University of South Alabama

Journal of Double Star Observations

VOLUME 8 NUMBER 4 October 1, 2012

Inside this issue:

The Double Stars of Abel Pourteau

Frank Smith

20 Coburn Way
Jaffrey, NH, 03452
fhasmith@frankandluann.net

Abstract: This article considers the double stars discovered by M.A. Pourteau. The article includes biographical material for M. Pourteau. The historical background of his work is covered. Discussion of his double stars and opportunities for study of his doubles by amateur astronomers is discussed.

Background

During my efforts in 2011 to measure double stars from the WDS catalog, I ended up imaging a number of stars discovered by Abel Pourtean (designation POU). The WDS "Top 25 Observers List" ranks him fourth in number of systems discovered with 5,718 doubles bearing his POU designation . The "references and discoverers codes" section of the Washington Double star Cataglog (Mason+ 2001-2012) shows all of Pourteau's discoveries come from a single reference, his 1933 publication: "*Catalog des étoiles doubles de la zone +24° de la Carte Photographique du Ciel" (Porteau 1933).*

An internet search produced no biographical material and no other references about him other than those related to his catalog. Intrigued, I decided to see what could be discovered about Mr. Pourteau. This article reports my results.

The Star Catalog

Abel Pourteau was deeply involved as both a "computer" and observatory assistant in one of the great efforts of Victorian science, the *Astrographic Catalog* and the related photographic charts program, the *Carte du Ciel.* The two programs were the result of an 1877 Astrographic Conference chaired by the Paris Observatory (1912 Turner). Twenty obser-

Figure 1: Sidney Observatory's Cart du Ceil measuring engine. Collection: Powerhouse Museum, Sydney. Photo: Chris Brothers.

vatories agreed to use a standard telescope to photograph the entire sky down to the 11th magnitude and to determine positions of stars to better than 0.5 arc.

A second goal was to repeat the sky survey in another set of plates reaching to 14th magnitude. Both programs were a huge investment in money and labor. Central to the data analysis were "computers." Prior to modern electronic devices, a "computer" was a person employed by a scientific institution to perform the mathematical computations by hand.

The labor of taking the plates was long and challenging. Each section of the sky had to be photographed several times and the plates had to be well matched in limiting magnitude to be useful. If producing the plates was difficult, the labor of reducing the data was brutal. Each of the plates had to be examined by a "computer" with a microscope. The position of each star was measured against a "reseau " (ruled grid). Then to control errors, after each plate had been measured, it was rotated 180 degrees and all the stars measured again!

The *Carte du Ciel* project was intended to produce star charts by transferring the images on the glass plates to copper engraving plates. Most observatories did not complete their assigned areas and a number never started. The scientific returns from both projects were limited by difficulty in using the data and the size and cost of resulting publications. The *Cart du Ciel* printed charts, if completed by all the observatories would have resulted in 887 volumes weighing two tons.

Double Star Catalogs Derived from the Carte du Ciel Project

In addition to M. Pourteau's work, the *Carte du Ciel* was the basis for three other double star catalogs: *Catalogo di Stelle Doppie* by Stein (Daley 2006), *Double Stars in the Greenwich Astrographic Catalogue* by H. Groot and a catalog by Andre Chatelu of the Algiers Observatory's zone covering the +04 to -02 degrees. (Pourteau 1933). In addition, catalogs *I/96 Astrographic Catalog*, +01 to +31 Degrees (Freasneau 1983) and I/303 *Bordeaux Carte du Ciel catalog* (Rapaport+ 2006) are derived from scans of *Astrographic Catalog* and *Carte du Ciel* plates.

While not a double star catalog per se , the *I/275 The AC 2000.2 Catalogue* (Urban+ 2001) is a re-reduction of the complete *Astrographic Catalog* Plates and could offer opportunities for amateur data-miners through VizieR catalog access tool, CDS, Strasbourg, France.

Biographical Information on Porteau

Abel Pourteau was born on Setember 17, 1862 in Etaules (Charentes-Maritime) , a coastal town on the Bay of Biscay. In 1890 he joined the Paris Observatory. He was hired as an auxiliary employee of the Observatory's Office of Calculations. Pourteau worked for twenty-nine years (1890 to 1919) in that position (Barbet 2011).

From 1919 to 1927 he assisted in the photographic work of the *Carte du Ciel*. The Paris Observatory measured and photographed 1261 plates between October 1891 and November 1927.

The Paris Observatory's photographic zone for *Carte du Ceil* was between declinations +18 and +24 degrees. The observatory's telescope was the original Henry brothers instrument that was intended to be the pattern for the entire project (Urban+ 1998). Porteau was apparently hired to assist in the workload generated by the project.

Pourteau was also involved in the data reduction of plates. This included calculation of tables to transform the Cartesian positions of the star images on the plates to equatorial coordinates. Production of the copper engraving plates for the Sky Charts was another one of his duties. Porteau advanced to Associate Astronomer during this period.

In 1923 in addition to all his other duties, Pourteau began a project to discover and measure new double stars in the Paris Observatory's zone down to 14.5 magnitude. He eventually found and measured over 5,000 new binary star systems. Besides his future catalog of double stars, the Paris Observatory records show only one other publication, a catalog of photographic reference stars with M. Jules Baillard, which appeared in "*Journal of the Observers, March 15, 1927*".

Abel Pourteau reached the mandatory retirement age of 65 in September of 1927, but was allowed to stay until December 31st of that year to complete his double star measures. The former director of the Paris Observatory, M. Baillaud, described his career as full of "honor, hard work and devotion."

In 1933 Porteau published his *Catalog des étoiles doubles de la zone +24° de la Carte Photographique du Ciel*. He promptly received the Laland Prize in Astronomy that same year .

The Paris Observatory did not have an image of Porteau or his date of death.

Divinus Lux Observatory Bulletin: Report # 25

Pourteau's Doubles as Basis for Further Work

Seventy-eight years after the publication of his catalog, Pourteau still holds 25th place in "means" (lines of data in the WDS measurement database) and 4th in number of discoveries in the WDW Top 25 Observer List (Mason+ 2001-2012).

In my own, necessarily limited survey of his doubles, I found his measures to be accurate in both position and separation.

In his catalog, Pourteau claimed standard deviations (root mean square errors) of:

Separation PA SEP

<7 arcsec 3.1 0.41
7 to 11 arcsec 2.5 0.51
>11 arcsec 1.9 0.57

To obtain a representative sample of his work, I extracted all his doubles from the 06-12 hr section of the WDS catalog and found 2,241 systems. The separations ranged from a low of 0.8 to a maximum of 26.8 arcseconds. The average separation was10.4 arcseconds and the average magnitude was 12.78 .

A separation of 10.4 arcseconds and 12 to 13 magnitude falls into a "sweet spot" for modern amateurs equipped with CCD cameras. In the above sample, the average number of measures of Pourteau's doubles was only 2.3. Some have only the discovery measure.

The blue sensitive plates that Pourteau worked with with seem to have recorded stars much deeper than he realized, often reaching 15+ magnitude. This leads to discrepancies with the WDS catalog's default V magnitudes. The WDS entry for POU 2324 lists 11.54 magnitude for the "A" star and 12.20 for "B". Those two stars appear to be UCAC3 226-078117 and 226-078126 with catalog magnitudes of 14.46 and 15.56. They were too faint to measure on my 15 second CCD image with a 300 mm telescope! Many other of his pairs are fainter than the listed magnitude.

Pourteau apparently only measured new doubles in his catalog. Dr. Brian Mason pointed out that Poutreau apparently was not totally familiar with double star nomenclature as he gave different designations to triple stars, for example, POU2341AB and POU2342AC. Because Pourteau's designations were published in his book, they were retained in the WDS catalog (Mason 2011).

A number of Pourteau's measurements are now over 100 years old. There is plenty of opportunity for amateurs to continue his work.

Acknowledgments

All of the biographical material in this article was provided by Virginie Barbet of the Paris Observatory's Library. Special thanks to her for combing the annual reports of the Paris observatory for references to Mr. Pourteau.

Thank you to my sister Gail Smith for her usual meticulous proofreading of my article.

Thanks to Brian Skiff of Lowell Observatory for reading the MS and supplying a number of useful comments as well as introducing me to *AC 2000.2.*

Thank you also to Dr. Brian Mason for reading an earlier version of this article.

Any errors or misunderstandings in this article are solely the fault of the author.

This research has made use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory.

References

Barbet, V. , 2010, Private communication. Paris Observatory Library staff. Paris Observatory website: http://www.bibli.obspm.fr/sedoc_eng.htm

Daley, J. ,2006, “Notes on the Double Stars of Father John W. Stein”, 2006, *JDSO*, **2**, 134-137.

Fresneau A., 1983, Survey of the Astrographic Catalogue from 1 to 30 degrees of northern declination. <Astron. Journ. 88, 1378

Mason, B.D., Gary L. Wycoff, William I. Hartkopf, Geoffrey G. Douglass, and Charles E. Worley, 2001-2012, *Washington Double Star Catalog.*Astrometry Department, United States Naval Observatory. WDS "Top 25 Observers List":http://ad.usno.navy.mil/wds/misc/top_twentyfive.txt

Mason B.D., Wycoff G.L., Hartkopf W.I., Douglass G.G., Worley C.E. <Astron. J. 122, 3466 (2001) The Washington Visual Double Star Catalog (WDS), Version 2011-12-25

Mason B.D., 2011. Private communication.

Pourteau A. *1933*, *Catalogue des étoiles doubles de la zone +24* degrés de la *Carte Photographique du Ciel*, Observatoire de Paris. Savary, F. 1827.

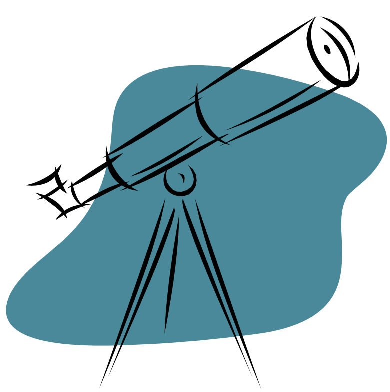
Rapaport M., Ducourant C., Le Campion J.F., Fresneau A., Argyle R.W., Soubiran C., Teixeira R., Camargo J.I.B., Colin J., Daigne G., Perie J.P.,

Divinus Lux Observatory Bulletin: Report # 25

Requieme Y. , (2006),<Astron. Astrophys. 449, 435 The CdC2000 Bordeaux Carte du Ciel catalogue. (+11°<delta<+18°)

Turner H.H., 1912. *The Great Star Map, Being a Brief General Account of the International Project Known as the Astrographic Chart* (John Murray). This book is available online: http://books.google.com/books/about/The_great_star_map.html?id=3HDvAAAAMAAJ

Urban S.E., Corbin T.E., Wycoff G.L., Hoeg E., Fabricius C., Makarov,V.V., *1998, <Astron. J. 115, 1212 . AC 2000.2: The Astrographic Catalogue on the Hipparcos System.* There is much interesting historical material about the Carte du Ciel, including the Paris Observatory's contributions, in the introductory text to AC 2002.2 available at: http://cdsarc.u-strasbg.fr/viz-bin/getCatFile_Redirect/?I/275/intro.tex



A New Common Proper Motion Pair in Sextans

Abdul Ahad

Luton, Bedfordshire
United Kingdom
aa_spaceagent@yahoo.co.uk

Abstract: This paper presents a new common proper motion double star that is not in the current edition of the Washington Double Star catalog. The result is a 13th magnitude companion that appears to share the same space motion with the 10th magnitude orange primary star, BD-09 3056, in Sextans.

Introduction

In the past few years, I have been seeking to identify new visual double stars that display a number of favorable attributes that make them attractive candidates for possible binary systems. This has meant conducting searches of the sky both visually, using my Skywatcher Explorer 8-inch EQ-5 F/5 Newtonian reflecting telescope, as well as photographically going down to as low as 13th magnitude pairs using the DSS / POSS survey images where possible.

Methods

The new pair reported in this paper first came to my attention as a pair of partially resolved stars of greatly unequal brightness in a STScI digitized sky survey image plate on January 21st 2012, while I was investigating another pair from the Washington Double Star (WDS) catalog. Later, I noticed the two stars were of similar orange colors, and were excluded from the WDS catalog and so I took an even greater interest. I was able to pinpoint them in the SIMBAD/Aladin previewer at ICRS coordinates 10 22 44.8972 -09 55 39.780 (J2000.0) which showed the primary star as BD-09 3056, of visual magnitude +10.20. A DSS image of the pair is shown in Figure 1.

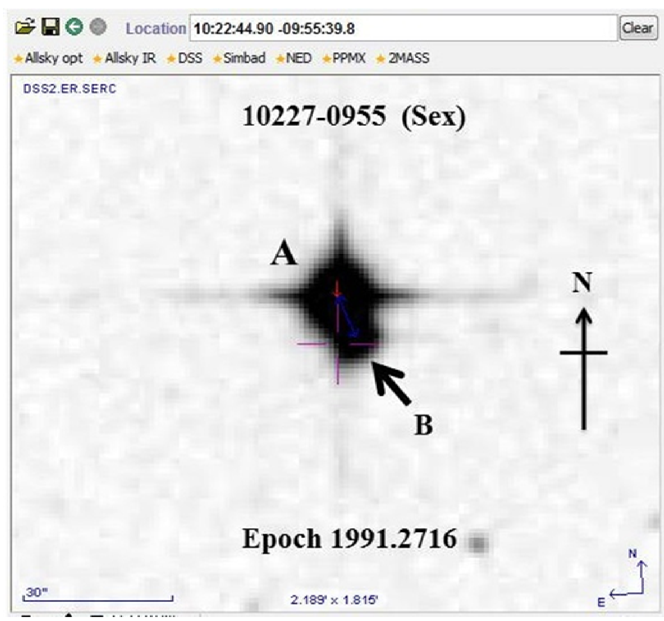


Figure 1: DSS image of the proposed new common proper motion pair.

Measurements

The Aladin applet facilitated taking a measurement of this pair on the above DSS image, yielding

A New Common Proper Motion Pair in Sextans

these results:

Position Angle (theta): 203.5°

Separation (rho): 8.804”

Via the ‘prop’ icon of Plane ID: DSS2.ER.SERC, the precise epoch of the above DSS image was found to be 1991-04-10 (J1991.2716). The stated measurements of theta and rho, therefore, are for this epoch.

Likelihood of Binarity

For two stars in a visual double star to have any kind of physical gravitational association between them, first and foremost they must both display very similar proper motions (PM) in RA and Dec, both in magnitude and in direction. The PPMXL catalog (Roeser+ 2010) shows this to be the case for this particular double star, giving the approximate results as shown in Table 1.

Table 1: Proper motion of components.

Sextans Double Star	Proper Motion in RA	Proper Motion in Dec
A-component	-1.0 mas/year	-44.5 mas/year
B-component	-2.2 mas/year	-41.5 mas/year

The pair, as a whole, thus has a total proper motion of: $([(-1.0)^2 + (-44.5)^2]^{½} + [(-2.2)^2 + (-41.5)^2]^{½}) / 2$ = ~43.0 milli-arcseconds per year.

Two further parameters are required to fully establish binarity in a visual double star system, i.e. the two stars must have similar radial velocities and also trigonometrical parallaxes. Neither of those was available for the two stars in this pair in the catalogs that I could access, so I resorted to other methods that I have used in the past to assess the situation.

In my report in the Webb Society DSSC 19[1] I showed for purposes of illustration the distances and proper motions of a number of binary systems, and the basic correlation that exists between these two parameters. Referring to that scale, a proper motion of ~ 43.0 mas/year for this Sextans double star suggests the pair is located somewhere around ~ 300 light-years distant from the Earth.

Considering the primary star in this pair is orange in color, for it to display a proper motion rate of 43 mas/year and shine with an apparent magnitude of 10.2, it is likely to be a K-type main sequence dwarf. If it were anything other than this, it would either shine with a different apparent brightness or display an altogether different rate of proper motion across the sky. Now the star 70 Ophiuchi A, in the 70 Ophiuchi binary system is a K0 V type main sequence dwarf star, whose apparent magnitude is +4.0 and whose absolute magnitude is +5.5. If we apply the distance modulus formulae I had previously stated in my report in the Webb Society DSSC 18[2] , we find that 70 Ophiuchi A would shine at an apparent magnitude of +10.3, virtually the same as the primary star’s apparent magnitude of +10.2 in this double.

This is strongly indicative that the primary star in this Sextans double star (BD-09 3056) is of comparable mass and luminosity to 70 Ophiuchi A.

The secondary star in this Sextans pair is listed as magnitude 13.0 in the PPMXL catalog. By a similar set of comparative calculations as with the primary shown above, the 13th magnitude secondary star in this pair is found to be a low-mass red dwarf, perhaps of similar mass and luminosity as the star 61 Cygni B in that famous binary system. At a projected distance of circa 300 light-years from Earth, the linear distance separating the two stars in this Sextans pair is likely to be: Tan (8.804”) x 300 x 63240 = 810 Astronomical Units. Where 63240 is the number of Astronomical Units in one light-year.

Conclusions

In the absence of precise parallax and radial velocity measurements for both stars it is difficult to be one hundred percent certain, but otherwise all the parameters fittingly point to this being a good candidate for a slow binary system of long orbital period.

References

Ahad, A. 2011 Webb Society Double Star Section Circular, **19**, 48

Ahad, A. 2010 Webb Society Double Star Section Circular, **18**, 49

Double Star Measurements in the Pleiades Cluster Using a DSLR Camera

Michel Michaud

Victoria, British Columbia, Canada
michelmichaud@shaw.ca

Abstract: This publication presents double star measurements of 91 double stars within the Pleiades using a DSLR camera. The images used for the measurements were taken in the period between 2011.971 and 2012.124. Furthermore, I have identified a fourth component in the HL 19 system. The new component complies with Aitken criteria and could be a physical pair.

Introduction

I have been observing double stars for several years for pleasure without recording any precise astrometric measurements. I have made a total of 657 visual observations on 200 distinct pairs. I was assuming throughout all these years this field of research was out of reach by amateur astronomers and the majority of the double star orbits were already resolved. A year ago, I viewed the Journal of Double Star Observations published by the University of South Alabama and that was an eye-opener. I immediately decided to learn the basis and finally contribute to the double star community. The Pleiades has been one of my favorite clusters and I wouldn't miss any opportunity to scrutinize it. This article presents double star measurements in the famous Pleiades Cluster areas.

Equipment

My observations were made from the Victoria Centre Observatory (VCO) of Royal Society of Canada in Victoria, British Columbia located at 48º 31' 19" N and 123º 25' 14" W. The permanent roll off roof observatory hosts a Meade 14" LX200 f/10 Schmidt-Cassegrain reflector telescope mounted on Paramount ME German equatorial fully computerized and managed by CCDSoft software. The DSLR camera was a modified (low-pass filter) Canon 20Da installed at prime focus of the primary telescope. No other filter was used.

Calibration

The calculation of the plate scale of the telescope/camera is essential to obtain precise separation of binaries. Inspired by "Calibrating a bifilar micrometer by measuring declination differences of H.I.C. stars in the Pleiades", a publication found in the Brayebrook Observatory web page [C.J.R. Lord], I decided to perform the plate scale calibration by measuring declination differences of selected bright stars in the Pleiades.

To determine the corrected RA's & DEC's for precession and proper motion to the exact 2011.970 positions, the FK5 coordinates (J2000) were extracted from the SIMBAD database [Centre de Données astronomiques de Strasbourg] and processed with the program Precessn [Argyle, 2004]. See Table 1 for results.

The next step was to convert the rectangular positions into polar positions between the selected stars to obtain their relative position angles and separa-

Double Star Measurements in the Pleiades Cluster Using a DSLR Camera

Table 1: Right ascension and declination

Star	RA (J2000)	DEC (J2000)	PMRA (mas/yr)	PMDEC (mas/yr)	RA (J2011.970)	DEC (J2011.970)
19 Tau	03 45 12.496	+24 28 02.21	21.24	-40.56	03 45 55.387	+24 30 14.52
20 Tau	03 45 49.607	+24 22 03.89	20.95	-45.98	03 46 32.481	+24 24 15.59
21 Tau	03 45 54.477	+24 33 16.24	20.18	-44.87	03 46 37.404	+24 35 27.88
22 Tau	03 46 02.900	+24 31 40.43	19.88	-44.37	03 46 45.822	+24 33 51.96
27 Tau	03 49 09.743	+24 03 12.30	17.70	-44.18	03 49 52.583	+24 05 21.10
28 Tau	03 49 11.216	+24 08 12.16	18.07	-47.20	03 49 54.080	+24 10 20.90

tions. The program RecToPol [Argyle, 2004] was used for the conversion.

The effect of atmospheric refraction on astronomical observations is recognized by every serious amateur astronomer and especially while conducting astrometric measurement, but frequently disregarded or simply not considered. The third column of table 2 included differential refraction correction for the corresponding separation binaries for the epoch 2011.970. The temperature (3.1 ºC), barometric pressure (1023.5 millibars), and the position angle to the zenith (28 º) were used for computation. The program DiffRefr [Argyle, 2004] was used for the calculations. In that phase of my study, only the corrected separation is required to obtain an accurate plate scale of the telescope/camera arrangement. All others measurements in this publication will include both corrected separations and position angles.

The separation measurements were processed with Florent Losse's program (Reduc). The first column of Table 3 shows the six selected bright star combinations. The second column shows the overall pixel sampling for each frame. The third column shows the number of frame per couple. The last column shows an average per frame of the pixel sampling.

From the Table 3, the overall average value of the plate scale considering all 22 frames is $\Phi = 0.35469$ arc seconds/pixel. The population standard deviation is $\sigma = 0.00012$ a.s./pixel.

Selection of double stars

Double stars selected for measurement for measurement were taken from the Washington Double Star Catalog (WDS). All the binaries between RA of 03h 42m - 03h 50m and DEC of 21º 42' N - 25º 25' N with a separation greater than 2 arc seconds were targeted. Unfortunately the weather in Southern

Table 2: Polar coordinates and corrected separations

Stars	Position Angle (deg)	Separation (a.s.)	Corrected Separation (a.s)
19-20	125.291	620.781	620.980
19-21	61.303	653.342	653.551
19-22	72.423	721.753	721.985
20-21	5.704	675.640	675.856
20-22	17.524	604.458	604.652
21-22	129.866	149.621	149.669
27-28	3.909	300.500	300.597

Table 3: Pixel sampling

Stars	Σ(pixel sampling)	N	μ(pixel sampling)
19-20	0.709267	2	0.3546335
19-21	1.4187414	4	0.35468535
19-22	1.4191342	4	0.35478355
20-21	0.7091026	2	0.3545513
20-22	0.7090462	2	0.3545231
21-22	1.420301	4	0.35507525
27-28	1.417491	4	0.35437275
All	7.8030834	22	0.354685601

Double Star Measurements in the Pleiades Cluster Using a DSLR Camera

Vancouver Island during the winter is usually cloudy and this year didn't differ at all, so only 69% of my wish list was observed.

