHAS-POSS-I proper motion survey of the Galactic plane (Deacon *et al.*, 2009), in order to obtain new common proper motion pairs (CPMPs from now on) not included in the WDS (Washington Double Star Catalog, Mason *et al.*, 2003). The IPHAS-POSS-I survey combines data from the Photometric H alpha survey (IPHAS, Drew *et al.*, 2005) with SuperCOSMOS scans of the first Palomar Sky Survey plates (POSS-I, Hambly *et al.*, 2001). The IPHAS data is a CCD survey in three filters (r, i, Ha). The IPHAS data was obtained with the 2.5-metre Isaac Newton Telescope (INT) in La Palma between 2003 and 2005. The POSS-I plates were taken in the 1950s. This gives a proper motion baseline of approximately fifty years. The survey contains 103058 objects with significant proper motions below 150 milliarc seconds per year (mas/yr) in the magnitude range $13.5 < r < 19$.

The goal of this project is to find previously uncataloged common proper motion pairs from this survey. This idea has been used in the past with good results; see for instance Greaves (2004).

The Data Mining Process

The process was started by downloading the 103,058 objects contained in the survey employing the online VizieR Service web page (Allende & Dambert 1999). This initial list was filtered, keeping only the objects with proper motion over 50 mas/yr. During this phase some repeated information was removed: it seems that for a few small zones, the catalog contains many entries for the same object with slightly different coordinates. The resulting list consisted of 19,152 values. From this list an initial set of 189 pairs were selected verifying:

- Separation under 90".
- Halbwachs criteria fulfilled (Halbwachs, 1986).
- Not already in WDS.

Halbwachs' criteria are:

$$(\mu_1 - \mu_2)^2 < -2(e_1^2 + e_2^2) \ln (0.05)$$
$$|\mu_1|,\ |\mu_2| \geq 0.05$$
$$\rho/\,|\mu_1|,\ \rho/|\mu_2| < 1000 \text{ yr}$$

where μ_1, μ_2 are the two proper motion vectors in arcseconds/year, e_i is the mean error of the projections

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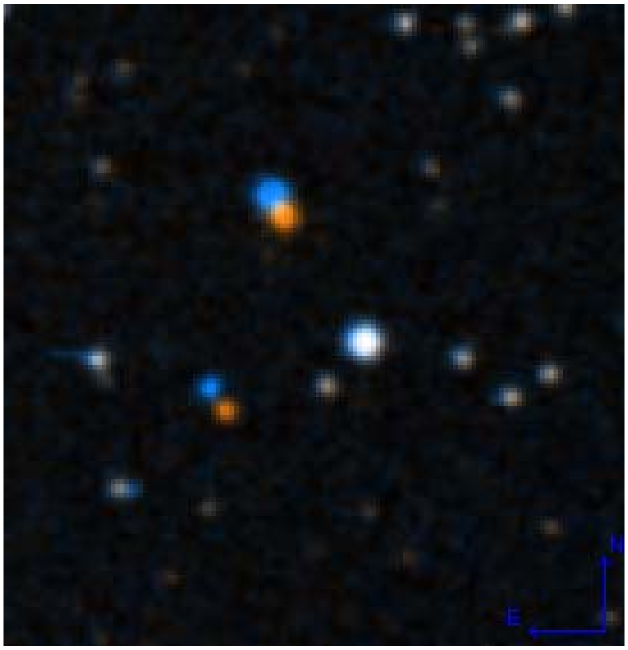

Figure 1:ALADIN composite image showing the movement of the pair found at 05 23 53.10+28 25 03.

on the coordinate axes of μ_i, and ρ is the angular separation of the two stars. The first condition checks if the hypothesis $\mu_1 = \mu_2$ is admissible with a 95% confidence considering the given errors e_1 and e_2. The second condition fixes a value of 50 mas/yr as the minimum required for proper motion pairs. The third condition relates the separation and the proper motion.

Although these criteria have proven to be very useful, the author has found in previous experiences that it allows some pairs with large proper motion differences. Therefore, an additional criterion was introduced: all the pairs having proper motion difference in any axis that was:

- greater than 10 mas/yr, and,
- greater than 10% of the minimum of the two values

were also discarded, leaving a final set of 141 candidates. These candidates were checked in the POSS I and POSS II plates corresponding to the Palomar Observatory Sky Surveys (Reid *et al.*, 1991) available at ALADIN (Bonnarel *et al.*, 2000). Every pair was checked for two stars with noticeable motion and roughly the same astrometry data in the expected position. Only 36 pairs of the 141 candidates were found. The rest of the pairs corresponded to stars with no noticeable movement, probably due to errors in the catalog generation.

