Study of Neglected Double Stars by LIADA Double Star Section in 2005, II: Astrometry, Astrophysical Properties, and Nature

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Abstract: LIADA's (Liga Iberoamericana de Astronomía) Double Star Section reports angular separations, position angles, V magnitudes and spectral types for 37 neglected visual double stars obtained in 2005. A total of 128 measures were averaged into 80 mean positions that range in separation from 3.12" to 348.74". Our observations were made by means of several techniques (CCD detectors, astrometric eyepieces, photographic plates, and astrometric catalogs). About 51 % of double stars were unconfirmed pairs discovered by John Herschel which remained neglected since before 1850. BVIJHK photometries, astrometric, and kinematical data were used/obtained to determine astrophysical parameters (spectral types and luminosity classes, photometric distances, etc). The nature of the double stars were determined using several criteria classifying them as optical, physical, or common origin pairs. Only 5-6 % were physical double stars. Two new systems were discovered.

Introduction

Very neglected and unconfirmed double stars were selected to design our observational programs. This sample of double stars have little astrophysical interest (from our historical analysis only about 5-10 % are physical pairs), but the task of updating their parameters and characterizing them is important. Other objects studied were double stars discovered recently by the North-American Dave Arnold (ARN), the Hungarian T. Ladanyi & E. Berko (BKO) and the French A. Debackere (DBR).

We present 128 individual relative measures for 37 double stars which were performed using different techniques. These observations are averaged into 80 mean positions and angular separations, which ranges from 3.12" (for HJ 1410 AB) to 348.74" (for SMY 4 Aa-B). About 81% of the observed double stars were closer than 15". 19 of them (51 %) were discovered by John Herschel and they have remained unconfirmed since 1820-1850!

From January 2005 through December 2005, CCD cameras, micrometric eyepieces, on-line surveys like the Digitized Sky Survey (DSS) and SuperCosmos Sky Survey (Hambly *et al.* 2001a,b,c), hereafter SCSS, astrometric catalogs like Two Micron All Sky Survey (Cutri *et al.* 2000), hereafter 2MASS, and AC2000 (Urban *et al.* 1998) were used to obtain relative astrometry.

23 double stars have been confirmed and of the unconfirmed double stars four of them could not be identified.

In 2005 we discovered 2 new wide common proper motion binaries (Figure 1). They are binaries composed by red dwarfs with high proper motions. FMR 17 is composed of weak stars of 17.0 (M1.5V) and 18.2 (M2.5V) magnitudes separated by 4.1". FMR 18 is composed of stars of 13.7 (M3.5V) and

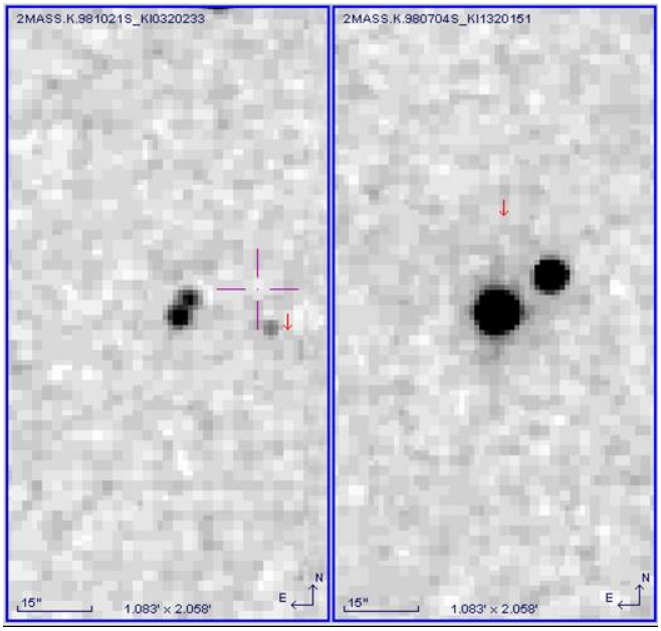

Figure 1. New binary systems discovered by Francisco Rica in 2005. CCD images came from 2MASS project (K-band). FMR 17 is the binary in the left panel and FMR 18 is the binary at right one.