Methodology

The Canon 20Da camera was set at ISO 1600. The exposure times were 5 – 60 seconds, depending on the brightness of the stars. The images used in the analysis are shown at the end of this article. Once again, I measured the pictures using Florent Losse's program Reduc. The orientation of the picture was accomplished using the star trail method and evaluated with the Drift Analysis function of the same software. Finally, a graphic-based technique is briefly explained to resolve unequal tight binaries.

Astrometric Measurements

The acronym 'Anon', for 'Anonymous', is used for pairs which have not been yet cataloged in the WDS. Table 3 lists 245 measures of 91 pairs. Only one of those observed systems will be reviewed in details.

Data Analysis

HL 19 – Introduction

HL 19 was first determined to be a multiple star by Asaph Hall on January 23 1887 (Bessell date 1887.063) while investigating stellar parallaxes and the positions of the stars in the Pleiades cluster at the USNO with the 26-inch "Great Equatorial" refractor telescope located at Washington, DC. That evening, Hall recorded the measurement of the primary star with three components. Those stars were revisited for a second occasion in 1997 (TMA2003), more than a century after the initial observations. Historic measurements of HL 19 are given in Table 6.

Table 6: Separation (") and position angle (º) for HL 19

Component	Date	P.A.	Sep.	RefCode
AB	1887.063	231.70	70.09	Hl_1888
AB	1997.82	228.0	66.96	TMA2003
AB	2012.124	227.375	66.872	author
AC	1887.063	254.26	154.08	Hl_1888
AC	1997.82	253.7	148.41	TMA2003
AC	2012.124	253.581	148.759	author
AD	1887.063	245.20	136.41	Hl_1888
AD	1997.82	244.1	131.46	TMA2003
AD	2012.124	243.897	131.732	author

The right ascension of the multiple star is 03h 47m 17.14s and the declination is +23º 43' 36.30". The system is located nearby the variable star of delta Sct type V650. The primary star has catalog designations of BD+23535, HD 23609, HIP 17684, SAO 76189, GSC 01800-01744, and WDS03473+2344.

HL 19 – Observations

The night of 30 December 2011 I was imaging double stars in the Pleiades and HL 19 was observed with its three assumed components. The second measurement of HL 19 occurred on the evening of 2 February 2012 (Bessell date 2012.091). To my surprise, a fourth component appeared very close to the primary star. I returned on the evening of 14 February 2012 and confirmed its existence. Moreover, because the position of the new component didn't move between the 2nd and 14th of February, the possibility of an asteroid or comet was then eliminated. I revisited the star again on the evening of 25 February 2012 (Bessell date 2012.154) to capture a series of images of the fourth component to obtain precise astrometric measurements.

The magnitude of the primary component of HL 19 is 7.03. I estimated the magnitude of the fourth component at 12.7 ± 0.5 using the photometric function of the AutostarIP program. The error on the estimated magnitude of 0.5 is due to the saturation of the DSLR star images. The calculated separation is 8.881 arc seconds and the position angle estimated at 41.026 degrees.

HL 19 - Analysis

While investigating the new component, the measurements given in Table 7 were found on the primary star in HL 19 in the 2MASS catalog.

An increase of 1.081" over the measure taken in 1997 is observed. Without taking into account the proper motion which is not calculated for the fourth component, this result seems plausible.

Since the measured separation is smaller than the maximum separation for a combined magnitude of 7.03, Aitken's criteria is satisfied and HL 19 A and fourth component could be a physical pair. I acknowledge this decisive factor is very restraining and no longer appropriate; nevertheless in this case the outcome is positive. New visual and interferometric measures are obviously required. The determination of the proper motion of the new component is primordial for consideration of its status as double star.

Image No. 22 shows an inverted magnified image of the primary star of HL 19 with the new component marked with an x.

(Continued on page 255)

Double Star Measurements in the Pleiades Cluster Using a DSLR Camera

Table 4: Astrometric Measurements

RA + Dec	Discoverer	Mags		PA	Sep	Epoch	N	Notes	Img
03431+2541	STF 435	7.20	8.87	3.971	13.367	B2012.091	2		1
03437+2339	HJL1024AB	7.96	9.61	174.654	196.796	B2011.998	2		2
03441+2402	HLD 172	11.2	11.7	308.561	5.551	B2012.091	4		3
03442+2406	LV 17AC	11.0	16.6	213.585	15.954	B2012.091	4		4
03448+2417	HL 6AB	5.45	11.0	264.127	88.43	B2011.974	2		5
03448+2417	HL 6AC	5.45	10.0	195.509	217.622	B2011.974	2		5
03449+2407	HL 7AB	3.71	13.0	143.626	99.115	B2011.974	4		6
03449+2407	HL 7AC	3.71	13.0	121.355	142.873	B2011.974	4		6
03449+2407	HL 7AD	3.71	11.0	193.149	216.21	B2011.974	2		6
03449+2407	HL 7AE	3.71	10.0	345.653	186.82	B2011.974	4		6
03452+2450	HL 8AB	5.64	14.0	128.656	73.002	B2012.091	2		7
03452+2450	HL 8AC	5.64	13.0	175.191	151.494	B2012.091	2		7
03452+2428	HL 9AC	4.30	14.0	54.011	52.69	B2011.999	2		8
03452+2428	HJL3251AB	4.30	8.10	329.399	71.74	B2011.999	2		8
03454+2402	HL 10AB	8.09	13.49	357.585	122.966	B2011.971	2		9
03454+2402	HL 10AC	8.09	14.73	137.343	140.235	B2011.971	2		9
03454+2312	UC 53	8.48	10.81	140.376	57.629	B2011.974	2		10
03456+2420	HJL1025AC	7.20	9.91	164.251	175.709	B2011.971	2		11
03457+2242	HWE 8	7.85	11.4	134.627	25.23	B2012.091	2		12
03457+2427	Anon.1AB	13.8	14.2	131.41	2.473	B2011.974	2	1	13
03458+2422	HL 11	3.87	13.0	72.952	113.309	B2011.974	2		14
03458+2309	STF 444AB	6.91	10.09	332.101	3.771	B2011.974	2		
03459+2433	HJL1026AB	5.75	6.42	129.743	149.745	B2011.999	6		15
03459+2433	HL 12AD	5.75	12.70	74.205	170.478	B2011.999	6		15
03459+2433	HL 14BC	6.42	15.10	266.135	51.464	B2011.999	4		15
03459+2433	POU 309DE	12.70	12.96	161.767	17.48	B2011.999	8		15
03459+2402	HL 13	7.89	14.0	320.828	163.892	B2011.971	2		16
03463+2411	S 437AC	8.13	7.70	308.614	39.557	B2011.971	2		17
03463+2411	BU 536CD	7.70	11.7	5.755	18.617	B2011.971	2		17
03463+2411	BAR9003DE	12.8	14.0	321.298	8.750	B2011.971	2		17
03463+2357	HL 15AB	4.15	14.0	179.694	110.649	B2011.999	2		18
03463+2357	HL 15AC	4.15	12.93	336.356	146.724	B2011.999	2		18
03465+2415	HL 16AB	7.34	14.0	35.215	118.742	B2011.971	2		19
03470+2431	HL 17AB	6.81	13.0	299.019	101.439	B2011.999	2		20
03470+2431	HL 17AC	6.81	13.0	190.468	123.328	B2011.999	2		20

Table continues on next page.

Double Star Measurements in the Pleiades Cluster Using a DSLR Camera

Table 4 (continued): Astrometric Measurements

RA + Dec	Discoverer	Mags	PA	Sep	Epoch	N	Notes	Img
03473+2348	HL 18	7.05 14.0	276.965	29.37	B2011.999	4		21
03473+2344	HL 19AB	7.03 11.0	227.375	66.872	B2012.124	2		22
03473+2344	HL 19AC	7.03 11.0	253.581	148.759	B2012.124	2		22
03473+2344	HL 19AD	7.03 12.0	243.897	131.732	B2012.124	2		22
03473+2344	Anon.2Ax	7.03 12.7	41.026	8.881	B2012.154	9	2	22
03474+2435	HL 20AB	7.69 14.61	95.167	33.083	B2012.091	2		23
03474+2435	HL 20AC	7.69 14.37	62.658	130.442	B2012.091	2		23
03474+2355	STF 450AB	7.29 9.1	261.295	5.703	B2011.999	4		24
03474+2355	HL 21AC	7.29 14.0	176.794	55.177	B2011.999	4		24
03474+2440	STF 449	8.78 11.3	330.715	6.808	B2012.091	2		25
03475+2417	HL 22	6.82 15.5	17.674	93.978	B2011.971	2		26
03475+2406	STFA 8AB	2.83 6.27	290.145	117.312	B2011.971	2		27
03475+2406	STFA 8AC	2.83 8.22	312.659	181.289	B2011.971	2		27
03475+2406	STFA 8AD	2.83 8.73	296.13	190.92	B2011.971	2		27
03475+2406	STFA 8BC	6.27 8.22	344.276	85.634	B2011.971	2		27
03475+2406	STFA 8BD	6.27 8.73	305.464	75.25	B2011.971	2		27
03475+2406	STFA 8CD	8.22 8.73	224.486	54.345	B2011.971	2		27
03475+2406	HL 23AE	2.83 15.0	231.471	77.546	B2011.971	2		27
03475+2406	HL 23AF	2.83 13.0	232.181	143.297	B2011.971	2		27
03475+2406	HL 23AG	2.83 11.0	52.986	199.385	B2011.971	2		27
03475+2406	HL 23AH	2.83 11.0	43.781	222.011	B2011.971	2		27
03479+2407	BU 538AB	11.1 12.1	127.486	1.739	B2012.124	2		28
03479+2407	BU 538AC	11.1 12.0	140.518	52.626	B2012.124	2		28
03483+2325	HL 25	5.43 12.0	297.775	176.63	B2011.971	2		29
03489+2351	HL 27AB	6.51 14.0	242.198	77.929	B2012.091	2		30
03489+2351	HL 27AC	6.51 15.3	332.34	86.503	B2012.091	2		30
03492+2408	HL 28AB	5.09 12.0	225.926	168.139	B2011.971	4		31
03492+2408	HL 28AC	5.09 10.0	274.38	223.109	B2011.971	4		31
03492+2408	HL 28AD	5.09 14.0	65.77	143.748	B2011.971	4		31
03492+2408	HL 28AE	5.09 15.0	76.518	96.397	B2011.971	4		31
03492+2403	HL 29AB	3.62 13.0	285.787	95.068	B2011.971	4		32
03492+2403	HL 29AC	3.62 15.0	36.575	49.622	B2011.971	4		32
03492+2403	HL 29AD	3.62 14.0	60.69	112.165	B2011.971	4		32
03492+2403	HL 29AE	3.62 10.0	240.61	214.204	B2011.971	4		32
03492+2403	HL 29AF	3.62 11.0	191.427	153.908	B2011.971	4		32

Table continues on next page.

Table 4 (conclusion): Astrometric Measurements

RA + Dec	Discoverer	Mags	PA	Sep	Epoch	N	Notes	Img
03492+2403	HL 29AG	3.62 11.5	124.724	171.337	B2011.971	4		32
03492+2403	HL 29AH	3.62 16.0	220.868	68.919	B2011.971	4		32
03492+2403	DAL 48DI	14.0 14.7	125.937	6.391	B2011.971	4		32
03494+2423	STTA 40AB	6.58 7.53	309.316	86.994	B2012.091	2		33
03494+2423	HL 31AE	6.58 13.4	83.457	116.069	B2012.091	2		33
03494+2423	HL 31AF	6.58 14.0	106.908	182.129	B2012.091	2		33
03494+2423	HL 31AG	6.58 14.3	211.743	158.871	B2012.091	2		33
03494+2423	HL 30BC	7.53 12.0	13.955	69.804	B2012.091	2		33
03494+2423	HL 30BD	7.53 11.5	242.213	80.846	B2012.091	2		33
03494+2423	HL 30BH	7.53 13.1	273.307	147.424	B2012.091	2		33
03494+2423	HL 30BI	7.53 13.9	229.575	146.99	B2012.091	2		33
03497+2320	LDS6118	8.15 9.17	320.973	179.981	B2012.091	2		34
03497+2343	HL 32AB	6.15 10.0	103.59	96.251	B2011.971	2		35
03497+2343	HL 32AC	6.15 12.0	201.029	116.33	B2011.971	2		35
03498+2421	HL 33AB	7.54 11.5	52.769	63.191	B2012.091	2		36
03498+2421	HL 33AC	7.54 11.5	227.845	39.427	B2012.091	2		36
03499+2357	Anon.3AB	9.9 12.66	182.371	9.098	B2012.124	2	3	37
03500+2351	STT 64AC	6.81 10.54	237.108	9.193	B2012.124	2		38
03500+2351	Anon.4Ax	6.81 13.99	269.846	24.553	B2012.124	2	4	38
03502+2353	Anon.5AB	13.17 13.22	108.423	9.624	B2012.124	2	5	38
03503+2241	STF 457AC	8.62 12.6	345.836	19.662	B2012.124	2		39

Table 4 Notes:

1. A = Melotte 22 HII 741
2. A = HL 19A
3. A = HD 283068, B = Melotte 22 HII 2497
4. A = STT 64A
5. A = Melotte 22 HII 2612, B = Melotte 22 HII 2623

Table 7: Measurement of the nearest star of HL 19A

Prox	Distance between source and nearest neighbor	7.8"
PxPA	Position angle of vector from source to nearest	42°
Date	Observation date	1997-10-28

Double Star Measurements in the Pleiades Cluster Using a DSLR Camera

(Continued from page 251)

STF 444AB Splitting technique

Resolving an unequal, very tight binary is challenging for an amateur astronomer. Many factors such as telescope resolution performance, seeing condition, object intensity, and exposure time could result in overlapping the two disks. An easy solution is to extract the pixel intensity from the Fits frame of the tight binary in a graphic-based tool as Microsoft Excel. Figure 1 shows the surprising result applying this simple technique to the rod-shaped binary STF 444. The geometric centroid of both disks could easily be projected and processed using basic trigonometric formulae to achieve an excellent estimation of the separation.

Conclusions

Five currently unlisted components which are excellent candidates to be double stars were found, and two unlisted new pairs. In all this paper lists 245 measures of 91 pairs.

Acknowledgments

This paper has made use of data products from the Washington Double Star Catalogue maintained at the U.S. Naval Observatory, the SIMBAD astronomical database, operated at CDS, Strasbourg, France, and the Two Micron All Sky Survey, 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.

A special thanks to Florent Losse for outstanding software REDUC, help and advice. I must thank John McDonald for the revision and correction of the syntactic and grammatical errors.

References

Calibrating a bifilar micrometer by measuring declination differences of H.I.C. stars in the Pleiades, http://www.brayebrookobservatory.org/BrayObsWebSite/BOOKS/BIFILAR MICROMETER CALIBRAT.pdf

Argyle, Bob, Observing and Measuring Visual Double Stars, Springer-Verlag London Limited 2004

Centre de Données astronomiques de Strasbourg, SIMBAD astronomical object database, http://simbad.u-strasbg.fr/simbad/

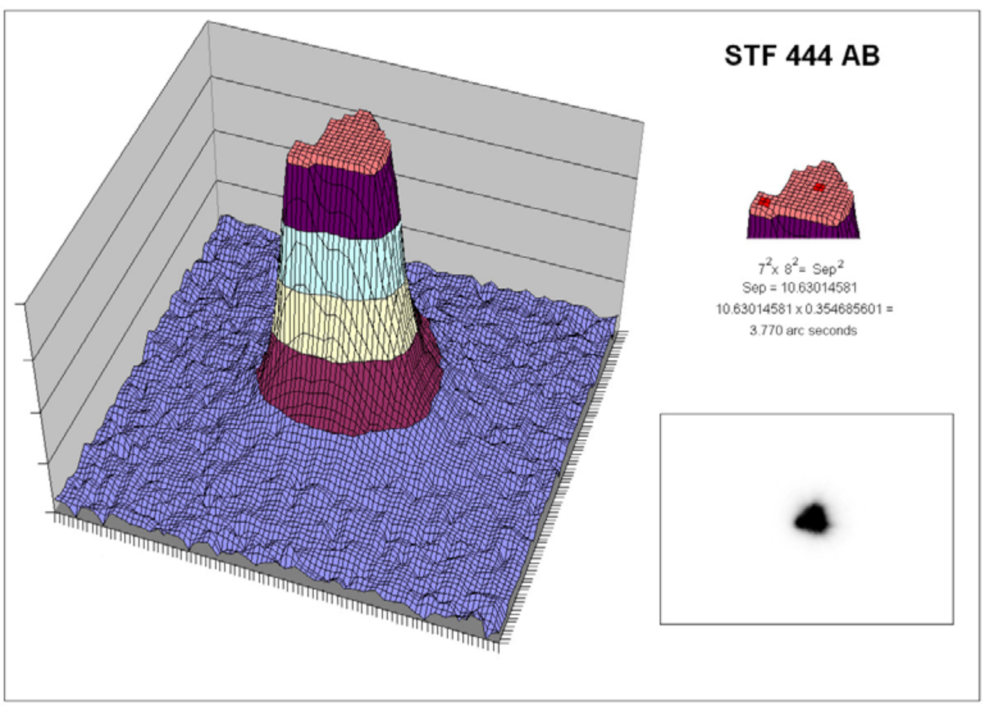


Figure 1: Graph of STF 444

Double Star Measurements in the Pleiades Cluster Using a DSLR Camera

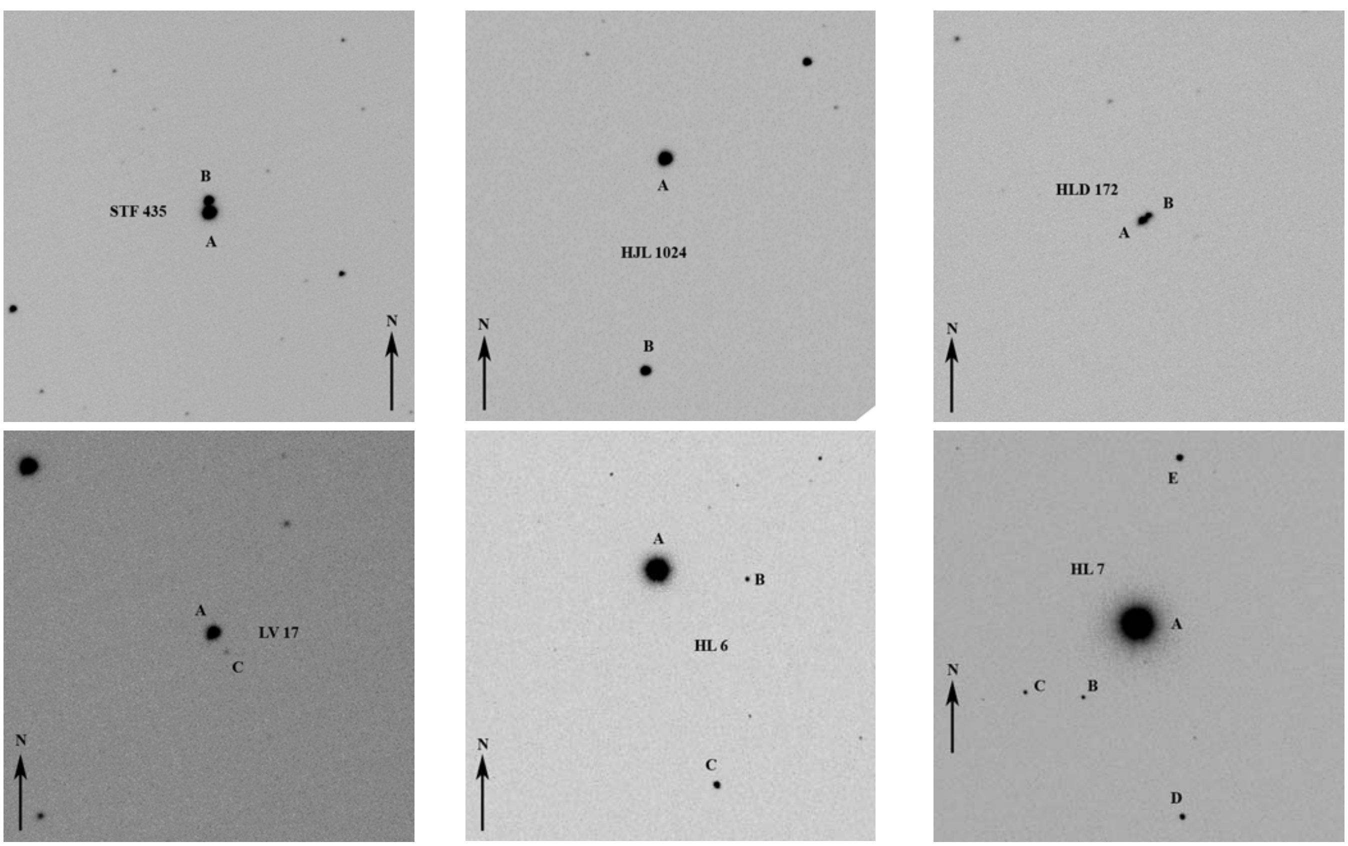
(Continued from page 255)

Mason, B. D., Wycoff, G. L. & Hartkopf, W. I.: Washington Double Star Catalogue, http://ad.usno.navy.mil/wds/

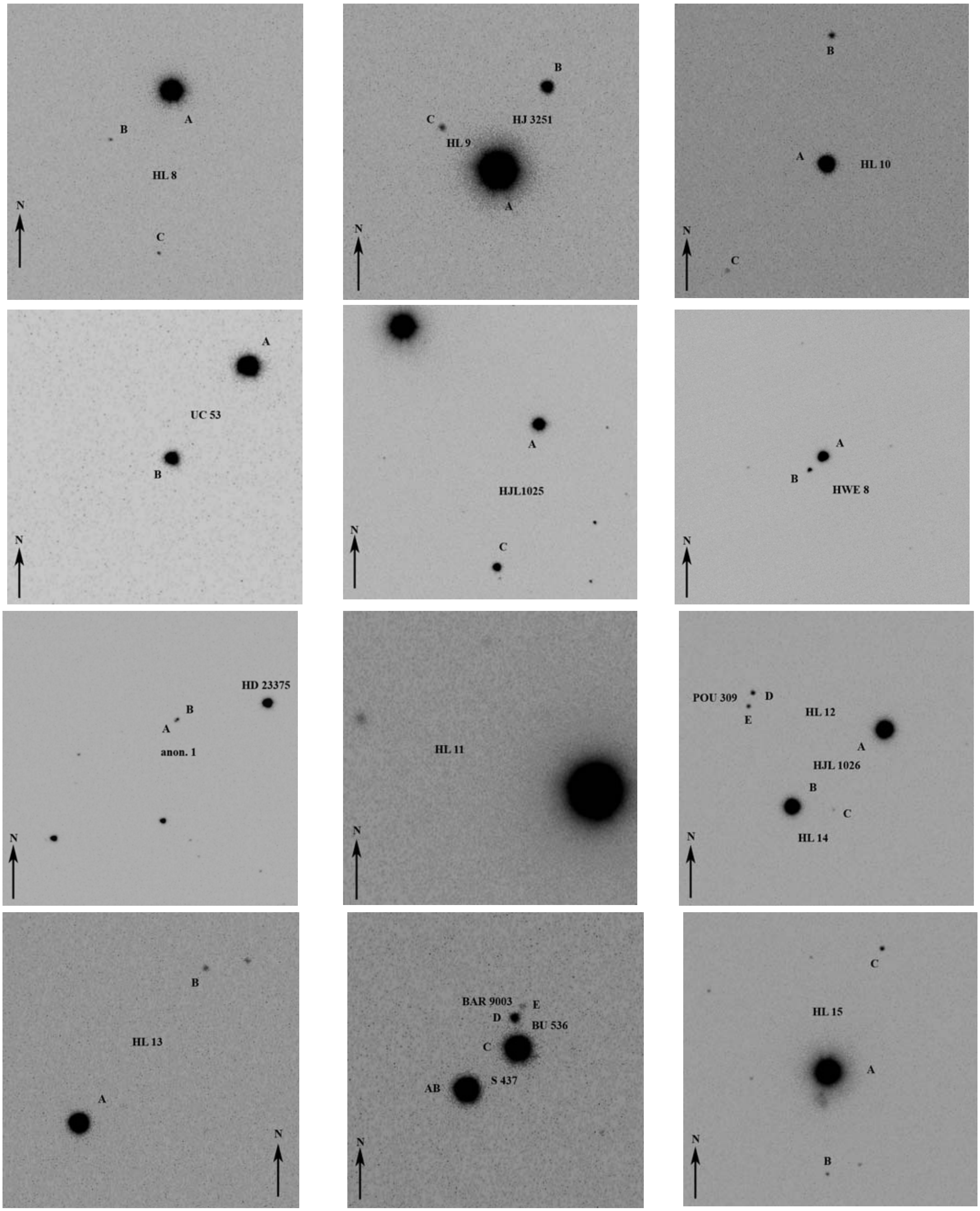
2MASS All-Sky Catalog of Point Sources (Cutri & al., 2003)

Romero, Francisco Rica, 2006, Aitken's Criterion to Detect Physical Pairs, The Double Star Observer, 2, 36-41.