Initially the use of the Reduced Proper Motion (RPM) discriminator proposed by Salim & Gould (2003) was not considered here, although it was employed in previous projects. The reason was that using this discriminator required both the magnitudes V and J for each component, and in particular V was difficult to obtain for most of the stars included in this survey. However, after obtaining the set of final candidates it was observed that it was possible to apply this filter to 27 out of the 36 pairs. The V magnitude was obtained from The Guide Star Catalogue, Version 2.3.2 (Lasker, 2008), and J magnitude from the Two Micron All Sky Survey (Skrutskie, 2006). Therefore the criterion based on the RPM discriminator proposed by Chanamé and Gould (2003) was applied. Two of the pairs were rejected because according to this criterion, they were composed of one disk and one halo star.

Results

Table 1 shows the final list of 34 CPMP that was obtained. For each pair we include:

- The coordinates of the primary in the catalog.
- The components, either A-B or A-C for triple systems. In fact there is only one triple system with primary at 03 55 11.44+54 38 32.7. The B component of this system was not found at IPHAS. Instead it was discovered while inspecting the photographic plates.
- The r magnitude of both components. This value was obtained from IPHAS-POSS-I, except for the component B of 03 55 11.44+54 38 32.7, which corresponds to the RMag from USNO-A2.0 (Monet et al., 1998). The magnitudes of Table 1 range from 12.2 to 18.95.
- The epoch and astrometry of the first and last measurement. The first measurement, whenever it exists, has been taken from USNO-A2.0. The last measurement corresponds either to IPHAS-POSS-I or, when the dates for the two components were different, from 2MASS. Of the 34 pairs, 28 have both first and last measurements. The maximum relative difference in separation between both measurements is 2.79%, corresponding to the pair at 05 54 16.68+28 50 54.1, which changes from 11.15" in 1955.810 to 10.85" in 2003.951. The maximum absolute difference in separation is 0.77", corresponding to 03 55 11.44+54 38 32.7. The maximum difference in PA is 1.57 degrees for the CPMP at 03 20 45.27+54 06 57.1. The astrometry data was obtained from the coordinates in decimal format following (Sinnott, 1984).

- The separation is given in seconds and the position angle in degrees.
- Finally some notes indicate the special situations.

Table 2 contains the proper motion data in milliarcsecond/year of the new CPMP. The data correspond to IPHAS-POSS-I, except in the case of the B component of the pair at 03 55 11.44+54 38 32.7, which has been obtained from USNO-B1 (Monet *et al.*, 2003). Table 3 presents the 2MASS photometry data for the new pairs.

Conclusions

Due to their weak gravitational bonds, wide binaries have been considered good detectors of massive objects such as massive stars, massive compact halo objects, or dark matter. In this paper we have examined the IPHAS-POSS-I catalog, finding 34 uncataloged common proper motion pairs. This research does not establish that these pairs are gravitationally attached. However, the criteria used to filter line-of-sight pairs indicate that they are at least good candidates for binaries.

Acknowledgements

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Table 1 : Astrometric Measurements of the new pairs