15.9 (M4.0V) magnitudes separated by 16.2". The binary nature was determined by the common proper motion in addition to photometric data and they are physical binaries, gravitationally bound, orbiting each other. These systems were discovered during work carried out by Francisco Rica consisting of characterization of about 300 newly proper motion stars discovered in 1999 by the professional astronomer Wroblesky (Wroblewski & Costa 1999).

We studied the nature of the programmed double stars. About 78 % (29 pairs) were optical pairs, that is, pairs with unrelated members. About 5-6% were physical pairs (members orbit each other) or common proper motion pairs. The nature for about 16% could be not determined.

Confirmation of Visual Double Stars

The WDS catalog includes several thousand double stars that have only been measured at their discovery epoch and some hundreds of them have not been even resolved since before 1900. These double stars are unconfirmed and they need a second measure.

In the period between 2005 January to 2005 December, LIADA has confirmed the existence of 23 visual double stars.

There are several reasons for this neglect: poor coordinates or large proper motion, erroneous magnitude or delta-m estimates or truly neglected (it is nearly impossible to measure the large amount of neglected double stars due to the few constant observers).

Of all the unconfirmed double stars in the observing program, 4 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 followed columns, from left to right, are listed the magnitude for primary and secondary; in column (5) the epoch of the only measure; and in the last two columns, the relative astrometry, ρ and θ.

Measurements

Relative Astrometry

The results of 128 individual relative measures, averaged into 80 mean positions, made with different techniques, are listed in Table 3. These observations range in separation from 3.12" (for HJ 1410 AB) to 348.74" (for SMY 4 Aa-B).

From January 2005 through December 2005, CCD cameras, photographic plates, and astrometric catalogs were used to measure the relative astrometry of 37 binaries. 23 double stars have been confirmed. Of the doubles studied, 19 (51%) of them were discovered by John Herschel and have remained unconfirmed since 1820 and 1850!

Several observational techniques were used to obtain astrometry and photometry. Some astrometric catalogs were used: Astrographic Catalogue 2000,

Table 1: Unidentified, Unconfirmed Double Stars

WDS No.	Designation	Mg.A	Mg.B	Epoch	ρ["]	θ[°]
11072+5711	HJ 2556	11	12	1830	3	...
18285-1013	HJ 5497	...	...	1823	20	225
19370+5111	HJ 1426	12	13	1828	4	100
18466+1659	MAD 10AC	8.40	...	1843	75	28

Table 2: Observers

Code	Name	Organization	City, Country
ARU	Alejandro Russo	LIADA	Argentina
BVD	Rafael Benavides	Astronomical Society of Córdoba	Córdoba, Spain
OMG	Luis & Salvador Lahuerta	G.E.A.	Valencia, Spain
FMR	Francisco Rica	Astronomical Society of Mérida	Mérida, Spain
DOS	Daniel Osanai		Argentina
ERE	Esteban Reina	Astronomical Observatory of Masquefa - MPC 232	Barcelona, Spain
2MASS		Two Micron All Sky Survey [2MASS]	
AC2000		Astrographic Catalog 2000	

HIPPARCOS, Tycho-2, Two Micron All Sky Survey and Sloan Digital Sky Survey**.**

CCD cameras were also used. Luis Lahuerta and Salvador Lahuerta are members of the *Grupo de Estudio, Observación y Divulgación de la Astronomía* (G.E.O.D.A.) and they worked from Manises' Observatory (MPC-IAU Code J98) in Valencia (Spain). They used a S/C Meade LX200 telescope of 0.25 meters (10 inches) diameter and 2,500 mm (98.4 inches) focal length. A Starlight Xpress MX516 CCD chip with 500 x 290 pixels was used to obtain digital images. The size of the pixels are 9.8 x 12.60 µm. The Lahuertas brothers worked with an f6.3 focal reducer (with a JMI motofocus) resulting in a focal length of 1,478 mm (58.2 inches). The pixel size is 1.37 x 1.76 arcseconds and the filed of view is 11.39 x 8.50 arcminutes. For astrometry and photometry, they used Charon software and the GSC-ACT catalog. Esteban Reina worked from the Astronomical Observatorio of Masquefa - MPC 232, Barcelona (Spain) using a Meade LX200 with 0.25 m objective and a SBIG ST7 ME CCD .