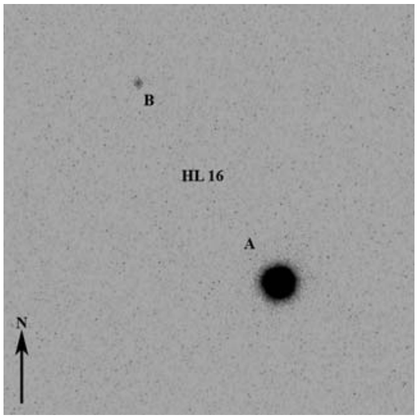
Berkó, Ernõ, 2008, Double Star Measures Using a DSLR Camera, The Double Star Observer, 4, 144-155.

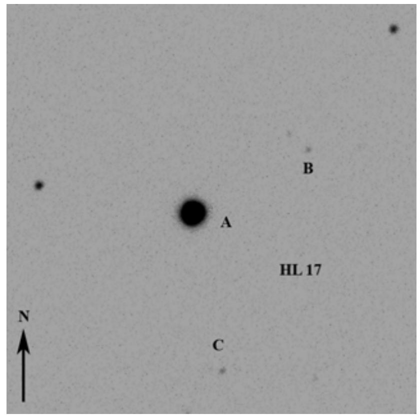


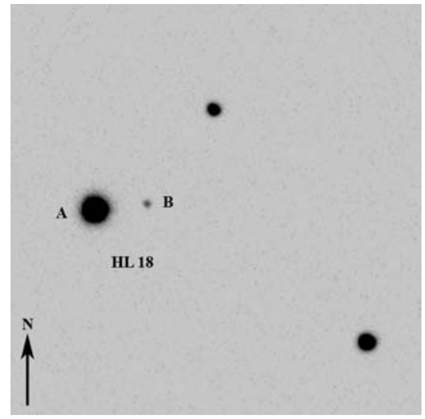
Double Star Measurements in the Pleiades Cluster Using a DSLR Camera

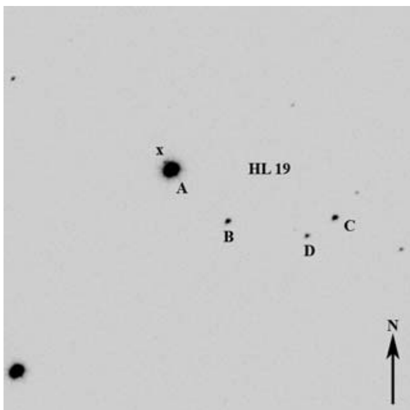


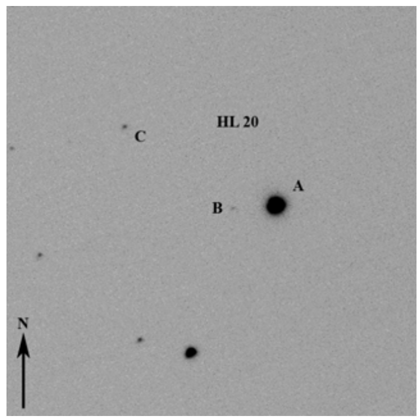
Double Star Measurements in the Pleiades Cluster Using a DSLR Camera

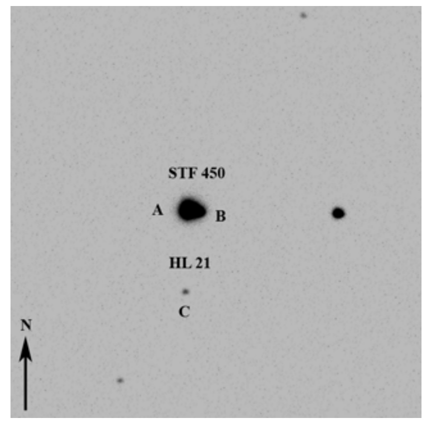


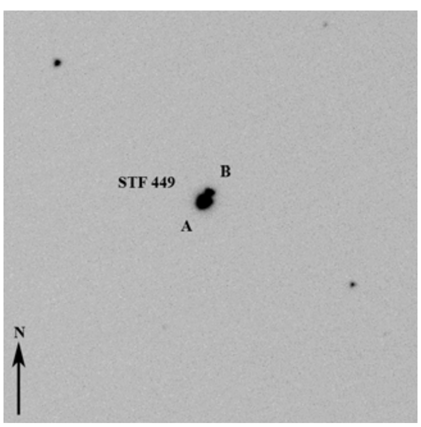


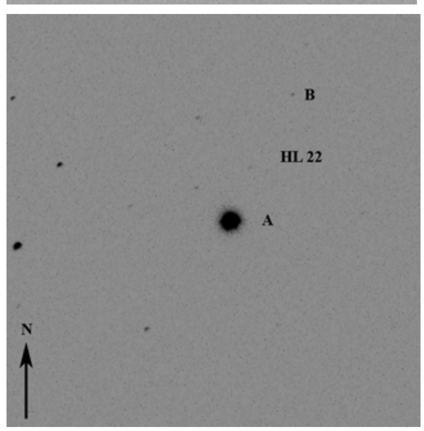


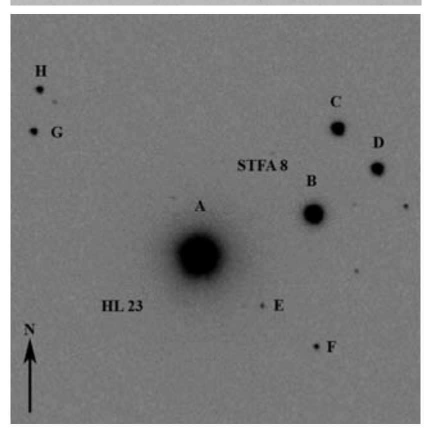


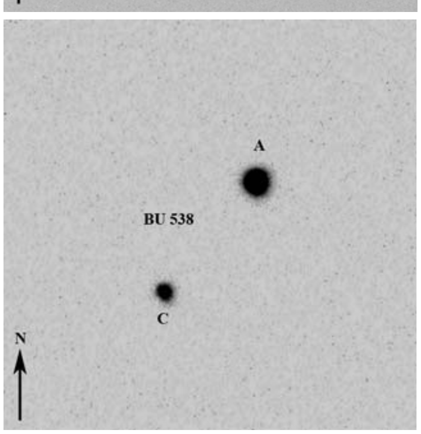


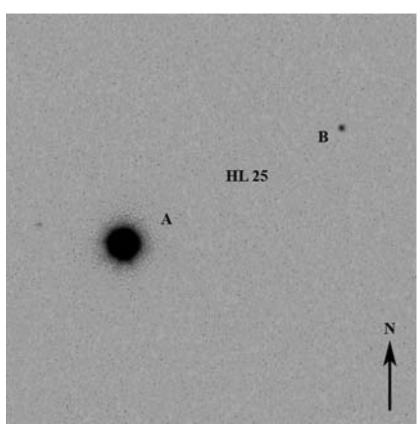


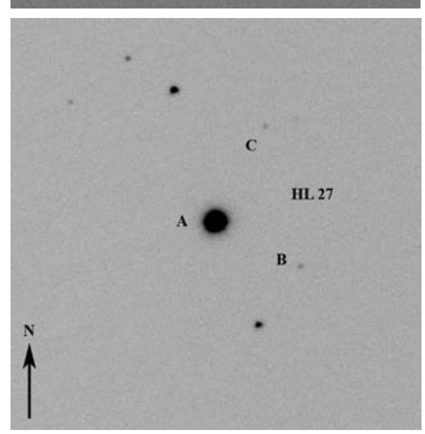




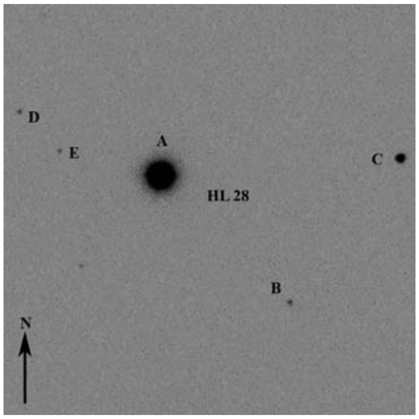


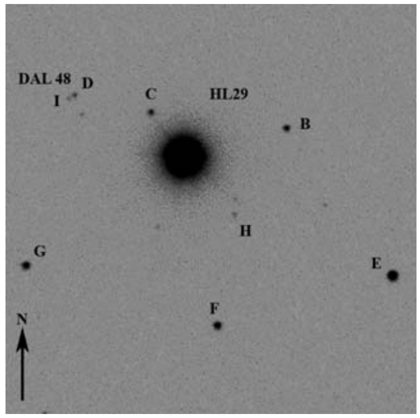


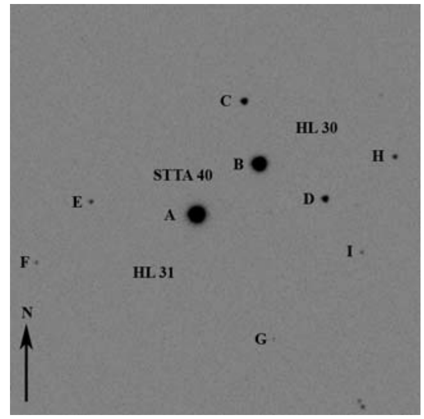


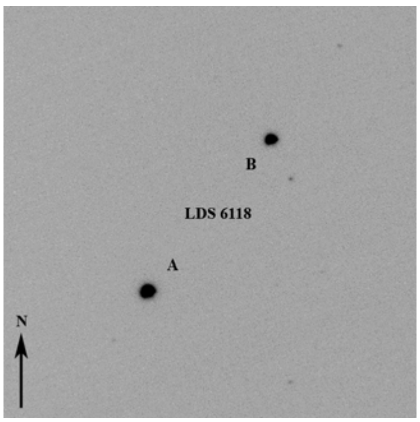


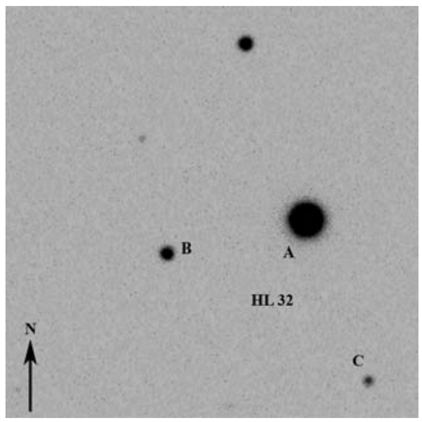
Double Star Measurements in the Pleiades Cluster Using a DSLR Camera

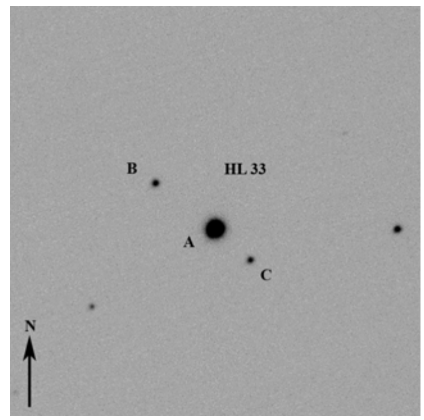


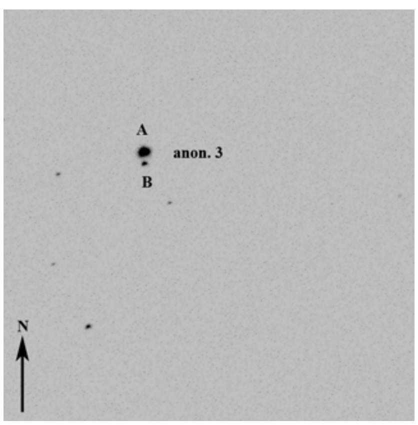


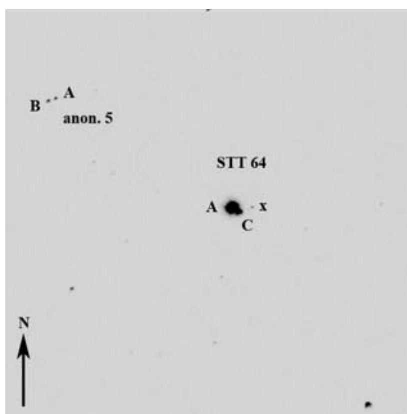


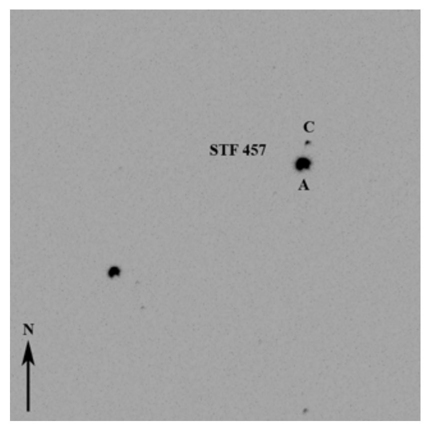












Mr. Michaud is a marine system engineering technician who lives in Victoria, BC. Member of the Royal Astronomical Society of Canada (Victoria centre), he has been a double star observer for 15 years. This work is his first contribution to the Journal.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

F. M. Rica

Double Star Section of Liga Iberoamericana de Astronomía (LIADA)
Astronomical Society of Mérida
frica0@gmail.com

Abstract: In this work the discovery of 145 new high (μ > 0.15 mas yr^{-1}) common proper motion binaries selected from the LSPM-North Catalog is presented and the study of other 75 uncataloged binaries at the beginning of this work but recently discovered before the publication of this article. Four hundred fifty-three astrometric measures (position angles and angular distances) were performed using astrometric catalogs (2MASS, CMC14 and SDSS). Spectral types, photometric distances and kinematics were determined from data obtained consulting the literature. Orbital periods and the semimajor axes were calculated. Of the stars in the sample, there are 5 stars nearer than 25 pc, 73 subdwarfs and 9 white dwarfs unreported in the literature. Of the binaries, some are composed of two subdwarfs and others are composed of two white dwarfs. Others have very wide physical separations (13 binaries with s > 20,000 AU) and 4 binaries are very wide (s > 5,000 AU) low-mass (Ma + Mb < 0.4) binaries.

1. Introduction

For several years double-star amateurs (most of them Spanish observers) have contributed to the astronomical community with interesting works (see *Introduction* section in Rica (2008)). Recently R. Caballero (2009, 2010a, 2010b) and R. Caballero *et al.* (2010) has published in JDSO articles reporting in total about 536 new uncataloged and wide common proper motion binaries. Other works are Benavides *et al.* (2010) with 141 new binary stars, Miret *et al.* (2011) and Miret & Tobal (2009, 2010) discovered 623 new binaries. Recently same Spanish amateurs have presented 387 new wide binaries in El Observador de Estrellas Dobles (OED) maganize (Agudo 2012; Benavides 2012; González 2012).

It is logical to think that most of the wide binaries have been discovered, but in this work 145 new high (> 0.15 arcsec yr^{-1}) common proper motion pairs not cataloged are presented.

Section 2 details how these new binaries were discovered; sections 3-7 describe the astrophysical study consulting astronomical literature, spectral type estimates, distance estimations, reddening corrections and stellar masses. Section 8 explains how the semimajor axis and orbital periods were obtained. In section 9 the astrometric measures and the astrophysical results are presented.

2. Searching for New Binaries

Pairs of stars with similar proper motions were searched for in the *LSPM-North Catalog* (Lepine & Shara 2005). This table contains 61,977 stars with proper motion greater than 0.15 arcsec yr^{-1}. The search was performed using the *TopCat* tool, a tool of the Virtual Observatory, exactly using an internal join (*Internal Match*) and selecting all the pairs of entries with similar proper motions and with a maximum angular separation of 360 arcsec. This search selected 2398 pairs of stars.

The selected pairs of stars were crossed with the WDS catalog using the *VizieR* tool. Finally 802 new and uncataloged common proper motion pairs were found. A visual inspection is needed to confirm the real existence of these binaries and in this work we only present the 220 most conspicuous binaries which 75 binaries were recently discovered (Agudo 2012; Benavides 2012; R. Caballero (2012) (CBL); González 2012; López 2012) and same of them yet not cataloged in the WDS. Others binaries were recently listed in the Garraf Wide Pairs: CPM wide pairs (>50 mas yr^{-1}) discovered in the Garraf Astronomica Observatory (OAG) CPMWP Survey.

3. Consulting the Astronomical Literature

The astronomical literature was consulted in order to obtain photometric, astrometric, kinematical data and other information. *Aladin*, *VizieR*, *Simbad* (Wenger *et al*. 2003) and the "services abstract" tools were used from the website of Centre de Dones Astronomiques de Strasburg (CDS), maintained by the Strasburg Observatory, and the Astrophysical Data Services (ADS) maintained by the NASA.

Photometry in B, V and I bands came from the Hipparcos (ESA 1997) and the Tycho-2 (Hog *et al*. 2000) catalogs. Infrared J, H and K photometry came from the Two Micron All Sky Survey (Cutri 2000), hereafter 2MASS. The proper motions came mainly from the *LSPM-North Catalog* (Lepine & Shara 2005) and from the Tycho-2, UCAC-3 (Zacharias el at. 2010) and the PPMXL (Roeeser, Demleitner, & Schilbach 2010) catalogs. The Tycho-2 catalog was chosen because the Hipparcos proper motions could be affected by Keplerian motion due to its smaller baseline. Spectral types, radial velocity and other astrophysical data were taken from several sources from CDS web page.

4. Spectral Types and Luminosity Class Estimates

The spectral types and the luminosity classes were obtained using the same procedure published in Benavides *et al*. (2010). In this work we also obtained the spectral types for the cool subdwarfs using the relationship between the V - K color and the spectral types. We could not determine the spectral types for white dwarfs. They are listed as "wd".

5. Distance Estimation and Reddening Correction

The distance was calculated using our determination of the absolute magnitude, therefore they are photometric distances. For the reddening correction, we followed the same procedure published in Benavides *et al*. (2010). In this work, we determined the absolute magnitude in the K band for cool subdwarf stars using the relation of Legget (1992) for halo stars, mainly using only V - K color in the range from 3.5 to 9.0. For subdwarfs with V - K < 3.5 the absolute magnitude could not be obtained. For stars with no 2MASS counterpart but listed in SDSS, the spectral type and luminosity class could be obtained using SDSS photometry and reduced proper motion diagrams (Jones 1972, Salim & Gould 2002, Nelson *et al*. 2002).

6. Stellar Masses

In this work the luminosity-mass relation of Henry & McCarthy (1993) was used if the star has a K absolute magnitude between 3.07 and 9.81 (stellar masses of $0.08 \leq$ Msun ≤ 1.0). This relation uses the K absolute magnitude which is obtained from Mv and V - K color.

The mass error when the Henry & McCarthy (1993) relation is used, is 21% for 0.08-0.50 Msun and 15% for 0.50-1.0 Msun. For evolved stars an arbitrary error of 25% for stellar masses was fixed. Other mass-luminosity relations used include:

- The relation between absolute magnitude (in J, H and K band) and stellar mass of Delfosse *et al*. (2000) for stars with masses < 0.6 Msun.
- The relation spectral type – absolute magnitude from the website http://isthe.com/chongo/tech/astro/HR-temp-mass-table-byhrclass.html for giant stars.
- The relation spectral types–stellar masses of Kirkpatrick & McCarthy (1994) for stars with spectral types M1V-M6.

The final stellar mass is an average of those intermediate values determined previously by the different relationships. The stellar masses for subdwarfs were calculated assuming that they are normal stars.

7. Studying the Nature of the Visual Stellar Systems

In this work a deep study of the nature for these pairs of common proper motion (MPC) was not per-

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

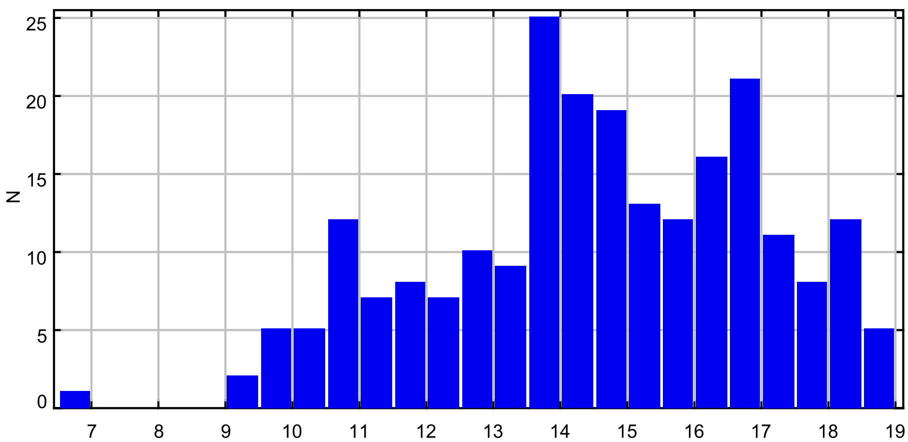
formed. Therefore, the only evidence of binarity is the high common proper motion ($\mu \geq 0.15$ arcsec yr^{-1}). Other binarity evidence could be the photometric distance of the stellar components, although due to the significant error in the distances calculated in this way, it must be used with caution. Most of the binaries listed in this work likely are common origin binaries, that is, binaries in which the stellar component does not orbit around the mass center. While a low-medium percentage of them could be physical binaries which stellar components is orbiting around the center of mass.