RA DEC	Comp	r Mags	First	Last	N	PA First	PA Last	Sep. First	Sep. Last	Note
00 22 17.48+67 08 49.6	AB	15.55 15.8	1952.631	2004.605	2	281.34	281.94	21.32	21.25	
02 46 04.81+56 56 39.8	AB	12.12 14.8	1957.967	2003.929	2	342.02	341.71	34.82	34.66	
03 02 31.04+61 34 10.4	AB	14.77 17.34	1954.074	2003.948	2	307.71	307.86	12.16	12.20	
03 20 45.27+54 06 57.1	AB	16.85 17.02	1954.739	2005.717	2	62.80	64.37	11.90	11.82	
03 50 03.66+60 31 38.5	AB	15.49 16.00	1954.011	2005.802	2	95.09	95.11	48.98	49.21	
03 55 11.44+54 38 32.7	AB	13.60 14.40	1954.747	2000.031	2	171.97	172.44	39.23	39.47	(1),(2)
03 55 11.44+54 38 32.7	AC	13.60 17.25	1954.747	2004.917	2	105.97	105.94	45.19	44.42	
03 58 12.79+52 00 20.1	AB	13.90 18.88		2006.902	1		301.85		10.64	(3)
04 19 01.82+50 52 19.0	AB	14.48 18.94		2007.932	1		343.98		19.18	(3)
04 23 50.19+56 12 35.1	AB	15.42 17.40	1953.767	2005.897	2	250.27	250.21	20.72	20.41	
04 27 48.89+47 52 16.1	AB	14.83 18.42		2006.856	1		266.07		10.51	
04 56 21.26+50 05 21.0	AB	13.74 18.31	1953.770	2005.851	2	275.46	275.48	35.78	35.48	
04 56 46.59+40 39 07.6	AB	16.74 17.59	1953.121	2005.851	2	140.82	139.82	21.73	21.72	
05 23 53.10+28 25 03.1	AB	12.82 14.67	1955.807	2003.833	2	163.20	163.05	44.82	44.75	
05 27 20.05+36 38 52.0	AB	15.48 16.78	1954.994	2006.757	2	102.87	102.70	26.04	26.03	
05 31 16.93+28 18 48.7	AB	15.25 16.55	1955.807	2003.838	2	220.08	220.00	27.85	27.96	
05 34 23.66+25 34 34.6	AB	13.96 16.29	1951.851	2003.841	2	142.61	142.83	41.33	41.65	
05 49 31.01+26 06 05.3	AB	17.26 18.78		2003.945	1		333.37		35.48	(3)
05 53 52.91+27 23 11.6	AB	12.51 16.38	1955.810	2003.951	2	111.35	111.56	17.64	17.73	
05 54 16.68+28 50 54.1	AB	13.83 18.10	1955.810	2003.951	2	353.83	354.50	11.15	10.85	
05 55 40.03+22 53 44.7	AB	16.01 18.23		2006.908	1		161.65		12.33	(3)
06 16 54.45+20 47 48.8	AB	14.10 16.08	1955.895	2005.93	2	10.22	10.17	56.45	56.40	
06 18 45.22+22 49 51.0	AB	14.05 15.08	1954.893	2005.933	2	336.19	336.67	29.29	29.33	
06 26 49.58+10 14 39.5	AB	14.33 16.46	1951.914	2006.949	2	333.5	334.70	16.3	16.25	
06 29 13.78+07 50 45.3	AB	16.75 16.98	1953.940	2006.951	2	193.01	193.56	13.78	14.00	
18 36 07.81+00 16 49.5	AB	14.52 16.12	1954.416	2007.469	2	182.37	182.32	44.43	44.46	
18 38 40.86-00 12 02.6	AB	14.17 15.08	1954.416	2004.438	2	338.97	338.94	24.53	24.65	
19 21 22.43+17 49 27.8	AB	16.11 16.68	1953.622	2000.428	2	149.81	149.10	14.71	14.47	(2)
21 09 39.94+51 58 03.6	AB	15.11 17.71	1952.710	2004.583	2	240.55	240.79	19.85	19.69	
21 35 11.92+50 22 00.1	AB	15.61 17.76	1952.705	2005.552	2	260.89	260.51	15.91	15.72	
21 41 17.04+52 26 46.2	AB	16.54 17.00	1955.936	2004.654	2	293.55	294.18	23.28	22.94	
22 15 43.69+61 32 42.3	AB	13.72 18.68		2003.844	1		244.90		21.39	(3)
22 19 42.65+61 42 21.9	AB	16.10 16.33	1952.708	2003.838	2	266.14	265.86	27.31	27.37	
23 43 47.52+63 42 27.8	AB	18.16 18.40	1952.628	2005.782	2	269.82	270.00	15.70	15.75	

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Table 2: Proper motion of each component (mas/yr)