Digitized photographic plates from the Digitized Sky Survey (DSS) and the SuperCosmos Sky Survey (SCSS) were also used for astrometry. Guide 6.0/7.0, Astrometrica and FitsView software were used for documentation and astrometry.

Table 3 lists relative astrometry for 37 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 the primary and secondary. If the magnitude listed has two decimal numbers these came from Tycho-2 (Hog et al. 2000) or else they came from calibrated GSC-I/GSC-II/USNO-B1.0 photometry or inferred by spectral distribution using JHK photometry. Next column, the spectral type and luminosity class estimated using photometric and kinematics data. Column 11 lists the observer code (see Table 2).

The observation methods are listed in the next column (**AC2000:** Astrographics Catalogue 2000; **CCD:** CCD camera; **DSS:** Digitized Sky Survey photographic plates; **HIP:** Hipparcos catalog; **SDSS**: Sloan Digital Sky Survey**; TYC2:** Tycho-2 Catalog; **2MASS:** 2MASS project images).

In column (13) the nature of the double star code is as follow: **PHY** = Physical; **OPT** = Optical; **CO** = Common Origin; **CPM =** Common Proper Motion; "**¿?"** = unknown; **"–"** = nature not studied. A "?"character at the end means that the nature listed is the most probable. 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.

Spectral Types and Luminosity Class Estimates

Columns (9) and (10) of Table 3 list, for both components, the spectral types and luminosity classes estimated by the LIADA group. When the luminosity class is unknown, it is not listed in Table 3 and then the spectral type matches with the main sequence dwarf is listed.

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

Table 3 lists 67 spectral types estimated by LIADA group, of them only 7 stars have spectral types

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Study of Neglected Double Stars by LIADA Double Star Section in 2005, II ...

