CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares (OACP): First Series

Edgardo Rubén Masa Martín

Double Star Section Coordinator
Syrma Astronomical Society (Syrma-MED)
Valladolid, Spain

Email: ermasa_dsa@orange.es
http://www.med.syrma.net/

Abstract: In this paper we present the results of CCD Theta/Rho measurements for 116 double and multiple stars (223 pairs) in 2007. The residuals in angular separation and position angle are computed for binaries with known orbit. Also, studies about the nature of three new pairs are reported. This first series of measurements is integrated in the observational programs that Syrma-MED is developing at present.

Introduction

The measurements reported in this work were carried out by CCD imaging at the Observatorio Astronómico Camino de Palomares (hereafter OACP, Latitude: 41° 39' 59.53296 N; Longitude: 4° 41' 42.15818 W; Altitude: 694.651 m, Valladolid, Spain), during the months July, August and September, 2007. The observation period was of 27 nights on the whole. The measurements reported here were made by using a CCD for the first time, and it is expected that there will be more of them in the future. Because of the experimental nature of this first series, the selections of the pairs that are measured have not followed a specific criterion. The main interest of the work is to calibrate the Meade DSI Pro CCD camera. Our intention is to verify the response of the equipment in the measurement of visual double stars. This is the reason why pairs of all kinds were chosen: close and wide pairs (the angular separation measured ranging from 2.5" to 421"), systems with great Delta-M, and others of equal magnitudes. The residuals in angular separation and position angle are computed for three binaries with known orbit. In addition to this, fixed and relatively fixed systems were measured for calibration purposes. We include pairs measured recently (2006), others relatively neglected (last measurement in the 1990's) as well as a few others with a unique official measure, so they have been, finally, confirmed. During the data reduction process, we found three uncataloged pairs near well-known ones. They have been evaluated for binarity with regular methods which were used before in previous articles (Masa, 2007) and we propose they be included in WDS.

No filter was used for the observations.

The Telescope

The main instrument of the OACP is a Newtonian telescope (D = 200 mm; F = 1,000 mm) mounted equatorially. It has been used at the prime focus as well as by attaching Barlow lens: Takahashi 2x and Meade Telenegative 3x. The mounting of the telescope does not have a GOTO system. For this reason, the pairs were located by using the settings circles. A refractor telescope (D = 70 mm; F = 700 mm) in parallel with the reflector and an illuminated reticle eyepiece were used to help in centering the desired object. This auxiliary element made locating tasks on the computer screen easier. At the same time, the software Guide 8.0 showed the expected stellar

Figure 1: The OACP Observatory is operative since October 2002.

field of the target area. Figure 1 shows the observatory building and the main telescope.

The Camera and the Image Acquisition Software

The camera, a Meade DSI Pro, incorporates the CCD monochrome image sensor, the Sony ICX254AL with EXview HAD CCD™ technology (Hole Accumulation Diode). The geometrical features of this sensor are shown in Table 1.

The raw frames have a resolution of 508 x 489 pixels. Nevertheless, this format was not used for the measurements. The image acquisition software provided by Meade (*Envisage*) allows resampling the raw image in real time. The geometrical correction is made internally by *Envisage* and gives a definitive image of 648 x 488 pixels, emulating square pixels of 7.5 x 7.5 µm size.

Envisage is powerful and versatile software capable of integrating hundreds of images into only one final image in real time. Generally, this composite image has a good signal to noise ratio. The real power of this algorithm, similar to *Lucky Imaging* techniques, consists of the addition of many short-exposure images. By doing this, the effects of the atmospheric turbulence are worked out, by means of "freezing" the seeing practically. We have been able to obtain good results on especially turbulent nights under very poor seeing conditions. Despite the live image continuously "dancing", the software could make a final composite image which was perfectly measurable. To obtain this digital frame, the main requirement is that the exposure times be as short as possible. The typical exposure times ranked from 0.02 to 1 second, depending on the stellar magnitudes and the quality of the sky. To align and to combine the images of the series, it is useful to select a star from the field (the main component, normally) which can serve as the reference. Only the images of high enough quality are used. They are evaluated continuously by *Envisage* in every partial frame. In general, the combined image was the result of adding at least 50 partial images and the total exposure time was around 25 seconds. The eventual polar misalignments and/or tracking errors are not critical factors and this is another advantage of this technique. Finally, another interesting feature of the software is that it allows the images to be pre-processed automatically beforehand. In this way, if the exposure time is set to one second, then the software will subtract the dark frames (which are taken at the

Image size	Diagonal 6 mm (Type 1/3)
No. of effective pixels	510 (H) × 492 (V) ≈ 250K pixels
Total number of pixels	537 (H) × 505 (V) ≈ 270K pixels
Chip size	6.00 mm (H) × 4.96 mm (V)
Image area size	4.8 mm (H) × 3.6 mm (V)
Unit cell size	9.6µm (H) × 7.5µm (V)

Table 1: Geometry of the Sony ICX254AL CCD sensor

beginning of the session). The image obtained after this action is the definitive one and, ordinarily, will be used to in making the measurements.

For the correct focusing of the stars we used a Hartman's mask with three triangular holes.

Instrumental constants

For each optical train, the “instrumental constants”, that is, the image scale in arsec/pixel and the orientation of the CCD sensor with regard to the sky's cardinal points, was determined by several methods:

i) The *Astrometrica* software (version 4.4.2.366) by Herbert Raab was used (when the images contained enough number of reference stars) jointly with the UCAC2 as reference star catalog. We obtained the scale and the orientation with this early reduction.

ii) We have measured several calibration pairs. They have been extracted from a list compiled by three members of The Double Star Commission of the French Astronomical Society (SAF): Guy Morlet and Florence and Pascal Mauroy (available for downloading at http://saf.etoilesdoubles.free.fr/). Thirty-two stable pairs made up this list and it is based on the results of the Hipparcos satellite. Whenever possible, two different reference pairs were registered every night; one at the beginning and another at the end of the observation.

iii) The new *Catalog of Rectilinear Elements* (http://ad.usno.navy.mil/wds/lin1.html) was used. Many systems in the Washington Double Star Catalog have shown significant relative motion since their discovery. The *Catalog of Rectilinear Elements* provides linear fits for those systems whose motion does not appear to be Keplerian. While a few of these may in fact be very long-period physical pairs whose orbital motion is not yet apparent, most are probably optical pairs. These linear fits, then, describe the relative proper motions between these pairs of stars and this property is very useful for CCD calibration. The predicted positions for the observation date were calculated by using a linear regression over the ephemerides of the catalog. Those values were compared to our measurements.

iv) Another auxiliary method was used for the orientation of the CCD chip. It made use of a function implemented in *Reduc* (the software of reduction; see next section), which was specifically designed for this purpose. First, with tracking turned off, a series of star trails in right ascension were recorded. Drift analysis is then carried out by reduction software after knowing the theoretical orientation of the transit frame (i.e., where the North/East cardinal points were). As a rule, four-trail measurements give an average final value of the sensor orientation. This procedure has yielded excellent results so far. Typically, the values of rotation of the sensor in relation to the sky never exceeded ± 1º. This was feasible because the camera was oriented as exactly as possible with the East/West line at the beginning of the observation.

The figures obtained by these four methods were equivalent for the same field. The calibration results for each different optical configuration are shown in Table 2.

Optical train	Escale (a.s./pixel)	Effective Focal Length (mm)	Focal Ratio (f/)	FOV (arcminutes)
Prime focus	1.55	1,000	5	12.6 x 16.7
Barlow 2x (2.26)	0.68	2,260	11.3	5.6 x 7.4
Barlow 3x (3.48)	0.44	3,480	17.4	3.6 x 4.8

Table 2. Instrumental constants

Reduction Software

Florent Losse’s *Reduc* software (version 3.80) was used to measure theta and rho from the CCD images. Lately, this software has spread impressively at an international level. More and more followers are using this tool in double star astronomy. It is undoubtedly, a fundamental piece, as well as an irreplaceable tool for relative astrometry tasks. The software has many features. Perhaps the most important feature is that *Reduc* is developed especially to measure double stars from images from webcams and CCD imagers. *Reduc* has an intuitive and friendly interface. The calculations are mostly made in an automatic way and it has an excellent set of tools. Among its special features, its power is the most noteworthy one: it is able to measure correctly over images with very saturated stars and over pairs with defective signal to noise ratio. *Reduc* can make a successful measurement for pairs whose magnitudes are very different. In such cases, almost unfailingly, it is necessary to either saturate or overexpose the main component so the dim component of the pair can be registered. This is one of the most important handicaps that appear while working with CCD images. We have been able to use observations made on the systems whose main star appears so saturated that even a "cross" is visible. These four orthogonal spikes (in our case) are produced by the diffraction of the spider vanes supporting the small

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

secondary mirror, whereas the weak component disguised by the principal's glare is hardly seen. Even in such extreme cases the algorithms of *Reduc* are able to find the centroids successfully.

Reduc is developed continuously by its author. In the last version (3.82) Florent Losse has introduced new and interesting functions. Among them, reading FITS images of 8, 16 and 32 bit integers; FITS 32 bit real, BMP, AVI-BMP conversion; darks and bias pre-processing; crop images; drift calibration; shift and add features; binning x2; Multilanguage platform (French, English, Spanish, and Italian).

Reduc, also includes Surface which is another powerful measurement algorithm, based in the adjustment of a three-dimensional surface. This feature uses the surface algorithm especially designed to measure very tight stars. Developed by Guy Morlet and Pierre Bacchus to measure the images acquired on the 50 cm refractor at the Nice Observatory, it was reserved for the private usage of the members of the SAF. Now, it is integrated in *Reduc* with the authorization and by courtesy of the authors.

Finally, *Reduc* works well under Windows, Linux and Wine, and the author provides the latest version for free at florent_losse@yahoo.fr.

To obtain further information about *Reduc* visit http://www.astrosurf.com/hfosaf/

The Measures

The results of measurements are presented in Table 3. A total of 223 measurements are listed. They belong to 116 double or multiple systems. The data structure in the table is as follows:

Columns 1 and 2: Identifier of the WDS catalog and name of the system. Note: the new pairs are labeled in Column 1 as "uncat". The precise coordinates (J2000) for the main star are reported in the section Discoveries.

Columns 3 and 4: Magnitudes for each component, given in WDS catalog. Note: the V magnitudes that we have calculated in this work are highlighted with boldface type.

Column 5: The epoch of the observation, given in fractional Besselian year.

Column 6: Position Angle.

Column 7: Angular Separation.

Column 8: Number of composite images measured for each pair.

Column 9: Number of nights.

Column 10: Notes.

The mean internal uncertainties for Theta and Rho (given as the average of standard deviation of all measurements) were 0.12º and 0.08" respectively (Figures 2 and 3).

