Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars: Results of LIADA's Double Star Section for 2003

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Abstract: LIADA's Double Star Section presents angular separations, position angles as well as V magnitudes for 103 neglected visual double stars obtained in 2003. A total of 701 measures were averaged into 311 mean positions that range in separation from 2.6" to 225.7". Our observations were made by means of several techniques (CCD detectors, astrometric eyepieces and photographic and digital surveys). About 45% of double stars were unconfirmed pairs discovered by John Herschel which remained neglected since before 1850. BVIJHK photometry, astrometric and kinematical data were used/obtained to determine astrophysical parameters (spectral types and luminosity classes, photometric distances, etc). Their nature was determined using several professional criteria, classifying them as optical, physical or common origin pairs. Only 6% were physical double stars. New companions were added to six known systems.

Introduction

As you probably know a large number of systems in the WDS are neglected or very neglected pairs and others in addition to this are unconfirmed double stars. A pair is unconfirmed if only the discovery measure was performed. While neglected pairs need more relative astrometry to allow us to characterize them, unconfirmed pairs need one more measurement to confirm their existence. There are several reasons for the neglect: poor coordinates or large proper motion, erroneous magnitude or delta-m estimates or true neglect (it is nearly impossible to measure the large amount of neglected double stars due to the lack of observers).

The Astrometry Department of the United State Naval Observatory (USNO) has published the Washington Double Star Catalog (Mason B.D., Wycoff G., & Hartkopf W. I., 2003, hereafter WDS) and has included on the web several lists of neglected and unconfirmed pairs. The USNO considers as neglected those double stars that have not been observed in twenty years. There are many thousands of pairs in these lists and amateurs play an important role not only in performing angular separation and position angle measures but studying the astrophysical parameters for their components and systems.

LIADA's Double Star Section has as its main goals to perform measurements of relative astrometry of these neglected and unconfirmed pairs, determine the astrophysical parameters for their members, and classify them, according to their nature, as physical, common origin, common proper motion or optical pairs.

The results of 701 individual relative measures for 103 visual double stars, performed with different techniques during 2003, are presented. Of these, 54 double stars have been confirmed.

We determined 150 spectral types and luminosity classes for their members. A study of the measured doubles determined that 5 double stars are physical pairs and another 5 pairs were classified as common origin pairs. New companions were added to six known systems.

Confirmation of visual double stars

In the period between January and December

2003 LIADA has confirmed the existence of 54 visual double stars. Of those confirmed, 48 of them were discovered by John Herschel and have remained unconfirmed since 1820 and 1830! Among all programmed unconfirmed double stars, four were not identified. These pairs are shown in Table I. In the first and second columns, the WDS identifier and discover code with their sequential number are listed; in the following columns, from left to right, are listed the magnitude for primary and secondary; in column 5 the epoch of the only measurement; and in the last two columns, the relative astrometry ρ and θ.

(1) WDS no.	(2) Designation	(3) Mg. A	(4) Mg. B	(5) Epoch	(6) ρ(")	(7) θ(deg)
21149+3240	HJ 1627	13	14	1828	2	182
21090+0410	HJ 5515	10	10	1823		15
21377+5728	HJ 1672	10	11	1828	12	261
21402+4422	HJ 1679	10	11	1828	3	86

Table 1: Unconfirmed Double Stars

Relative Astrometry

The results of 701 individual relative measurements, averaged into 311 mean positions, for 103 visual double stars were made with different techniques. The angular separation ranges from 2"59 to 225"69.

Several techniques were used to obtain astrometry and photometry. A Microguide eyepiece was used by Rafael Benavides -- Astronomical Society of Córdoba (Spain) – using a refractor telescope of 0.12 meter. Several 0.2-0.3 meter telescopes with a CCD were used by John Ryan -- "Spirit of 33", Salamanca (Spain/ USA) – and Francisco Rica – Astronomical Society of Mérida (Spain) -- . Jim Jones (from U.S.A.), Alejandro Russo (from Argentina), Lahuerta brothers (from Spain) and Daniel Osanai (from Argentina) were new members reporting their results.

Internet resources were also used for astrometry. The digitized images of Two Micron All Sky Survey (Cutri R.N. et al. 2000, hereafter 2MASS) project, enabled us to make measurements of great accuracy. Digitized Sky Survey (DSS) was also used for astrometry. Guide 6.0/7.0, Astrometrica, and FitsView software were used for documentation and astrometry.

Table 2 lists relative astrometry for 103 double stars. In the first and second columns, the WDS identifier and discoverer code with their sequential numbers are listed; in the following columns, from left to right, the Besselian epoch of the astrometry; the number of measurements; the position angle and the angular separation; the V magnitude of primary and secondary. If the magnitude listed has two decimal numbers these came from Tycho-2 (Hog E. et al. 2000) or else they came from calibrated GSC 1.2 (Morrison 2001), GSC-II, USNO-B1.0 (Monet 2003) photometry or inferred by spectral distribution using JHK photometry. The spectral type and luminosity class estimated using photometric and kinematic data.

Column (11) lists the observer code as follows: **FMR** (Francisco Rica, Astronomical Society of Mérida (Spain)), **ARU** (Alejandro Russo, amateur from Argentina), **JRY** (John Ryan, "Spirit of 33" group, amateur from Spain/USA.); **BVD** (Rafael Benavides, Astronomical Society of Córdoba –Spain-); **JJO (**Jim Jones, amateur from USA); **DOS** (Daniel Osanai, amateur from Argentina); **OMG** (Lahuerta's Brothers, Observatory of Manises –Valencia, Spain).

The observation methods are listed in the next column (**CCD:** CCD camera, **MCG:** MicroGuide eyepiece, **2MASS:** 2MASS project images; **DSS:** Digitized Sky Survey; **AC2000:** Astrographics Catalogue 2000).

In column (12) the nature of the double star code is as follow: **PHY**= Physical; **OPT**=Optical; **CO** = Common Origin; "**¿?"** = unknown; "--"=nature not studied. A "?" character means that the nature listed is not confirmed. In the last column the confirmed double stars show a "C" letter; a number indicates the years since the last measure. "#" character followed by a number refers to a note number.