Table 3: Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars

WDS Id.	Discover + Num.	Epoch	N	θ (°)	ρ (")	V_A	V_B	SP_A	SP_B	Obs.	Method	Type	Notes
03218+5904	ARN 61AB	1983.844	1	30.1	78.70	9.39	9.6	F9III:	M4III	FMR	DSS	OPT?	#19
05032+2921	HJ 354AB	1999.900	1	296.0	12.05	11.2	11.8	K/M III	F9V:	2MASS	2MASS	OPT?	--
06024+5845	BKO 105AC	2000.030	1	264.4	19.39	11.9	13.1	K0:	F6V	2MASS	2MASS	OPT?	C, #20
06071-0339	HJ 2295AB	2005.244	3	311.2	9.30	12.0	11.7	K III	K III	OMG	CCD	OPT?	C, 177
06087-0729	HJ 35AB	2005.244	3	56.1	12.68	11.6	12.0	G4	F6V	OMG	CCD	¿?	114
06118+0956	HJ 719AB	1916.268	1	43.4	10.33	11.59	11.66	K2II	K3III	AC2000	AC2000	OPT	C, 185, #2
		1999.735	1	38.8	10.14					2MASS	2MASS		
		2005.280	3	38.7	10.08					OMG	CCD		
06176-0620	HJ 37AB	1983.936	1	279.8	20.54	11.58	12.3	F6	K2III:	FMR	DSS	OPT?	C, 177
06195+1220	STF 892AB	2005.244	3	40.8	39.46	10.44	10.65	K2V:	A0	OMG	CCD	OPT	#3
06246-0014	HJ 727AB	2005.180	3	337.1	17.76	12.7	12.8	G6V	K3III	OMG	CCD	OPT	--
06269+2951	HJ 388AB	2005.244	3	142.0	25.50	11.6	11.8	F6V	G8V	OMG	CCD	OPT	#4
06336+2710	HJ 393AB	2005.244	3	248.0	14.06	11.2	12.1	K1III	F4V	OMG	CCD	OPT	#5
06386-1027	HJ 2327AB	1904.120	1	51.6	11.97	11.4	12.1	K4III	F3	AC2000	AC2000	OPT?	C, 177
		2005.280	3	47.1	12.19					OMG	CCD		
06394-0614	HJ 737AB	2005.280	3	247.9	15.25	10.05	11.8	F4V:	F5V:	OMG	CCD	OPT	#6
06397+0334	HJ 2329AB	2005.280	3	86.6	17.25	10.89	11.87	F4V	A4	OMG	CCD	OPT	#7
07111+4954	BKO 108AC	1983.113	1	176.2	49.87	8.04	12.4	K3III	G7V:	FMR	DSS	OPT?	C
07120+3112	BKO 109AC	1998.895	1	261.3	11.29	12.1	13.2	F9V	F5V	2MASS	2MASS	OPT	C
11485+0046	HJ 1199AB	1909.236	1	45.5	26.42	11.57	12.1	K5V:	G0III:	AC2000	AC2000	OPT?	C, 179
		1952.083	1	46.3	27.22					DOS	SCSS		
		1952.086	1	46.5	27.23					DOS	DSS		
		1984.392	1	45.9	27.15					DOS	DSS		
		1991.183	1	45.9	27.36					DOS	SCSS		
		1993.155	1	45.9	27.57					DOS	SCSS		
		1993.316	1	46.0	27.50					DOS	DSS		
		1995.004	1	46.2	27.86					DOS	DSS		
13105+0339	HJ 1227AB	1956.190	1	130.3	28.80	11.57	15.4	G4V	G4	DOS	DSS	OPT	C, 172, #8
		1983.291	1	128.3	30.30					DOS	DSS		
		1990.370	1	128.1	30.30					DOS	DSS		
		1997.027	1	128.3	30.30					DOS	DSS		
		2000.193	1	128.1	30.63					2MASS	2MASS		
13304-1256	HJ 2656AB	1983.36	1	325.5	21.03	10.42	11.59	K4	K5	ARU	DSS	OPT	
18367+3036	HJ 1330AB	1998.298	1	286.3	7.13	13.2	14.8	G9	K2	2MASS	2MASS	¿?	C, 179, #9

Table 3 continued on next page.