Three reference patterns were used in order to evaluate the accuracy of our measurements: three orbital pairs, 10 stable pairs based upon the results of Hipparcos mission and 10 pairs included in the Catalog of Rectilinear Elements. In all the cases the residuals (O-C) were calculated between the observed positions and the calculated ones. Two of the three orbital systems measured are of grade 5, so that (due to the imprecision of the orbit solution) the residuals are more marked. The residuals are shown in Tables 4, 5 and 6.

A comparative review of the residuals in Tables 5 and 6 was made. We calculated the Root Mean Square (RMS) of the residuals or Quadratic Mean by using Theta/Rho residuals of the two former tables. The

(Continued on page 30)

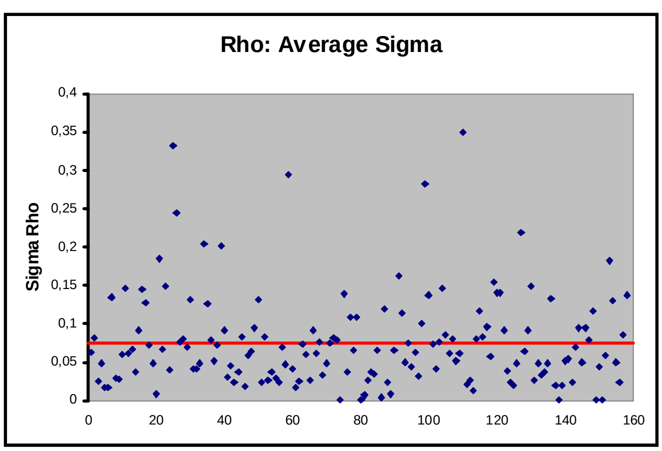

Figure 2: Internal errors in Position Angle.

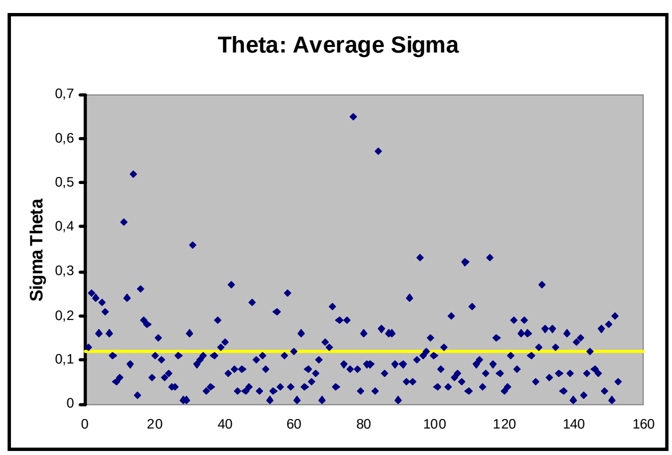

Figure 3: Internal errors in Separation.

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

WDS Id.	Discoverer	WDS Mag. 1	WDS Mag. 2	Epoch	Theta (deg)	Rho (a.s.)	N img.	Nights	Notes
00013+6021	STTA254AB	7.40	8.33	2007.6386	89.67	56.991	4	1	1
00013+6021	STTA254AC	7.40	9.56	2007.6386	323.87	155.535	3	1	1
00013+6021	STTA254AD	7.40	10.35	2007.6386	118.07	181.467	4	1	1
00013+6021	STTA254BD	8.33	10.35	2007.6386	129.71	134.153	4	1	1
Uncat	MRI 4	**11.99**	**12.31**	2007.6386	359.78	21.375	2	1	2
00056+7617	HJ 3237	8.93	12.15	2007.6688	308.89	48.982	2	1	3
00084+2905	H 5 32Aa-B	2.22	11.11	2007.5703	283.86	90.625	1	1	4
00116+5945	BU 254AB	8.00	12.00	2007.6426	239.34	7.714	7	2	5
00116+5945	BU 254AC	8.00	12.70	2007.6426	240.78	37.240	5	2	5
00141+7601	STTA 1	7.39	7.81	2007.6688	103.86	73.430	3	1	6
00152+5947	HJ 1008AB	8.12	11.31	2007.6385	125.29	21.698	3	1	7
00152+5947	ABH 2AD	8.06	13.08	2007.6385	147.07	78.852	3	1	7
00152+5947	ABH 2AE	8.06	14.20	2007.6385	58.27	106.226	4	1	7
00152+5947	ABH 2AF	8.06	14.10	2007.6385	340.60	58.698	3	1	7
00152+5947	ES 1BC	11.60	13.30	2007.6385	226.52	10.140	4	1	7
00152+7801	STF 11	8.48	10.14	2007.6689	192.84	8.155	3	1	8
00170+6132	BU 392	5.73	12.48	2007.6659	71.07	19.450	2	1	9
00327+2312	BU 1310AC	6.80	12.50	2007.6880	276.26	27.217	6	1	10
00327+2312	BU 1310AD	7.10	9.20	2007.6880	154.83	94.376	5	1	10
00355+5841	STF 38	8.66	8.97	2007.6740	144.53	17.045	5	1	11
00362+2402	HO 623	7.30	12.30	2007.6880	155.24	9.067	4	1	12
00393+3052	BU 491AB	3.25	12.44	2007.6878	298.04	28.936	4	1	13
00399+2126	STF 46	5.56	8.49	2007.6881	194.98	6.568	5	1	14
00400+7652	STTA 5	6.86	8.78	2007.6689	141.90	118.027	3	1	15
00403+2403	STF 47AB	7.25	8.82	2007.6879	205.37	16.650	7	1	16
00403+2403	BU 1348AC	7.21	11.10	2007.6879	232.84	46.706	4	1	16
00403+2403	BU 1348BC	9.51	11.10	2007.6879	246.48	32.924	3	1	16
00405+5632	H 5 18AD	2.35	8.98	2007.6795	282.23	70.490	3	1	17
00444+7713	STF 50	8.01	10.62	2007.6690	95.74	22.104	3	1	18

Table 3: Relative astrometry of the observed pairs.

Table continued on next page.

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

WDS Id.	Discoverer	WDS Mag. 1	WDS Mag. 2	Epoch	Theta (deg)	Rho (a.s.)	N img.	Nights	Notes
00464+3057	STFA 1	7.25	7.43	2007.6879	46.79	47.594	4	1	19
00491+5749	STF 60AB	3.52	7.36	2007.6768	320.39	12.965	6	2	20
01170+3828	STF 104	8.03	9.83	2007.6851	322.87	13.822	4	1	21
01188+3724	STF 108	6.52	9.57	2007.6850	63.75	6.350	3	1	22
01201+3639	WEI 3	8.93	9.82	2007.6850	187.29	4.912	4	1	23
01317+6103	STF 128	7.80	9.50	2007.6414	309.17	11.283	3	1	24
01317+6101	STI 228	12.60	13.50	2007.6414	333.43	5.970	3	1	25
01321+1657	STF 132AB	6.88	10.61	2007.6304	342.12	61.993	8	1	26
01321+1657	STF 132AC	6.80	10.90	2007.6304	247.87	67.752	4	1	26
01321+1657	STF 132AD	6.90	10.00	2007.6304	109.42	115.662	3	1	26
01321+1657	STF 132DF	10.00	10.60	2007.6304	288.87	5.053	2	1	26
01332+6041	STF 131AB	7.30	9.90	2007.6415	143.15	13.870	2	1	27
01332+6041	STF 131AC	7.23	11.80	2007.6415	145.42	28.030	3	1	27
01332+6041	STF 131BC	9.90	11.80	2007.6415	147.63	14.181	2	1	27
01332+6041	FLE 2AD	7.23	11.74	2007.6415	120.90	46.300	2	1	27
01332+6041	FLE 2AE	7.30	10.62	2007.6415	135.97	82.161	2	1	27
01349+1234	STF 136AB	7.33	8.33	2007.6306	77.30	15.510	4	1	28
01535+1918	STF 180AB	4.52	4.58	2007.6374	0.20	7.423	9	2	29
01535+1918	STF 180AC	4.52	8.63	2007.6374	80.63	217.590	3	2	29
01535+1918	STF 180BC	4.58	8.63	2007.6374	82.49	216.512	3	2	29
01581+4123	S 404AB	7.64	7.64	2007.6307	83.67	28.992	2	1	30
01581+4123	S 404BC	9.60	12.50	2007.6307	100.92	83.471	4	1	30
02011+3518	STF 197AB	8.21	9.30	2007.6184	232.68	36.943	2	1	31
02011+3518	STF 197AC	8.10	14.00	2007.6184	73.71	40.749	2	1	31
02039+4220	STF 205A-BC	2.31	5.02	2007.6442	62.48	9.107	6	2	32
02103+3322	STF 219	8.03	8.89	2007.6183	183.09	11.582	3	1	33
02109+3902	STF 222	6.05	6.71	2007.6442	36.00	16.692	7	2	34
02187+3429	STF 246	7.82	9.26	2007.6447	123.33	9.825	9	3	35
02336+3125	HJ 653	7.40	11.10	2007.6416	42.67	23.142	2	1	36

Table continued on next page.

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

WDS Id.	Discoverer	WDS Mag. 1	WDS Mag. 2	Epoch	Theta (deg)	Rho (a.s.)	N img.	Nights	Notes
02390+6235	STTA 28	6.65	7.56	2007.666	147.71	67.887	3	1	37
02420+4248	HJ 1123	8.39	8.46	2007.6199	248.67	20.059	3	1	38
02425+4016	STF 292	7.56	8.23	2007.6252	211.92	23.121	3	1	39
02451+5708	STI1936	8.20	12.80	2007.6253	217.85	9.927	2	1	40
02454+5634	STF 297Aa-B	8.55	8.87	2007.6553	278.28	15.884	10	2	41
02454+5634	STF 297Aa-C	7.80	10.40	2007.6553	108.01	28.779	10	2	41
02454+5634	STF 297BC	7.80	10.40	2007.6553	104.48	44.503	10	2	41
02456+5709	STI1937	12.20	12.80	2007.6253	30.51	5.813	4	1	42
02476+5357	STF 301	7.85	8.70	2007.6854	16.38	8.278	3	1	43
02507+5554	STF 307AB	3.76	8.50	2007.6471	300.46	28.750	8	2	44
02507+5554	STF 307AC	3.76	9.90	2007.6471	270.22	68.877	8	2	44
02507+5554	WAL 19AF	3.76	11.44	2007.6471	24.72	57.473	6	2	44
02507+5554	WAR 1CD	9.90	10.40	2007.6089	116.01	5.139	3	1	44
02507+6249	STI 396AB	8.70	10.80	2007.6661	148.22	11.504	5	1	45
02507+6249	SIN 5AD	8.70	13.00	2007.6661	95.01	39.365	4	1	45
02507+6249	SIN 5AF	8.70	12.80	2007.6661	267.15	92.169	4	1	45
02507+6249	SIN 5AG	8.70	14.40	2007.6661	262.18	128.845	2	1	45
03068+4545	ES 558	7.65	10.62	2007.6363	0.12	8.252	4	1	46
03136+3909	STF 364	8.73	8.92	2007.6293	310.82	11.742	2	1	47
03215+4523	HO 319AB	7.50	11.80	2007.6362	47.42	11.574	2	1	48
03215+4523	HO 319AC	7.50	14.50	2007.6362	302.92	9.994	2	1	48
Uncat	MRI 3AD	7.50	12.01	2007.6362	267.10	155.649	3	1	48
03293+4503	STF 391	7.60	8.32	2007.6362	95.04	4.312	2	1	49
03294+4656	STT 55AB	6.24	10.80	2007.6361	295.38	31.053	3	1	50
03294+4656	A 982BC	10.80	13.80	2007.6361	238.67	3.651	3	1	50
03294+4656	A 982BD	10.80	14.50	2007.6361	301.98	21.187	2	1	50
03294+4656	A 982BE	10.80	14.00	2007.6361	273.80	44.724	2	1	50
03294+4656	A 982EF	14.00	14.70	2007.6361	307.77	2.632	2	1	50
03316+4752	STT 56AB	6.76	10.67	2007.6361	352.43	32.675	2	1	51

Table continued on next page.