This year four observers have reported their results for the first time:

Jim Jones, is an amateur from USA and member of "Spirit of 33" group. Jim used a 0.2 meter telescope, with SkyWalker GoTo system. A SBIG ST7ei CCD camera was used to obtain the images which were reduced by AIP4WIN software.

Daniel Osanai, an amateur from Argentina.

Luis and Salvador Lahuerta Zamora from Manises' Observatory (MPC-IAU Code J98). The Lahuerta brothers are members of *Grupo de Estudio, Observación y Divulgación de la Astronomía* (G.E.O.D.

A.) in Valencia (Spain). They used an 0.25 meter S/C Meade LX200 telescope (2500 mm of focal length). A Starlight Xpress MX516 CCD camera was used to obtain the images. The pixel size used is of 1.37 x 1.76 arcsec. The field of view was of 11.39 x 8.50 arcmin. Charon software was used to perform astrometric and photometric reduction.

New companions to known systems

New companions were added to the systems HJ 3100, HJ 1637, HJ 1368, HJ 780, HJ 84, HJ 438. For HJ 84 two new companions were added. The new companions were found by Rafael Benavides (BVD 1 to BVD 5) and John Ryan (JRY 1). The relation of the new companions to the members of the known systems were studied. Five of them were not bound to any member of the known system. The nature of the other two new companions remain undetermined due to missing or inaccurate data. Although LIADA's Double Star Section doesn't usually propose that optical companions to be listed in the WDS catalog, we suggest including these in order to avoid future erroneous faulty observer reports.

Spectral Types and luminosity classes

The process to estimate spectral types and luminosity classes using BVJHK photometry and kinematical data were explained in detail in Rica (2005).

Table 2 lists 150 spectral types estimated by the LIADA group; only 15 of these stars had spectral types previously published in the literature.

Table 3 compares spectral types determined by LIADA with those listed in the literature. For most of the stars, the difference is less than or equal to 2 spectral subclasses. In Table 2 there are many spectral types that were estimated using only JHK photometry due to the star component not being listed in Tycho-2, so their results were of lower accuracy than those obtained using BVJHK photometry.

Studying the Nature of Visual Double Stars

To study the nature of visual double stars and classify them as optical, physical, common proper motion or common origin pairs, BVJHK photometric and astrometric (proper motion and relative astrometry) data were used. The historical relative astrometry (θ corrected for precession and proper motion) in addition to our own measures were plotted in X (= ρ*cos(θ)) against epoch and Y(=ρ*sin (θ)) against epoch diagrams. A linear fit shows the relative proper motion of B with respect to A. This data is very important because nearly all the methods that allow us to determine their nature use these data. If a double star is physical then these data will give us the projected relative orbital motion and velocity.

The Tycho-2 optical BV photometry and the 2MASS infrared JHK photometry in addition to the individual proper motions allow us to obtain the spectral type and luminosity class. Finally the photometric and astrometric data were analyzed using up to 6 professional methods that allow us to classify visual double stars according to their nature. We analyzed individual proper motions using the method of Halbwachs (1986).

Figure 1 shows a summary of this study. Of the 103 visual double stars measured, LIADA studied the nature of 83 of them. About 75 % (62 visual double stars) were optical or suspected optical, while only 6% (5 doubles) were physical or suspected physical. Of the double stars studied there were pairs with photometric and astrometric data consistent with pairs located

(Continued on page 130)