RA DEC	Comp.	PM Primary (m_1)	PM Secondary (m_2)	Error PM	Error PM	Notes
00 22 17.48+67 08 49.6	AB	(57.2, 27.2)	(59.1, 25.6)	(5.0, 5.6)	(5.0, 5.6)	
02 46 04.81+56 56 39.8	AB	(49.2, -47.3)	(45.9, -53.6)	(6.1, 6.2)	(6.1, 6.8)	
03 02 31.04+61 34 10.4	AB	(59.1, -53.5)	(65.2, -51.4)	(5.2, 5.8)	(4.8, 4.4)	
03 20 45.27+54 06 57.1	AB	(51.9, -53.1)	(52.2, -57.7)	(3.5, 6.3)	(4.1, 7.0)	
03 50 03.66+60 31 38.5	AB	(-8.9, -60.4)	(-1.5, -61.6)	(4.6, 5.2)	(5.1, 5.8)	
03 55 11.44+54 38 32.7	AB	(54.3, -30.8)	(48.0, -30.0)	(8.9, 9.1)	(4.0, 1.0)	(4)
03 55 11.44+54 38 32.7	AC	(54.3, -30.8)	(45.9, -25.0)	(8.9, 9.1)	(6.5, 4.7)	
03 58 12.79+52 00 20.1	AB	(47.9, -41.0)	(41.3, -41.2)	(5.1, 5.2)	(5.7, 6.2)	
04 19 01.82+50 52 19.0	AB	(47.4, -30.9)	(51.4, -31.2)	(6.5, 9.2)	(4.7, 4.3)	
04 23 50.19+56 12 35.1	AB	(86.4, -58.9)	(90.5, -53.8)	(4.9, 5.6)	(5.3, 4.9)	
04 27 48.89+47 52 16.1	AB	(106.9, -84.0)	(101.1, -83.1)	(7.6, 8.4)	(7.3, 7.2)	
04 56 21.26+50 05 21.0	AB	(15.5, -50.1)	(18.5, -50.7)	(4.7, 4.8)	(5.2, 3.6)	
04 56 46.59+40 39 07.6	AB	(-14.2, -59.5)	(-15.2, -58.4)	(4.4, 4.7)	(4.7, 5.0)	
05 23 53.10+28 25 03.1	AB	(-60.1,-107.1)	(-61.4,-103.3)	(7.7, 7.8)	(7.7, 8.5)	
05 27 20.05+36 38 52.0	AB	(-34.3, -58.1)	(-35.8, -59.7)	(6.8, 7.6)	(6.8, 7.3)	
05 31 16.93+28 18 48.7	AB	(-46.9, -49.4)	(-45.1, -50.4)	(6.9, 7.8)	(7.0, 7.4)	
05 34 23.66+25 34 34.6	AB	(16.7, -48.0)	(16.1, -48.5)	(5.7, 5.8)	(8.6, 9.2)	
05 49 31.01+26 06 05.3	AB	(32.2, -64.9)	(23.7, -71.8)	(3.5, 4.0)	(3.1, 12.7)	
05 53 52.91+27 23 11.6	AB	(36.4, -56.2)	(43.3, -60.1)	(5.7, 5.8)	(3.1, 3.1)	
05 54 16.68+28 50 54.1	AB	(18.3, -52.7)	(13.7, -54.2)	(5.2, 5.3)	(4.0, 5.0)	
05 55 40.03+22 53 44.7	AB	(62.5, -74.7)	(64.0, -69.9)	(6.4, 6.8)	(7.3, 5.2)	
06 16 54.45+20 47 48.8	AB	(75.0, 6.2)	(72.0, 9.4)	(7.1, 7.8)	(2.5, 5.4)	
06 18 45.22+22 49 51.0	AB	(-33.2, -97.7)	(-24.1, -95.1)	(5.4, 6.0)	(4.8, 5.5)	
06 26 49.58+10 14 39.5	AB	(-37.3, -74.6)	(-29.9, -74.3)	(4.5, 5.0)	(6.8, 7.3)	
06 29 13.78+07 50 45.3	AB	(24.0, -79.3)	(25.2, -82.7)	(2.8, 2.2)	(4.9, 3.8)	
18 36 07.81+00 16 49.5	AB	(18.3, 52.4)	(19.3, 52.9)	(5.9, 6.6)	(5.4, 5.7)	
18 38 40.86-00 12 02.6	AB	(-22.1, -74.8)	(-20.9, -74.3)	(6.9, 7.6)	(5.5, 6.2)	
19 21 22.43+17 49 27.8	AB	(2.2, 60.4)	(5.1, 64.1)	(4.1, 4.4)	(4.8, 5.1)	
21 09 39.94+51 58 03.6	AB	(59.1, 35.1)	(60.2, 37.7)	(6.1, 6.9)	(7.1, 7.5)	
21 35 11.92+50 22 00.1	AB	(54.9, 17.4)	(56.0, 19.6)	(6.0, 6.8)	(4.8, 4.2)	
21 41 17.04+52 26 46.2	AB	(43.4, 31.4)	(44.0, 36.4)	(6.5, 4.7)	(5.8, 5.5)	
22 15 43.69+61 32 42.3	AB	(-32.1, -38.3)	(-30.0, -41.4)	(5.2, 5.3)	(4.8, 4.7)	
22 19 42.65+61 42 21.9	AB	(-44.0, -33.9)	(-46.2, -33.5)	(5.1, 5.4)	(5.6, 5.9)	
23 43 47.52+63 42 27.8	AB	(56.3, 5.8)	(53.2, 8.8)	(4.2, 3.8)	(4.0, 4.1)	