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

WDS Id.	Discoverer	WDS Mag. 1	WDS Mag. 2	Epoch	Theta (deg)	Rho (a.s.)	N img.	Nights	Notes
03316+4752	WAL 23AC	6.76	12.51	2007.6361	47.29	45.824	4	1	51
03332+4615	ES 560	8.33	11.29	2007.6362	142.45	9.633	3	1	52
03541+3153	STF 464AB	2.85	9.16	2007.6171	208.03	12.818	2	1	53
03541+3153	STF 464AC	2.85	11.24	2007.6171	287.07	32.713	4	1	53
03541+3153	STF 464AD	2.86	10.44	2007.6171	195.41	98.317	2	1	53
03541+3153	STF 464AE	2.86	9.96	2007.6171	185.61	119.972	2	1	53
03541+3153	STF 464CD	11.24	9.90	2007.6171	177.16	104.450	2	1	53
03541+3153	STF 464CE	11.24	9.90	2007.6171	171.38	130.454	2	1	53
03541+3153	STF 464DE	10.44	9.96	2007.6171	149.67	28.518	2	1	53
03541+3153	SLV 2BC	9.16	11.24	2007.6171	309.61	32.775	2	1	53
03541+3153	SLV 2BD	9.16	10.44	2007.6171	193.54	85.855	2	1	53
03573+4153	STF 469	6.90	9.92	2007.6389	145.57	9.060	4	1	54
04009+2312	STF 479AB	6.92	7.76	2007.6855	127.02	7.510	4	1	55
04009+2312	STF 479AC	6.92	9.45	2007.6855	241.31	58.320	5	1	55
04078+6220	STF 485AC	6.91	10.39	2007.6664	0.03	11.032	3	1	56
04078+6220	STF 485AD	6.91	14.10	2007.6664	132.05	14.398	2	1	56
04078+6220	STF 485AE	6.91	6.94	2007.6664	305.01	17.871	2	1	56
04078+6220	STF 485AF	6.91	12.20	2007.6664	320.05	36.294	4	1	56
04078+6220	STF 484AG	6.91	9.63	2007.6664	260.59	60.142	2	1	56
04078+6220	STF 484AH	6.91	10.50	2007.6664	256.71	57.120	3	1	56
04078+6220	STF 484AI	6.91	9.81	2007.6664	278.94	69.564	3	1	56
04078+6220	STF 485AL	6.91	10.40	2007.6664	71.47	98.401	2	1	56
04078+6220	STF 485AO	6.91	9.40	2007.6664	77.81	138.788	2	1	56
04078+6220	HZG 2AN	6.91	9.62	2007.6664	206.22	116.186	2	1	56
04078+6220	WSI 20AQ	6.91	13.20	2007.6664	324.56	45.623	3	1	56
04078+6220	STF 485EC	6.94	11.70	2007.6664	87.13	14.642	2	1	56
04078+6220	STF 485EF	6.94	11.90	2007.6664	333.78	19.581	2	1	56
04078+6220	STF 485EG	6.94	9.63	2007.6664	245.79	49.004	2	1	56
04078+6220	STF 484EH	6.94	10.50	2007.6664	240.23	47.165	3	1	56

Table continued on next page.

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

WDS Id.	Discoverer	WDS Mag. 1	WDS Mag. 2	Epoch	Theta (deg)	Rho (a.s.)	N img.	Nights	Notes
04078+6220	STF 484EI	6.94	9.81	2007.6664	270.62	54.062	3	1	56
04078+6220	WSI 20EQ	6.94	---	2007.6664	336.4	29.407	4	1	56
04078+6220	WSI 20FQ	12.20	13.20	2007.6664	342.12	9.842	2	1	56
04078+6220	STF 484GH	9.63	10.50	2007.6664	131.88	5.494	2	1	56
04078+6220	STF 484GI	9.63	9.81	2007.6664	335.73	22.688	2	1	56
04078+6220	STF 484HI	10.50	9.81	2007.6664	331.25	27.371	5	1	56
04078+6220	HZG 2IJ	9.81	12.00	2007.6664	155.89	60.388	2	1	56
04078+6220	HLM 3LM	10.40	11.40	2007.6664	215.55	5.401	4	1	56
04078+6220	HZG 2LO	10.40	9.40	2007.6664	92.64	42.425	5	1	56
04078+6220	HZG 2OP	9.40	---	2007.6664	228.79	17.292	5	1	56
04089+2306	STF 494	7.53	7.65	2007.6855	188.65	5.321	2	1	57
04198+2344	STF 523AB	7.58	9.86	2007.6854	163.30	10.471	6	1	58
04198+2344	STF 523AC	7.58	8.92	2007.6854	49.83	109.427	4	1	58
04240+2418	STF 534AB	6.36	7.94	2007.6854	290.56	29.213	5	1	59
04335+1801	STF 559	6.97	7.02	2007.6692	277.02	2.812	2	1	60
04588+4408	STF 613AB	8.59	9.58	2007.6445	99.65	11.859	3	1	61
04588+4408	STF 613AC	8.59	10.90	2007.6445	51.62	21.158	3	1	61
04588+4408	STF 613BC	9.90	10.90	2007.6445	17.67	15.872	2	1	61
05003+3924	STT 92AB	6.02	9.50	2007.6691	281.64	4.045	3	1	62
05091+4907	STT 96	6.67	11.10	2007.6554	105.11	21.171	8	2	63
05138+4658	STT 101	7.59	10.64	2007.6663	184.02	5.961	3	1	64
05167+1826	STF 670A-Bb	7.72	8.28	2007.6883	165.28	2.499	3	1	65
05175+2008	STF 674	6.82	9.68	2007.6882	148.33	10.081	4	1	66
05185+1800	J 1818	9.00	10.50	2007.6883	354.02	6.121	5	1	67
05189+4515	STF 669	8.44	8.97	2007.6445	278.38	9.878	3	1	68
05192+2008	STF 680	6.22	9.66	2007.6882	203.82	9.107	6	1	69
05207+4658	STF 681	6.61	9.21	2007.6553	182.34	23.325	7	2	70
05232+4701	STT 104	7.10	11.10	2007.6554	190.15	21.092	10	2	71
05243+2008	HU 447	8.40	12.90	2007.6882	210.60	4.944	7	1	72

Table continued on next page.

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

WDS Id.	Discoverer	WDS Mag. 1	WDS Mag. 2	Epoch	Theta (deg)	Rho (a.s.)	N img.	Nights	Notes
05323+4924	STF 718AB	7.47	7.54	2007.6444	73.45	7.785	2	1	73
05323+4924	STF 718AC	7.47	11.22	2007.6444	186.41	117.867	3	1	73
05351+0956	STF 738AB	3.51	5.45	2007.6882	43.97	4.206	3	1	74
05364+2200	STF 742	7.09	7.47	2007.6884	274.04	4.056	6	1	75
05413+2929	STF 764	6.38	7.08	2007.6856	14.01	26.071	4	1	76
05425+2951	BU 14	7.30	10.50	2007.6856	192.26	5.025	7	1	77
12492+8325	STF1694AB	5.29	5.74	2007.5729	326.31	21.397	1	1	78
12492+8325	WAL 63AC	5.29	11.50	2007.5729	222.67	73.323	1	1	78
13126+5827	STF1732AB	8.68	10.42	2007.6303	127.16	25.845	2	1	79
13239+5456	STF1744AB	2.23	3.88	2007.6167	152.96	14.419	8	2	80
14286+2817	STF1850	7.11	7.56	2007.6068	261.78	25.440	4	1	81
14318+3022	HJ 2728	3.58	11.50	2007.6084	345.10	35.045	2	1	82
14596+5352	SHJ 191	6.86	7.57	2007.6031	341.55	40.311	4	1	83
16460+8202	HDO 143	4.23	11.20	2007.6029	0.89	77.410	2	1	84
Uncat	MRI 2	**13.74**	**13.93**	2007.6032	177.44	17.715	5	1	85
17322+5511	STFA 35	4.87	4.90	2007.6032	311.11	62.175	2	1	86
18448+3736	STFA 38AD	4.34	5.62	2007.6155	149.88	43.705	2	1	87
18448+3736	BU 968AC	4.30	13.30	2007.6155	270.18	48.460	3	1	87
18448+3736	BU 968AE	4.30	11.50	2007.6155	298.30	62.026	3	1	87
18501+3322	STFA 39AB	3.63	6.69	2007.6006	148.03	45.615	5	1	88
18501+3322	BU 293AE	3.63	10.14	2007.6006	317.84	67.372	4	1	88
18501+3322	BU 293AF	3.63	10.62	2007.6006	18.43	86.516	5	1	88
18501+3322	BU 293BE	6.69	10.14	2007.6006	321.97	112.500	5	1	88
18501+3322	BU 293BF	6.69	10.62	2007.6006	1.53	120.776	4	1	88
18501+3322	BU 293EF	10.14	10.62	2007.6006	66.08	79.349	5	1	88
18562+0412	STF2417AB	4.59	4.93	2007.6686	103.59	22.411	6	1	89
18562+0412	STF2417AC	4.59	6.78	2007.6686	58.10	420.965	3	1	89
18562+0412	STF2417BC	4.93	6.78	2007.6686	55.84	405.583	4	1	89
19171+0920	STT 370AB	8.34	8.71	2007.6687	14.07	19.686	7	1	90

Table continued on next page.