8. Semimajor Axis and Orbital Periods

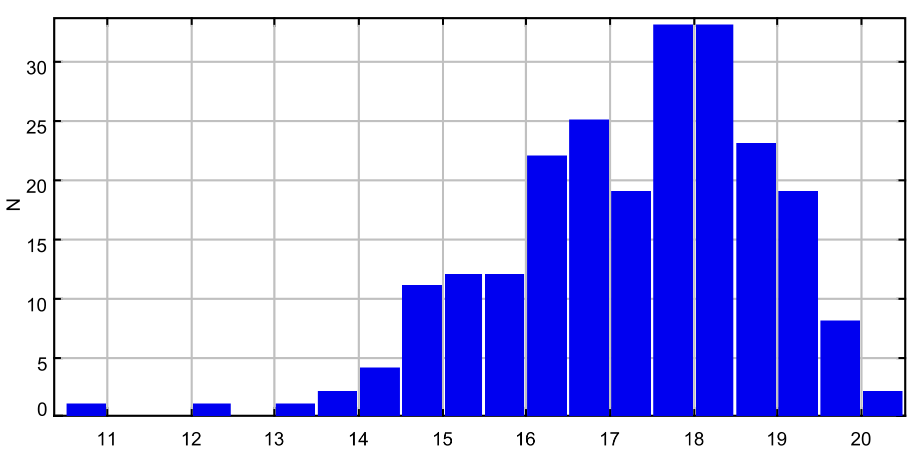
For the semimajor axis and orbital period estimation, the same procedure published in Benavides et al. (2010) was followed.

9. Results

In this work astrometric measures for the 220 binaries was performed. In addition to this, an astrophysical characterization for the 440 stellar components was performed. The expected semimajor axes and orbital period was estimated for all the stellar systems. Most of the stars in my sample are red dwarfs (K-M spectral types) and cool subdwarfs in



1A: V mag. For the Primary Components.



1B: Vmag. for Secondary Components

Figure 1: (A) Distribution of the V magnitude for the primary components. **(B)** Distribution of the V magnitude for the secondary components.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

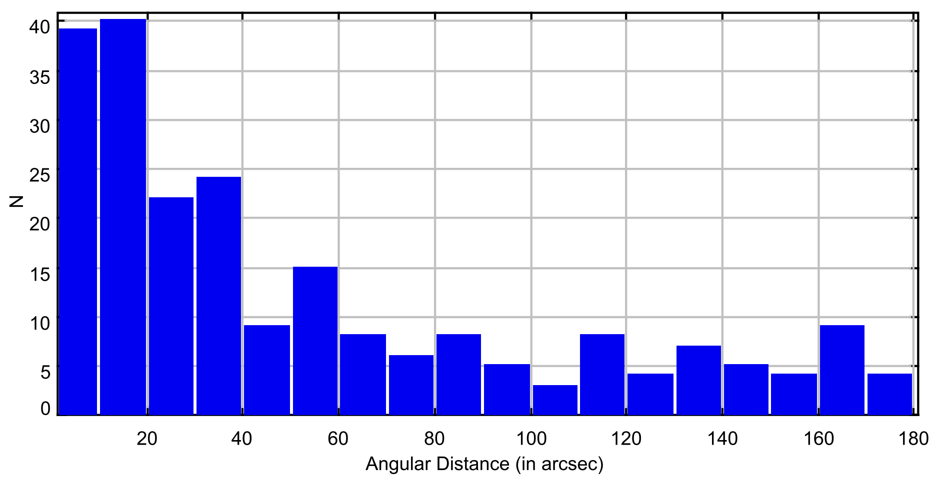


Figure 2: Distribution of the angular separations (in arcsec).

addition to a few white dwarfs. Therefore the weakness of the stars is showed in the apparent magnitudes with a weak end of 18-19 magnitude for the primaries components and 20.0-20.5 magnitudes for the secondary components. Figures 1A and 1B show a magnitude distribution for the primary and secondary components.

9.1 Measurements of the Position Angle and Angular Separation

Table 1 lists 453 measurements of position angles (θ) and angular distances (ρ) for 220 binaries stars. These measures were obtained automatically (programming small computed routines) using the positional data (RA and DEC) and epochs for the 2MASS, Carlsberg Meridian Catalog 14 (CMC 2006, hereafter CMC14) and Sloan Digital Sky Survey (Adelman-McCarthy *et al.* 2009, hereafter SDSS) catalog. When no counterpart in these catalogs exists, then the DSS photographic plates were used to obtain astrometric measures. The observational epochs range from 1951.513 to 2005.841 and the angular separation ranges from 4.54 to 177.17 arcsec (mean of 53.7 arcsec). In Table 1, column 1 lists the designation name proposed for the stellar system. For Lopez (2012) binaries we use the LSPM designation because they are not listed in WDS at the writing of this article. Columns 2 and 3 list the equatorial coordinate for equinox 2000. The Besselian epoch, theta (θ) and rho (ρ) values are listed in columns 4-6. Positional angles are expressed for 2000 equinox. The observational method code is given in column 7. The code for the observational method is *2MASS* for measures obtained from astrometric data (RA and DEC) of the 2MASS catalog; *CMC14*, if the AR and DEC came from the CMC14 catalog and *SDSS*, if the AR and DEC came from the SDSS catalog. If a DSS photographic plate was used, this column shows "DSS".

Figure 2 shows the distribution of the angular separation. Most of the double stars have angular separations closer than 40 arcsec.

The CMC14 and the SDSS catalogs were accessed via *VizieR* tools. The CMC14 is an astrometric and photometric catalogue of 95.9 million stars in the red (SDSS r') magnitude range 9 to 17 and covers the declination range -30° to +50°. It was compiled using digital images taken by a CCD camera attached on the Carlsberg Meridian Telescope, a refractor of 17.8 cm of diameter. The CCD camera was built by the Copenhagen University Observatory and it has a Kodak 2060 x 2048 (KAF-4202 Grade:C1) chip. The astrometric data (RA and DEC) is on ICRS system and it has an external accuracy of 33-34 mas for stars with r' < 13 (88 and 63 mas in RA and DEC, for stars with r' = 16.)

The SDSS catalog was compiled using the CCD images taken by a 2.5 m telescope at Apache Point Observatory in New Mexico (USA). This telescope takes images using a photometric system of five filters (named *u*, *g*, *r*, *i* and *z*). The telescope's camera is made up of 30 CCD chips each with a resolution of 2048 × 2048 pixels, totaling approximately 120 megapixels. The astrometric data (RA and DEC) is on ICRS system and it has an error of 45 mas.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

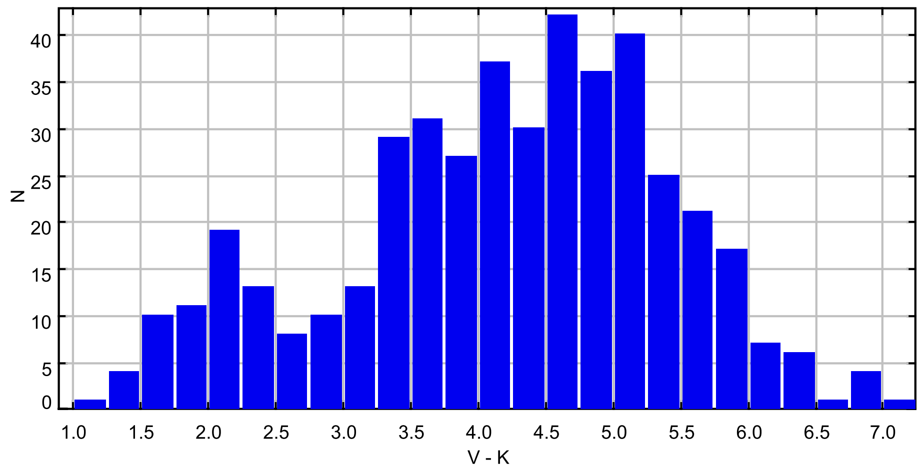


Figure 3. Distribution of the V – K colors.

9.2 Astrophysical Results

These binaries with high common proper motions have an important astrophysical interest. An astrophysical characterization was performed for the 440 stellar components determining the spectral types, absolute magnitudes, photometric distances, tangential velocities and stellar masses. Photometric data was corrected by the interstellar reddening.

Table 2 presents the astrophysical characterization for the stellar components. Column 1 lists the proposed designation name and the stellar component. Column 2 and 3 list the RA and DEC position for 2000 Equinox. These positional data were taken from the 2MASS catalog. Columns 4 – 8 show photometric data (V, B - V, K, J - K and V - K). Columns 9 and 10 list the proper motions in RA and DEC extracted from the *LSPM-North Catalog*. Columns 11 through 14 list the spectral type, V absolute magnitude, photometric distance (in pc) and tangential velocity (in km s^{-1}). And finally the columns 15 and 16 list the stellar mass, in solar mass, and the reddening in B-V.

9.2.1 Photometric data and Estimation of the V magnitude

Photometric data in the Hipparcos, Tycho-2, SDSS, CMC14 and UCAC3 catalogs were used. For each star, the procedure to select the V magnitude is as follows: if the star is listed in the Hipparcos catalog, the V magnitude is used if it is brighter than 10th. Otherwise, if the star is listed in the Tycho-2 catalog, the V_{TYC} photometry (converting to Johnson system using standard transformations) is used if $V_{TYC} <$ 11.25 and the error in $V_{TYC} < 0.2$. Otherwise, the averaged V magnitude is estimated from the CMC14 and the UCAC3 catalogs (Rica 2011). If the star is not listed in the CMC14 and the UCAC3 catalogs then the V magnitudes inferred using SDSS photometry (Rica 2011) is selected.

In spite of this procedure, weak stars were found for which no V magnitude was estimated. For these stars, the V magnitudes listed in the *LSPM-North Catalog* were used, which were determined using photographic magnitudes from the USNO-B1.0 catalog (± 0.5 mag). For the other stars, the V magnitudes were checked comparing them with the estimated V from the *LSPM-North Catalog*. When the difference was greater than 0.5 magnitudes, other values for V using GSC2.3 and USNO-B1.0 was estimated to reject wrong values.

For a few stars, the B - V color was listed. It mainly came from the Hipparcos and the Tycho-2 catalogs. The J, H, and K photometry came from the 2MASS catalog. Figure 3 shows the distribution in the V - K colors

9.2.2 Spectral Type Estimation

The spectral types and luminosity classes for 456 stars were estimated. Two hundred and eighty eight stars were classified as M red dwarfs. The coolest star was 0550+0939 B, a near star (18.9 pc) of M6V spec-

(Continued on page 293)

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1. Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
FMR 29	00 11 41.96	+03 23 17.6	1998.877	189.11	6.74	2MASS
FMR 29	00 11 41.96	+03 23 17.6	2001.134	186.98	6.77	CMC14
FMR 30	00 23 55.55	+16 46 45.9	1997.544	57.06	173.39	2MASS
FMR 30	00 23 55.55	+16 46 45.9	2001.594	57.02	173.65	CMC14
FMR 31	00 41 30.19	+07 28 34.8	2000.724	262.22	32.08	2MASS
FMR 31	00 41 30.19	+07 28 34.8	2005.742	262.22	32.11	SDSS
FMR 32	00 42 15.23	+07 31 18.6	2000.724	275.16	13.10	2MASS
FMR 32	00 42 15.23	+07 31 18.6	2005.742	275.53	13.38	SDSS
FMR 33	00 44 27.83	+19 35 05.3	1997.760	253.80	9.11	2MASS
FMR 33	00 44 27.83	+19 35 05.3	2001.501	253.44	9.08	CMC14
FMR 34BC	00 50 21.36	+59 23 19.4	2000.033	135.35	15.75	2MASS
FMR 35	00 50 12.71	+62 34 58.8	1999.869	112.48	20.29	2MASS
FMR 36	00 53 11.05	+31 44 13.5	1997.916	39.79	159.68	2MASS
FMR 36	00 53 11.05	+31 44 13.5	2001.986	39.75	159.54	CMC14
FMR 37	00 56 17.47	+81 03 15.3	2000.760	177.05	63.89	2MASS
FMR 38	00 59 51.55	+27 01 28.8	1997.828	261.41	72.91	2MASS
FMR 38	00 59 51.55	+27 01 28.8	2001.679	261.50	73.03	CMC14
FMR 39	01 00 30.94	+09 33 09.8	2000.748	250.41	19.42	2MASS
FMR 39	01 00 30.94	+09 33 09.8	2001.129	250.16	19.46	CMC14
FMR 40	01 05 16.73	+16 20 24.9	1997.678	188.28	7.72	2MASS
FMR 40	01 05 16.73	+16 20 24.9	2001.619	188.80	7.74	CMC14
FMR 41	01 07 43.48	+57 59 11.5	1998.990	246.79	116.16	2MASS
0111+4248	01 11 55.14	+42 48 02.4	1998.839	215.27	115.15	2MASS
0111+4248	01 11 55.14	+42 48 02.4	2002.847	215.29	115.17	CMC14
FMR 42AB	01 15 50.17	+47 02 02.3	1998.839	330.37	27.14	2MASS
FMR 42AB	01 15 50.17	+47 02 02.3	2002.658	330.09	27.11	CMC14
FMR 43	01 21 32.50	+39 20 35.2	2000.752	238.86	15.80	2MASS
FMR 43	01 21 32.50	+39 20 35.2	2003.323	238.95	15.76	CMC14
FMR 43	01 21 32.50	+39 20 35.2	2004.653	238.63	15.76	SDSS
FMR 44	01 31 01.43	+54 31 55.4	1999.790	153.86	42.98	2MASS
FMR 45	01 56 19.06	+37 28 48.7	1998.858	33.76	6.79	2MASS
FMR 45	01 56 19.06	+37 28 48.7	2002.710	33.29	6.67	CMC14
FMR 46	02 00 01.17	+07 32 46.8	2000.732	342.30	18.13	2MASS
FMR 46	02 00 01.17	+07 32 46.8	2004.953	341.41	18.32	SDSS
FMR 47	02 00 20.14	+26 35 59.9	1997.842	94.91	13.96	2MASS
FMR 47	02 00 20.14	+26 35 59.9	2001.649	94.79	13.93	CMC14
0201+0218	02 01 15.09	+02 18 25.7	2000.656	151.50	63.84	2MASS
FMR 48	02 05 24.83	+17 09 22.1	1998.730	71.85	11.90	2MASS
FMR 49	02 12 39.74	+01 18 31.7	2000.205	46.48	7.33	CMC14
FMR 49	02 12 39.74	+01 18 31.7	2000.631	45.19	7.24	2MASS
FMR 50	02 22 41.63	+56 27 03.1	1954.754	14.21	30.47	DSS
FMR 50	02 22 41.63	+56 27 03.1	1957.965	14.16	30.37	DSS

Table 1 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1 (continued). Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
FMR 50	02 22 41.63	+56 27 03.1	1995.790	14.69	30.00	DSS
FMR 51	02 26 02.36	+53 24 49.3	1998.927	142.86	114.74	2MASS
FMR 52	02 27 41.12	+06 13 53.9	2000.741	279.34	6.95	2MASS
FMR 52	02 27 41.12	+06 13 53.9	2001.762	279.12	6.97	CMC14
FMR 52	02 27 41.12	+06 13 53.9	2005.781	279.34	6.96	SDSS
FMR 53	02 30 55.18	+62 48 50.8	1999.012	126.90	19.62	2MASS
FMR 54	02 31 33.05	+38 53 14.3	1998.774	209.76	7.34	2MASS
FMR 54	02 31 33.05	+38 53 14.3	2003.208	209.55	7.36	CMC14
FMR 55	02 32 29.68	+06 06 15.6	2000.661	56.49	18.47	2MASS
FMR 55	02 32 29.68	+06 06 15.6	2005.781	56.21	18.25	SDSS
CBL 212	02 32 43.60	+74 08 54.9	1999.823	160.42	14.78	2MASS
CBL 212	02 32 43.60	+74 08 54.9	2005.841	160.89	14.76	SDSS
CBL 213	02 33 01.14	+01 05 38.9	1999.970	344.52	29.17	CMC14
CBL 213	02 33 01.14	+01 05 38.9	2000.661	344.49	29.09	2MASS
CBL 213	02 33 01.14	+01 05 38.9	2001.890	344.56	29.13	SDSS
FMR 56	02 34 03.02	+09 50 14.0	2000.746	273.42	6.70	2MASS
FMR 57	02 40 09.93	+14 38 47.6	1998.735	97.61	9.75	2MASS
FMR 57	02 40 09.93	+14 38 47.6	2001.882	97.59	9.70	CMC14
FMR 58	02 44 21.78	+32 07 16.5	1999.845	48.29	63.38	2MASS
FMR 58	02 44 21.78	+32 07 16.5	2002.208	48.26	63.54	CMC14
FMR 59	02 51 07.90	+06 48 23.3	1999.959	322.65	47.04	2MASS
FMR 59	02 51 07.90	+06 48 23.3	2001.408	322.66	47.10	CMC14
FMR 59	02 51 07.90	+06 48 23.3	2004.953	322.74	47.16	SDSS
FMR 60	02 51 30.43	+34 06 37.5	1994.172	48.27	77.38	SDSS
FMR 60	02 51 30.43	+34 06 37.5	1997.962	48.22	77.25	2MASS
FMR 60	02 51 30.43	+34 06 37.5	2003.685	48.25	77.36	CMC14
FMR 61	02 53 59.42	+66 06 07.3	2000.170	343.65	9.10	2MASS
FMR 62	03 17 26.20	+64 03 57.8	1999.022	172.20	52.28	2MASS
GWP 453	03 20 52.06	+12 09 56.4	1998.738	215.32	53.81	2MASS
GWP 453	03 20 52.06	+12 09 56.4	2000.901	215.20	53.69	CMC14
0323+1506	03 23 27.30	+15 06 52.0	1998.738	185.33	67.85	2MASS
0323+1506	03 23 27.30	+15 06 52.0	2001.036	185.32	67.71	CMC14
GWP 512	03 47 07.04	+05 20 16.9	1955.939	246.25	6.80	DSS
GWP 512	03 47 07.04	+05 20 16.9	1996,686	242,61	6,90	DSS
FMR 63	03 50 50.19	+45 45 34.1	1999.766	327.37	27.69	2MASS
FMR 63	03 50 50.19	+45 45 34.1	2002.858	327.68	27.83	CMC14
FMR 64	04 11 26.59	+54 24 02.9	2000.793	168.42	172.08	2MASS
FMR 64	04 11 26.59	+54 24 02.9	2004.790	168.49	172.11	SDSS
FMR 65	04 17 51.16	+51 43 36.7	1999.785	333.09	13.10	2MASS
FMR 66	04 24 49.26	+01 06 56.1	1999.986	106.45	25.89	CMC14
FMR 66	04 24 49.26	+01 06 56.1	2000.071	106.71	25.82	2MASS
0433+0013	04 33 17.84	+00 13 59.5	1999.953	40.72	19.03	CMC14

Table 1 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1 (continued). Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
0433+0013	04 33 17.84	+00 13 59.5	2000.071	40.59	19.07	2MASS
FMR 67	04 48 06.47	+41 38 04.7	1998.779	94.23	8.39	2MASS
0509+1038	05 09 42.59	+10 38 43.8	1999.987	316.91	45.43	2MASS
FMR 68	05 19 34.13	+34 20 38.7	1998.088	122.53	50.72	2MASS
FMR 68	05 19 34.13	+34 20 38.7	2002.937	122.51	50.77	CMC14
0524+0315	05 24 49.76	+03 15 15.4	2000.082	245.93	48.26	2MASS
0524+0315	05 24 49.76	+03 15 15.4	2000.597	245.96	48.31	CMC14
FMR 69	05 44 17.22	+30 38 31.6	1998.091	88.19	50.04	2MASS
FMR 69	05 44 17.22	+30 38 31.6	2002.797	88.18	50.02	CMC14
FMR 70	05 45 45.39	+66 38 30.2	2000.703	129.57	11.17	2MASS
0546+1116	05 46 17.26	+11 16 46.6	1999.765	207.08	53.81	2MASS
0550+0939	05 50 11.74	+09 39 49.2	1999.705	317.28	16.19	2MASS
0550+0939	05 50 11.74	+09 39 49.2	2000.940	317.27	15.81	CMC14
FMR 71	05 51 49.91	+18 04 29.4	1998.752	195.81	20.27	2MASS
FMR 71	05 51 49.91	+18 04 29.4	2002.074	195.93	20.43	CMC14
GWP 736	06 05 03.52	+07 23 30.5	1999.812	347.26	8.75	2MASS
GWP 736	06 05 03.52	+07 23 30.5	2000.825	347.54	8.57	CMC14
GWP 744	06 06 13.38	+06 48 22.3	2000.025	297.70	9.22	2MASS
0610+2802	06 10 25.64	+28 02 23.6	1998.020	170.88	161.00	2MASS
0610+2802	06 10 25.64	+28 02 23.6	2002.773	170.90	160.99	CMC14
0610+4439	06 10 43.98	+44 39 49.8	1998.843	39.49	142.03	2MASS
0610+4439	06 10 43.98	+44 39 49.8	2003.008	39.53	141.80	CMC14
FMR 72	06 10 48.30	+03 15 12.9	1999.894	280.87	45.47	2MASS
FMR 73	06 15 40.49	+34 27 03.8	1995.122	119.04	7.52	SDSS
FMR 73	06 15 40.49	+34 27 03.8	1998.891	119.18	7.55	2MASS
FMR 73	06 15 40.49	+34 27 03.8	2002.825	120.38	7.36	CMC14
FMR 74	06 18 10.57	+67 04 15.2	1999.820	25.55	7.61	2MASS
0628+2829	06 28 28.26	+28 29 23.0	1998.037	148.22	100.24	2MASS
0628+2829	06 28 28.26	+28 29 23.0	2002.129	148.24	100.15	CMC14
FMR 75	06 28 31.05	+59 06 23.1	1999.009	349.44	36.68	2MASS
0649+2942	06 49 53.22	+29 42 03.8	1995.131	181.73	34.23	SDSS
0649+2942	06 49 53.22	+29 42 03.8	1998.058	181.77	34.23	2MASS
0649+2942	06 49 53.22	+29 42 03.8	2002.063	181.66	34.22	CMC14
FMR 83	06 51 04.45	+18 43 43.1	1997.908	330.63	111.71	2MASS
FMR 83	06 51 04.45	+18 43 43.1	2001.666	330.66	111.83	CMC14
FMR 76	06 58 34.34	+75 14 17.7	1999.156	169.93	131.42	2MASS
0705+4129	07 05 32.54	+41 29 10.0	1998.247	134.90	87.21	2MASS
0705+4129	07 05 32.54	+41 29 10.0	2003.159	134.89	87.18	CMC14
GWP 876	07 10 52.54	+06 12 30.6	1999.922	334.68	21.38	2MASS
GWP 876	07 10 52.54	+06 12 30.6	2001.178	334.77	21.39	CMC14
FMR 77	07 15 21.11	+03 01 27.8	1999.946	214.74	19.32	2MASS
0727+4228	07 27 50.77	+42 28 19.8	1998.302	172.75	32.08	2MASS