Notes to Tables 1 and 2

1. Component B not in IPHAS. The astrometry for this pair corresponds to 2MASS, and the r Mag. value corresponds actually to the R magnitude from USNO-A2.0.
2. Astrometry source for the last measurement from 2MASS.
3. Not Found in USNO-A2.0.
4. Component B not in IPHAS. Proper Motion from USNO-B1

Table 3: 2MASS photometry in JHK

RA DEC	Comp.	2MASS	J	e_J	H	e_H	K	e_K
00 22 17.48+67 08 49.6	A	00221744+6708495	12.842	0.024	12.205	0.031	12.004	0.025
	B	00221387+6708538	12.988	0.024	12.377	0.031	12.172	0.025
02 46 04.81+56 56 39.8	A	02460478+5656399	10.931	0.026	10.56	0.03	10.476	0.021
	B	02460346+5657128	12.696	0.027	12.017	0.035	11.858	0.024
03 02 31.04+61 34 10.4	A	03023099+6134106	13.417	0.032	13.075	0.037	12.986	0.028
	B	03022964+6134182	15.16	0.047	14.601	0.064	14.377	0.075
03 20 45.27+54 06 57.1	A	03204522+5406574	14.16	0.038	13.597	0.042	13.276	0.03
	B	03204644+5407024	14.447	0.044	13.887	0.052	13.593	0.04
03 50 03.66+60 31 38.5	A	03500369+6031387	12.418	0.022	11.833	0.03	11.591	0.026
	B	03501031+6031344	13.108	0.024	12.501	0.03	12.271	0.03
03 55 11.44+54 38 32.7	A	03551140+5438328	11.83	0.025	11.239	0.023	11.099	0.018
	B	03551200+5437537	12.448	0.028	11.864	0.037	11.636	0.028
	C	03551633+5438205	13.607	0.024	13.003	0.032	12.792	0.026
03 58 12.79+52 00 20.1	A	03581276+5200202	12.219	0.026	11.636	0.03	11.469	0.021
	B	03581179+5200258	15.195	0.06	14.651	0.054	14.373	0.076
04 19 01.82+50 52 19.0	A	04190178+5052191	12.725	0.024	12.108	0.028	12.051	0.026
	B	04190121+5052375	15.204	0.047	14.478	0.064	14.162	0.067
04 23 50.19+56 12 35.1	A	04235011+5612354	13.829	0.024	13.309	0.026	13.074	0.025
	B	04234781+5612286	14.985	0.04	14.364	0.04	14.091	0.054
04 27 48.89+47 52 16.1	A	04274880+4752168	11.95	0.02	11.246	0.021	11.012	0.019
	B	04274776+4752160	14.278	0.032	13.618	0.034	13.311	0.032
04 56 21.26+50 05 21.0	A	04562124+5005213	11.883	0.021	11.277	0.029	11.101	0.023
	B	04561757+5005247	14.781	0.03	14.188	0.039	13.919	0.049
04 56 46.59+40 39 07.6	A	04564660+4039079	13.92	0.022	13.26	0.024	13.067	0.032
	B	04564782+4038514	14.375	0.029	13.825	0.037	13.512	0.044

Table 3 continued on next page.