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

WDS Id.	Discoverer	WDS Mag. 1	WDS Mag. 2	Epoch	Theta (deg)	Rho (a.s.)	N img.	Nights	Notes
19171+0920	STT 370AC	8.34	----	2007.6687	77.45	22.653	6	1	90
19171+0920	STT 370BC	9.10	----	2007.6687	129.43	22.406	5	1	90
19307+2758	STFA 43Aa-B	3.19	4.68	2007.5895	54.30	34.546	5	1	91
19307+2758	WAL 114Aa-C	3.19	10.99	2007.5950	340.25	65.030	7	2	91
19369+1116	J 133AB	6.07	14.00	2007.6359	57.58	14.802	2	1	92
19369+1116	J 133AC	6.07	12.50	2007.6359	310.27	20.389	2	1	92
19369+1116	WAL 115AD	6.07	11.25	2007.6359	51.09	63.884	3	1	92
19411+1041	STF2558	8.00	10.50	2007.6358	307.16	27.793	2	1	93
19441+1222	STF2567	7.93	9.96	2007.6344	309.96	17.902	5	1	94
19487+1149	STF2583AC	5.70	12.20	2007.6357	296.56	36.092	3	1	95
19523+1021	STF2590AB	6.50	10.31	2007.6058	308.54	13.517	3	1	96
19523+1021	STF2590CD	11.60	12.20	2007.6058	271.94	8.279	5	1	96
19533+1150	STF2593AB	8.70	10.10	2007.6358	242.99	12.182	3	1	97
19533+1150	STF2593BC	10.10	11.40	2007.6358	309.38	3.550	3	1	97
20391+1550	BU 288AC	5.90	10.80	2007.5923	123.80	39.956	3	1	98
20391+1550	BU 288AD	5.90	14.30	2007.5923	147.11	29.268	2	1	98
20391+1550	BU 288AE	5.90	14.30	2007.5923	32.51	21.661	2	1	98
21287+7034	STF2806Aa-B	3.17	8.63	2007.6440	249.10	13.131	3	1	99
22106+7008	STF2883	5.56	8.56	2007.6440	252.06	14.489	5	1	100
22284+5825	H 4 31AB	8.54	10.52	2007.6468	3.74	25.082	4	1	101
22284+5825	ARN 79AC	8.54	9.46	2007.6468	320.21	78.747	3	1	101
22292+5825	BU 702AB	4.21	13.00	2007.6467	284.24	20.918	2	1	102
22292+5825	STFA 58AC	4.21	6.11	2007.6467	191.37	40.798	5	1	102
22330+6955	STF2924AB-C	6.00	10.50	2007.6441	196.73	124.403	3	1	103
22330+6955	STF2924AB-D	6.00	10.20	2007.6441	196.90	187.828	3	1	103
22331+6830	BU 706AC	7.77	10.98	2007.6441	251.03	31.069	3	1	104
22332+7022	STF2923AB	6.32	9.24	2007.6440	47.45	9.681	3	1	105
22332+7022	STF2923AC	6.30	11.30	2007.6440	148.22	96.243	3	1	105
22403+6830	BU 845AB	8.10	12.10	2007.6442	203.36	6.743	2	1	106

Table continued on next page.

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

WDS Id.	Discoverer	WDS Mag. 1	WDS Mag. 2	Epoch	Theta (deg)	Rho (a.s.)	N img.	Nights	Notes
22403+6830	BU 845AC	8.10	13.20	2007.6442	16.36	16.495	2	1	106
22403+6830	FOX 269AD	8.10	13.30	2007.6442	96.78	44.754	3	1	106
22450+6808	STT 529AB	9.08	9.89	2007.6445	200.42	3.765	2	1	107
22450+6808	STT 529AC	9.08	10.81	2007.6445	219.21	20.467	3	1	107
23100+4758	STF2985	7.21	8.02	2007.6808	256.07	15.804	5	1	108
23104+4901	STF2987	7.42	10.41	2007.6823	150.03	4.374	1	1	109
23144+2943	HJ 1858	8.68	11.09	2007.6085	81.90	20.401	2	1	110
23144+2946	HJ 1859	6.41	9.90	2007.6085	122.23	33.923	2	1	111
23144+2946	ARN 26AC	6.45	8.68	2007.6085	181.30	190.888	3	1	111
23177+4901	FOX 273AD	5.01	11.60	2007.6823	233.06	58.569	4	1	112
23461+6028	STF3037AC	7.39	9.53	2007.6388	188.71	29.146	3	1	113
23461+6028	STF3037AD	7.35	10.86	2007.6388	232.76	52.585	3	1	113
23461+6028	STF3037AE	7.35	9.70	2007.6388	62.85	109.943	2	1	113
23461+6028	STF3037AF	7.35	11.13	2007.6388	147.20	123.461	2	1	113
23496+6052	STI1222	9.16	9.57	2007.6373	21.56	11.975	5	1	114
23527+6042	BU 1153AB-C	11.14	12.25	2007.6387	336.24	14.004	4	1	115
23527+6042	BU 1153AB-D	11.14	6.89	2007.6387	66.09	176.945	2	1	115
23531+6042	STT 511AB	6.89	10.58	2007.6387	34.24	9.819	4	1	116
23531+6042	STT 511AC	6.90	14.10	2007.6387	39.71	35.788	3	1	116
23531+6042	STT 511AD	6.90	10.34	2007.6387	130.52	68.322	3	1	116

Table 3 concluded. Notes begin on page 36

WDS Id.	Discoverer	Grade	Reference	Residual (O-C)	
				Theta (°)	Rho (")
00491+5749	STF 60AB	3	Str1969a	-0.08	-0.155
05003+3924	STT 92AB	5	Cve2006e	+0.76	-0.022
05364+2200	STF 742	5	Hop1973b	-0.57	-0.064

Table 4. Residuals of orbital systems measures in this series

WDS Id.	Discoverer	Epoch	Observation (O)		Ephemerides (C)		Residual (O-C)	
			Theta	Rho	Theta	Rho	Theta	Rho
00355+5841	STF 38	2007.6740	144.53	17.045	144.26	16.93	+0.27	+0.115
01349+1234	STF 136AB	2007.6306	77.30	15.510	77.10	15.54	+0.20	-0.030
02109+3902	STF 222	2007.6442	36.00	16.692	35.90	16.69	+0.10	+0.002
02425+4016	STF 292	2007.6252	211.92	23.121	211.57	23.05	+0.35	+0.071
02454+5634	STF 297Aa-B	2007.6553	278.28	15.884	278.64	15.81	-0.36	+0.074
04078+6220	STF 485AE	2007.6664	305.01	17.871	304.73	17.91	+0.28	-0.039
04240+2418	STF 534AB	2007.6854	290.56	29.213	290.74	29.08	-0.18	+0.133
05413+2929	STF 764	2007.6856	14.01	26.071	13.96	26.01	+0.05	+0.061
19171+0920	STT 370AB	2007.6687	14.07	19.686	13.56	19.52	+0.51	+0.166
23100+4758	STF2985	2007.6808	256.07	15.804	256.51	15.61	-0.44	+0.194

Table 5: Residuals of the stable pairs based upon the results of Hipparcos mission (extracted from Morlet-Mauroy's list) o f

WDS Id.	Discoverer	Epoch	Observation (O)		Ephemerides (C)		Residual (O-C)	
			Theta	Rho	Theta	Rho	Theta	Rho
00084+2905	H 5 32Aa-B	2007.5703	283.86	90.625	284.078	90.278	-0.218	+0.347
00444+7713	STF 50	2007.6690	95.74	22.104	95.541	21.937	+0.199	+0.167
00464+3057	STFA 1	2007.6879	46.79	47.594	46.636	47.288	+0.154	+0.306
01321+1657	STF 132AB	2007.6304	342.12	61.993	341.939	62.157	+0.181	-0.164
01581+4123	S 404AB	2007.6307	83.67	28.992	83.358	28.872	+0.312	+0.120
02011+3518	STF 197AB	2007.6184	232.68	36.943	232.556	37.461	+0.124	-0.518
03316+4752	STT 56AB	2007.6361	352.43	32.675	352.300	32.716	+0.130	-0.041
04588+4408	STF 613AB	2007.6445	99.65	11.859	99.286	11.931	+0.364	-0.072
05232+4701	STT 104	2007.6554	190.15	21.092	189.194	21.015	+0.956	+0.077
23144+2943	HJ 1858	2007.6085	81.90	20.401	81.776	20.128	+0.124	+0.273

Table 6: Residuals of the pairs included in the Catalog of Rectilinear Elements

(Continued from page 21)

results (Table 7) showed a great coherency. The RMS values are very similar, either in Theta or in Rho, demonstrating two important statements: 1) the reliability of the ephemerides in both samples, in spite of being small ones and chosen at random; and 2) the regularity and linearity of our procedure of measurement.

Discoveries

Three new pairs were found. These pairs are uncataloged as well as likely true binary systems. One of them is a new companion for a known system. They are listed in order of increasing right ascension.

Because all the new components are located near the galactic plane, we have derived the interstellar reddening for each of them. The total line-of-sight interstellar reddening (hereafter denoted by the suffix "∞") was obtained from the Schlegel *et al.* (1998) maps, using the NED database extinction calculator. This tool is available on-line at the web site http://nedwww.ipac.caltech.edu/forms/calculator.html

This previous reddening was reduced by the expo-

Sample	RMS Theta	RMS Rho
Stable pairs Hipparcos (Morlet-Mauroy)	0.30692019	0.10619275
Catalog of Rectilinear Elements	0.36538062	0.25276016

Table 7: RMS residuals for the two samples

nential law derived by Anthony-Twarog & Twarog (1994), which takes into account the galactic latitude and the distance. The reduction fraction (f) is given by the expression:

$$f = 1 - \exp(-Hr \sin b),$$

where r is the star's distance, b is the galactic latitude, and H is an observational constant equal to 0.008 pc^{-1}.

Using the same methods as used previously (Masa, 2007) in order to analyze data found in the literature, the following conclusions were drawn:

MRI 4

This uncataloged pair is located in the vicinity of STTA254. The main star is in position (J2000) RA = 00h 00m 51.56s and Dec = +60º 23' 06.6". The optical photometry in the literature is not reliable. The Tycho-2 catalog only gives VT magnitude for the principal star, so our study is based on the NIR photometry of 2MASS. For both components, the 2MASS`s quality flag, labeled "AAA", indicates the best quality grade of the JHK magnitudes. First, working with the reddened JHK magnitudes, we derived the preliminary spectral types, those derived by energy distribution, and a crude estimation of the photometric distances, as well. Several standard tables to assign intrinsic V magnitudes and (B – V) and (V – I) color indexes were consulted. The M_{Ks} absolute magnitude of each component by means (V – K_S) color, according to the procedure of Henry *et al.* (2004) was derived (see below). The M_V absolute magnitude came from $M_V = M_{Ks} + (V - K_S)$. In the next step, using the preliminary distances, we corrected the NIR photometry by reddening and extinction (the components are placed near the galactic plane (A: b = -1.875º; B: b = -1.869º). The new set of distance values was used to calculate a more reliable value of reddening. Lastly, in this second iteration of the recursive method, the definitive color excess values are $E(B - V)_0 = 0.025$ and $E(B - V)_0 = 0.023$ for A and B components respectively. The total absorption for the 2MASS magnitudes came from the equations of Fiorucci & Munari (2003):

$$A_J = 0.887\ E(B - V)$$
$$A_H = 0.565\ E(B - V)$$
$$A_{Ks} = 0.382\ E(B - V)$$

We present the results of our reddening study in Table 8.