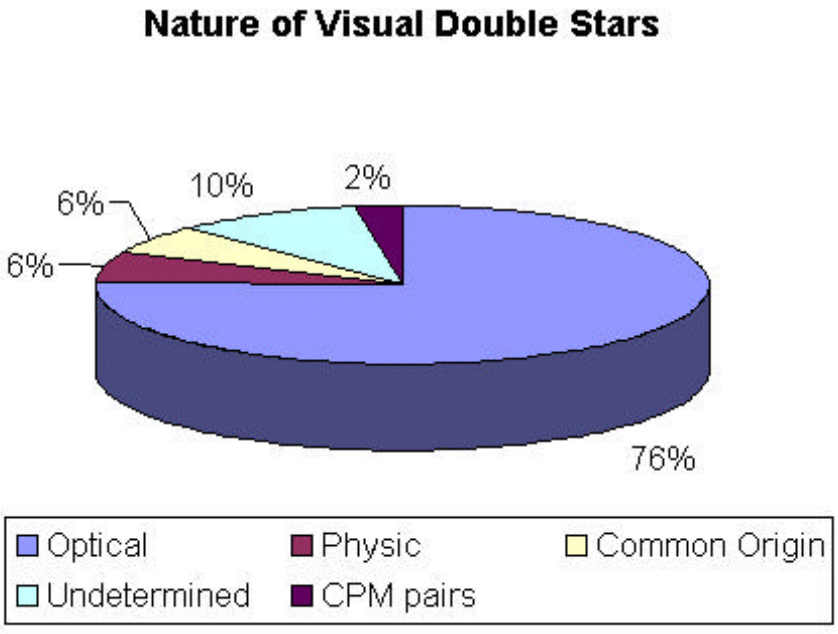

Figure 1: Study of the visual double stars' nature. Most of the neglected and unconfirmed visual double stars are optical pairs with no astrophysical interest.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
00023+0732	LDS6084	1955.861	1	127.1	15.33	17.8	18.0		JJO	DSS	CPM	C
		1991.697	1	127.8	14.89				JJO	DSS		
		1991.699	1	127.9	15.25				JJO	DSS		
00027+5958	ARG 47	1999.713	3	290.0	10.09	9.29	10.07		FMR	2MASS	--	
		2003.066	4	290.2	9.84				JRY	CCD		
01487+7528	HJ 2075 AB	1999.825	3	231.1	30.80	9.98	11.29	G8V+K6V	FMR	2MASS	CPM	
		2003.074	4	230.7	30.67				JRY	CCD		
01487+7528	HJ 2075 AC	1999.825	3	238.5	36.98	9.98	11.29	G8V	FMR	2MASS	OPT	C. 173
		2003.074	4	238.6	36.91				JRY	CCD		
01151+3125	WFC 248	1998.889	3	8.4	10.74	12.0	12.0		FMR	2MASS	--	
		2003.066	4	8.6	10.66				JRY	CCD		
03083+3101	HJ 331	1993.798	1	307.7	19.76	11.06	12.5	K7+K9	RBE	DSS	OPT	C. 173
		1998.031	3	308.0	18.01				FMR	2MASS		
		2003.074	4	308.7	18.03				JRY	CCD		
03278+5627	STI1984	1998.981	3	73.6	10.83	10.81	11.8		FMR	2MASS	--	
		2003.066	4	74.4	10.81				JRY	CCD		
03314+0131	HJ 2194	1951.686	1	122.2	30.83	11.30	11.63	F8+K1	JJO	DSS	OPT	
		1995.953	1	121.7	33.81				JJO	DSS		
		1995.953	1	121.6	30.64				RBE	DSS		
		2000.049	3	120.8	33.70				FMR	2MASS		
		2003.074	4	120.8	33.81				JRY	CCD		
03378+4943	WFC 250	1999.140	3	68.4	11.17	10.88	12.2		FMR	2MASS	--	
		2003.066	4	68.0	11.07				JRY	CCD		
03428+0015	HJ 2202	1995.953	1	80.4	33.68	10.18	12.0	K9	RBE	DSS	OPT?	C. 173
		2000.055	3	79.1	33.85				FMR	2MASS		
		2003.074	4	78.7	33.68				JRY	CCD		
03540+0316	HJ 2213 AB	1953.998	1	9.4	12.73	11.27	14.6		JJO	DSS	¿?	C. 173
		1991.787	1	8.3	13.12				RBE	DSS		
		1992.733	1	7.6	12.99				RBE	DSS		
		2000.058	3	7.7	13.47				FMR	2MASS		
		2003.074	4	7.6	13.31				JRY	CCD		
03540+0316	HJ 2213 AC	1953.998	1	95.6	20.99	11.27	14.8		JJO	DSS	¿?	C. 173
		1991.787	1	94.4	21.06				RBE	DSS		
		1992.733	1	93.4	21.08				JJO	DSS		
		2000.058	2	93.0	21.38				FMR	2MASS		
		2003.074	4	93.1	21.23				JRY	CCD		
04017+4905	WFC 251	1999.782	3	305.7	13.83	10.8	11.8		FMR	2MASS	--	

Table 2: Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

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(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		2003.066	4	305.6	13.89				JRY	CCD		
04067+0324	HJ 2221	1992.066	1	256.2	16.74	11.77	13.52	K2+G7	FMR	DSS	OPT	
		1999.859	3	257.6	16.88				FMR	DSS		
		2000.061	3	257.6	17.16				FMR	DSS		
		2003.074	4	257.3	17.14				RBE	DSS		
04074+0521	HJ 2222	1992.066	1	144.8	21.08	10.95	12.8	M0(K4V)	RBE	DSS	OPT?	C.173.#1
		2000.061	3	144.1	21.00				FMR	2MASS		
		2003.074	4	144.3	21.00				JRY	CCD		
04154+1641	HJ 3254	1991.932	1	228.2	25.82	10.88	12.5	G1+G5	RBE	DSS	OPT	C. 173
		1997.760	3	228.6	25.64				FMR	2MASS		
		2003.074	4	228.8	25.77				JRY	CCD		
04196+3355	HJ 674	1955.812	1	21.5	15.74	12.14	12.98	K8+F2	JJO	DSS	OPT	
		1982.806	1	20.2	16.43				JJO	DSS		
		1989.826	1	21.2	16.67				JJO	DSS		
		1993.798	1	20.7	16.53				FMR	DSS		
		1998.891	3	20.9	16.84	12.12	12.7		FMR	2MASS		
		2000.936	7	21.5	16.69				FMR	2MASS		
		2003.074	4	20.6	16.81				JRY	CCD		
04258+2855	HJ 343 AB	1992.753	1	124.8	24.86	10.32	12.8	F3+F9	RBE	DSS	OPT?	
		1997.910	3	125.2	24.70				FMR	2MASS		
		2003.074	4	125.0	24.77				JRY	CCD		
04258+2855	HJ 343 AC	1992.753	1	127.2	38.84	10.32	13.3	F3	RBE	DSS	OPT?	
		1997.910	3	127.7	38.78				FMR	2MASS		
		2003.074	2	127.5	38.92				JRY	CCD		
04258+2855	HJ 343 AD	1992.753	1	91.7	62.02	10.32	13.7	F3+G9	RBE	DSS	OPT?	
		1997.910	3	91.8	61.69				FMR	2MASS		
		2003.078	2	91.9	61.82				JRY	CCD		
04514-0613	HJ 28	1985.052	1	201.7	17.76	12.2	12.5	K2+K5	RBE	DSS	¿?	C. 183
		1998.779	3	203.4	17.90				FMR	2MASS		
04537-0618	HJ 29	1985.052	1	298.5	29.77	10.67	11.50		ARU	DSS	OPT	97
		1998.779	3	299.1	30.34				FMR	2MASS		
04553-0352	HJ 352 AC	1985.052	1	344.3	48.15	9.40	11.82	G1+K0	ARU	DSS	OPT	C. 183
		1985.052	1	344.7	47.62				RBE	DSS		
		1998.705	3	344.4	49.80				FMR	2MASS		
08002+0128	HJ 3306	2003.364	4	186.4	14.38	9.90	13.3		JRY	CCD	--	
		2003.399	1	186.1	15.00				OMG	CCD		
08005-0837	HJ 2425	1984.179	1	246.2	12.15	10.56	12.90	G4+F3	DOS	DSS	--	C