Table 1 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1 (continued). Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
0727+4228	07 27 50.77	+42 28 19.8	2003.838	172.84	31.85	CMC14
0727+4228	07 27 50.77	+42 28 19.8	2003.886	172.80	32.09	SDSS
CBL 235	07 28 20.77	+31 00 13.0	1995.128	296.10	9.40	SDSS
CBL 235	07 28 20.77	+31 00 13.0	1998.900	295.93	9.38	2MASS
CBL 235	07 28 20.77	+31 00 13.0	2003.115	296.02	9.65	CMC14
FMR 78	07 38 12.77	+43 34 24.0	1998.916	283.38	177.17	2MASS
FMR 79	07 40 57.40	+06 41 04.8	1999.924	353.01	6.91	2MASS
FMR 79	07 40 57.40	+06 41 04.8	2000.433	351.93	6.98	CMC14
0749+2435	07 49 54.56	+24 35 13.1	1998.774	342.11	96.92	2MASS
0749+2435	07 49 54.56	+24 35 13.1	2002.099	342.10	96.79	CMC14
0749+2435	07 49 54.56	+24 35 13.1	2002.106	342.05	96.85	SDSS
FMR 80	07 49 19.76	+49 50 31.2	2000.157	321.98	66.66	2MASS
FMR 80	07 49 19.76	+49 50 31.2	2002.959	322.08	66.63	CMC14
0802+0019	08 02 50.06	+00 19 09.1	2000.057	114.94	78.83	CMC14
0802+0019	08 02 50.06	+00 19 09.1	2000.072	114.95	78.68	2MASS
FMR 81	08 20 39.80	+48 03 18.0	2000.217	77.85	166.83	2MASS
FMR 81	08 20 39.80	+48 03 18.0	2000.258	77.93	166.95	SDSS
FMR 81	08 20 39.80	+48 03 18.0	2002.981	77.89	166.58	CMC14
BVD 202	08 31 20.84	+44 24 07.1	1998.302	27.64	34.75	2MASS
BVD 202	08 31 20.84	+44 24 07.1	2001.145	27.78	34.78	SDSS
CBL 263	08 37 33.75	+24 41 32.1	1998.091	132.75	99.38	2MASS
CBL 263	08 37 33.75	+24 41 32.1	2004.130	132.79	99.64	SDSS
0840+6144	08 40 04.61	+61 44 44.4	2000.225	74.94	84.72	2MASS
0840+6144	08 40 04.61	+61 44 44.4	2003.886	74.86	84.74	SDSS
FMR 82	08 48 51.11	+17 17 32.3	1998.878	244.72	168.16	2MASS
FMR 82	08 48 51.11	+17 17 32.3	2005.047	244.87	168.57	SDSS
0855+3732	08 55 59.87	+37 32 10.8	1998.253	125.48	80.25	2MASS
0855+3732	08 55 59.87	+37 32 10.8	2000.195	125.37	80.08	CMC14
0855+3732	08 55 59.87	+37 32 10.8	2002.038	125.50	80.23	SDSS
0900+0643	09 00 52.07	+06 43 31.5	2000.140	198.55	44.70	2MASS
0900+0643	09 00 52.07	+06 43 31.5	2000.238	198.61	44.65	CMC14
0900+0643	09 00 52.07	+06 43 31.5	2002.868	198.62	44.59	SDSS
FMR 84	09 00 26.61	+53 06 57.9	1999.826	35.23	99.24	2MASS
FMR 84	09 00 26.61	+53 06 57.9	2000.258	35.24	99.30	SDSS
0902+0600	09 02 51.27	+06 00 28.0	2000.083	15.86	105.48	2MASS
0902+0600	09 02 51.27	+06 00 28.0	2000.219	15.86	105.54	CMC14
0902+0600	09 02 51.27	+06 00 28.0	2002.868	15.85	105.65	SDSS
0906+7226	09 06 56.14	+72 26 09.3	1999.315	73.82	24.44	2MASS
FMR 85	09 16 22.75	+25 39 49.8	1999.225	333.43	44.00	2MASS
FMR 85	09 16 22.75	+25 39 49.8	2004.291	333.62	44.12	SDSS
FMR 86	09 21 18.96	+24 43 32.3	1999.225	42.48	7.14	2MASS
FMR 86	09 21 18.96	+24 43 32.3	2004.948	42.19	7.14	SDSS

Table 1 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1 (continued). Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
0929+0350	09 29 09.81	+03 50 07.9	2000.113	227.74	37.84	**2MASS**
0929+0350	09 29 09.81	+03 50 07.9	2000.167	227.37	37.69	**CMC14**
0929+0350	09 29 09.81	+03 50 07.9	2001.140	227.77	37.85	**SDSS**
FMR 87	09 41 15.75	+07 07 43.4	2000.614	244.87	22.73	**CMC14**
FMR 87	09 41 15.75	+07 07 43.4	2000.903	244.95	22.77	**2MASS**
FMR 87	09 41 15.75	+07 07 43.4	2002.933	244.95	22.72	**SDSS**
CBL 288	09 42 22.64	+64 22 23.3	1999.048	277.45	14.82	**2MASS**
CBL 288	09 42 22.64	+64 22 23.3	2003.810	277.52	14.80	**SDSS**
FMR 88	09 47 44.84	+35 08 27.4	1998.182	298.21	138.86	**2MASS**
FMR 88	09 47 44.84	+35 08 27.4	2003.087	298.25	138.62	**SDSS**
FMR 88	09 47 44.84	+35 08 27.4	2003.159	298.26	138.64	**CMC14**
FMR 89	10 01 21.81	+23 52 27.1	1998.067	171.92	6.25	**2MASS**
FMR 89	10 01 21.81	+23 52 27.1	2005.047	171.60	6.29	**SDSS**
CBL 304	10 13 59.78	+03 05 56.4	1955.222	97.68	26.34	**DSS**
CBL 304	10 13 59.78	+03 05 56.4	1997.178	97.45	26.39	**DSS**
FMR 90	10 17 33.63	+26 10 37.1	1998.149	90.12	168.67	**2MASS**
FMR 90	10 17 33.63	+26 10 37.1	2004.951	90.07	168.22	**SDSS**
FMR 91	10 18 07.84	+54 22 48.6	1999.187	139.40	72.19	**2MASS**
FMR 91	10 18 07.84	+54 22 48.6	2002.024	139.40	72.17	**SDSS**
FMR 92	10 31 39.65	+43 51 15.4	1998.370	218.47	129.80	**2MASS**
FMR 92	10 31 39.65	+43 51 15.4	2002.663	218.47	129.77	**CMC14**
FMR 93	10 34 36.13	+53 23 23.9	1998.936	90.43	49.44	**2MASS**
FMR 93	10 34 36.13	+53 23 23.9	2001.888	90.43	49.39	**SDSS**
FMR 94 AC	10 45 21.40	+18 14 29.0	1998.078	333.39	113.36	**2MASS**
FMR 94 AC	10 45 21.40	+18 14 29.0	2002.129	333.39	113.44	**CMC14**
FMR 95	10 46 33.43	+19 06 37.3	1998.078	115.44	36.31	**2MASS**
FMR 95	10 46 33.43	+19 06 37.3	2005.356	115.48	36.36	**SDSS**
FMR 96	10 46 58.66	+24 36 52.4	1999.400	50.94	9.95	**2MASS**
FMR 96	10 46 58.66	+24 36 52.4	2001.663	49.42	9.79	**CMC14**
FMR 96	10 46 58.66	+24 36 52.4	2005.047	49.44	9.89	**SDSS**
FMR 97	10 51 02.12	+38 57 37.7	1998.258	3.37	8.71	**2MASS**
FMR 97	10 51 02.12	+38 57 37.7	2004.130	2.75	8.71	**SDSS**
GWP1473	10 51 03.61	+14 58 19.8	1997.955	73.98	14.02	**2MASS**
GWP1473	10 51 03.61	+14 58 19.8	2001.745	73.14	14.12	**CMC14**
GWP1473	10 51 03.61	+14 58 19.8	2003.076	73.85	13.96	**SDSS**
CBL 323	10 54 16.16	+00 02 59.5	1995.541	117.27	42.13	**SDSS**
CBL 323	10 54 16.16	+00 02 59.5	1999.447	117.54	41.97	**CMC14**
CBL 323	10 54 16.16	+00 02 59.5	2000.116	117.49	42.09	**2MASS**
CRB 87	10 57 30.49	+30 08 29.8	1998.185	257.92	7.26	**2MASS**
CRB 87	10 57 30.49	+30 08 29.8	2001.792	255.14	7.31	**CMC14**
CRB 87	10 57 30.49	+30 08 29.8	2004.362	256.87	7.40	**SDSS**
1102+2353	11 02 01.98	+23 53 08.5	1998.080	118.99	97.75	**2MASS**

Table 1 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1 (continued). Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
1102+2353	11 02 01.98	+23 53 08.5	2001.668	119.03	97.79	CMC14
1102+2353	11 02 01.98	+23 53 08.5	2005.096	118.96	97.80	SDSS
BVD 216	11 08 21.35	+47 51 38.5	1999.239	223.02	23.01	2MASS
BVD 216	11 08 21.35	+47 51 38.5	2002.219	222.63	22.92	SDSS
BVD 216	11 08 21.35	+47 51 38.5	2002.740	222.91	23.00	CMC14
GWP1557	11 11 59.28	+04 02 42.0	2000.236	55.11	25.44	2MASS
GWP1557	11 11 59.28	+04 02 42.0	2001.290	54.93	25.74	SDSS
FMR 98	11 19 44.46	+06 11 24.9	2000.173	106.24	147.94	2MASS
FMR 98	11 19 44.46	+06 11 24.9	2003.248	106.38	147.83	SDSS
FMR 99	11 22 27.00	+52 46 46.7	2000.157	98.38	15.54	2MASS
FMR 99	11 22 27.00	+52 46 46.7	2002.035	98.42	15.48	SDSS
FMR 100	11 23 42.68	+65 54 31.7	1999.228	132.30	33.79	2MASS
FMR 100	11 23 42.68	+65 54 31.7	2000.321	132.19	34.00	SDSS
FMR 101	11 31 49.44	+35 13 06.8	1998.187	144.02	7.36	2MASS
FMR 101	11 31 49.44	+35 13 06.8	2002.373	144.08	7.41	CMC14
FMR 101	11 31 49.44	+35 13 06.8	2004.283	143.92	7.38	SDSS
1135+3109	11 35 11.94	+31 09 26.7	1998.357	350.70	131.31	2MASS
1135+3109	11 35 11.94	+31 09 26.7	2002.685	350.60	131.26	CMC14
1135+3109	11 35 11.94	+31 09 26.7	2004.368	350.74	131.32	SDSS
CBL 346	11 35 40.36	+04 57 29.5	2000.176	30.40	10.16	2MASS
CBL 346	11 35 40.36	+04 57 29.5	2001.290	30.54	10.16	SDSS
FMR 102	11 39 07.20	+16 34 42.9	1999.955	212.17	8.15	2MASS
FMR 102	11 39 07.20	+16 34 42.9	2001.342	212.01	8.19	CMC14
FMR 102	11 39 07.20	+16 34 42.9	2005.416	211.99	8.18	SDSS
1147+1640	11 47 16.86	+16 40 07.4	1998.023	153.80	8.38	2MASS
1147+1640	11 47 16.86	+16 40 07.4	2001.342	154.17	8.38	CMC14
GWP1677	11 48 06.30	+03 06 20.2	2000.074	237.65	22.65	CMC14
GWP1677	11 48 06.30	+03 06 20.2	2000.111	237.82	22.71	2MASS
GWP1677	11 48 06.30	+03 06 20.2	2000.979	237.43	22.26	SDSS
1148+0018	11 48 51.56	+00 18 03.8	1999.221	154.92	4.54	SDSS
1148+0018	11 48 51.56	+00 18 03.8	2000.111	155.28	4.61	2MASS
BVD 221	12 02 37.52	+44 17 57.8	1999.111	239.30	12.91	2MASS
BVD 221	12 02 37.52	+44 17 57.8	2003.226	239.26	12.87	SDSS
1206+1218	12 06 02.12	+12 18 19.0	1998.031	269.50	38.07	2MASS
1206+1218	12 06 02.12	+12 18 19.0	2001.326	269.39	37.99	CMC14
1206+1218	12 06 02.12	+12 18 19.0	2003.245	269.49	38.12	SDSS
1209+2818	12 09 41.82	+28 18 08.8	1998.171	193.85	13.43	2MASS
1209+2818	12 09 41.82	+28 18 08.8	2005.047	193.83	13.46	SDSS
FMR 103	12 16 36.93	+40 57 36.2	1998.275	163.87	29.58	2MASS
FMR 103	12 16 36.93	+40 57 36.2	2003.316	164.54	29.51	SDSS
FMR 104	12 17 05.76	+07 42 30.2	2000.203	273.95	11.61	2MASS
FMR 104	12 17 05.76	+07 42 30.2	2003.248	274.12	11.47	SDSS

Table 1 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1 (continued). Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
FMR 105	12 23 23.67	+39 20 15.7	1998.283	293.79	9.23	2MASS
FMR 105	12 23 23.67	+39 20 15.7	2003.316	292.63	9.07	SDSS
1223+0625	12 23 43.48	+06 25 10.3	2000.203	159.47	23.43	2MASS
1223+0625	12 23 43.48	+06 25 10.3	2003.248	159.32	23.33	SDSS
FMR 106	12 27 45.45	+75 53 57.7	1999.209	338.10	35.35	2MASS
1233+0824	12 33 13.45	+08 24 03.9	2003.248	147.19	110.88	SDSS
FMR 107	12 35 52.36	+69 39 27.9	1999.215	208.34	8.05	2MASS
1235+4402	12 35 54.41	+44 02 49.7	2003.226	298.76	36.88	SDSS
1236+1457	12 36 13.40	+14 57 17.1	1998.040	14.13	80.49	2MASS
1236+1457	12 36 13.40	+14 57 17.1	2004.075	14.23	80.54	SDSS
FMR 108	12 36 16.09	+21 13 17.4	1999.313	311.43	37.13	2MASS
FMR 108	12 36 16.09	+21 13 17.4	2005.195	311.38	37.09	SDSS
CBL 390	12 40 08.21	+37 21 46.8	2000.286	76.60	33.02	2MASS
CBL 390	12 40 08.21	+37 21 46.8	2002.063	76.51	32.93	CMC14
CBL 390	12 40 08.21	+37 21 46.8	2004.207	76.62	33.03	SDSS
FMR 109	12 43 07.93	+35 53 19.7	2000.286	92.88	89.22	2MASS
FMR 109	12 43 07.93	+35 53 19.7	2002.227	92.76	88.82	CMC14
FMR 109	12 43 07.93	+35 53 19.7	2004.291	92.68	89.01	SDSS
FMR 110	12 44 50.98	+77 40 20.7	1999.209	295.73	51.36	2MASS
FMR 111	12 52 53.82	+28 35 45.9	2000.031	178.32	125.90	2MASS
FMR 111	12 52 53.82	+28 35 45.9	2004.392	178.22	125.84	SDSS
1310+3252	13 10 21.43	+32 52 58.4	1998.193	359.91	66.47	2MASS
1310+3252	13 10 21.43	+32 52 58.4	2001.940	359.98	66.52	CMC14
1310+3252	13 10 21.43	+32 52 58.4	2004.362	359.92	66.43	SDSS
1311+1106	13 11 41.81	+11 06 24.7	2000.231	252.52	146.73	2MASS
1311+1106	13 11 41.81	+11 06 24.7	2000.249	252.53	146.51	CMC14
1311+1106	13 11 41.81	+11 06 24.7	2003.223	252.54	146.73	SDSS
FMR 112	13 23 13.02	+36 33 39.1	1998.292	94.11	28.00	2MASS
FMR 112	13 23 13.02	+36 33 39.1	2001.438	94.16	27.85	CMC14
FMR 112	13 23 13.02	+36 33 39.1	2004.130	94.13	28.02	SDSS
FMR 113	13 43 09.06	+25 53 06.4	2000.264	330.03	130.85	2MASS
FMR 113	13 43 09.06	+25 53 06.4	2004.447	330.04	130.81	SDSS
1352+2806	13 52 02.28	+28 06 48.8	1999.431	0.85	11.38	2MASS
1352+2806	13 52 02.28	+28 06 48.8	2001.247	1.67	11.44	CMC14
1352+2806	13 52 02.28	+28 06 48.8	2004.392	5.36	11.81	SDSS
1358+3842	13 58 44.94	+38 42 32.8	1998.297	348.06	39.79	2MASS
1358+3842	13 58 44.94	+38 42 32.8	2003.313	347.90	39.75	SDSS
LDS2333	14 00 23.58	+66 37 28.8	1999.261	76.75	51.30	2MASS
1424+1804	14 24 36.02	+18 04 14.0	2000.029	224.81	33.33	2MASS
1424+1804	14 24 36.02	+18 04 14.0	2005.354	224.82	33.32	SDSS
CBL 461	14 35 45.90	+04 58 11.6	1999.918	335.38	51.75	CMC14
CBL 461	14 35 45.90	+04 58 11.6	2000.264	335.33	51.72	2MASS

Table 1 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1 (continued). Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
CBL 461	14 35 45.90	+04 58 11.6	2001.214	335.37	51.82	SDSS
FMR 114	14 42 52.06	+07 23 56.3	2000.239	278.21	111.08	2MASS
FMR 114	14 42 52.06	+07 23 56.3	2002.575	278.17	111.19	CMC14
CBL 468	14 46 08.44	+10 59 02.1	2000.310	86.43	20.68	2MASS
CBL 468	14 46 08.44	+10 59 02.1	2003.047	86.54	20.57	CMC14
CBL 468	14 46 08.44	+10 59 02.1	2003.314	86.34	20.68	SDSS
FMR 115	14 52 21.74	+12 31 22.3	1998.349	127.53	108.95	2MASS
FMR 115	14 52 21.74	+12 31 22.3	2003.409	127.52	109.01	SDSS
FMR 116	14 54 55.24	+23 06 47.1	1997.434	36.68	6.66	2MASS
FMR 116	14 54 55.24	+23 06 47.1	2004.450	36.76	6.66	SDSS
CBL 477	15 00 51.87	+13 14 47.4	1998.335	234.75	19.34	2MASS
CBL 477	15 00 51.87	+13 14 47.4	2000.753	234.32	19.31	CMC14
CBL 477	15 00 51.87	+13 14 47.4	2005.364	234.55	19.23	SDSS
FMR 117	15 11 46.72	+00 04 32.6	1999.214	179.57	128.14	2MASS
FMR 117	15 11 46.72	+00 04 32.6	1999.218	179.55	128.05	SDSS
CBL 485	15 17 22.83	+09 04 01.6	2000.310	338.01	18.11	2MASS
CBL 485	15 17 22.83	+09 04 01.6	2003.314	337.80	18.13	SDSS
FMR 118	15 17 36.63	+15 17 13.8	2000.029	22.05	12.62	2MASS
FMR 118	15 17 36.63	+15 17 13.8	2005.354	21.93	12.62	SDSS
FMR 119	15 19 49.96	+64 15 41.6	1955.370	207.64	5.76	DSS
FMR 119	15 19 49.96	+64 15 41.6	1992.400	208.16	6.30	DSS
FMR 120	15 42 33.51	+00 52 06.5	2000.329	295.43	85.67	2MASS
FMR 120	15 42 33.51	+00 52 06.5	2001.858	295.38	85.53	CMC14
FMR 121	15 54 53.03	+48 52 28.9	2000.155	127.81	31.16	2MASS
FMR 121	15 54 53.03	+48 52 28.9	2001.392	127.81	31.14	SDSS
FMR 121	15 54 53.03	+48 52 28.9	2002.290	128.14	31.14	CMC14
FMR 122	16 01 49.43	+25 18 42.6	2000.207	192.82	8.29	2MASS
FMR 122	16 01 49.43	+25 18 42.6	2001.252	192.82	8.21	CMC14
FMR 123	16 12 02.59	+31 58 47.6	1998.256	104.38	8.83	2MASS
FMR 123	16 12 02.59	+31 58 47.6	2001.392	103.75	8.59	CMC14
FMR 123	16 12 02.59	+31 58 47.6	2003.404	104.49	8.83	SDSS
FMR 124	16 12 38.93	+23 41 05.3	2000.127	330.12	60.27	2MASS
FMR 124	16 12 38.93	+23 41 05.3	2002.340	329.65	60.04	CMC14
FMR 125	16 21 38.86	+02 54 58.3	1999.803	135.93	32.08	CMC14
FMR 125	16 21 38.86	+02 54 58.3	2000.401	135.81	32.11	2MASS
FMR 126	16 39 35.67	+41 24 55.1	1998.327	261.85	83.40	2MASS
FMR 126	16 39 35.67	+41 24 55.1	2000.261	261.84	83.38	SDSS
FMR 126	16 39 35.67	+41 24 55.1	2001.510	261.83	83.51	CMC14
FMR 127	16 41 52.51	+10 34 33.8	2000.346	180.29	14.13	2MASS
FMR 128	16 54 42.98	+46 54 33.5	1998.428	222.04	9.17	2MASS
FMR 128	16 54 42.98	+46 54 33.5	2001.578	221.84	9.17	CMC14
FMR 128	16 54 42.98	+46 54 33.5	2003.481	221.97	9.14	SDSS