With the corrected JHK magnitudes, the dereddened optical magnitudes and the colors in the BVRI Johnson-Cousins photometric system were obtained. We used the color transformations presented by Bilir *et al.* (2008) in a recent work. The $(B - V)_0$ and $(R - I_C)_0$ colors are calculated as a function of $(J - H)_0$ and $(H - K_S)_0$ by the equations:

$$(B - V)_0 = 1.622\ (J - H)_0 + 0.912\ (H - K_S)_0 + 0.044$$
$$(R - I)_0 = 0.954\ (J - H)_0 + 0.593\ (H - K_S)_0 + 0.025$$

The average of the results obtained with the following formulae give us the standard V magnitude:

$$(V - J)_0 = 1.210\ (B - V)_0 + 1.295\ (R - I)_0 - 0.046$$
$$(V - H)_0 = 1.816\ (B - V)_0 + 1.035\ (R - I)_0 + 0.016$$
$$(V - K_S)_0 = 1.896\ (B - V)_0 + 1.131\ (R - I)_0 - 0.004$$

Note: the numerical values of the coefficients of the above five transformations are related with the total sample of stars studied by Bilir *et al.*, without taking into account the metallicity.

Next, the $(V - I_C)_0$ color index is derived by means of the Dough West's transformation as a function of the $(J - K_S)_0$ color index (http://members.aol.com/dwest61506/page72.html). This formula assumes an error of 0.05 mag. and is valid in the range [$-0.1 < (J - K_S) < 0.8$]:

	2MASS original data			Colour excess and total absorption							De-reddened 2MASS photometry		
Star	J	H	K_S	b	$E(B-V)_\infty$	$E(B-V)_0$	A_V	A_J	A_H	A_{Ks}	J_0	H_0	$(K_S)_0$
A	9.950	9.410	9.227	+1.875	1.076	0.025	0.079	0.022	0.014	0.010	9.928	9.396	9.217
B	10.037	9.447	9.227	+1.869	1.084	0.023	0.071	0.020	0.013	0.009	10.017	9.434	9.218

Table 8: Colour excess and total absorption for MRI 4

Star	$(B-V)_0$	$(R-I)_0$	$(V-I_C)_0$	$(J-H)_0$	$(H-K_S)_0$	$(J-K_S)_0$	V_0	B_0	$(I_C)_0$	M_{Ks}	M_V	$V-M_V$	d	SpT
A	1.070	0.638	1.210	0.532	0.178	0.710	11.994	13.063	13.204	4.419	7.199	4.745	91	K4V
B	1.186	0.709	1.351	0.583	0.216	0.798	12.308	13.494	13.660	4.679	7.769	4.539	81	K6V

Table 9: Results of the photometric study of MRI 4

$$(V-I_C)_0 = 1.6032\,(J-K_S)_0 + 0.0715$$

Lastly, we calculate the absolute magnitude, M_{KS}, according to the equation of Henry *et al.* (2004), which is useful for an $(V-K_S)$ applicable range of 2.24-9.27:

$$M_{KS} = 0.00959\,(V-K_S)^4 - 0.23953\,(V-K_S)^3 + 2.05071\,(V-K_S)^2 - 5.9823\,(V-K_S) + 9.77683$$

In a last step, the definitive photometric distances and the spectral types (spectral distribution of energy in BVIJHK bands) are derived. We have summarized the photometric results of our study in Table 9.

Because no proper motions were found in the literature, a preliminary estimation was carried out. Using old positions measured over a DSS plate (epoch 1954.747) and those from the Two Micron All Sky Survey (2MASS) (epoch 1999.737), the proper motions of the components were estimated. The DSS plate was measured using the *fv* software provided by HEAR-SAC. The temporal baseline between the two positions expands 44.9901 years on the whole and the results are very similar for both components. The values we have obtained are listed in Table 10. In addition, the joint shift of the two components in the expected position angle was corroborated visually by means of the blink feature provided by Aladin. According to this, if our estimation is correct, the applied characterization criteria indicates that MRI 4 has a 73% probability of being a physical pair.

MRI 3AD

This is a star of magnitude V = 12.011 that could be a new distant component for the HO 319 triple system. Its position (J2000) is RA = 03h 21m 15.04s and Dec = +45º 23' 05.5" and is separated 155" from the A component (V = 7.41). Aladin seemed to indicate the D component has a proper motion very similar to that of the main star. Fortunately, values of proper motions appear in the literature. These values are all very similar. They are also within the range of the errors (Table 11). The AD pair, as can be gathered from the other three sets of relative astrometric measurements for several epochs (along a baseline of 111.56 years) has remained stable (Table 12). This is as expected for a common proper motion pair. The system is very close to the galactic plane (A: *b* = -9.857; B: *b* = -9.883º) so the photometry of the components was corrected by reddening and extinction [A component: $E(B–V)_o = 0.115$ and Av = 0.36; D component: $E(B–V)_o = 0.108$ and Av = 0.33].

After this step, we obtained spectral types B9III and F4V for A and D components by means of the spectral distribution of energy in BVIJHK bands. In accordance with several sources in literature, the A component is a B8 star. Other more modern refer-

Source	Epoch		RA (°)	Dec (°)	μα (mas·yr^{-1})	μδ (mas·yr^{-1})	θ	ρ
DSS	1954.747	A	0.21402	60.3856819	+64	-42	0.400	21.251
		B	0.2141	60.3915847				
2MASS	1999.737	A	0.214822	60.385159	+57	-40	359.975	21.352
		B	0.214817	60.391090				
OACP	2007.6386	CCD measures					359.78	21.375

Table 10: Proper motions and relative astrometry of MRI 4

Source / Component		μα (mas·yr-1)	σ(μα) ±	μδ (mas·yr-1)	σ(μδ) ±
Tycho-2	A	-4.1	0.9	-1.5	0.9
	D	-4.3	3.1	-1.9	2.9
USNOB-1.0	A	-6	--	-2	--
	D	-6	--	-2	--
ASCC-2.5	A	-3.62	1.16	-1.22	0.98
	D	-4.31	3	-1.79	2.89
UCAC-2	A	-4.33	0.89	-2.52	0.8
	D	-5.1	0.7	-1.5	0.7

Table 11: Proper motions of MRI 3AD from the literature

ences indicate A is a B9.5 Ib-II star (Abt, 1985; Reed, 2005; Skiff, 2007), though. In any case its giant character is confirmed.

Hipparcos recorded a parallax of moderate precision for HO 319A, π= 2.29 ± 1.05 mas, placing it at a distance of about 440 parsec. Within the errors, this value is consistent with the 517.6 parsec obtained photometrically in our study. For the D component, we have found a photometric distance of about 487.5 parsecs. Judging from the distance modulus, the probability for the two stars to be at the same distance from us rises to 99%. Though not definite, our results indicate there could be a high probability of a physical relation between the new component and the main system.

MRI 2

MRI 2 was found near STT 312 (eta Dra). The main component is in position (J2000) RA = 16h 23m 30.84s and Dec = +61º 31' 37.8". The V magnitudes of the components were extracted from the NOMAD database (source Yb6, which is not yet published by USNO). They are 13.660 and 13.940 for A and B respectively. NOMAD also offers photometric data in the B and R bands (USNO-B1.0). The infrared photometry measured by 2MASS gives magnitudes A: J-H-K = 12.754-12.458-12.449 and B: J-H-K = 12.968-12.698-12.645. Nevertheless, we decided to use the same procedure carried out with MRI 4, that is, to calculate the visual photometry on the basis of the NIR photometry of 2MASS.

The same reddening [$E(B–V)_o$ = 0.019 and Av = 0.06] for the two stars was obtained. An identical spectrum F7V was derived for both stars. The luminosity classes were verified by means of JH/HK double-color diagrams as well as Reduced-Proper-Motion diagrams.

According to the procedure given by Reid & Murray (1992), the absolute visual magnitudes (M_V) were derived:

$$M_V = 0.427 + 8.121(B-V) - 1.777(B-V)^2$$

The results obtained are consistent with the theoretical value (M_V = 3.8) for an F7V spectrum found in the standard conversion tables for spectrum-magnitude. Our values are: A component, M_V = 4.17

Source	Epoch		RA HH MM SS.S	RA (°)	Dec ° ' "	Dec (°)	θ	ρ
AC2000.2	1896.0745	A	03 21 29.838	50.37433	+45 23 13.44	+45.380667	267.263	155.422
		D	03 21 15.102	50.31293	+45 23 05.96	+45.3849889		
ASCC-2.5	1991.25	A	03 21 29.80431	50.37418461	+45 23 13.40272	+45.38705631	267.177	155.467
		D	03 21 15.06522	50.31277176	+45 23 05.68673	+45.38491298		
2MASS	1999.8740	A	03 21 29.79336	50.374139	+45 23 13.2576	+45.387016	267.165	155.631
		D	03 21 15.03888	50.312662	+45 23 05.4996	+45.384861		
OACP	2007.6362	CCD measures					267.100	155.649

Table 12. Additional relative astrometry of MRI 3AD.

	2MASS original data			Colour excess and total absorption							De-reddened 2MASS photometry		
Star	J	H	K_S	b	$E(B-V)_\infty$	$E(B-V)_0$	A_V	A_J	A_H	A_{Ks}	J_0	H_0	$(K_S)_0$
A	12.754	12.458	12.449	+41.0004	0.019	0.018	0.06	0.017	0.011	0.007	12.737	12.447	12.442
B	12.968	12.698	12.645	+41.0018	0.019	0.018	0.06	0.017	0.011	0.011	12.951	12.687	12.638

Table 13: Colour excess and total absorption for MRI 2

Star	$(B-V)_0$	$(R-I)_0$	$(V-I_C)_0$	$(J-H)_0$	$(H-K_S)_0$	$(J-K_S)_0$	V_0	B_0	$(I_C)_0$	M_{Ks}	M_V	$V-M_V$	d	SpT
A	0.519	0.308	0.552	0.290	0.005	0.295	13.74	14.26	13.19	2.872	4.17	9.57	591.6	K7V
B	0.511	0.302	0.568	0.264	0.049	0.313	13.93	14.44	13.36	2.818	4.11	9.82	619.4	K7V

Table 14: Results of the photometric study of MRI 2

and B component, M_V = 4.11. These figures place both stars at practically the same distance from the Sun: 591.6 pc and 619.4 pc, in that order, for A and B components. See Tables 13 and 14 for details.

Another two pairs of theta/rho measurements were obtained by using the positions of APM and 2MASS catalogs for epochs 1954.491 and 1999.3182 (Table 15). These measurements are congruent with the one we have carried out in the OACP and show the pair has been stable during the 52 years that have passed. This fact seems to indicate the components are moving together in the space and may have a common origin.