Table 3 (continued): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars

WDS Id.	Discover + Num.	Epoch	N	θ (°)	ρ (")	V_A	V_B	SP_A	SP_B	Obs.	Method	Type	Notes
18468-0203	HJ 5502AB	1950.546	1	6.2	25.63	9.46	12.9	G3:	?	BVD	DSS	¿?	C, 180, #10
		1950.546	1	6.2	25.63					BVD	DSS		
		1997.497	1	6.4	25.66					BVD	DSS		
		1997.497	1	6.4	25.66					BVD	DSS		
		1999.604	1	4.7	25.69					2MASS	2MASS		
		1999.604	1	4.7	25.69					2MASS	2MASS		
		2005.640	3	4.7	25.62					OMG	CCD		
		2005.640	3	4.7	25.62					OMG	CCD		
18553-2618	SMY 4Aa-B	1991.478	1	239.2	348.74	2.05	9.8	B2.5V		HIP	HIP	OPT	C, 170, #11
19078-1647	HJ 1363AB	2000.245	1	327.7	9.63	12.7	12.3	G7	F7	2MASS	2MASS	OPT?	C, 179
		2005.640	3	322.6	11.04					OMG	CCD		
19212-1221	HJ 597AB	1991.650	1	229.9	17.62	10.74	10.96	K2III	K4III	TYC2	TYC2	OPT?	C, 187
		1999.385	1	230.0	17.70					2MASS	2MASS		
		2005.640	3	230.0	17.70					OMG	CCD		
19310+4050	HJ 1410AB	1998.412	1	248.2	3.12	12.8		M1V:		2MASS	2MASS	¿?	C, 179, #12
19362-0439	HJ 891AB	1998.722	1	16.8	11.86	11.6	12.9			2MASS	2MASS	OPT	C, 187, #13
		2005.640	3	17.4	11.84					OMG	CCD		
19439+1528	HJ 1432AB	1997.559	1	208.7	7.53	12.9	12.9	G2	G8	2MASS	2MASS	--	C, 179, #14
		2006.251	7	208.4	7.19					ERE	CCD		
19470+1232	HJ 1435AB	1991.690	1	296.4	13.24	11.82	11.62	F4	F8	TYC2	TYC2	OPT	C, 179, #15
		1997.561	1	296.8	13.13					2MASS	2MASS		
		2005.640	3	296.6	13.10					OMG	CCD		
19481+0523	HJ 2897AB	2000.600	1	330.7	8.11	12.1	13.2	K5	K4	2MASS	2MASS	¿?	C, 177
		2005.640	3	332.0	8.16					OMG	CCD		
19503+4126	HJ 1444AB	1998.393	1	302.8	10.16	12.9	12.4	F9	K/M III	2MASS	2MASS	OPT?	C, 179, #16
		2005.640	3	302.9	10.26					OMG	CCD		
19542+4104	HJ 1452AB	1998.391	1	234.9	8.09	11.8	12.5	K2III	F7	2MASS	2MASS	OPT	C, 179
		2005.640	3	235.7	8.22					OMG	CCD		
19543+3210	HJ 1451AB	1998.356	1	231.6	10.73	10.08	11.6	A4	F5	2MASS	2MASS	OPT?	C, 179, #17
		2005.640	3	231.4	10.62					OMG	CCD		

Table 3 continued on next page.

Table 3 (conclusion): Relative Astrometry, Photometry, Spectral Data and Nature of Measured Double Stars

WDS Id.	Discover + Num.	Epoch	N	θ (°)	ρ (")	V_A	V_B	SP_A	SP_B	Obs.	Method	Type	Notes
19569+0816	HJ 2847 AB	1991.548	1	43.7	13.98	10.83	10.76	F5	A9	ARU	DSS	OPT	C, 177, #18
		1995.557	1	45.3	14.01					ARU	DSS		
		2000.562	1	44.1	14.94					2MASS	2MASS		
		2005.640	3	44.2	14.89					OMG	CCD		
20502-0640	FMR 17AB	1998.804	1	331.7	4.09	17.02	18.24	M1.5V	M2.5V	2MASS	2MASS	PHY?	#1, new
		2000.673	1	332.5	4.16					SDSS	SDSS		
22117-2044	FMR 18AB	1977.546	1	304.0	13.02	13.7	15.9	M3.5V	M4.0V	FMR	DSS	PHY	#1, new
		1984.774	1	305.6	12.75					FMR	DSS		
		1991.753	1	302.6	12.87					FMR	DSS		
		1994.774	1	302.8	12.93					FMR	DSS		
		1998.504	1	299.7	16.15					2MASS	2MASS		
23046+5122	DBR 2AB	1983.675	1	94.1	12.05	11.71	12.8	K1III	K2III	FMR	DSS	OPT?	
		1983.675	1	93.9	12.16					FMR	DSS		
23049+5119	DBR 3AB	1954.583	1	32.6	23.16	11.3	13.2			FMR	DSS	OPT?	
		1983.675	1	31.4	23.16					FMR	DSS		
		1983.675	1	31.5	23.39					FMR	DSS		

Notes:

1. A detailed study about FMR 17 and FMR 18 will be published in the next number of JDSO.
2. Magnitudes came from "Extension of ICRF for selected areas down to V=16" (Camargo et al. 2003)
3. STF 892: located at 5.8 arc minutes from WDS position; the accurate coordinate is : 06h 19m 51.50s +12d 17' 34.50". Spectral types determined in this work: K2V: for primary and A0 for secondary. Henry Draper Catalog lists K0 and A7. In the catalog "Stellar Spectra in Milky Way Regions. VIII. A region in Orion" (McCuskey 1959) lists G8V and B8. The reddening calculated in this work is E(B-V) = 0.01 (using others reddening maps a value E(B-V) < 0.1 was obtained).
4. Has 3 measures listed in WDS, the last one in 1982 (143 degrees and 24.6")
5. Has 4 measures listed in WDS, the last one in 1998 (249 degrees and 14.1"). The main component is HD 259348 with spectral type K0 (Henry Draper Catalog).
6. Has 4 measures listed in WDS, the last one in 1998 (248 degrees and 15.4"). Incompatible proper motion for the components: optical double star. Luis Lahuerta and Salvador Lahuerta detected a weak star with 13.5 magnitude at 14.42" in direction 216.2 degrees. From JHK photometry it is a F6 star.
7. Has 4 measures listed in WDS, the last one in 2000 (87 degrees and 17.2")
8. Double star located at 6 arcminute from WDS position. The accurate coordinate is AR: 13h 10m 18.09s and DEC: +03d 33' 26.0".
9. Doubtful identification. Double star located at 5.4 arc minutes from WDS position. The accurate coordinate is AR: 18h 36m 56.47s and DEC: +30d 31' 29.6".
10. A is a F0V star [Michigan Catalog, vol.5, Houk 1999]; In Milky Way; possible large reddening. LIADA not corrected by reddening.
11. A is a B2.5V star. It has a close companion to < 0.1 arcsec in direction 202 degrees (only measured in 1991).
12. UCAC2 lists combined proper motion of +41±5 and +33±2 mas/yr.
13. The accurate coordinate is 19h 36m 10.92s –4d 38' 25.52".
14. Doubtful identification.
15. The accurate coordinate is 19h 46m 58.44s +12d 31' 43.9".
16. The accurate coordinate is 19h 50m 14.70s +41d 26' 28.7".
17. A = HD 331501; in literature A is a A0 star [Neterov et al. 1995]; In Milky Way; possible large reddening. not corrected by reddening.
18. A weak star of 14.4 magnitude was observed at 6.2 arc seconds to A in direction of 225 degrees. From JHK 2MASS photometry, in this work we deter-

mined a spectral type of G. The nature of this pair could not be determined due to lack of data.

19. Discovered in 2003 (Arnold 2004) by the amateur Dave Arnold (33 deg and 79 arcsec). Their components are F8 (PPM catalog) and M1 ("Catalogue of Stellar Spectral Classification") stars according to the literature. In this work I obtained spectral types of F9III and M4III. Hipparcos parallax likely is in error because the distance is not in agreement with the spectral type determined in this work.
20. Discovered in 2003 by Hungarian amateurs (264 deg and 19.2 arcsec). In this work I obtained spectral types of G/K and F6V.

(Continued from page 268)

published in the professional literature.

Table 4 lists components with known spectral types and luminosity classes in the literature. LIADA spectral type estimates are also listed. The difference (in subclass) is listed in column "differ".

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 motions and relative astrometry) data were used. For a detailed explanation about this classification and about the criteria used to obtain the nature of a double star, read the work published by Benavides *et al.* (2010).

The historical relative astrometry (θ corrected by precession and proper motions) in addition to our own measures are plotted in a 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 of nearly all the methods that allow us to know their nature used it. If a double star is physical then this 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 (see the previous section).

Finally the photometric and astrometric data are analyzed using several methods or criteria that allow us to classify visual double stars according to their nature (Benavides *et al.* 2010).

Table 3 shows in column (13) the conclusion of this study. Of the 37 visual double stars measured, LIADA studied the nature of all of them but HJ 1432 AB. About 78% (29 visual double stars) were optical or optical suspected while only 5-6 % (2 doubles) were physical or physical suspected. No common origin pairs were found.

About 14 % of the visual double stars have an undetermined nature due to insufficient or no accurate data and more astrometric and photometric data are needed. Figure 2 shows the distribution of the nature of double stars studied by LIADA. The results have been very similar to those of the last year. As in previous surveys the very low percent of physical pairs did not surprise us because we previously knew of the low astrophysical interest in long neglected and unconfirmed visual double stars where the most of them are bona-fide or candidate optical pairs.