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

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(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		1985.052	1	244.1	13.52				DOS	DSS		
08020+2532	HJ 435	1996.121	1	104.6	12.65	10.84	11.23	F4+F4	RBE	DSS	CO	
		2003.364	4	284.5	12.86				JRY	CCD		
		2003.399	1	285.4	12.70				OMG	CCD		
08023+0220	GSH 1	2003.364	4	315.0	225.69	4.39	10.45		JRY	CCD	--	
08023+1039	HJ 76	1951.236	1	85.4	9.44	10.60	11.4	F5+F7	RBE	DSS	OPT	
		1997.851	1	85.1	9.83				RBE	DSS		
		1999.960	3	84.6	10.12				FMR	2MASS		
		2003.364	4	85.1	10.07				JRY	CCD		
08039-3133	LDS 201 AB	1987.245	1	236.2	47.83	8.73	9.64	G4V+G6V	DOS	DSS	CO	#2
		1992.025	1	236.4	48.47				DOS	DSS		
		2000.236	3	236.9	47.89				FMR	2MASS		
08039-3133	LDS 201 AC	1992.025	1	258.1	75.12	8.73	10.96	G4V	DOS	DSS	OPT	C
		2000.236	3	258.1	73.24				FMR	2MASS		
08039-3133	B 2164 CD	1992.025	1	56.0	3.40	10.9	11.5	B9+A4V	DOS	DSS	CO?	
		2000.236	3	58.9	4.01				FMR	2MASS		
08042+3136	HJ 438 AB	1955.195	1	128.9	24.63	10.28	11.7		FMR	DSS	OPT	C.173.#3
		1998.214	3	128.7	24.65				FMR	2MASS		
		1998.217	1	128.7	24.67				RBE	DSS		
		2003.364	4	128.3	24.61				JRY	CCD		
		2003.399	1	128.7	25.10				OMG	CCD		
08042+3136	BVD 1 AC	1955.195	1	5.0	14.75	10.22	15.0		RBE	DSS	OPT	**new com.**
		1998.214	2	5.3	15.07				FMR	2MASS		
		1998.217	1	4.7	15.01				RBE	DSS		
08113+1045	HJ 82	1951.236	1	245.3	20.41	11.20	11.3	K4+K6	RBE	DSS	OPT	C. 183
		1997.851	1	243.7	21.60				RBE	DSS		
		2000.171	3	243.1	21.87				FMR	2MASS		
		2003.364	4	243.1	21.84				JRY	CCD		
08126+0431	HJ 84 AB	1949.914	1	250.1	8.11	12.3	13.1	K7V:+M0V	RBE	DSS	OPT	C. 183
		1997.165	1	245.0	8.38				RBE	DSS		
		2000.072	3	246.0	8.61				FMR	2MASS		
		2003.364	4	246.2	8.58				JRY	CCD		
08126+0431	BVD 2 AC	1949.914	1	186.2	13.48	12.3	14.6	K7V:+G5	RBE	DSS	OPT	**new com.**
		1997.165	1	189.3	14.95				RBE	DSS		
		2000.072	3	189.7	15.1				FMR	2MASS		
		2003.364	4	188.7	14.92				JRY	CCD		
08126+0431	BVD 2 AD	1949.914	1	234.9	24.37	12.3	12.5	K7V:+K4	RBE	DSS	OPT	**new com.**

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

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		1997.165	1	189.3	14.95				RBE	DSS		
		2000.072	3	189.7	15.1				FMR	2MASS		
		2003.364	4	188.7	14.92				JRY	CCD		
08126+0431	BVD 2 AD	1949.914	1	234.9	24.37	12.3	12.5	K7V:+K4	RBE	DSS	OPT	new com.
		1997.165	1	232.8	25.22				RBE	DSS		
		2000.072	3	232.7	25.73				FMR	2MASS		
		2003.364	4	232.5	25.59				JRY	CCD		
08127+0428	HJ 83	1949.914	1	115.9	28.93	13.1	13.3	G4V:+K0	RBE	DSS	OPT	C. 183
		1996.881	1	111.5	29.90				RBE	DSS		
		2000.072	3	111.7	29.82				FMR	2MASS		
		2003.364	4	111.5	29.82				JRY	CCD		
08171+3348	HJ 780 AB	1954.154	1	203.7	14.79	11.7	12.6	K4+K0	RBE	DSS	OPT	C. 183
		1989.859	1	206.0	14.61				RBE	DSS		
		1998.214	3	206.7	14.76				FMR	2MASS		
		2003.364	4	207.6	14.63				JRY	CCD		
		2003.399	1	207.3	14.70				OMG	CCD		
08171+3348	BVD 3 AC	1954.154	1	190.9	24.72	11.7	13.8	K4+K0	RBE	DSS	OPT	new com.
		1989.859	1	191.7	25.06				RBE	DSS		
		1998.214	3	191.4	25.73				FMR	2MASS		
		2003.364	4	191.7	25.65				JRY	CCD		
08171+3348	BVD 3 BC	1954.154	1	173.7	11.38	12.60	13.8		RBE	DSS	¿?	new entry
		1989.859	1	173.3	11.65				RBE	DSS		
		1998.214	3	172.5	12.16				FMR	2MASS		
		2003.364	4	172.7	12.25				JRY	CCD		
		2003.399	1	173	12.3				OMG	CCD		
08195-0045	HJ 88	1954.971	1	129.6	24.15	7.84	11.6	K0III+ M1III	DOS	DSS	OPT	C.183.#4
		1983.040	1	128.2	25.38				DOS	DSS		
		1991.053	1	128.0	25.68				DOS	DSS		
		1998.943	3	128.0	25.35				FMR	2MASS		
08209-3613	HJ 4083	1988.035	1	118.7	28.97	10.24	11.7	K2III	DOS	DSS	--	#7
08231+1205	HJ 91	1951.987	1	244.7	19.82	11.9	11.8	F4+F4	RBE	DSS	CO	C.183.#5
		1988.189	1	244.6	20.10				RBE	DSS		
		1989.178	1	244.6	19.85				RBE	DSS		
		2000.178	3	244.3	20.31				FMR	2MASS		
08242+4722	HJ 2442	1953.121	1	93.5	15.47	10.61	12.6	F5+F8	RBE	DSS	OPT	C. 173
		1989.157	1	95.8	14.80				RBE	DSS		
		1998.296	3	96.0	15.25				FMR	2MASS		