The annual relative proper motion of the B component with regard to the primary star was calculated by means of these three sets of Theta/Rho. The result of this calculation was 6 mas·year^{-1}. In addition to this, the proper motions of both components were estimated by using the positions of 1954 and 1999 (A: $\mu\alpha$ = 16 mas·year^{-1} and $\mu\delta$ = -4 mas·year^{-1}; B: $\mu\alpha$ = 9 mas·year^{-1} and $\mu\delta$ = -0.001 mas·year^{-1}). The small motions in RA and Dec (in the same order of magnitude for both components) show they move together in the same direction and at comparable speeds. Moreover, the relative motion of this system is also consistent with these values, being within the margins of error, thus showing how good the estimation is.

Finally, the characterization criteria indicate a moderate probability of 50% of physical relation due to the small differences in the estimated proper motions. Nevertheless, other empirical criteria cause us to consider the system as physical. In order to check

Source	Epoch		RA HH MM SS.S	RA (°)	Dec ° ' "	Dec (°)	θ	ρ
APM	1954.4910	A	16 23 30.789	245.878287	+61 31 38.4	+61.527234	177.176	18.002
		B	16 23 30.913	245.878806	+61 31 20.06	+61.522239		
2MASS	1999.3182	A	16 23 30.83808	245.878492	+61 31 37.848	+61.527180	177.675	17.856
		B	16 23 30.93936	245.878914	+61 31 20.0064	+61.522224		
OACP	2007.6032	CCD measures					177.440	17.715

Table 15: Additional relative astrometry for MRI 2

the evolution of this system in the future, more measures of relative astrometry are needed.

The three new pairs are shown in Figures 4, 5 and 6.

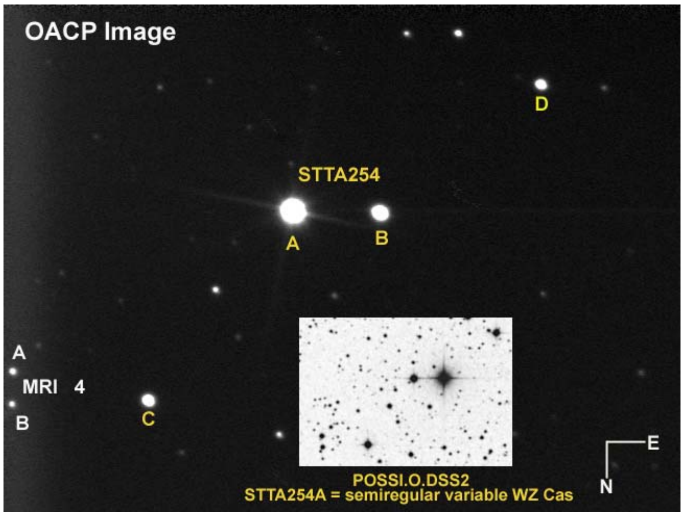

Figure 4. MRI 4. New pair in the vicinity of STTA254. As a curiosity, the superimposed diagram from a DSS plate shows the variability of STTA254A (at minimum).

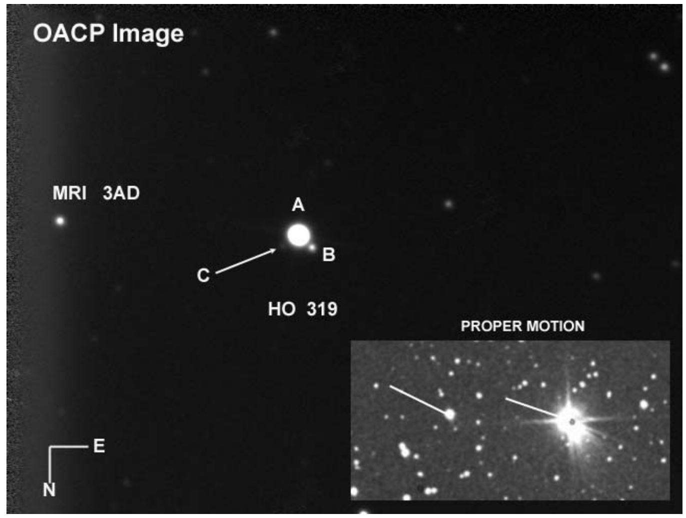

Figure 5. MRI 3AD. A new distant CPM companion for the triple system HO 319. The superimposed diagram represents the proper motion vectors for 10,000 years. Note: also, the pair located at the right top corner has been studied by us and it is optical.

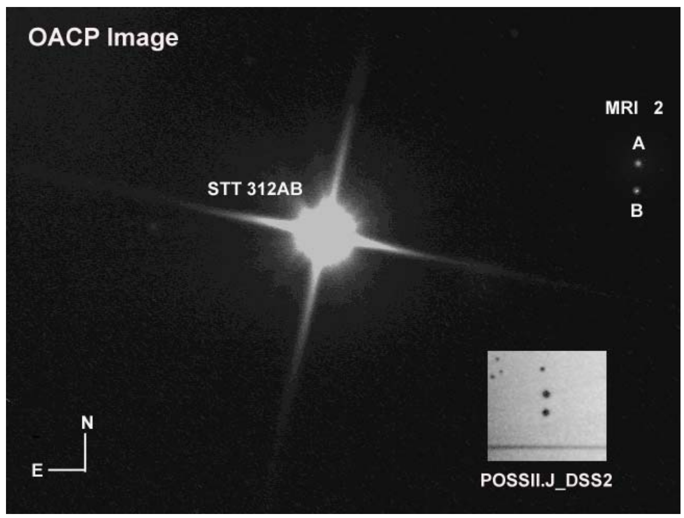

Figure 6. MRI 2. New pair located nearby of STT 321AB.

Notes

In the following, the acronyms "CPM" and "Relfix" mean Common Proper Motion and Relatively Fixed.

1. STTA254AB. In Cas. Similar proper motions. Relfix. A component (WZ Cas) is a semiregular variable type SRb, P = 186 days.
   STTA254AC: Similar proper motions. Relfix.
   STTA254AD: Incompatible proper motions. Optical pair.
   STTA254BD: Incompatible proper motions. Optical pair.
2. MRI 4. In Cas. New pair. Nearby of STTA254. See "Discoveries" and Figure 4.
3. HJ 3237. In Cep. Incompatible proper motions. Optical pair.
4. H 5 32Aa-B. In And (alpha And). A is a spectroscopic binary, P = 96.7 days. Incompatible proper motions. Optical pair. Included in the *Catalog of Rectilinear Elements*.
5. BU 254AB. In Cas. Theta: dispersion in the historical measures but the tendency is stable. Rho stable.
   BU 254AC: Theta and Rho slightly decreasing.
6. STTA 1. In Cep. Incompatible proper motions. Optical pair.
7. HJ 1008AB. In Cas. Relfix.
   ABH 2AD: Theta slightly decreasing. Rho slightly increasing.
   ABH 2AE: Only three official measures. Relfix.
   ABH 2AF: Only three official measures. Relfix.
   ES 1BC: Relfix.
8. STF 11. In Cep. CPM. Stable pair.
9. BU 392. In Cas. Relfix.
10. BU 1310AC. In And. High proper motion of A component. Theta decreasing. Rho increasing.

BU 1310AD: Theta increasing. Rho decreasing.

11. STF 38. In Cas. CPM. Calibration pair.
12. HO 623. In And. Relfix. Rho slightly decreasing.
13. BU 491AB. In And (delta And). A is a spectroscopic binary.
14. STF 46. In Psc (55 Psc). CPM.
15. STTA 5. In Cas. Incompatible proper motions. Optical pair.
16. STF 47AB. In And. CPM.
    BU 1348AC: Theta and Rho increasing.
    BU 1348BC: Theta and Rho increasing.
17. H5 18AD. In Cas. Subsystem of BU 1349 (alpha Cas). Also HJ 1993. Theta and Rho increasing. Incompatible proper motions. Optical pair.
18. STF 50. In Cas. Incompatible proper motions. Optical pair. Included in the *Catalog of Rectilinear Elements*.
19. STFA 1. In And. Optical pair. Included in the *Catalog of Rectilinear Elements*.
20. STF60AB. In Cas. (eta Cas). Orbital pair. See Table 4 for residuals.
21. STF 104. In And. Similar proper motions. Relfix. Rho slowly increasing.
22. STF 108. In And. Similar proper motions. Relfix. A is a spectroscopic binary.
23. WEI 3. In And. High CPM. Relfix. Theta and Rho slightly increasing.
24. STF 128. In Cas. Also STI 227. Theta increasing. Rho decreasing.
25. STI 228. In Cas. Only three official measures. Relfix.
26. STF 132AB. In Psc. High proper motion of A component. A is a spectroscopic binary, P = 36.6 days. Optical pair. Included in the *Catalog of Rectilinear Elements*.
    STF 132AC: Theta increasing. Rho decreasing. Optical pair.
    STF 132AD: Theta and Rho decreasing. Optical pair.
    STF 132DF: Only four official measures. Relfix.
27. STF 131AB. In Cas. Inside of M 103. CPM. Fixed.
    STF 131AC: Theta stable. Rho very slightly decreasing.
    STF 131BC: Theta increasing and Rho decreasing.
    FLE 2AD: Only three official measures. The first measure by the discoverer disagrees. Since 1996 the pair appears to be stable.
    FLE 2AE: Fixed.
28. STF 136AB. In Psc. Similar proper motions. Calibration pair. Relfix.
29. STF 180AB. In Ari (gamma Ari). CPM. A is a variable of the Alpha CVn type.
    STF 180AC: Incompatible proper motions. Optical pair.
    STF 180BC: Incompatible proper motions. Optical pair.
30. S 404AB. In And. Incompatible proper motions. Optical pair. Included in the *Catalog of Rectilinear Elements*.
    S 404BC: Only two official measures. Rho increasing.
31. STF 197AB. In Tri. Incompatible proper motions. Optical pair. Included in the *Catalog of Rectilinear Elements*.
    STF 197AC: only one official measure (1909). Confirmed. Due to de high proper motion of A component Theta and Rho increasing (6º and 10").

Optical pair.

32. STF 205 A-BC. In And (gamma And). CPM. BC pair is the orbital system STT 38BC, not split by our instrument. Also, B is a spectroscopic binary.
33. STF 219. In tri. CPM.
34. STF 222. In And (55 And). Calibration pair. Stable.
35. STF 246. In Tri. High CPM.
36. HJ 653. In Tri. Rho increasing.
37. STTA28. In Cas. CPM.
38. HJ 1123. In Per. Inside of M34. Theta decreasing. Rho increasing.
39. STF 292. In Per. CPM. Calibration pair.
40. STI1936. In Per. Theta increasing. Rho decreasing.
41. STF 297Aa-B. In Per. Calibration pair.

STF 297Aa-C: Relfix.

STF 297BC: Relfix.