Table 3 (continued): 2MASS photometry in JHK

RA DEC	Comp.	2MASS	J	e_J	H	e_H	K	e_K
05 23 53.10+28 25 03.1	A	05235312+2825037	10.611	0.018	10.025	0.016	9.832	0.018
	B	05235411+2824209	11.826	0.019	11.294	0.016	11.04	0.018
05 27 20.05+36 38 52.0	A	05272008+3638523	12.815	0.022	12.213	0.029	11.994	0.021
	B	05272218+3638466	13.838	0.028	13.294	0.037	13.069	0.031
05 31 16.93+28 18 48.7	A	05311695+2818489	12.007	0.022	11.468	0.022	11.188	0.018
	B	05311559+2818276	12.82	0.022	12.24	0.022	11.973	0.021
05 34 23.66+25 34 34.6	A	05342365+2534349	11.625	0.02	11.009	0.022	10.769	0.02
	B	05342551+2534018	13.02	0.023	12.369	0.022	12.171	0.02
05 49 31.01+26 06 05.3	A	05493098+2606056	15.401	0.05	14.861	0.068	14.569	0.079
	B	05492980+2606371	16.458	0.115	15.727	0.159	15.536	
05 53 52.91+27 23 11.6	A	05535289+2723118	11.325	0.024	10.881	0.025	10.792	0.021
	B	05535413+2723054	13.761	0.026	13.062	0.025	12.888	0.019
05 54 16.68+28 50 54.1	A	05541667+2850544	12.386	0.02	11.881	0.022	11.78	0.02
	B	05541659+2851052	14.738	0.031	14.152	0.034	13.816	0.039
05 55 40.03+22 53 44.7	A	05553999+2253453	13.371	0.025	12.775	0.023	12.529	0.023
	B	05554028+2253335	14.941	0.035	14.336	0.042	14.053	0.045
06 16 54.45+20 47 48.8	A	06165442+2047487	11.263	0.021	10.635	0.028	10.426	0.024
	B	06165513+2048441	12.65	0.022	12.121	0.034	11.862	0.027
06 18 45.22+22 49 51.0	A	06184522+2249514	11.625	0.023	10.914	0.03	10.695	0.02
	B	06184437+2250183	12.105	0.023	11.503	0.033	11.223	0.018
06 26 49.58+10 14 39.5	A	06264960+1014401	12.583	0.023	11.959	0.026	11.834	0.026
	B	06264912+1014547	13.761	0.027	13.169	0.021	12.955	0.032
06 29 13.78+07 50 45.3	A	06291377+0750459	13.241	0.026	12.687	0.028	12.442	0.03
	B	06291355+0750322	13.369	0.029	12.785	0.025	12.465	0.033
18 36 07.81+00 16 49.5	A	18360779+0016491	11.629	0.022	11.105	0.025	10.828	0.022
	B	18360767+0016047	12.941	0.026	12.381	0.028	12.121	0.026
18 38 40.86-00 12 02.6	A	18384086-0012023	12.538	0.026	11.92	0.028	11.765	0.029
	B	18384027-0011393	13.064	0.022	12.358	0.025	12.215	0.025
19 21 22.43+17 49 27.8	A	19212243+1749278	12.921	0.024	12.269	0.027	12.027	0.019
	B	19212295+1749154	13.178	0.033	12.489	0.038	12.261	0.033
21 09 39.94+51 58 03.6	A	21093991+5158033	12.893	0.032	12.249	0.033	12.108	0.033
	B	21093806+5157538	14.828	0.048	14.253	0.053	14.097	0.081

Table 3 continued on next page.

New Common Proper-Motion Pairs from the IPHAS-POSS-I Survey

Table 3 (concluded): 2MASS photometry in JHK

RA DEC	Comp.	2MASS	J	e_J	H	e_H	K	e_K
21 35 11.92+50 22 00.1	A	21351189+5022000	12.566	0.026	11.922	0.031	11.7	0.022
	B	21351026+5021573	13.9	0.026	13.352	0.032	12.981	0.03
21 41 17.04+52 26 46.2	A	21411703+5226460	13.439	0.027	12.901	0.033	12.658	0.034
	B	21411473+5226554	13.78	0.031	13.205	0.041	12.971	0.036
22 15 43.69+61 32 42.3	A	22154370+6132424	11.661	0.027	10.971	0.03	10.802	0.018
	B	22154099+6132334	14.747	0.039	14.133	0.034	13.844	0.052
22 19 42.65+61 42 21.9	A	22194267+6142220	13.384	0.029	12.731	0.031	12.558	0.028
	B	22193883+6142200	13.568	0.027	12.885	0.033	12.701	0.025
23 43 47.52+63 42 27.8	A	23434747+6342278	15.014	0.039	14.362	0.052	14	0.055
	B	23434509+6342279	14.942	0.038	14.222	0.041	14.014	0.053