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		2003.364	4	96.3	14.93				JRY	CCD		
		2003.399	1	96.3	14.60				OMG	CCD		
08268+0226	STF1229	2003.364	4	115.7	21.67	9.59	11.7		JRY	CCD	--	
08287+0539	HJ 5473	1953.023	1	222.3	11.96	13.4	13.4	G4V:+G0:	RBE	DSS	OPT	#6
		1996.881	1	240.3	13.63				RBE	DSS		
		2000.080	3	241.4	13.77				FMR	2MASS		
08292+1343	HJ 2450	1951.987	1	175.0	27.45	10.24	10.94	K4+K3	RBE	DSS	OPT	C. 173
		1989.850	1	173.0	28.01				RBE	DSS		
		1997.851	3	172.8	28.22				FMR	2MASS		
		2003.364	4	172.7	28.08				JRY	CCD		
08361+3233	HJ 791	1953.026	1	237.3	7.99	12.8	13.1	K1+K2	RBE	DSS	OPT	C. 183
		1989.858	1	235.7	8.12				RBE	DSS		
		1998.217	3	236.6	8.52				FMR	2MASS		
		2003.364	4	236.0	8.42				JRY	CCD		
08364+1841	HJ 2456	1954.974	1	136.0	13.06	11.46	13.8	F0+F6	RBE	DSS	OPT	C. 173
		1990.077	1	134.1	13.16				RBE	DSS		
		1998.834	3	134.7	13.37				FMR	2MASS		
		2003.364	4	135.3	13.37				JRY	CCD		
08377+1931	HJ 454	2003.364	4	271.2	36.86	8.24	11.7		JRY	CCD	--	
		2003.399	1	270.5	37.40				OMG	CCD		
08391+1941	S 570 AC	2003.364	4	344.9	178.20	7.45	9.34		JRY	CCD	--	
		2003.399	1	83.7	57.10				OMG	CCD		
11037-2941	HDS1577	1978.111	1	8.5	11.53	9.90	13.00	G8.5III:+G4	ARU	DSS	OPT	C.13.#8
		1978.113	1	4.5	11.09				ARU	DSS		
		1999.518	1	5.3	10.83				FMR	2MASS		
11119-5312	HDS1595	1979.310	1	345.0	23.91	8.87	10.72	K2III+F5	ARU	DSS	OPT	C.13.#9
		1987.080	1	345.3	23.68				ARU	DSS		
11521-0259	HJ 192	1952.090	1	55.2	21.17	11.4	13.4	G6+F6:	ARU	DSS	OPT	
		1983.360	1	52	22.07				ARU	DSS		
		1998.300	1	50.4	22.57				ARU	DSS		
12089-0317	HJ 1211	1955.300	1	147.8	11.81	10.61	13.4	F5:+K3	DOS	DSS	OPT?	
		1984.420	1	149	11.32				DOS	DSS		
		1988.300	1	149.5	11.49				DOS	DSS		
		1996.290	1	152.8	10.79				DOS	DSS		
12437-0448	HJ 215	1992.410	1	294.3	12.14	12.07			DOS	DSS	--	C. 184
18028-2705	HLD 32	1998.212	3	101.2	5.05	8.37	9.2	F8V+F9V	FMR	2MASS	PHY	
18091-6154	LDS 624	1975.450	1	90.3	19.03	15.3	15.7	K7VI:+K8IV:	FMR	DSS	CO	

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		1975.660	1	89.5	18.95				FMR	DSS		
		1990.470	1	90.3	19.02				FMR	DSS		
		1995.650	1	90.6	19.19				FMR	DSS		
		2000.510	3	89.7	19.3				FMR	2MASS		
18107+3903	ES 2569	1950.603	1	272.7	10.12	11.04	12.6	F6+F8	FMR	DSS	PHY?	
		1951.647	1	276.2	9.79				FMR	DSS		
		1982.393	1	274.3	9.66				FMR	DSS		
		1989.505	1	274.0	9.77				FMR	DSS		
		1992.484	1	279.1	9.74				FMR	DSS		
18422+8818	HJ 2971 AC	2003.540	4	61.7	28.42	9.72	11.50	K8	JRY	CCD	--	
18425+0439	HJ 866 AB	1950.442	1	87.5	16.21	11.54	11.80	G5.5+K3.5III	RBE	DSS	OPT	C. 184
		1990.467	1	83.1	17.14				RBE	DSS		
		1999.598	3	83.2	17.11				FMR	2MASS		
		2003.540	4	83.8	17.47				JRY	CCD		
18425+0439	HJ 866 AC	1950.442	1	313.2	11.74	11.54	12.50	G5.5+G8.5	RBE	DSS	OPT	C. 184
		1990.467	1	318.4	12.3				RBE	DSS		
		1999.598	3	320.5	12.73				FMR	2MASS		
		2003.540	4	321.1	12.65				JRY	CCD		
18464+3116	HJ 1345	1951.508	1	171.5	11.41	12.30	13.40	K8.5III+G0	RBE	DSS	OPT	C.176.#10
		1989.508	1	171.8	11.51				RBE	DSS		
		1998.303	3	169.5	11.79				FMR	2MASS		
		2003.540	4	169.4	11.75				JRY	CCD		
		2003.712	3	167.4	12.15				OMG	CCD		
18470-1912	HJ 2837	1987.465	1	88.4	10.49	11.29	12.60		DOS	DSS	--	C. 174
		1992.571	1	88.4	10.77				DOS	DSS		
18476+2335	HJ 2841	1997.437	3	254.1	10.57	11.73	13.30	G8III:+G0	FMR	2MASS	OPT	C.174.#11
		2003.540	4	254.1	10.51				JRY	CCD		
18498+0801	HJ 869	2003.622	3	271	10.07	11.20	10.90		OMG	CCD	--	
19097+1221	HJ 1368 AB	1952.397	1	34.1	19.43	10.76	13.40	G3III:+G7.5	RBE	DSS	OPT?	C. 176
		1990.628	1	30.2	19.54				RBE	DSS		
		1997.530	3	46.3	22.04				FMR	2MASS		
		2003.540	4	31.3	19.52				JRY	CCD		
		2003.622	3	30.5	19.31				OMG	CCD		
19097+1221	HJ 1368 AC	2003.540	3	270.7	17.92	10.76	13.70	G3III:+G0	JRY	CCD	--	C. 176
		2003.622	3	270.9	17.87				OMG	CCD		
19097+1221	BVD 4 AD	1952.397	1	230.8	4.77	10.76	12.30	G3III:+G1	RBE	DSS	OPT?	new com.
		1990.628	1	220.6	6.77				RBE	DSS		