42. STI1937. In Per. Only two official measures. Relfix. In the same field of STI1936.
43. STF301. In Per. CPM. A is a long-period spectroscopic binary, P = 675 days.
44. STF 307AB. In Per (eta Per). CPM. A is a spectroscopic binary.
    STF 307AC: Relfix.
    WAL 19AF: only one official measure. Confirmed? The most probable candidate for F component is located at (J2000) 025044.71 +555435.8 (Vmag 10.82 from NOMAD). According to this, Theta has decreased 15.3º since the first measure by Wallenquist in 1944. Our Rho measure is very similar to the original one. A blink with Aladin by using DSS and 2MASS plates do not confirm this great shift of Theta. We have not consulted the catalog where the author published his measure; because of it we think that is a mistake of the discoverer or of transcription.
    WAR 1CD: Relfix.
45. STI 396AB. In Cas. Relfix.
    SIN 5AD: Only two official measures. Stable.
    SIN 5AF: Only one official measure. Confirmed. Our Rho measure is 13" smaller than the original one. Theta is stable.
    SIN 5AG: Only two official measures. Stable pair.
46. ES 558. In Per. CPM. Stable pair.
47. STF 364. In Per. CPM. Physical pair.
48. HO 319AB. In Per. Relfix.
    HO 319AC: Only one official measure (1914). Confirmed. Change in angle (decreasing): 5º. Change in distance (decreasing): 8”.
    MRI 3AD: New component. See *“Discoveries”* and Figure 5. D is TYC 3311 2401.
49. STF 391. In Per. Relfix.
50. STT 55AB. In Per. Theta and Rho increasing.
    A 982BC: Difficult. Elongated shape. Our Theta measure is about 6º greater than the last official measure from 2MASS (1999)! Rho matches well.
    A 982BD: Only two official measures. Relfix.
    A 982BE: Only one official measure (1916). Confirmed. Relfix.
    A 982EF: Only one official measure (1916). Confirmed. Relfix.
51. STT 56AB. In Per. Incompatible proper motions. Optical pair. Included in *Catalog of Rectilinear Elements*.
    WAL 23AC: Only two official measures. Discrepancy between the three measures. By means of Aladin, our conclusion is that the last measure (1999) corresponds surely to a weak star (V=16.76, GSG 2.3 NCC8056318) nearby to the real C component. According UCAC-2 catalog, the proper motion of C component is pmRA = 44.1 and pmDec = -3.5 (mas). These values are incompatible with those of the primary, so the AC pair may be optical, too.
52. ES 560. In Per. CPM. Physical pair.
53. STF 464AB. In Per (zeta Per). A is a spectroscopic binary. Relfix.
    STF 464AC: Relfix.
    STF 464AD: Rho increasing.
    STF 464AE: Relfix.
    STF 464CD: Rho increasing.
    STF 464CE: Relfix.
    STF 464DE: High proper motion of D component: the stars are approaching.
    SLV 2BC: Slow approximation.
    SLV 2BD: Theta decreasing. Rho increasing.
54. STF 469. In Per. CPM.
55. STF479AB. In Tau. CPM.
    STF 479AC: Incompatible proper motions. Optical pair.
56. STF 485(*). In Cam. Inside NGC 1502. A complex multiple system with many historical errors. See WDS Notes for details. There are 28 pairs with the same WDS identifier. We reported measures for 25 pairs on the whole. The others three unreported pairs are: ES 2603AB, great Delta-M, overlapping; CHR 209Aa, too close and HZG 2JK, the K component not have been identified in our images. This pair has only two official measures. The last of them came from 2MASS (1999).

Our image of the field in Aladin does not show any possible candidate around the J star. We think the measure of 2MASS is erroneous and the K component is not identified. See image below for identification of the components (Figure 7).

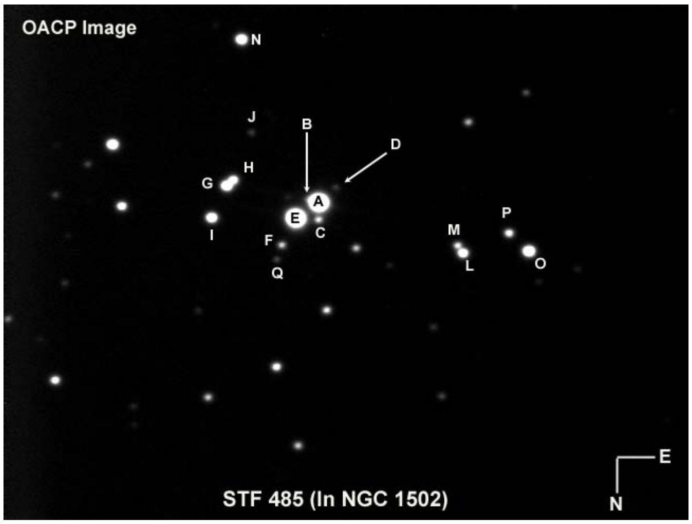

Figure 7. In this OACP image are labeled all the components of this complex multiple system. An exception: we have not found the component K in the surroundings of the J component.

The comments about our measures are the following:

STF 485AC: Relfix.
STF 485AD: Theta increasing. Rho stable.
STF 485AE: Calibration pair. Twins BOIII. Stable with slightly increasing of Theta.
STF 485AF: Relfix.
STF 484AG: Relfix.
STF 484AH: Neglected. Not measured since 1908. Rho decreasing. Theta increasing.
STF 484AI: Rho slightly decreasing. Theta slightly increasing.
STF 485AL: Only one official measure (1902). Confirmed. Rho increasing (8.5”).
STF 485AO: Stable.
HZG 2AN: Relfix.
WSI 20AQ: Only three official measures. Relfix.
STF 485EC: Theta and Rho slightly increasing.
STF 485EF: Relfix.
STF 485EG: Relfix.
STF 484EH: Relfix.
STF 484EI: Relfix.
WSI 20EQ: Only three official measures. Relfix.
WSI 20FQ: Only three official measures. Relfix.
STF 484GH: Relfix.
STF 484GI: Theta slightly increasing.
STF 484HI: Theta stable. Rho decreasing. Great dispersion in the historical measures.
HZG 2IJ: Only two official measures. Stable since 1999 (measure of 2MASS).
HLM 3LM: Theta slightly increasing.
HZG 2LO: Relfix.
HZG 2OP: Relfix.

57. STF 494. In Tau. Twins A8IV. Stable.
58. STF 523AB. In Tau. Relfix.
    STF 523AC: Incompatible proper motions. Optical pair.
59. STF 534AB. In Tau (62 Tau). CPM. Calibration pair. B is the close double BAG 13Ba,Bb.
60. STF 559. In Tau. Incompatible proper motions but the system is stable.
61. STF 613AB. In Aur. Incompatible proper motions. Optical pair. Included in the *Catalog of Rectilinear Elements.*
    STF 613AC: Theta and Rho decreasing.
    STF 613BC: Relfix.
62. STT 92AB. In Aur. Orbital. See Table 4 for residuals.
63. STT 96. In Aur. Only five measures but appear to be stable.
64. STT 101. In Aur. Difficult, great Delta-M. Relfix.
65. STF 670Aa-Bb. In Tau. Difficult. Relfix.
66. STF 674. In Tau. CPM. A is the Algol-type binary CD Tau, P = 3.44 days.
67. J 1818. In Tau. Relfix.
68. STF 669. In Aur. Similar proper motions. Relfix.
69. STF 680. In Aur. CPM. WDS Note: Spectrum composite; G8II-III+G1IV-V (BSC).
70. STF 681. In Aur. The system is stable. The proper motion of B is surely erroneous. More details about this system coming soon.
71. STT 104. In Aur. Optical pair. Included in the *Catalog of Rectilinear Elements*.
72. HU 447. In Tau. Great dispersion in Theta (historical measures). Rho slowly increasing.
73. STF 718. In Aur. CPM.
    STF 718AC: Probably optical.
74. STF 738AB. In Ori (lambda Ori). CPM.
75. STF 742. In Tau. Orbital. See Table 4 for residuals.
76. STF 764. In Aur. CPM. Calibration pair. A is a spectroscopic binary.
77. BU 14. In Aur. Difficult, great Delta-M. Theta decreasing.
78. STF1694AB. In Cam. Similar proper motions.

Relfix. B is a spectroscopic binary, spectrum A0V+A2V.
WAL 63AC: Only two official measures. Theta and Rho decreasing.

79. STF 1732AB. In UMa. CPM. B is the close double BU 1434BC.
80. STF1744AB. In UMa (Mizar). CPM.
81. STF1850. In Boo. CPM. B is a spectroscopic binary.
82. HJ 2728. In Boo (rho Boo). Theta increasing. Rho decreasing. Incompatible proper motions. Optical pair. Included in the *Catalog of Rectilinear Elements*.
83. SHJ 191. In Boo. CPM. Physical.
84. HDO 143. In UMi (epsilon UMi). A is an Algol-type system. Neglected pair (last measure 1959). Theta decreasing.
85. MRI 2. In Dra. New pair. See *"Discoveries"* and Figure 6.
86. STFA 35. In Dra (nu Dra). High CPM. Physical pair.
87. STFA 38AD. In Lyr (zeta 2 Lyr). Similar proper motions. Fixed. Physical.
    BU 968AC: Theta decreasing. Rho increasing.
    BU 968AE: Theta Decreasing. Rho slowly increasing.
88. STFA 39AB. In Lyr (beta Lyr). A is the prototype variable of its class. Relfix.
    BU 293AE: Relfix.
    BU 293AF: Relfix.
    BU 293BE: Relfix.
    BU 293BF: Theta very slowly decreasing. Rho relfix.
    BU 293EF: Only one official measure (without data for Theta). Confirmed.
89. STF2417AB. In Ser (theta Ser). Similar proper motions. Relfix.
    STF2417AC: Relfix. Surely Physical.
    STF2417BC: Relfix.
90. STT 370AB. In Aql. Similar proper motions. Calibration pair. B is the Algol-type system V342 Aql. Surely Physical.
    STT 370AC: Only two official measures. Relfix.
    STT 370BC: Only two official measures. Relfix.
91. STFA 43Aa-B. In Cyg (Albireo). Similar proper motions. Surely physical.
    WAL 114Aa-C: Only one official measure (1944). Confirmed. Theta stable. Rho increasing (15").
92. J 133AB. In Aql. Neglected pair (last measure 1959). Poor signal in our images. Rho decreasing.
    J 133AC: Theta and Rho decreasing.
    WAL 115AD: Only one official measure. Confirmed. Incompatible proper motions. Theta increasing and Rho notably decreasing. Optical pair. *Note:* B component is KUI 92BE. (E component mag 14.5). This pair has only one official measure (1934) and it is registered in the OACP's images with a bad resolution and poor signal. Hence the pair not was measured. Confirmed visually but not measured.
93. STF2558. In Aql. Relfix.
94. STF2567. In Aql. CPM. Same as STF2568. Rho decreasing.
95. STF2583AC. In Aql. The close pair AB is pi Aql. We have measured the AB-C pair. Theta decreasing. Rho increasing.
96. STF2590AB. In Aql. CPM. Relfix. A is variable of BE type.
    STF2590CD: Only one official measure (1909). Confirmed. Rho increasing. Our measure is congruent with other one derived by means of the astrometry from CMC14 (epoch 2001.4816): 271.903º and 8.348".
97. STF2593AB. In Aql. Theta increasing.
    STF2593BC: Relfix. Our Theta measure is uncertain and discordant. Rho is congruent.
98. BU 288AC. In Del. Theta and Rho decreasing.
    BU 288AD: Relfix with only three official measures.
    BU 288AE: Relfix with only three official measures.
99. STF2806Aa-B. In Cep (beta Cep). A is a close double. Rho decreasing.
100. STF2883. In Cep. CPM. Physical.
101. H 4 31AB. In Cep. Incompatible proper motions. Optical pair.
     ARN 79AC: CPM.
102. BU 702AB. In Cep (delta Cep). Prototype of the Cepheid variables P = 5.36 days. Neglected pair (last measure 1961). Great Delta-M: 7.3 in our images. Stable.
     STFA 58AC: CPM. Physical.
103. STF2924AB-C. In Cep. AB close double of high CPM and orbital. Only two official measures. Theta and Rho increasing. Optical pair.
     STF2924AB-D: Theta and Rho increasing. Optical pair.
104. BU 706AC. In Cep. Theta decreasing. Rho increasing.
105. STF2923AB. In Cep. CPM. Relfix.
     STF2923AC: Only two official measures. Relfix.
106. BU 845AB. In Cep. Theta and Rho increasing.