Table 1 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1 (continued). Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
CBL 511	16 58 09.97	+26 52 27.4	1999.433	272.45	18.45	2MASS
CBL 511	16 58 09.97	+26 52 27.4	2001.288	272.30	18.38	CMC14
CBL 511	16 58 09.97	+26 52 27.4	2002.353	272.40	18.42	SDSS
FMR 129	16 58 51.61	+32 11 46.5	1999.253	182.87	161.05	2MASS
FMR 129	16 58 51.61	+32 11 46.5	2002.438	182.81	160.97	SDSS
FMR 130	17 01 43.51	+38 06 58.0	1998.352	135.35	9.86	2MASS
FMR 130	17 01 43.51	+38 06 58.0	2001.225	135.57	9.89	SDSS
FMR 131	17 02 22.12	+16 47 32.2	1999.158	331.40	9.27	2MASS
FMR 131	17 02 22.12	+16 47 32.2	2000.496	331.21	9.35	CMC14
FMR 131	17 02 22.12	+16 47 32.2	2003.330	331.26	9.30	SDSS
1712+0132	17 12 43.18	+01 32 04.4	2000.507	145.10	22.43	2MASS
1712+0132	17 12 43.18	+01 32 04.4	2003.805	145.24	22.61	CMC14
FMR 132	17 22 35.02	+29 31 03.9	1994.635	342.18	31.56	SDSS
FMR 132	17 22 35.02	+29 31 03.9	2000.168	342.23	31.54	2MASS
FMR 133	17 32 51.62	+43 45 08.9	1998.447	127.46	147.03	2MASS
FMR 133	17 32 51.62	+43 45 08.9	2001.537	127.51	147.02	CMC14
FMR 134	17 33 10.94	+04 31 55.9	2000.404	291.78	10.25	2MASS
FMR 134	17 33 10.94	+04 31 55.9	2003.279	289.94	9.57	CMC14
1734+4858	17 34 39.68	+48 58 04.9	1998.472	145.04	55.41	2MASS
1734+4858	17 34 39.68	+48 58 04.9	2001.603	145.03	55.43	CMC14
FMR 135	17 35 15.19	+81 19 05.8	1999.439	89.00	162.98	2MASS
1738+3939	17 38 08.57	+39 39 15.4	1999.300	157.48	21.16	2MASS
FMR 136	17 38 33.26	+63 32 29.5	1999.360	280.21	14.33	2MASS
FMR 136	17 38 33.26	+63 32 29.5	2001.720	280.27	14.24	SDSS
FMR 137	17 39 46.45	+05 37 29.3	2000.060	250.52	9.42	CMC14
FMR 137	17 39 46.45	+05 37 29.3	2000.404	250.08	9.34	2MASS
FMR 138	17 47 24.95	+40 08 52.2	1998.371	318.96	63.53	2MASS
FMR 138	17 47 24.95	+40 08 52.2	2001.490	318.82	63.52	CMC14
FMR 139	18 09 05.99	+53 13 41.5	2000.324	149.17	22.23	2MASS
BVD 262	18 15 16.20	+40 54 19.5	1951.643	307.34	21.00	DSS
BVD 262	18 15 16.20	+40 54 19.5	1992.482	307.74	21.06	DSS
1823+0403	18 23 19.83	+04 03 16.4	1999.523	9.21	78.99	CMC14
1823+0403	18 23 19.83	+04 03 16.4	1999.600	9.46	78.99	2MASS
1823+2022	18 23 59.62	+20 22 48.7	2000.242	50.87	87.71	2MASS
FMR 140	18 25 54.70	+53 37 43.4	1998.486	84.43	16.13	2MASS
FMR 141	18 54 05.07	+39 22 18.5	1999.445	344.62	31.18	2MASS
FMR 141	18 54 05.07	+39 22 18.5	2002.814	344.57	31.03	CMC14
FMR 141	18 54 05.07	+39 22 18.5	2005.444	344.58	31.23	SDSS
FMR 142	19 00 17.37	+64 59 08.0	1999.406	344.97	8.59	2MASS
FMR 143	19 06 57.51	+21 34 30.7	2000.281	98.30	36.13	2MASS
FMR 143	19 06 57.51	+21 34 30.7	2001.455	98.21	36.04	CMC14
FMR 144	19 09 19.19	+39 12 03.7	1998.398	116.39	162.42	2MASS

Table 1 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1 (continued). Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
FMR 144	19 09 19.19	+39 12 03.7	2003.378	116.43	162.52	CMC14
FMR 145	19 14 05.54	+28 25 53.3	1997.699	135.36	9.62	2MASS
FMR 145	19 14 05.54	+28 25 53.3	2001.430	134.86	9.47	CMC14
FMR 146	19 15 26.40	+54 24 30.7	2000.768	156.46	17.21	2MASS
FMR 147	19 25 04.23	+22 47 56.4	1997.451	265.09	13.95	2MASS
FMR 148	19 32 56.04	+17 23 56.7	1998.729	159.68	150.58	2MASS
FMR 149	19 32 57.27	+04 57 08.8	1999.590	23.85	53.52	2MASS
FMR 149	19 32 57.27	+04 57 08.8	2003.636	23.86	53.51	CMC14
FMR 150	19 35 39.88	+06 16 42.4	1999.557	185.95	17.16	2MASS
FMR 150	19 35 39.88	+06 16 42.4	2001.556	185.81	17.19	CMC14
FMR 151	19 38 12.41	+01 40 30.3	1999.592	146.64	93.39	2MASS
FMR 152	19 42 07.35	+28 40 17.9	1997.726	24.02	56.97	2MASS
FMR 152	19 42 07.35	+28 40 17.9	2001.436	23.92	57.05	CMC14
FMR 153	19 43 19.57	+54 33 45.5	2000.365	102.86	36.77	2MASS
FMR 154	19 45 30.41	+46 50 07.5	1998.448	1.50	8.65	2MASS
FMR 155	19 50 56.24	+04 34 55.3	2000.551	46.84	172.41	2MASS
FMR 155	19 50 56.24	+04 34 55.3	2001.578	46.84	172.46	CMC14
FMR 156	20 03 00.32	+08 03 35.0	1953.678	170.21	11.25	DSS
FMR 156	20 03 00.32	+08 03 35.0	1995.554	172.06	11.03	DSS
FMR 157	20 04 57.78	+25 25 39.1	1997.770	355.56	24.54	2MASS
FMR 157	20 04 57.78	+25 25 39.1	2001.463	355.60	24.58	CMC14
FMR 158	20 16 12.36	+19 27 12.0	1999.494	41.04	22.15	2MASS
FMR 158	20 16 12.36	+19 27 12.0	2001.542	41.15	22.16	CMC14
FMR 159	20 39 52.60	+42 20 33.5	1998.839	75.81	135.76	2MASS
FMR 159	20 39 52.60	+42 20 33.5	2002.458	75.82	135.80	CMC14
FMR 160	20 40 13.46	+29 15 35.4	2000.336	215.36	59.69	2MASS
FMR 161	20 41 07.02	+16 30 55.7	1951.513	320.67	27.77	DSS
FMR 161	20 41 07.02	+16 30 55.7	1953.749	320.60	27.98	DSS
FMR 161	20 41 07.02	+16 30 55.7	1993.531	322.50	28.09	DSS
CRB 13	20 56 51.17	+08 42 09.1	2000.658	357.34	131.53	2MASS
CRB 13	20 56 51.17	+08 42 09.1	2002.559	357.26	131.73	CMC14
FMR 162	20 57 45.93	+13 38 47.4	2000.792	290.07	13.03	2MASS
2106+5924	21 06 18.29	+59 24 01.8	1999.713	332.37	120.27	2MASS
FMR 163	21 25 05.84	+03 29 30.0	2000.630	11.72	15.40	2MASS
FMR 164	21 39 28.15	+05 44 06.9	1999.578	88.32	148.23	CMC14
FMR 164	21 39 28.15	+05 44 06.9	2000.541	88.30	148.37	2MASS
FMR 164	21 39 28.15	+05 44 06.9	2005.736	88.32	148.35	SDSS
2146+1550	21 46 32.30	+15 50 38.9	1997.686	324.44	154.97	2MASS
2146+1550	21 46 32.30	+15 50 38.9	2000.934	324.45	155.01	CMC14
FMR 165	21 50 51.16	+12 43 21.5	1997.686	305.88	38.13	2MASS
FMR 165	21 50 51.16	+12 43 21.5	2000.685	305.64	38.28	CMC14
FMR 165	21 50 51.16	+12 43 21.5	2000.740	305.56	38.29	SDSS

Table 1 concludes on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 1 (concluded). Astrometric measures

Double	AR_{2000}	DEC_{2000}	Epoch	θ	ρ	Method
FMR 166	22 03 11.60	+57 07 39.3	1999.768	95.35	10.31	2MASS
FMR 167	22 04 14.78	+10 04 10.5	2000.532	286.18	12.36	2MASS
FMR 167	22 04 14.78	+10 04 10.5	2000.603	285.60	12.28	CMC14
FMR 168	22 05 32.99	+25 23 59.7	1999.858	243.07	75.43	2MASS
FMR 168	22 05 32.99	+25 23 59.7	2001.499	243.06	75.56	CMC14
LDS4945	22 08 32.20	+02 09 37.6	2000.598	187.92	32.26	2MASS
LDS4945	22 08 32.20	+02 09 37.6	2001.175	187.78	32.28	CMC14
2211+1819	22 11 43.89	+18 19 14.1	1999.853	170.72	17.32	2MASS
2211+1819	22 11 43.89	+18 19 14.1	2000.764	171.05	17.31	CMC14
FMR 169	22 16 40.97	+29 10 23.8	1997.842	257.46	154.79	2MASS
CBL 540	22 20 25.38	+05 19 57.5	2000.543	271.31	31.54	2MASS
CBL 540	22 20 25.38	+05 19 57.5	2005.742	271.33	31.54	SDSS
2222+2309	22 22 33.61	+23 09 49.6	2000.398	204.15	119.04	2MASS
2222+2309	22 22 33.61	+23 09 49.6	2001.493	204.21	119.04	CMC14
2222+2309	22 22 33.61	+23 09 49.6	2004.712	204.19	118.92	SDSS
FMR 170	22 29 43.90	+24 23 29.2	1953.706	171.48	49.26	DSS
FMR 170	22 29 43.90	+24 23 29.2	1995.546	170.75	49.14	DSS
CRB 20	22 35 01.25	+41 03 37.3	1998.773	195.16	23.43	2MASS
CRB 20	22 35 01.25	+41 03 37.3	2002.167	195.02	23.44	CMC14
FMR 171	22 58 05.84	+28 08 52.3	1994.955	120.41	59.48	SDSS
FMR 171	22 58 05.84	+28 08 52.3	1997.874	120.31	59.38	2MASS
FMR 171	22 58 05.84	+28 08 52.3	2001.518	120.45	59.41	CMC14
2312+2701	23 12 47.00	+27 01 04.5	1998.748	109.38	53.33	2MASS
AZC 129	23 22 49.17	+23 22 28.1	1997.776	176.63	12.70	2MASS
AZC 129	23 22 49.17	+23 22 28.1	2001.112	176.93	12.48	CMC14
FMR 172	23 28 13.66	+33 59 45.7	1999.754	76.23	162.97	2MASS
FMR 172	23 28 13.66	+33 59 45.7	2001.923	76.29	163.05	CMC14
2335+6750	23 35 38.00	+67 50 01.6	1999.779	330.90	133.84	2MASS
2343+1345	23 43 18.10	+13 45 43.0	1997.746	118.63	160.02	2MASS
2343+1345	23 43 18.10	+13 45 43.0	2001.715	118.62	160.06	SDSS
2349+1108	23 49 17.66	+11 08 51.4	2000.721	45.79	16.98	2MASS
2352+4625	23 52 15.05	+46 25 52.0	1998.825	347.09	56.41	2MASS
2352+4625	23 52 15.05	+46 25 52.0	2002.677	347.12	56.50	CMC14

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2. Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
FMR 29A	00 11 41.96	+03 23 17.6	16.10		11.98	0.67	4.12	286	-45	M1.5V	10.14	151.7	208	0.37	0.02
FMR 29B	00 11 41.89	+03 23 10.9	16.20		12.09	0.74	4.11	286	-45	M1.5V	9.98	170.2	234	0.37	0.02
FMR 30A	00 23 55.55	+16 46 45.9	16.41		13.28	0.77	3.13	48	-156	K7VI					
FMR 30B	00 24 05.68	+16 48 20.2	16.56		12.14	0.83	4.43	53	-163	M2V	10.46	153.6	125	0.37	0.05
FMR 31A	00 41 30.19	+07 28 34.8	15.10		11.06	0.80	4.04	152	-79	M1V	9.58	119.8	97	0.54	0.03
FMR 31B	00 41 28.05	+07 28 30.4	19.39		13.37	0.90	6.02	152	-79	M4.5V	14.10	108.1	88	0.18	0.03
FMR 32A	00 42 15.23	+07 31 18.6	14.85		12.58	0.59	2.27	175	-77	G/K VI					
FMR 32B	00 42 14.35	+07 31 19.8	19.32		14.92	1.00	4.40	175	-77	M3VI	11.40	351.3	318	0.26	0.06
FMR 33A	00 44 27.83	+19 35 05.3	15.03		10.66	0.77	4.37	90	-143	M2.5V	10.66	73.1	59	0.37	0.01
FMR 33B	00 44 27.21	+19 35 02.7	15.83		11.27	0.82	4.56	90	-143	M2.5V	11.01	89.6	72	0.37	0.02
FMR 34B	00 50 21.36	+59 23 19.4	14.00		9.47	0.80	4.53	153	-157	M2.5V	11.02	38.5	40	0.37	0.02
FMR 34C	00 50 22.81	+59 23 08.2	18.01		15.23	0.81	2.79	153	-157						
FMR 35A	00 50 12.71	+62 34 58.8	16.76		11.23	0.86	5.54	-102	-117	M4.5V	13.41	46.6	34	0.18	0.00
FMR 35B	00 50 15.42	+62 34 51.0	17.41		11.04	0.86	6.37	-102	-117	M5V	15.13	28.6	21	0.12	0.00
FMR 36A	00 53 11.05	+31 44 13.5	10.06	0.91	7.89	0.59	2.17	19	-175	K1V	6.18	58.6	49	0.74	0.01
FMR 36B	00 53 19.06	+31 46 16.2	14.93		10.47	0.80	4.46	32	-175	M2.5V	10.87	63.4	53	0.37	0.01
FMR 37A	00 56 17.47	+81 03 15.3	16.92		12.88	0.82	4.04	170	85	K9V	8.60	358.1	323	0.63	0.15
FMR 37B	00 56 18.88	+81 02 11.5	17.52		13.68	0.69	3.84	170	85	M0VI	9.76	292.2	263	0.46	0.13
FMR 38A	00 59 51.55	+27 01 28.8	10.35	0.92	8.13	0.54	2.22	-182	-82	K1V	6.18	66.3	63	0.74	0.02
FMR 38B	00 59 46.15	+27 01 17.9	17.80		12.06	0.88	5.74	-175	-73	M4.5V	13.67	65.0	58	0.18	0.02
FMR 39A	01 00 30.94	+09 33 09.8	14.97		11.41	0.86	3.56	156	21	K9V	8.26	208.4	156	0.66	0.04
FMR 39B	01 00 29.70	+09 33 03.3	16.44		11.43	0.82	5.01	156	21	M3.5V	12.16	69.5	52	0.18	0.02
FMR 40A	01 05 16.73	+16 20 24.9	14.70		12.70	0.77	2.00	196	14	G VI					
FMR 40B	01 05 16.65	+16 20 17.2	15.52		11.11	0.82	4.41	196	14	M2.5V	10.67	90.2	84	0.37	0.02
FMR 41A	01 07 43.48	+57 59 11.5	17.31		13.20	0.81	4.11	152	-63	M0V	9.10	357.8	279	0.58	0.12
FMR 41B	01 07 30.06	+57 58 25.7	17.97		13.12	0.85	4.85	158	-45	M3V	11.39	186.2	145	0.26	0.06
0111+428A	01 11 55.14	+42 48 02.4	11.23	0.58	9.19	0.51	2.04	126	-170	G9V	5.74	125.2	126	0.81	0.02
0111+4248B	01 11 49.09	+42 46 28.3	14.50		10.74	0.73	3.76	128	-182	M0V	9.06	118.1	125	0.57	0.02
FMR 42Aa,Ab	01 15 50.17	+47 02 02.3	14.70		9.31	0.90	5.39	186	-14	M4V	13.02	21.5	19	0.18	0.00
FMR 42B	01 15 48.85	+47 02 25.9	17.71		11.28	0.91	6.43	186	-14	M5V	15.16	32.1	28	0.12	0.01
FMR 43A	01 21 32.50	+39 20 35.2	11.61	1.30	8.82	0.73	2.80	200	12	K5V	7.30	71.4	68	0.59	0.01
FMR 43B	01 21 31.33	+39 20 27.1	15.37		10.65	0.83	4.72	173	-4	M3V	11.51	58.1	48	0.26	0.01
FMR 44A	01 31 01.43	+54 31 55.4	16.87		11.65	0.84	5.22	202	2	M3.5V	12.58	69.2	66	0.18	0.02
FMR 44B	01 31 03.61	+54 31 16.8	18.23		12.67	0.86	5.56	202	2	M4V	13.19	96.0	92	0.18	0.03
FMR 45A	01 56 19.06	+37 28 48.7	17.20		11.55	0.89	5.65	206	-46	M4.5V	13.55	52.8	53	0.18	0.01
FMR 45B	01 56 19.38	+37 28 54.3	17.22		11.69	0.90	5.53	206	-46	M4V	13.23	61.7	62	0.18	0.01
FMR 46A	02 00 01.17	+07 32 46.8	15.12		10.38	0.86	4.74	144	-102	M3V	11.45	52.3	44	0.26	0.02
FMR 46B	02 00 00.80	+07 33 04.1	18.00		12.98	0.86	5.02	144	-102	M3.5V	11.88	155.0	130	0.18	0.04
FMR 47A	02 00 20.14	+26 35 59.9	10.99	1.54	7.59	0.77	3.40	174	69	K8V	8.18	35.8	32	0.66	0.01
FMR 47B	02 00 21.17	+26 35 58.7	14.77		10.02	0.84	4.75	152	60	M3V	11.49	44.3	34	0.26	0.01
0201+0218A	02 01 15.09	+02 18 25.7	17.44		14.44	0.75	3.00	217	-33						
0201+0218B	02 01 17.13	+02 17 29.6	18.50		14.64	0.95	3.86	217	-33	M1VI	10.42	398.0	414	0.54	0.03

Table 2 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2 (continued). Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
FMR 48A	02 05 24.83	+17 09 22.1	12.85		10.96	0.44	1.89	138	-135	G VI					
FMR 48B	02 05 25.61	+17 09 25.8	16.69		14.30	0.78	2.39	138	-135	K VI					
FMR 49A	02 12 39.74	+01 18 31.7	14.90		10.39	0.85	4.51	157	-96	M2.5V	10.98	59.6	52	0.37	0.01
FMR 49B	02 12 40.08	+01 18 36.8	17.06		11.83	0.81	5.23	157	-96	M4V	12.73	71.9	63	0.18	0.01
FMR 50A	02 22 41.63	+56 27 03.1	16.27					181	-14	?					
FMR 50B	02 22 40.64	+56 26 32.7	16.63		11.94	0.81	4.69	181	-14	M3V	11.36	108.2	93	0.26	0.03
FMR 51A	02 26 02.36	+53 24 49.3	17.86		13.52	0.86	4.34	165	-1	M2V	10.06	326.8	256	0.37	0.06
FMR 51B	02 26 10.11	+53 23 17.9	18.29		13.61	0.78	4.68	165	-1	M2.5V	11.11	250.3	196	0.37	0.05
FMR 52A	02 27 41.12	+06 13 53.9	14.48		9.90	0.80	4.58	-72	-150	M2.5V	11.15	45.2	36	0.37	0.02
FMR 52B	02 27 40.66	+06 13 55.0	16.17		10.87	0.82	5.30	-72	-150	M4V	12.77	46.6	37	0.18	0.02
FMR 53A	02 30 55.18	+62 48 50.8	13.50		11.09	0.59	2.41	177	10	K2VI					
FMR 53B	02 30 57.47	+62 48 39.0	16.17		12.98	0.79	3.19	177	10	K6VI					
FMR 54A	02 31 33.05	+38 53 14.3	13.31		10.97	0.81	2.34	155	-111	K2V	6.46	226.9	205	0.69	0.02
FMR 54B	02 31 32.74	+38 53 07.9	15.56		11.40	0.79	4.16	155	-111	M2V	10.12	120.0	108	0.37	0.01
FMR 55A	02 32 29.68	+06 06 15.6	14.44		10.52	0.80	3.92	137	-97	M0.5V	9.38	97.1	77	0.55	0.03
FMR 55B	02 32 30.72	+06 06 25.8	18.45		13.17	0.81	5.27	137	-97	M3.5V	12.55	140.7	112	0.18	0.04
CBL 212A	02 32 43.60	+74 08 54.9	18.42		14.33	0.89	4.09	215	-58	K9VI	9.24	449.3	474	0.51	0.29
CBL 212B	02 32 44.81	+74 08 41.0	18.61		14.25	0.88	4.36	215	-58	M1VI	10.41	313.1	330	0.54	0.22
CBL 213A	02 33 01.14	+01 05 38.9	15.69		10.62	0.83	5.07	157	-53	M3.5V	12.32	46.7	37	0.18	0.01
CBL 213B	02 33 00.63	+01 06 07.0	16.16		10.95	0.83	5.22	157	-53	M4V	12.64	50.1	39	0.18	0.01
FMR 56A	02 34 03.02	+09 50 14.0	17.77		13.71	0.83	4.06	61	-153	M0.5V	9.41	413.3	323	0.55	0.07
FMR 56B	02 34 02.56	+09 50 14.4	18.77		14.30	0.93	4.48	61	-153	M3VI	11.48	257.3	201	0.26	0.06
FMR 57A	02 40 09.93	+14 38 47.6	15.28		10.80	0.90	4.48	172	-62	M2V	10.51	81.6	71	0.37	0.06
FMR 57B	02 40 10.59	+14 38 46.3	17.53		12.43	0.85	5.10	172	-62	M3V	11.89	118.0	102	0.26	0.08
FMR 58A	02 44 21.78	+32 07 16.5	10.81	0.51	8.34	0.55	2.47	175	-110	K0V	5.90	88.2	86	0.79	0.05
FMR 58B	02 44 25.51	+32 07 58.6	16.52		11.27	0.82	5.25	173	-107	M3.5V	12.47	60.2	58	0.18	0.04
FMR 59A	02 51 07.90	+06 48 23.3	13.67		9.72	0.89	3.95	140	-129	M0.5V	9.16	72.8	66	0.57	0.05
FMR 59B	02 51 05.99	+06 49 00.7	16.35		11.23	0.85	5.12	140	-129	M3.5V	12.11	64.7	58	0.18	0.05
FMR 60A	02 51 30.43	+34 06 37.5	10.54	0.87	8.10	0.57	2.45	171	-107	K2V	6.46	63.7	61	0.69	0.02
FMR 60B	02 51 35.07	+34 07 29.0	16.72		11.45	0.85	5.27	173	-113	M4V	12.70	61.8	61	0.18	0.02
FMR 61A	02 53 59.42	+66 06 07.3	14.74		10.82	0.86	3.92	158	-82	K9V	8.49	143.1	121	0.63	0.13
FMR 61B	02 53 58.99	+66 06 16.0	14.52		10.14	0.82	4.39	158	-82	M2V	10.36	62.0	52	0.37	0.06
FMR 62A	03 17 26.20	+64 03 57.8	11.47	0.75	8.13	0.78	3.34	112	-134	K5V	7.30	62.7	52	0.78	0.05
FMR 62B	03 17 27.28	+64 03 06.0	14.91		9.86	0.85	5.05	107	-133	M3.5V	12.10	34.7	28	0.18	0.03
GWP 453A	03 20 52.06	+12 09 56.4	15.49		12.54	0.64	2.95	100	-129	K6VI					
GWP 453B	03 20 49.94	+12 09 12.5	16.30		13.04	0.67	3.26	100	-129	K8/9VI					
0323+1506A	03 23 27.30	+15 06 52.0	14.26		10.06	0.79	4.21	-61	-152	M1.5V	9.83	69.8	54	0.37	0.06
0323+1506B	03 23 26.86	+15 05 44.4	16.13		11.08	0.77	5.05	-61	-152	M3.5V	12.03	60.5	47	0.18	0.05
GWP 512A	03 47 07.04	+05 20 16.9	17.29		11.96	0.82	5.33	168	-53	M3.5V	12.37	83.1	69	0.18	0.09
GWP 512B	03 47 06.59	+05 20 15.4	18.11					168	-53	?					
FMR 63A	03 50 50.19	+45 45 34.1	14.29		10.74	0.81	3.55	24	-192	K8V	8.32	139.4	128	0.63	0.07
FMR 63B	03 50 48.77	+45 45 57.5	18.29		13.36	0.73	4.93	24	-192	M3V	11.41	201.8	185	0.26	0.10