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		1997.530	3	224.9	6.51				FMR	2MASS		
		2003.540	4	226.7	5.73				JRY	CCD		
19135-1632	HJ 2856	1986.640	1	151.4	3.3	11.00	12.00		DOS	DSS	--	C.174.#12
		1987.573	1	133.9	2.59				DOS	DSS		
19163+0438	HJ 880	2003.540	4	116.2	10.5	11.70	12.20	F3.5+K7	JRY	CCD	--	C. 184
		2003.622	3	117.2	10.55				OMG	CCD		
19165+0712	HJ 2861	1950.612	1	54.5	11.65	10.82	13.40	A0+F6	RBE	DSS	OPT	C.174.#13
		1995.622	1	54.4	11.76				RBE	DSS		
		1999.590	3	53.5	11.89				FMR	2MASS		
		2003.622	3	55.1	12				OMG	CCD		
19192+0401	HJ 2864	1950.617	1	216.2	21.92	9.96	12.90	G9III:+K9.5V:	RBE	DSS	OPT	C.174.#14
		1992.585	1	215.5	20.8				RBE	DSS		
		1999.609	3	216.5	20.48				FMR	2MASS		
		2003.540	4	216	20.52				JRY	CCD		
		2003.622	3	214.8	20.44				OMG	CCD		
19198+1036	HJ 882	1952.397	1	109.9	9.43	9.70	11.72	M5III+G7V:	RBE	DSS	OPT	15. #15
		1987.576	1	109.4	9.66				RBE	DSS		
		1999.603	3	110.7	9.84				FMR	2MASS		
		2003.540	4	110.4	9.64				JRY	CCD		
19215+0412	HJ 883	2003.712	3	302.4	8.99	11.80	13.40		OMG	CCD	--	C. 184
19221+3050	HJ 1389	2000.311	1	93	13.03	12.00	12.50	K1III+F4V	FMR	2MASS	OPT	C. 176
19251+3511	HJ 1394	2003.519	6	28.9	17.24	10.77	11.52	K2III:+K5III	JJO	CCD	OPT	
		2003.540	4	29	17.38				JRY	CCD		
		2003.712	3	28	17.26				OMG	CCD		
19287+4905	HJ 1408	1998.483	3	236.3	7.42	10.36	12.70	G1III:+G5V	FMR	2MASS	OPT	C.176.#15
		2003.540	4	236.1	7.23				JRY	CCD		
21021+1016	J 158 AB	2000.330	1	166	4.91	10.77	13.00	G9III+F5V	FMR	2MASS	OPT?	52. #16
21033+1259	HJ 272	1952.635	1	257.7	10.77	9.58	13.00	K5III+sdF?	FMR	DSS	OPT	#17
		1987.716	1	253.5	11.23				FMR	DSS		
		1991.541	1	256.3	11.29				FMR	DSS		
		1999.759	2	253.8	11.11				FMR	2MASS		
		2000.531	2	253.8	11.42				PMA	CCD		
		2003.882	6	254.7	11.29				JRY	CCD		
21043+3608	HJ 1610	1951.519	1	249.4	10.02	9.11	12.20	B9V:+K6V:	BVD	DSS	OPT	C.176.#18
		1991.702	1	246.3	10.87				BVD	DSS		
		2003.882	6	245	11.01				JRY	CCD		
		2003.993	3	252.9	10.9				OMG	CCD		

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
21071+4134	HJ 1613	1989.680	1	4.4	15.87	10.01	12.80	F3V+F7V	BVD	DSS	OPT	C.176.#19
		2003.882	5	4.4	16.23				JRY	CCD		
		2003.953	3	3.6	16.13				OMG	CCD		
21126+0437	HJ 3013	2003.802	5	118.3	11.21	11.00	13.30	G7V+K0	JRY	CCD	OPT?	
		2003.996	3	119.3	10.91				OMG	CCD		
21141-5428	LDS 735	1975.451	1	61.7	15.42	12.30	13.20	K9V+M0.5V	FMR	DSS	PHY	C. 46
		1977.528	1	60.6	15.13				FMR	DSS		
		1991.679	1	59.4	15.44				FMR	DSS		
		1992.563	1	61.4	15.38				FMR	DSS		
		1992.567	1	60.8	15.25				RBE	DSS		
		1999.852	3	61.2	15.3				FMR	2MASS		
21202+1018	HJ 933	1917.148	1	239	16.85	10.11	11.60	F+F3.5	FMR	AC2000	OPT	C.185#20
		1951.579	1	240	16.36				BVD	DSS		
		1990.570	1	239.6	16.84				BVD	DSS		
		2000.333	3	238.7	17.01				FMR	2MASS		
		2003.996	3	239.6	16.94				OMG	CCD		
21226+3158	HJ 1637 AB	1987.797	1	104.6	13.19	8.63	12.00	F6V:+K3V	BVD	DSS	PHY?	C.176.#21
		1998.461	3	104	13.55				FMR	2MASS		
		2003.882	6	103.7	13.42				JRY	CCD		
		2003.996	3	102.8	12.22				OMG	CCD		
21226+3158	JRY 1 AC	2003.882	3	142.7	8.44	8.63	14.0		JRY	CCD	¿?	new com.
21270+4315	HJ 1646	1895.658	1	118.6	21.6	7.62	11.40	A0+G8:III	FMR	AC2000	OPT	C.176.#22
		1953.679	1	116.9	21.76				BVD	DSS		
		1989.679	1	115.5	22.61				BVD	DSS		
		2003.882	6	115.6	22.52				JRY	CCD		
		2003.996	3	114.3	21.9				OMG	CCD		
21278-1049	HJ 283	1987.712	1	71.2	9.47	12.60	13.10	A9+K1	BVD	DSS	¿?	C. 184
		1999.366	3	70.8	9.86				FMR	2MASS		
21327+0751	HJ 937	2003.882	5	162.3	10.87	11.80	11.50	G6V:+K7	JRY	CCD	OPT	#23
		2003.996	3	160.7	10.81				OMG	CCD		
21337-1444	HJ 3036	1987.798	1	96.9	5.83	12.10	12.10	K3V+K3V	BVD	DSS	PHY	
		1999.412	3	91.7	6.04				FMR	2MASS		
21341-1716	HJ 3037	1977.550	1	352.2	25.66	8.75	13.30	K1III+G9	BVD	CCD	¿?	C.174.#24
		1987.798	1	352.8	26.46				BVD	CCD		
		1999.412	3	352.5	26.5				FMR	2MASS		
21361-1023	HJ 5518	1988.774	1	159.9	49.27	11.55	11.44	K2III+K3V	BVD	DSS	OPT	C.180.#25
21377+1312	HJ 1667	1953.630	1	200.3	15.5	12.00	12.70	K2.5III: +K4III	BVD	DSS	OPT	