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

BU 845AC: Theta and Rho increasing.
FOX 269AD: Only two official measures. Rho decreasing.

107. STT 529AB. In Cep. A is the Algol-type system ZZ Cep. Incompatible proper motions. Optical pair.
STT 529AC: CPM. Fixed.
108. STF2985. In And. Calibration pair. B is a BY Dra-type variable, and a double-lined spectroscopic binary, P = 3.03 days. Physical.
109. STF2987. In And. High CPM. Difficult, great Delta-M. Physical.
110. HJ 1858. In Peg. Incompatible proper motions. Optical pair. Included in the *Catalog of Rectilinear Elements*.
111. HJ 1859. In Peg. Relfix.
ARN 26AC: Relfix but incompatible proper motions. Optical pair. A curious case: two systems have been merged. The C component of ARN 26 is the A component of HJ 1858 which is located in the vicinity of HJ 1859. See image below (Figure 8).

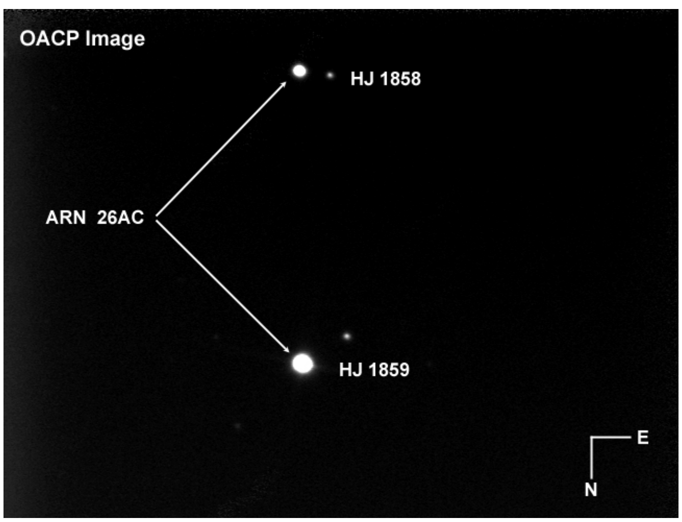

Figure 8. Merged systems: the C component of ARN 26 is the A component of HJ 1858

112. FOX 273AD. In And. Subsystem of BU 717 (8 And). Only two official measures. Theta stable. Rho increasing.
113. STF3037AC. In Cas. Because de AB pair in not split by our instrument the measure reported correspond to AB-C. Similar proper motions. Relfix.
STF3037AD: Theta increasing. Rho slowly increasing.
STF3037AE: Relfix.
STF3037AF: Theta slowly increasing. Rho slowly decreasing.
114. STI1222. In Cas CPM. Fixed.
115. BU 1153AB-C. In Cas. In the same field of STT511. The A component is a close double. Theta fastly decreasing.
BU 1153AD. D component is the A component of STT 511. Fixed.
116. STT 511AB. In Cas. Relfix.
STT 511AC. Only two official measures. Fixed.
STT 511AD: Only five official measures. Relfix.

Conclusions

The results obtained in this first series of Theta/Rho measurements show that the equipment and the techniques used are suitable for this task. We have verified that our measurements match very well with those from 2MASS (1999) as well as those of Tycho-2 (1991) (logically in the case of pairs fixed or relfix). This fact is a clear indication of the reliability of our procedure.

We have confirmed the existence of 12 pairs that previously had only the discovery measurement. In addition, we have reported measures for 16 pairs with two official measures and for others nine pairs with three official measures, which will serve to check the tendency of the components. Also, a number of neglected pairs have been included.

Acknowledgements

This research has made use of the Washington Double Star Catalog (WDS), the *Catalog of Rectilinear Elements*, the *Sixth Catalog of Orbits of Visual Binary Stars*, the USNO-B1.0 and the UCAC2 maintained at the U.S. Naval Observatory.

This research has made use of The Naval Observatory Merged Astrometric Dataset (NOMAD) at http://www.nofs.navy.mil/nomad/. NOMAD is a simple merge of data from the Hipparcos, Tycho-2, UCAC-2 and USNO-B1 catalogs, supplemented by photometric information from the 2MASS final release point source catalog. The primary aim of NOMAD is to help users retrieve the best currently available astrometric data for any star in the sky by providing these data in one place.

This research has made use of The APM-North Catalog. http://www.ast.cam.ac.uk/~apmcat/.

This research has made use of the All-sky Compiled Catalog of 2.5 million stars (ASCC-2.5, 2nd version) at http://webviz.u-strasbg.fr/viz-bin/VizieR?-source=I/280A.

This research has made use of the AC 2000.2: The Astrographic Catalogue on The Hipparcos System. Catalogue of Positions Derived from the Astrographic Catalogue Measures. Positions are from the Hipparcos System (HCRS, J2000.0) at the Mean Epochs of Observation. (http://webviz.u-strasbg.fr/viz-bin/VizieR?-source=I/275).

This research has made use of the Carlsberg Meridian Catalog 14 (CMC14) (http://vizier.u-strasbg.fr/viz-bin/VizieR?-source=I/304).

This research has made use of the Astrophysics Data System (ADS) in order to consult several professional works. Web Site: http://adswww.harvard.edu/index.html

This research has made use of data products 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.

This research has made use of DSS. The Digitized Sky Survey was produced at the Space Telescope Science Institute under U.S. Government grant NAG W-2166. The images of these surveys are based on photographic data obtained using the Oschin Schmidt Telescope on Palomar Mountain and the UK Schmidt Telescope. The plates were processed into the present compressed digital form with the permission of these institutions.

This research has made use of Aladin, an interactive software sky atlas allowing the user to visualize digitized images of any part of the sky, to superimpose entries from astronomical catalogs or personal user data files, and to interactively access related data and information from the *SIMBAD*, *NED*, *VizieR*, or other archives for all known objects in the field. Aladin is particularly useful for multi-spectral cross-identifications of astronomical sources, observation preparation and quality control of new data sets (by comparison with standard catalogues covering the same region of sky). Available at http://aladin.u-strasbg.fr/

This research has made use of the *fv* software, a tool for viewing and editing any FITS format image or table. It is provided by the High Energy Astrophysics Science Archive Research Center (HEARSAC) at NASA/GSFC. The package is available in: http://heasarc.gsfc.nasa.gov/docs/software/ftools/fv/

This research has made use of Guide 8.0 astronomical software of Project Pluto. Internet site: http://www.projectpluto.com/

This research has made use of *Astrometrica*, an interactive software tool for scientific grade astrometric data reduction of CCD images. The author: Herbert Raab. Internet site: http.//www.astrometrica.at/

Special thanks to Dr. Brian D. Mason for supplying the historical data of many systems discussed in this paper.

Finally, the author is very grateful to Mrs. Teresa Herranz Yuste for the preliminary translation (Spanish-English) of this work.

References

Abt, H. A., 1985, *Visual multiples. VIII - 1000 MK types*, Astrophysical Journal Supplement Series (ISSN 0067-0049), vol. 59, p. 95-112

Anthony-Twarog B. J., Twarog B. A., 1994, *Reddening estimation for halo red giants using UVBY photometry*, Astronomical Journal, 107, No 4, 1577-1590

Bidelman, W. P., G. P., 1985, *Kuiper's spectral classifications of proper-motion stars,* Astrophysical Journal Supplement Series (ISSN 0067-0049), vol. 59, p. 197-227

Bilir, S. *et al*, 2008, *Transformations between 2MASS, SDSS and BVRI photometric systems: bridging the near-infrared and optical,* Monthly Notices of the Royal Astronomical Society, Vol. 384, Issue 3, pp. 1178-1188

Fiorucci M., Munari U., 2003, *The Asiago Database on Photometric Systems (ADPS). II. Band and reddening parameters*, Astronomy & Astrophysics, 401, 781-796

Henry, T.J. *et al*, 2004, *The Solar Neighborhood. X. New Nearby Stars in the Southern Sky and Accurate Photometric Distance Estimates for Red Dwarfs*, Astronomical Journal, 128, 2460

Masa, E. R., 2007, *SDSS J001708.1-102649.5 & SDSS J001707.99-102647.3:Serendipitous Discovery of a New Binary System Candidate,* Journal of Double Star Observations, Vol.3, No. 1, 34

Reed, S., 2005, *Photometry and Spectroscopy for Luminous Stars*, http://vizier.cfa.harvard.edu/viz-bin/VizieR?-source=V/125

Leggett, S. K., 1992, *Infrared Colors of Low-Mass Stars*, Astrophysical Journal Supplement Series, 82, 351-394

CCD Double-Star Measurements at Observatorio Astronómico Camino de Palomares ...

Reid, Neill; Murray, C. A., 1992, *High-velocity stars toward the South Galactic CAP*, Astrophysical Journal, 103, 514

Schlegel. D. J. *et al*., 1998, *Maps of Dust Infrared Emission for Use in Estimation of Reddening and Cosmic Microwave Background Radiation Foregrounds,* Astrophysical Journal, v.500, p.525-533

Skiff, B. A., 2007, *Catalogue of Stellar Spectral Classifications*, On-line data:

http://vizier.cfa.harvard.edu/viz-bin/VizieR?-source=B/mk