Table 2 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2 (continued). Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
FMR 64A	04 11 26.59	+54 24 02.9	10.38	0.88	7.77	0.68	2.60	-11	-179	K3V	6.74	51.4	44	0.66	0.02
FMR 64B	04 11 30.55	+54 21 14.3	15.89		11.16	0.80	4.73	5	-178	M3V	11.43	74.0	62	0.26	0.03
FMR 65A	04 17 51.16	+51 43 36.7	14.98		10.85	0.87	4.13	75	-143	M1.5V	9.95	99.1	76	0.37	0.01
FMR 65B	04 17 50.53	+51 43 48.4	15.23		11.17	0.85	4.06	75	-143	M1.5V	9.74	121.6	93	0.37	0.02
FMR 66A	04 24 49.26	+01 06 56.1	12.90		8.49	0.89	4.41	155	11	M2.5V	10.63	27.6	20	0.37	0.02
FMR 66B	04 24 50.91	+01 06 48.7	16.56		10.75	0.85	5.81	155	11	M4.5V	13.85	33.6	25	0.18	0.02
0433+0013A	04 33 17.84	+00 13 59.5	11.48	0.61	9.78	0.43	1.70	-60	-151	G6VI					
0433+0013B	04 33 18.67	+00 14 14.0	16.85		12.58	0.76	4.27	-62	-149	M2V	10.25	195.6	150	0.37	0.04
FMR 67A	04 48 06.47	+41 38 04.7	14.68		10.33	0.85	4.35	128	-165	M2.5V	10.57	65.0	64	0.37	0.01
FMR 67B	04 48 07.22	+41 38 04.0	16.04		11.96	0.88	4.09	128	-165	M1.5V	9.66	179.5	178	0.37	0.03
0509+1038A	05 09 42.59	+10 38 43.8	14.70		11.19	0.79	3.51	-36	-177	K6V	7.64	193.5	166	0.55	0.17
0509+1038B	05 09 40.48	+10 39 17.0	18.99		13.57	0.76	5.42	-36	-177	M3.5V	12.11	180.3	154	0.18	0.16
FMR 68A	05 19 34.13	+34 20 38.7	15.86		10.92	0.84	4.94	67	-199	M3.5V	12.00	58.0	58	0.18	0.01
FMR 68B	05 19 37.59	+34 20 11.4	16.07		11.09	0.86	4.99	67	-199	M3.5V	12.06	62.2	62	0.18	0.01
0524+0315A	05 24 49.76	+03 15 15.4	10.71	1.59	7.56	0.79	3.15	271	-127	K8V	8.32	29.7	42	0.60	0.01
0524+0315B	05 24 46.82	+03 14 55.7	14.70		13.01	0.58	1.69	253	-120	G7VI					
FMR 69A	05 44 17.22	+30 38 31.6	10.68	0.80	8.61	0.51	2.07	44	-154	K0V	5.90	89.2	68	0.79	0.01
FMR 69B	05 44 21.10	+30 38 33.2	15.61		11.10	0.82	4.51	53	-160	M2.5V	11.01	82.2	66	0.37	0.01
FMR 70A	05 45 45.39	+66 38 30.2	12.51		9.37	0.82	3.14	30	-153	K6V	7.64	88.2	65	0.55	0.04
FMR 70B	05 45 46.84	+66 38 23.1	14.06		9.44	0.82	4.62	30	-153	M3V	11.17	36.7	27	0.26	0.02
0546+1116A	05 46 17.26	+11 16 46.6	16.50		10.75	0.85	5.75	-124	-155	M4.5V	13.75	34.4	32	0.18	0.02
0546+1116B	05 46 15.59	+11 15 58.7	18.21		15.63	0.70	2.58	-124	-155	K2VI					
0550+0939A	05 50 11.74	+09 39 49.2	16.01		10.33	0.85	5.68	258	235	M4.5V	13.62	29.4	49	0.18	0.01
0550+0939B	05 50 10.99	+09 40 01.1	17.75		10.64	0.94	7.11	258	235	M6V	16.34	18.9	31	0.09	0.01
FMR 71A	05 51 49.91	+18 04 29.4	17.49		12.55	0.73	4.94	107	-198	M3V	11.79	127.9	136	0.26	0.05
FMR 71B	05 51 49.52	+18 04 09.9	17.98		13.32	0.73	4.66	107	-198	M2.5V	10.97	221.5	236	0.37	0.08
GWP 736A	06 05 03.52	+07 23 30.5	14.99		11.96	0.81	3.03	-197	-100	K4VI					
GWP 736B	06 05 03.39	+07 23 39.1	16.83		13.08	0.75	3.75	-197	-100	M0VI	9.88	218.7	229	0.46	0.08
GWP 744A	06 06 13.38	+06 48 22.3	16.73		11.00	0.82	5.73	21	269	M4.5V	13.74	38.7	49	0.18	0.01
GWP 744B	06 06 12.84	+06 48 26.6	18.90		12.30	0.89	6.60	21	269	M5.5V	15.38	49.0	63	0.09	0.02
0610+2802A	06 10 25.64	+28 02 23.6	10.80	0.86	8.03	0.65	2.77	-100	-143	K4V	7.02	54.8	45	0.62	0.02
0610+2802B	06 10 27.56	+27 59 44.7	13.41		9.25	0.86	4.16	-97	-144	M1.5V	10.00	46.5	38	0.37	0.02
0610+4439A	06 10 43.98	+44 39 49.8	16.73		13.10	0.79	3.63	193	-143	M0VI	9.76	230.2	262	0.46	0.05
0610+4439B	06 10 52.44	+44 41 39.5	17.93		14.43	0.77	3.50	179	-140	M0VI					
FMR 72A	06 10 48.30	+03 15 12.9	15.92		11.34	0.85	4.58	-40	-151	M2V	10.41	106.9	79	0.37	0.10
FMR 72B	06 10 45.32	+03 15 21.5	18.23		12.82	0.84	5.41	-40	-151	M3.5V	12.34	124.3	92	0.18	0.11
FMR 73A	06 15 40.49	+34 27 03.8	16.75		11.89	0.84	4.86	60	-144	M3V	11.55	102.0	75	0.26	0.04
FMR 73B	06 15 41.02	+34 27 00.2	18.16		12.85	0.83	5.32	60	-144	M3.5V	12.62	118.5	88	0.18	0.05
FMR 74A	06 18 10.57	+67 04 15.2	18.39		12.08	0.94	6.31	55	-264	M5V	14.80	50.9	65	0.12	0.02
FMR 74B	06 18 11.13	+67 04 22.0	19.00		12.73	0.98	6.27	55	-264	M5V	14.69	70.1	90	0.12	0.02
0628+2829A	06 28 28.26	+28 29 23.0	16.03		12.13	0.77	3.90	-115	-152	M0V	9.12	221.3	200	0.57	0.05
0628+2829B	06 28 32.27	+28 27 57.8	17.59		12.83	0.77	4.76	-115	-152	M3V	11.40	161.6	146	0.26	0.04

Table 2 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2 (continued). Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
FMR 75A	06 28 31.05	+59 06 23.1	17.19		11.47	0.92	5.73	58	-168	M4.5V	13.66	49.7	42	0.18	0.01
FMR 75B	06 28 30.18	+59 06 59.1	19.00		12.85	0.91	6.15	58	-168	M5V	14.50	77.2	65	0.12	0.02
0649+2942A	06 49 53.22	+29 42 03.8	13.70		9.32	0.82	4.38	-28	189	M2.5V	10.69	39.6	36	0.37	0.01
0649+2942B	06 49 53.13	+29 41 29.6	15.98		10.83	0.87	5.15	-28	189	M3.5V	12.43	50.5	46	0.18	0.01
FMR 83A	06 51 04.45	+18 43 43.1	17.65		12.22	0.77	5.43	205	-241	M4V	13.15	78.2	117	0.18	0.01
FMR 83B	06 51 00.59	+18 45 20.5	18.07		12.21	0.77	5.86	205	-241	M4.5V	14.11	61.3	92	0.18	0.01
FMR 76A	06 58 34.34	+75 14 17.7	15.79		10.73	0.82	5.06	39	-195	M3.5V	12.29	49.0	46	0.18	0.01
FMR 76B	06 58 40.35	+75 12 08.3	18.99		13.21	0.77	5.78	83	-174	M4.5V	13.78	105.7	97	0.18	0.02
0705+4129A	07 05 32.54	+41 29 10.0	16.39		12.66	0.82	3.73	138	-94	K9V	8.75	310.0	245	0.60	0.05
0705+4129B	07 05 38.04	+41 28 08.4	13.98		10.51	0.79	3.48	138	-94	K8V	8.21	136.2	108	0.66	0.03
GWP 876A	07 10 52.54	+06 12 30.6	14.05		10.34	0.75	3.71	94	-258	M0V	8.99	100.2	130	0.58	0.01
GWP 876B	07 10 51.93	+06 12 49.9	16.94		11.80	0.74	5.14	94	-258	M3.5V	12.56	73.8	96	0.18	0.01
FMR 77A	07 15 21.11	+03 01 27.8	13.83		10.17	0.86	3.66	26	-152	M0V	8.77	99.9	73	0.60	0.02
FMR 77B	07 15 20.37	+03 01 11.9	18.65		12.87	0.84	5.78	26	-152	M4.5V	13.84	89.3	65	0.18	0.01
0727+4228A	07 27 50.77	+42 28 19.8	16.03		10.94	0.81	5.09	60	-155	M3.5V	12.39	52.4	41	0.18	0.01
0727+4228B	07 27 51.14	+42 27 48.0	17.89		12.43	0.77	5.47	60	-155	M4V	13.19	84.5	67	0.18	0.02
CBL 235A	07 28 20.77	+31 00 13.0	15.11		10.94	0.86	4.17	31	-155	M2V	10.10	97.7	73	0.37	0.02
CBL 235B	07 28 20.12	+31 00 17.1	17.91		12.67	0.86	5.24	31	-155	M4V	12.60	111.7	84	0.18	0.02
FMR 78A	07 38 12.77	+43 34 24.0	9.64	0.97	7.42	0.55	2.22	-116	-150	K2V	6.46	42.6	38	0.69	0.01
FMR 78B	07 37 56.91	+43 35 05.0	18.46		14.79	0.69	3.67	-52	-162	M0VI	9.87	485.2	391	0.46	0.05
FMR 79A	07 40 57.40	+06 41 04.8	16.00		10.87	0.83	5.13	161	-41	M3.5V	12.49	50.1	39	0.18	0.00
FMR 79B	07 40 57.35	+06 41 11.7	15.90		11.63	0.79	4.27	161	-41	M2V	10.43	122.6	97	0.37	0.01
0749+2435A	07 49 54.56	+24 35 13.1	11.98		8.31	0.83	3.67	-14	-178	M0V	8.89	40.9	35	0.59	0.01
0749+2435B	07 49 52.37	+24 36 45.4	15.08		10.19	0.81	4.88	-14	-178	M3.5V	11.87	43.1	36	0.18	0.01
FMR 80A	07 49 19.76	+49 50 31.2	10.40	0.73	8.73	0.43	1.67	-38	-168	G5V	5.10	110.2	90	0.94	0.02
FMR 80B	07 49 15.52	+49 51 23.7	18.00		12.83	0.79	5.17	-47	-175	M3.5V	12.47	121.6	104	0.18	0.03
0802+0019A	08 02 50.06	+00 19 09.1	13.41		9.89	0.80	3.52	-119	-141	K9V	8.49	94.5	83	0.63	0.01
0802+0019B	08 02 54.81	+00 18 35.9	16.83		12.06	0.78	4.77	-119	-141	M3V	11.65	106.4	93	0.26	0.01
FMR 81A	08 20 39.80	+48 03 18.0	15.32		10.61	0.76	4.71	227	-83	M3V	11.52	56.7	65	0.26	0.01
FMR 81B	08 20 56.07	+48 03 53.1	17.18		15.78	0.33	1.40	227	-79	wd	14.00	43.2	49		0.01
BVD 202A	08 31 20.84	+44 24 07.1	12.75		9.48	0.79	3.27	-113	-144	K7V	7.98	88.6	77	0.67	0.01
BVD 202B	08 31 22.34	+44 24 37.9	18.84		13.08	0.83	5.76	-113	-144	M4.5V	13.84	98.2	85	0.18	0.01
CBL 263A	08 37 33.75	+24 41 32.1	13.84		9.98	0.83	3.86	-149	-128	M0.5V	9.32	78.8	73	0.56	0.01
CBL 263B	08 37 39.11	+24 40 24.7	18.53		12.57	0.88	5.97	-149	-128	M4.5V	14.20	72.2	67	0.18	0.01
0840+6144A	08 40 04.61	+61 44 44.4	18.68		14.79	0.84	3.89	-75	-228	M1VI	10.15	446.0	507	0.54	0.08
0840+6144B	08 40 16.13	+61 45 06.5	19.09		15.36	0.46	3.73	-75	-228	M0VI	9.76	638.1	726	0.46	0.09
FMR 82A	08 48 51.11	+17 17 32.3	17.04		11.54	0.92	5.51	119	-248	M4V	13.25	57.0	74	0.18	0.00
FMR 82B	08 48 40.49	+17 16 20.5	19.70		12.73	0.96	6.97	3	-236	M5.5V	16.12	51.7	58	0.09	0.00
0855+3732A	08 55 59.87	+37 32 10.8	13.91		10.05	0.83	3.87	-174	38	M0.5V	9.32	80.8	68	0.56	0.01
0855+3732B	08 56 05.36	+37 31 24.2	17.37		12.18	0.83	5.19	-174	38	M3.5V	12.54	90.0	76	0.18	0.02
0900+0643A	09 00 52.07	+06 43 31.5	13.53		9.80	0.80	3.73	-154	53	M0V	8.97	79.3	61	0.59	0.02
0900+0643B	09 00 51.11	+06 42 49.1	16.14		11.17	0.81	4.98	-154	53	M3.5V	12.09	63.1	49	0.18	0.01

Table 2 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2 (continued). Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
FMR 84A	09 00 26.61	+53 06 57.9	15.83		10.87	0.80	4.96	-114	-162	M3.5V	12.14	54.4	51	0.18	0.00
FMR 84B	09 00 32.97	+53 08 18.9	19.58		14.07	0.75	5.51	-61	-192	M4V	13.45	165.7	158	0.18	0.01
0902+0600A	09 02 51.27	+06 00 28.0	9.80	0.62	8.28	0.38	1.51	-149	111	G0V	4.40	116.0	102	1.12	0.02
0902+0600B	09 02 53.20	+06 02 09.5	14.35		10.45	0.81	3.90	-144	107	M0.5V	9.38	95.6	81	0.55	0.02
0906+7226A	09 06 56.14	+72 26 09.3	16.03		11.05	0.77	4.98	175	-465	M3.5V	12.08	59.9	141	0.18	0.02
0906+7226B	09 07 01.33	+72 26 16.2	17.93		12.05	0.79	5.88	175	-465	M4.5V	14.08	57.1	135	0.18	0.02
FMR 85A	09 16 22.75	+25 39 49.8	11.62	1.33	8.12	0.81	3.50	167	-171	K9V	8.40	43.5	49	0.64	0.01
FMR 85B	09 16 21.30	+25 40 29.1	17.75		16.31	0.22	1.45	149	-180	wd	15.24	31.8	35		0.00
FMR 86A	09 21 18.96	+24 43 32.3	16.36		12.35	0.74	4.01	-236	-40	M1V	9.72	205.7	233	0.54	0.02
FMR 86B	09 21 19.32	+24 43 37.6	17.62		13.26	0.73	4.36	-236	-40	M2V	10.65	238.5	271	0.37	0.02
0929+0350A	09 29 09.81	+03 50 07.9	16.21		11.11	0.82	5.10	-119	-167	M3.5V	12.36	57.6	56	0.18	0.01
0929+0350B	09 29 07.94	+03 49 42.4	16.65		11.42	0.83	5.23	-119	-167	M4V	12.65	61.8	60	0.18	0.01
FMR 87A	09 41 15.75	+07 07 43.4	16.09		11.51	0.78	4.58	-58	-158	M2.5V	11.15	95.0	76	0.37	0.01
FMR 87B	09 41 14.36	+07 07 33.7	16.75		11.99	0.74	4.76	-58	-158	M3V	11.63	103.0	82	0.26	0.01
CBL 288A	09 42 22.64	+64 22 23.3	12.93		10.80	0.54	2.13	-157	-76	K0/1VI					
CBL 288B	09 42 20.38	+64 22 25.3	18.48		14.09	0.62	4.39	-157	-76	M2V	10.77	324.6	268	0.37	0.04
FMR 88A	09 47 44.84	+35 08 27.4	14.18		11.44	0.71	2.74	-208	-121	K3/4VI					
FMR 88B	09 47 34.86	+35 09 33.0	16.54		12.46	0.82	4.08	-172	-131	M1.5V	9.90	210.7	216	0.37	0.01
FMR 89A	10 01 21.81	+23 52 27.1	16.54		11.67	0.82	4.88	-161	-33	M3V	11.85	85.1	66	0.26	0.01
FMR 89B	10 01 21.87	+23 52 20.9	18.05		12.78	0.83	5.27	-161	-33	M4V	12.76	111.5	87	0.18	0.01
CBL 304A	10 13 59.78	+03 05 56.4	18.03					106	-113	wd	14.55	49.7	37		0.01
CBL 304B	10 14 01.52	+03 05 53.0	18.29					106	-113	wd	15.00	45.5	33		0.01
FMR 90A	10 17 33.63	+26 10 37.1	18.48		14.68	0.84	3.79	-125	-162	M1VI	10.27	420.6	408	0.54	0.03
FMR 90B	10 17 46.16	+26 10 36.8	18.98		13.56	0.74	5.42	-180	-126	M4V	13.12	144.5	151	0.18	0.02
FMR 91A	10 18 07.84	+54 22 48.6	13.93		10.37	0.78	3.56	-181	39	K9V	8.62	114.7	101	0.62	0.00
FMR 91B	10 18 13.22	+54 21 53.8	16.66		12.17	0.78	4.49	-181	39	M2.5V	10.99	135.1	119	0.37	0.00
FMR 92A	10 31 39.65	+43 51 15.4	11.64	0.58	9.72	0.48	1.92	-169	-65	G9V	5.74	151.4	130	0.87	0.01
FMR 92B	10 31 32.18	+43 49 33.7	15.26		11.10	0.80	4.16	-176	-75	M2V	10.15	103.6	94	0.37	0.01
FMR 93A	10 34 36.13	+53 23 23.9	16.58		11.90	0.80	4.68	6	-220	M3V	11.43	105.6	110	0.26	0.01
FMR 93B	10 34 41.66	+53 23 23.5	19.61		13.77	0.97	5.84	6	-220	M4.5V	13.81	141.9	148	0.18	0.01
FMR 94A	10 45 21.40	+18 14 29.0	9.58	0.66	7.86	0.36	1.72	-183	-38	G6V	5.26	72.1	64	0.91	0.01
FMR 94C	10 45 17.83	+18 16 10.4	16.01		11.12	0.80	4.89	-164	-35	M3.5V	11.93	64.5	51	0.18	0.01
FMR 95A	10 46 33.43	+19 06 37.3	13.34		9.37	0.85	3.97	-144	-91	M1V	9.49	56.7	46	0.54	0.02
FMR 95B	10 46 35.74	+19 06 21.7	18.40		12.89	0.88	5.51	-144	-91	M4V	13.05	110.7	89	0.18	0.04
FMR 96A	10 46 58.66	+24 36 52.4	13.31		9.32	0.84	3.99	-164	-30	M1V	9.67	52.5	41	0.54	0.01
FMR 96B	10 46 59.23	+24 36 58.7	14.64		10.40	0.84	4.24	-164	-30	M2V	10.26	73.5	58	0.37	0.01
FMR 97A	10 51 02.12	+38 57 37.7	18.28		13.09	0.77	5.19	-160	-47	M4V	12.64	132.5	105	0.18	0.01
FMR 97B	10 51 02.16	+38 57 46.4	19.49		14.15	0.71	5.34	-160	-47	M4V	12.98	196.6	155	0.18	0.01
GWP1473A	10 51 03.61	+14 58 19.8	16.19		11.02	0.86	5.17	29	-168	M3.5V	12.58	52.4	42	0.18	0.01
GWP1473B	10 51 04.54	+14 58 23.7	17.95		12.25	0.85	5.70	29	-168	M4.5V	13.73	69.2	56	0.18	0.01
CBL 323A	10 54 16.16	+00 02 59.5	12.64		9.63	0.72	3.01	111	-106	K5V	7.30	113.0	82	0.59	0.02
CBL 323B	10 54 18.65	+00 02 40.1	17.02		11.92	0.76	5.10	111	-106	M3.5V	12.43	80.5	59	0.18	0.02