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

(1) WDS Id.	(2) Discover	(3) Epoch	(4) N	(5) θ (°)	(6) ρ (")	(7) V_A	(8) V_B	(9) Spec. Type	(10) Obs.	(11) Method	(12) Type	(13) Notes
		1990.805	1	201.4	16.23				BVD	DSS		
		2003.882	5	202.2	16.44				JRY	CCD		
21399+3931	HJ 1675 AC	1951.510	1	262.7	35.13	6.98	13.10	A9+G6V	BVD	DSS	OPT	C. 176. #26
		1987.567	1	264.2	36.41				BVD	DSS		
		2003.882	6	263.7	37.41				JRY	CCD		
		2003.996	3	263.4	37.39				OMG	CCD		
21403+0848	HJ 3047	2003.885	6	37.6	17.5	11.05	13.20	K3+G9	JRY	CCD	OPT	#27
21418+0145	HJ 3049	1909.713	1	14	29.94	10.21	11.26	K2III+G1V	FMR	AC2000	OPT	C. 174
		2003.882	6	26.2	34.9				JRY	CCD		
21431+1338	HJ 1682	1953.630	1	75.3	18.66	10.15	12.0	G9+K2III	BVD	DSS	OPT	C. 176
		1990.806	1	77.5	20.28				BVD	DSS		
		2003.882	6	77.3	20.8				JRY	CCD		
21437+0230	HJ 3052	2003.882	6	292.5	14.2	10.26	13.3	K2III+G6V	JRY	CCD	OPT	C.174.#28
21462+0536	HJ 3057	1953.781	1	7.8	19.8	11.42	12.6		BVD	DSS	OPT	C. 174
		1995.568	1	7.4	20.76				BVD	DSS		
		2003.885	6	7.5	20.84				JRY	CCD		
22167-1112	BVD 5 BC	1989.733	1	304.1	5.08	11.13	15.7	F8III:+K5	BVD	DSS	¿?	new com.
		1998.795	3	305.1	5.01				BVD	DSS		
22167-1112	HJ 3100 AB	1989.733	1	75.7	38.31	9.22	12.60	G0V+F8III:	BVD	DSS	OPT	#29

Table 2 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars.

Notes:

(# 1): HJ 2222: Stephenson (1986) lists A as a K4 star.

(# 2): LDS 201 AB: Primary is a G3 V star according to the literature in agree with LIADA's estimate. Distance for the components inferred by Hipparcos' trigonometric parallax are 79 and 75 pc. Estimate of LIADA (71 pc) is in excellent agreement with Hipparcos data. Our result shows that A component could be an unresolved close binary.

(# 3): HJ 438: A weak companion of V = 15.0 located at 15.0 arcsec in direction 5 degrees is not bound to the system.

(# 4) HJ 88: Primary is a K0III giant star according to the literature (LIADA estimated K0III).

(# 5) HJ 91: It is located at 08h 22m 40s387 and +12d 04' 24"19, 6 arcminutes West of the WDS coordinate.

(# 6) HJ 5473: There are an optical companion at 11.3 arcsec in direction 333 degrees

(# 7): HJ 4083: it is located in NGC 2579 open cluster which according to literature is located at a distance of 3000 light-years, on the Milky Way. According to Lindoff (1974) NGC 2579 could be a false open cluster. Primary component could be located at 2000-2500 light-years. The proper motion of the main component is nearly the same at this of suspected open cluster. The secondary component is the planetaria nebulae PK 254.6+00.2. If both components are members of the open cluster remain unknowns.

(# 8) HDS 1577: According to literature primary is a K0 suspected variable star classified as NSV18596. CCDM catalog lists a double star with RSU observer code with a measure performed in 1976. Was HIPPARCOS not the first in resolved it?.

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Astrometry, Astrophysical Properties, and Nature of Neglected Visual Double Stars. . .

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(# 9) HDS 1595: Primary is a K2III star according to the literature in excellent agreement with LIADA's result.

(#10) HJ 1345 = SLE 121. Is the main component a variable star?

(#11) HJ 2841 = POU 3552

(#12) HJ 2856 = J 1667

(#13) The star at 14" in direction 168 degrees of HJ 2861 A likely is not gravitationally bounded at any component of HJ 2861 system.

(#14) The star located at 28”9 and 237 degrees of HJ 2864 A is likely not bound at any component. The spectral type listed in the table is corrected by reddening.

(#15) Spectral type of A is corrected by interestellar absorption.

(#16) J 158 AB: it was discovered by J. Jonckheere in 1910 (167 degrees and 3"8 with magnitudes of 10.7 and 12.9]. Later it was measured in 1952 (164 degrees and 4”7).

(#17) HJ 272: Secondary component is located in the H-K and J-H diagram in a region occupied by subdwarfs. However the reduced proper motion is typical for dwarfs stars. Primary is a K2 star according to Henry Draper catalog.