Acknowledgments

This report made use of data from the Two Micron All Sky Survey (2MASS), 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.

Table 4: Comparison between LIADA's spectral types and spectral types in the literature

Name#1	Name#2	Mg V	Sp_Lit	Sp_LIADA	Differ.
GSC 739-1246	STF 892 A	10.44	G8V	K2V	-4
HD 173724	HJ 5502 A	9.46	F5V	F8V	-3

Note.- The spectral type for HJ 5502 A estimated by LIADA was corrected by reddening (calculated in this work) of E(B-V) = 0.10.

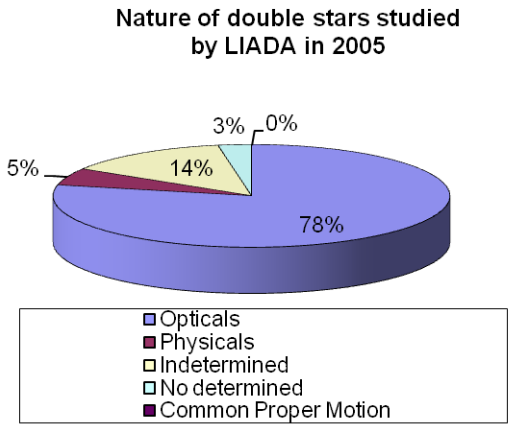

Figure 2: Study of the visual double stars' nature. Most of the neglected and unconfirmed visual double stars are optical pairs with no astrophysical interest.

The *Guide Star Catalog-I* was produced at the Space Telescope Science Institute under a U.S. Government grant. These data are based on photographic data obtained using the Oschin Schmidt Telescope on Palomar Mountain and the UK Schmidt Telescope. The *Guide Star Catalogue-II* is a joint project of the Space Telescope Science Institute and the Osservatorio Astronomico di Torino. Space Telescope Science Institute and is operated by the Association of Universities for Research in Astronomy, for the National Aeronautics and Space Administration under contract NAS5-26555. The participation of the Osservatorio Astronomico di Torino is supported by the Italian Council for Research in Astronomy. Additional support is provided by European Southern Observatory, Space Telescope European Coordinating Facility, the International GEMINI project and the European Space Agency Astrophysics Division.

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This publication has made use of the Washington Double Star Catalog, UCAC2 and USNO-B1.0 maintained at the U.S. Naval Observatory.

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References

Arnold, D. 2004, DSO, 10, 6.

Benavides, R., Rica, F., Reina, E., Castellano, J., Naves, R., Lahuerta, L., Lahuerta, S. 2010, JDSO, **6**, 30.

Camargo, J.I.B., Ducourant, C., Teixeira, R., Le Campion, J.-F., Rapaport, M., Benevides-Soares, P. 2003, A&A, 409, 361.

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

Hambly, N. C., MacGillivray, H. T., Read, M. A., et al. 2001a, MNRAS, **326**, 1279.

Hambly, N. C., Irwin, M. J., & MacGillivray, H. T. 2001b, MNRAS, **326**, 1295.

Hambly, N. C., Davenhall, A. C., Irwin, M. J., & MacGillivray, H. T. 2001c, MNRAS, **326**, 1315.

Houk N., Swift C., 1999, Department of Astronomy, University of Michigan, Ann Arbor, Michigan.

McCuskey, S. W. 1959, ApJS, **4**, 23.

Nesterov, V. V., Kuzmin, A. V., Ashimbaeva, N. T., Volchkov, A. A., Röser, S., Bastian, U. 1995, A&AS, **110**, 367.

Rica, F. 2005, JDSO, **1**, 1.

Urban, S. E., Corbin, T. E., Wycoff, G. L., Hoeg, E., Fabricius, C., Makarov,V. V. 1998, AJ, **115**, 1212.

Wroblewski, H., Costa, E. 1999, A&AS, **139**, 25.