(#18) HJ 1610: Primary is an A0 star according to the literature with a radial velocity of –22 Km/s (Malaroda 2001).

(#19) HJ 1613: Primary is a F2 star according to the literature.

(#20) HJ 933: Primary is a A0 star according to the literature.

(#21) HJ 1637: Primary is a F5 star according to the literature.

(#22) HJ 1646: Primary is a A0 star according to the literature located at 184 pc (LIADA estimated a photometric distance of 199 pc).

(#23) HJ 937: The last WDS measure was performed in 2000. LIADA observed the secondary component as the brighter star.

(#24) HJ 3037: Primary is a K1III star according to the literature in excellent agreement with LIADA result .

(#25) HJ 5518: Secondary is a K3V high proper motion star located at 275 light-years. LIADA performed a search for unknown companions within 5 arc minutes. No companion candidate was founded.

(#26) HJ 1675 AC: Primary is a A2 star according to the literature.

(#27) HJ 3047: A new proper motion star was discovered while LIADA searched for unknown companions around HJ 3047 A. The proper motion of this star is μ(α)=-0”014 and μ(δ)=-0”086 and the star has V magnitude of 15.7 (inferred by B and R GSC-II photometry). It is located at a=21h 40m 17s36 y d=+08º 49’ 23”2. The reduced proper motions is typical for subdwarfs.

(#28) HJ 3052: Primary is a K2 star according to the literature.

(#29) HJ 3100: Primary is a F8 star according to the literature. HIPPARCOS determined a distance of 138 pc (LIADA estimated a photometric distance of 92 pc).

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at the same distance with the same kinematics, but not gravitationally bound: they are called *‘common origin’* pairs and were 6% of all double stars studied. The common proper motion (CMP) pairs are composed of two stars with similar or very similar proper motion but with no physical relationship suspected.

About 10% of the visual double stars have an undetermined nature due to insufficient or inaccurate data, and thus more astrometric and photometric data are needed. The results have been very similar to those of the last year. As in previous surveys, the very low percentage of physical pairs has not surprised us. Most of the neglected and unconfirmed visual double stars are bona-fide or candidate optical pairs, hence their low astrophysical interest.

Acknowledgments

This report makes use of data from the Two Micron All Sky Survey (MASS), which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center/California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

Name #1	Name #2	MgV	Sp_Lit	Ref.	Sp_LIADA	Diff.
GSC 0079-1186	HJ 2222 A	11.0	K4V	1	M0	+6
HD 66791	LDS 201 A	8.7	G3V	2	G4V	+1
PPM 177392	HJ 88 A	7.8	K0III	3	K0III	0
PPM 258457	HDS1577 A	9.9	K0	4	G9III:	-1
HD 97395	HDS1595 A	8.9	K2III	5	K2III	0
SAO 106801	HJ 272 A	9.6	K2	6	K5III	+3
HD 200755	HJ 1610 A	9.1	A0	6	B9V:	-1
PPM 60978	HJ 1613 A	10.0	F2	6	F3V	+1
PPM 139963	HJ 933 A	10.1	A0	6	F	
HD 203613	HJ 1637 A	8.6	F5	6	F6V:	+1
HD 204402	HJ 1646 A	7.6	A0	6	A0	0
HD 205205	HJ 3037 A	8.8	K1III	7	K1III	0
HD 206261	HJ 1675 A	7.0	A2	6	A9	+7
GSC 0547-0776	HJ 3052 A	10.3	K2	8	K2III	0
HD 211359	HJ 3100 A	9.2	F8	3	G0V	+2

Table 3: Comparison between LIADA's and spectral types from the literature.
Reference: 1. Stepheson 1986, 2. Houk 1982 3. Houk, Swift 1999 4. Bastian, Roeser 1993, 5. Houk 1978, 6. Bastian, Roeser 1988, 7. Houk 1988, 8. Wenger, et al. 2003

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References

Bastian U., Roeser S., 1988, A&AS, 74, 449R

Bastian U., Roeser S., 1993, Catalogue of Position and Proper Motions- South, Astronomisches Rechen-Institut, Heidelberg.

Cutri R.N. et al., 2000, Explanatory to the 2MASS Second Incremental Data Release, http://www.ipac.caltech.edu/2mass/releases/second/index.html

Halbwachs J.L., 1986, A&AS, **66**, 131B

Hog E. et al., 2000, A&A, **355,** 27L

Houk N., 1978, Michigan Catalogue of Two-Dimensional Spectral Types for the HD Stars. vol. 2: Declinations –53 to – 40 degrees (Ann. Arbol: Univ. Michigan)

Houk N., 1982, Michigan Catalogue of Two-Dimensional Spectral Types for the HD Stars. vol. 3: Declinations –40 to – 26 degrees (Ann. Arbol: Univ. Michigan)

Houk N., 1988, Michigan Catalogue of Two-Dimensional Spectral Types for the HD Stars. vol. 4: Declinations –26 to – 12 degrees (Ann. Arbol. Univ. Michigan)

Houk N., Swift C., 1999, Michigan Catalogue of Two-Dimensional Spectral Types for the HD Stars. vol. 5 (Ann. Arbol: Univ. Michigan).

Lasker, B.M., et al., 1992, Guide Star Catalogue Version 1.1

Lindoff U., 1974, Arkiv För Astronomia, vol 5, no. 4

Malaroda S., Levato H., Galliani S., 2001, Complejo Astronomico El Leoncito (CASLEO), San Juan, Argentina

Mason B.D., Wycoff G., & Hartkopf W. I., 2003, The Washington Double Star Catalog, http://ad.usno.navy.mil/proj/WDS/wds.html

Monet D.G., Levine S.E., Casian B., et al., 2003, AJ, **125**, 984M

Morrison J.E., Roeser S., McLean B., Bucciarelli B., Lasker B., 2001, AJ, **121**, 1752M

Rica F., 2005, JDSO vol. 1, No 1

Stephenson C.B., 1986, AJ, **91**, 144S

Wenger M., Ochsenbein, F., Egret, D., et al. 2003, SIMBAD astronomical databa base, http://simbad.u-strasbg.fr/