Table 2 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2 (continued). Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
CRB 87A	10 57 30.49	+30 08 29.8	16.64		11.26	0.83	5.38	122	-230	M4V	13.05	51.8	64	0.18	0.00
CRB 87B	10 57 29.94	+30 08 28.3	17.50		15.98	0.43	1.51	122	-230	wd	13.87	53.1	66		0.01
1102+2353A	11 02 01.98	+23 53 08.5	14.15		10.80	0.77	3.35	-157	-100	K8V	8.32	144.0	127	0.63	0.01
1102+2353B	11 02 08.21	+23 52 21.1	16.69		12.12	0.82	4.57	-157	-100	M2.5V	11.14	126.3	111	0.37	0.01
BVD 216A	11 08 21.35	+47 51 38.5	13.97		10.00	0.82	3.97	-117	-182	M1V	9.64	72.3	74	0.54	0.01
BVD 216B	11 08 19.79	+47 51 21.7	16.44		11.11	0.84	5.33	-117	-182	M4V	12.94	49.5	51	0.18	0.01
GWP1557 A	11 11 59.28	+04 02 42.0	18.15		14.42	1.06	3.73	-185	-71	M1VI	10.05	392.5	369	0.54	0.04
GWP1557B	11 12 00.67	+04 02 56.6	19.39		15.63	0.77	3.76	-185	-71	M1VI	10.09	677.9	637	0.54	0.04
FMR 98A	11 19 44.46	+06 11 24.9	9.20	0.73	7.42	0.43	1.78	119	-213	G6V	5.26	59.1	68	0.91	0.02
FMR 98B	11 19 53.98	+06 10 43.5	19.48		13.72	0.89	5.75	17	-213	M4.5V	13.49	146.1	148	0.18	0.04
FMR 99A	11 22 27.00	+52 46 46.7	14.99		11.21	0.82	3.78	-156	78	M0.5V	9.12	146.6	121	0.57	0.01
FMR 99B	11 22 28.69	+52 46 44.4	15.38		11.26	0.80	4.12	-156	78	M1.5V	10.05	115.0	95	0.37	0.01
FMR 100A	11 23 42.68	+65 54 31.7	13.65		10.37	0.78	3.28	-151	-75	K7V	7.98	135.0	108	0.67	0.00
FMR 100B	11 23 46.76	+65 54 08.9	18.95		15.31	0.65	3.65	-151	-75	M0VI	10.06	593.7	474	0.44	0.01
FMR 101A	11 31 49.44	+35 13 06.8	15.39		11.56	0.85	3.83	-160	-14	M0.5V	9.19	169.4	129	0.57	0.02
FMR 101B	11 31 49.80	+35 13 00.8	15.54		11.60	0.85	3.94	-160	-14	M1V	9.51	156.9	119	0.54	0.01
1135+3109A	11 35 11.94	+31 09 26.7	16.45		11.46	0.84	4.99	-161	-46	M3.5V	12.14	71.4	57	0.18	0.01
1135+3109B	11 35 10.29	+31 11 36.3	18.29		13.60	0.74	4.69	-157	-42	M3V	11.43	227.7	175	0.26	0.02
CBL 346A	11 35 40.36	+04 57 29.5	14.73		10.84	0.78	3.89	-218	23	M0.5V	9.39	114.2	119	0.55	0.01
CBL 346B	11 35 40.71	+04 57 38.3	19.70		13.29	0.83	6.40	-218	23	M5V	15.12	80.6	84	0.12	0.01
FMR 102A	11 39 07.20	+16 34 42.9	15.64		11.27	0.84	4.37	-291	-18	M2.5V	10.59	99.9	138	0.37	0.01
FMR 102B	11 39 06.90	+16 34 36.0	16.33		11.46	0.83	4.87	-291	-18	M3V	11.80	79.3	110	0.26	0.01
1147+1640A	11 47 16.86	+16 40 07.4	16.57		13.08	0.72	3.49	-294	-90	M0VI					
1147+1640B	11 47 17.12	+16 39 59.9	16.63		13.43	0.74	3.20	-294	-90	K8VI					
GWP1677A	11 48 06.30	+03 06 20.2	14.93		10.88	0.79	4.05	-72	-148	M1.5V	9.83	102.6	80	0.37	0.01
GWP1677B	11 48 05.02	+03 06 08.1	17.04		12.04	0.76	5.00	-72	-148	M3.5V	12.21	90.8	71	0.18	0.01
1148+0018A	11 48 51.56	+00 18 03.8	15.13		12.70	0.73	2.43	-176	-3	K2VI					
1148+0018A	11 48 51.69	+00 17 59.6	18.04		14.30	0.83	3.74	-176	-3	M1VI	10.15	363.6	303	0.54	0.03
BVD 221A	12 02 37.52	+44 17 57.8	16.97		12.04	0.81	4.93	-168	-72	M3.5V	12.04	95.6	83	0.18	0.01
BVD 221B	12 02 36.49	+44 17 51.2	19.44		13.57	0.89	5.87	-168	-72	M4.5V	13.98	121.9	106	0.18	0.01
1206+1218A	12 06 02.12	+12 18 19.0	13.23	0.52	11.65	0.38	1.58	-6	-182	G VI					
1206+1218B	12 05 59.52	+12 18 18.7	16.53		13.38	0.77	3.15	-6	-182	K8VI					
1209+2818A	12 09 41.82	+28 18 08.8	18.85		14.15	0.72	4.70	-168	-55	M3V	11.56	278.1	233	0.26	0.02
1209+2818B	12 09 41.58	+28 17 55.7	19.58		14.61	0.73	4.97	-168	-55	M3.5V	12.15	296.1	248	0.18	0.02
FMR 103A	12 16 36.93	+40 57 36.2	18.56		15.36	0.73	3.20	-185	-84	K8VI					
FMR 103B	12 16 37.66	+40 57 07.8	18.72		13.50	0.81	5.22	-185	-84	M4V	12.63	161.1	155	0.18	0.01
FMR 104A	12 17 05.76	+07 42 30.2	15.25		13.03	0.53	2.23	24	-167	K1VI					
FMR 104B	12 17 04.98	+07 42 31.0	18.14		14.89	0.53	3.25	24	-167	K8/9VI					
FMR 105A	12 23 23.67	+39 20 15.7	18.27		14.54	1.26	3.73	-135	-97	M1VI	10.14	408.2	322	0.54	0.03
FMR 105B	12 23 22.94	+39 20 19.4	19.32		15.96	0.54	3.37	-135	-97	K9VI					
1223+0625A	12 23 43.48	+06 25 10.3	13.85		11.13	0.73	2.72	-183	-29	K4/5VI					
1223+0625B	12 23 44.03	+06 24 48.3	18.33		13.80	0.83	4.53	-183	-29	M2.5V	10.86	302.1	265	0.37	0.02

Table 2 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2 (continued). Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
FMR 106A	12 27 45.45	+75 53 57.7	12.16	0.81	9.98	0.53	2.18	-138	-138	K1VI					
FMR 106B	12 27 41.84	+75 54 30.5	19.31		13.79	0.73	5.52	-115	-145	M4V	13.33	151.1	133	0.18	0.02
1233+0824A	12 33 13.45	+08 24 03.9	18.53					-172	132	wd	13.96	82.1	84		0.01
1233+0824B	12 33 17.47	+08 22 30.4	19.09					-172	132	wd	14.70	75.5	78		0.01
FMR 107A	12 35 52.36	+69 39 27.9	14.29		9.77	0.82	4.52	146	-63	M2.5V	11.06	44.0	33	0.37	0.00
FMR 107B	12 35 51.63	+69 39 20.8	18.35		14.65	2.00	3.70	146	-63	M1VI	10.13	430.0	324	0.54	0.02
1235+4402A	12 35 54.41	+44 02 49.7	13.00		9.21	0.87	3.79	188	-266	M0.5V	9.07	60.3	93	0.58	0.01
1235+4402B	12 35 51.46	+44 03 07.5	19.55					188	-266	wd	15.17	75.3	116		0.01
1236+1457A	12 36 13.40	+14 57 17.1	15.85		11.32	0.79	4.52	-159	-118	M2.5V	11.03	89.2	84	0.37	0.02
1236+1457B	12 36 14.76	+14 58 35.2	17.83		12.61	0.83	5.22	-159	-118	M4V	12.54	110.3	103	0.18	0.02
FMR 108A	12 36 16.09	+21 13 17.4	10.42	1.09	7.98	0.58	2.44	-183	-112	K3V	6.74	53.3	54	0.66	0.01
FMR 108B	12 36 14.09	+21 13 42.0	19.46		12.69	0.97	6.78	-179	-107	M5.5V	15.69	55.7	55	0.09	0.01
CBL 390A	12 40 08.21	+37 21 46.8	14.08		9.59	0.82	4.50	138	-196	M2.5V	11.02	40.6	46	0.37	0.00
CBL 390B	12 40 10.90	+37 21 54.5	17.31		11.45	0.87	5.86	138	-196	M4.5V	14.02	45.2	51	0.18	0.00
FMR 109A	12 43 07.93	+35 53 19.7	10.91	0.98	8.68	0.52	2.23	-150	79	K2V	6.46	76.9	62	0.69	0.01
FMR 109B	12 43 15.27	+35 53 15.2	17.37		12.23	0.85	5.15	-147	78	M3.5V	12.49	93.7	74	0.18	0.01
FMR 110A	12 44 50.98	+77 40 20.7	11.52	1.01	9.33	0.55	2.19	-21	-171	K1V	6.18	113.4	93	0.74	0.02
FMR 110B	12 44 36.54	+77 40 43.0	15.76		11.65	0.76	4.11	-37	-174	M1.5V	9.96	139.2	117	0.37	0.02
FMR 111A	12 52 53.82	+28 35 45.9	14.66		10.45	0.83	4.21	-190	-31	M2V	10.30	74.0	68	0.37	0.00
FMR 111B	12 52 54.10	+28 33 40.1	20.31		14.17	0.83	6.15	-167	-6	M5V	14.70	131.4	104	0.12	0.01
1310+3252A	13 10 21.43	+32 52 58.4	14.33	1.41	9.66	0.83	4.67	-173	11	M3V	11.41	38.1	31	0.26	0.00
1310+3252B	13 10 21.44	+32 54 04.9	17.30	1.46	11.59	0.86	5.71	-173	11	M4.5V	13.74	51.0	42	0.18	0.00
1311+1106A	13 11 41.81	+11 06 24.7	12.84		11.45	0.38	1.39	-111	-130	F VI					
1311+1106B	13 11 32.30	+11 05 40.6	17.56		14.30	0.73	3.26	-115	-122	K8/9VI					
FMR 112A	13 23 13.02	+36 33 39.1	13.01		10.27	0.67	2.74	-178	0	K4V	7.02	155.4		0.62	0.01
FMR 112B	13 23 15.34	+36 33 37.1	17.78		12.52	0.87	5.26	-178	0	M4V	12.81	97.6		0.18	0.01
FMR 113A	13 43 09.06	+25 53 06.4	12.11	0.86	9.73	0.60	2.38	-161	5	K2V	6.46	132.8	101	0.69	0.01
FMR 113B	13 43 04.21	+25 54 59.7	18.20		12.75	0.74	5.45	-158	-4	M4V	13.29	94.7	71	0.18	0.01
1352+2806A	13 52 02.28	+28 06 48.8	14.01		10.03	0.84	3.98	-188	54	M1V	9.71	71.7	66	0.54	0.01
1352+2806B	13 52 02.29	+28 07 00.1	14.39		9.92	0.95	4.47	-188	54	M2.5V	10.78	52.2	48	0.37	0.00
1358+3842A	13 58 44.94	+38 42 32.8	14.15		10.70	0.80	3.45	-201	-21	K8V	8.27	147.5	141	0.65	0.01
1358+3842B	13 58 44.23	+38 43 11.7	18.55		13.56	0.81	4.99	-201	-21	M3.5V	12.11	189.5	181	0.18	0.01
LDS2333A	14 00 23.58	+66 37 28.8	11.53	0.92	9.35	0.56	2.18	89	-137	K1V	6.18	115.4	89	0.74	0.01
LDS2333B	14 00 31.98	+66 37 40.6	17.80		12.87	0.84	4.93	103	-157	M3.5V	11.92	146.7	131	0.18	0.01
1424+1804A	14 24 36.02	+18 04 14.0	16.53		12.00	0.82	4.53	-149	-70	M2.5V	11.06	121.1	95	0.37	0.01
1424+1804B	14 24 34.37	+18 03 50.3	18.84		13.46	0.84	5.38	-149	-70	M4V	12.92	149.0	116	0.18	0.02
CBL 461A	14 35 45.90	+04 58 11.6	17.46		13.22	0.80	4.24	36	-178	M2V	10.17	272.9	235	0.37	0.03
CBL 461B	14 35 44.46	+04 58 58.6	17.61		13.29	0.85	4.32	36	-178	M2V	10.36	268.6	231	0.37	0.03
FMR 114A	14 42 52.06	+07 23 56.3	9.60	0.54	8.18	0.32	1.42	-189	40	F8V	4.00	128.6	118	1.23	0.02
FMR 114B	14 42 44.67	+07 24 12.1	17.23		12.24	0.80	4.99	-158	35	M3.5V	12.18	100.0	77	0.18	0.01
CBL 468A	14 46 08.44	+10 59 02.1	12.39		10.18	0.57	2.21	72	-149	K1V	6.18	169.7	133	0.74	0.02
CBL 468B	14 46 09.84	+10 59 03.4	17.17		12.63	0.73	4.54	72	-149	M2.5V	11.10	159.3	125	0.37	0.02

Table 2 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2 (continued). Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
FMR 115A	14 52 21.74	+12 31 22.3	18.50		13.94	0.70	4.56	-170	-99	M2.5V	11.20	277.7	259	0.37	0.02
FMR 115B	14 52 27.64	+12 30 15.9	19.29		13.56	0.69	5.73	-170	-99	M4.5V	13.92	115.5	108	0.18	0.01
FMR 116A	14 54 55.24	+23 06 47.1	17.72		12.75	0.83	4.97	-125	99	M3.5V	11.98	135.6	103	0.18	0.02
FMR 116B	14 54 55.52	+23 06 52.4	19.38		13.57	0.82	5.82	-125	99	M4.5V	13.89	121.1	92	0.18	0.02
CBL 477A	15 00 51.87	+13 14 47.4	15.68		10.57	0.87	5.12	37	-164	M3.5V	12.41	44.4	35	0.18	0.01
CBL 477B	15 00 50.78	+13 14 36.3	15.95		10.75	0.86	5.20	37	-164	M4V	12.59	46.0	37	0.18	0.01
FMR 117A	15 11 46.72	+00 04 32.6	14.04		12.37	0.38	1.67	-165	-25	G VI					
FMR 117B	15 11 46.79	+00 02 24.4	18.39		14.67	1.04	3.72	-201	-9	M0VI	9.98	446.5	426	0.45	0.05
CBL 485A	15 17 22.83	+09 04 01.6	16.68		13.91	0.67	2.77	-94	-125	K2/4VI					
CBL 485B	15 17 22.38	+09 04 18.4	18.23		14.87	0.80	3.36	-94	-125	K9VI					
FMR 118A	15 17 36.63	+15 17 13.8	15.69		10.57	0.83	5.12	-203	31	M3.5V	12.40	44.9	44	0.18	0.01
FMR 118B	15 17 36.96	+15 17 25.5	19.52		12.61	0.92	6.91	-203	31	M5.5V	16.01	49.7	48	0.09	0.01
FMR 119A	15 19 49.96	+64 15 41.6	18.30					-186	180	?					
FMR 119B	15 19 49.61	+64 15 35.9	19.06					-186	180	?					
FMR 120A	15 42 33.51	+00 52 06.5	9.77	0.68	7.95	0.43	1.82	-168	27	G5V	5.10	81.4	66	0.94	0.03
FMR 120B	15 42 28.35	+00 52 43.2	17.08		12.00	0.77	5.08	-162	7	M3.5V	12.21	88.6	68	0.18	0.04
FMR 121A	15 54 53.03	+48 52 28.9	14.09		12.15	0.47	1.94	-103	-134	G/K VI					
FMR 121B	15 54 55.53	+48 52 09.8	18.13		13.60	0.73	4.53	-74	-147	M2.5V	11.16	242.0	189	0.37	0.01
FMR 122A	16 01 49.43	+25 18 42.6	15.20		10.33	0.85	4.87	-194	-72	M3V	11.80	46.9	46	0.26	0.01
FMR 122B	16 01 49.30	+25 18 34.6	16.42		11.45	0.85	4.97	-194	-72	M3.5V	11.97	74.9	73	0.18	0.02
FMR 123A	16 12 02.59	+31 58 47.6	14.44		9.43	0.84	5.01	-269	-46	M3.5V	12.22	27.7	36	0.18	0.00
FMR 123B	16 12 03.27	+31 58 45.4	16.64		10.94	0.91	5.70	-269	-46	M4.5V	13.66	39.1	51	0.18	0.01
FMR 124A	16 12 38.93	+23 41 05.3	13.64		11.41	0.51	2.23	-67	-155	K1VI					
FMR 124B	16 12 36.74	+23 41 57.6	17.93		14.48	0.80	3.45	-67	-155	M0VI					
FMR 125A	16 21 38.86	+02 54 58.3	13.67		11.86	0.43	1.81	-41	-179	G VI					
FMR 125B	16 21 40.35	+02 54 35.2	16.71		13.39	0.78	3.32	-41	-179	K9VI					
FMR 126A	16 39 35.67	+41 24 55.1	13.52		9.90	0.80	3.62	-65	-155	M0V	8.80	87.4	70	0.60	0.00
FMR 126B	16 39 28.33	+41 24 43.2	16.91		11.81	0.78	5.10	-65	-155	M3.5V	12.49	76.3	61	0.18	0.00
FMR 127A	16 41 52.51	+10 34 33.8	13.68		9.24	0.82	4.44	-322	-294	M2.5V	10.86	36.1	75	0.37	0.01
FMR 127B	16 41 52.50	+10 34 19.6	18.50		14.92	2.01	3.58	-322	-294	wd					
FMR 128A	16 54 42.98	+46 54 33.5	14.64		10.06	0.82	4.58	-44	215	M2.5V	11.18	48.7	51	0.37	0.01
FMR 128B	16 54 42.38	+46 54 26.7	16.16		11.50	0.78	4.67	-44	215	M3V	11.42	87.4	91	0.26	0.01
CBL 511A	16 58 09.97	+26 52 27.4	12.63		10.65	0.49	1.98	-85	-141	G/K VI					
CBL 511B	16 58 08.59	+26 52 28.2	17.52		13.30	0.72	4.22	-85	-141	M1.5V	10.04	285.8	223	0.37	0.05
FMR 129A	16 58 51.61	+32 11 46.5	17.76		14.09	0.75	3.67	-33	-199	M0VI	10.00	343.2	328	0.45	0.03
FMR 129B	16 58 50.98	+32 09 05.7	17.92		13.15	0.74	4.77	24	-197	M3V	11.59	178.2	168	0.26	0.02
FMR 130A	17 01 43.51	+38 06 58.0	17.73		13.10	0.72	4.63	-113	-110	M3V	11.33	186.0	139	0.26	0.01
FMR 130B	17 01 44.09	+38 06 51.0	18.92		13.51	0.82	5.41	-113	-110	M4V	13.08	144.2	108	0.18	0.01
FMR 131A	17 02 22.12	+16 47 32.2	15.70		11.15	0.73	4.55	-99	-147	M2.5V	11.08	80.8	68	0.37	0.02
FMR 131B	17 02 21.81	+16 47 40.4	16.43		11.90	0.70	4.52	-99	-147	M2.5V	11.01	115.5	97	0.37	0.03
1712+0132A	17 12 43.18	+01 32 04.4	13.50		9.38	0.85	4.12	-152	23	M1.5V	9.72	54.0	39	0.37	0.03
1712+0132B	17 12 44.04	+01 31 46.0	15.42		11.25	0.81	4.17	-152	23	M1V	9.73	123.5	90	0.54	0.06

Table 2 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2 (continued). Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
FMR 132A	17 22 35.02	+29 31 03.9	14.57		10.44	0.87	4.13	-21	-176	M2V	10.01	80.4	68	0.37	0.01
FMR 132B	17 22 34.29	+29 31 33.9	19.29		13.44	0.88	5.84	-21	-176	M4.5V	13.90	117.1	98	0.18	0.01
FMR 133A	17 32 51.62	+43 45 08.9	13.99		10.90	0.78	3.10	61	-231	K7/8VI					
FMR 133B	17 33 02.39	+43 43 39.4	15.47		11.04	0.80	4.43	33	-220	M2.5V	10.81	84.5	89	0.37	0.01
FMR 134A	17 33 10.94	+04 31 55.9	16.43		12.19	0.77	4.24	-83	123	M1.5V	9.89	179.4	126	0.37	0.07
FMR 134B	17 33 10.30	+04 31 59.7	17.92		13.45	0.74	4.48	-83	123	M2V	10.31	280.2	197	0.37	0.10
1734+4858A	17 34 39.68	+48 58 04.9	13.87		10.42	0.81	3.45	-54	155	K8V	8.23	131.2	102	0.66	0.01
1734+4858B	17 34 42.90	+48 57 19.5	13.95		10.47	0.81	3.48	-54	155	K9V	8.35	129.1	100	0.64	0.01
FMR 135A	17 35 15.19	+81 19 05.8	14.77		10.44	0.83	4.33	-53	219	M2V	10.42	70.8	76	0.37	0.03
FMR 135B	17 36 27.16	+81 19 08.6	14.91		11.05	0.81	3.87	-88	195	M0V	9.06	136.6	139	0.58	0.05
1738+3939A	17 38 08.57	+39 39 15.4	16.66		11.66	0.86	5.00	-55	150	M3.5V	12.12	79.7	60	0.18	0.01
1738+3939B	17 38 09.27	+39 38 55.8	19.94		13.51	1.02	6.43	-55	150	M5V	15.00	95.6	72	0.12	0.01
FMR 136A	17 38 33.26	+63 32 29.5	12.44		9.01	0.81	3.43	15	-210	K8V	8.24	68.6	68	0.65	0.01
FMR 136B	17 38 31.15	+63 32 32.0	16.12		11.19	0.79	4.94	15	-210	M3.5V	12.06	64.5	64	0.18	0.01
FMR 137A	17 39 46.45	+05 37 29.3	17.18		13.72	0.74	3.46	-129	-161	M0VI					
FMR 137B	17 39 45.86	+05 37 26.1	17.53		13.92	0.75	3.61	-129	-161	K9VI	9.24	398.6	390	0.51	0.09
FMR 138A	17 47 24.95	+40 08 52.2	16.16		10.95	0.79	5.21	-176	-56	M4V	12.72	48.3	42	0.18	0.01
FMR 138B	17 47 21.31	+40 09 40.1	16.59		13.88	0.71	2.71	-155	-83	K3/4VI					
FMR 139A	18 09 05.99	+53 13 41.5	18.32		13.11	0.82	5.22	-73	173	M4V	12.62	134.9	120	0.18	0.01
FMR 139B	18 09 07.26	+53 13 22.4	20.30		14.28	0.79	6.02	-73	173	M5V	14.42	146.7	131	0.12	0.01
BVD 262A	18 15 16.20	+40 54 19.5	17.32		15.52	1.15	1.80	-76	-158	wd					
BVD 262B	18 15 14.58	+40 54 33.3	17.86					-76	-158	?					
1823+0403A	18 23 19.83	+04 03 16.4	16.52		11.94	0.72	4.58	-170	9	M2.5V	10.94	117.9	95	0.37	0.06
1823+0403B	18 23 20.70	+04 04 34.3	17.57		12.71	0.78	4.86	-170	9	M3V	11.42	149.1	120	0.26	0.08
1823+2022A	18 23 59.62	+20 22 48.7	18.13		15.93	0.67	2.20	-166	-78	wd					
1823+2022B	18 24 04.46	+20 23 44.1	18.73		11.85	0.92	6.88	-166	-78	M5.5V	15.89	36.1	31	0.09	0.01
FMR 140A	18 25 54.70	+53 37 43.4	15.28		11.58	0.75	3.70	-92	-129	M0V	9.01	176.2	132	0.58	0.01
FMR 140B	18 25 56.50	+53 37 44.9	18.85		13.86	0.67	4.99	-92	-129	M3.5V	12.26	203.7	153	0.18	0.01
FMR 141A	18 54 05.07	+39 22 18.5	11.29	0.80	8.32	0.72	2.97	58	-138	K4V	7.02	70.2	50	0.62	0.01
FMR 141B	18 54 04.35	+39 22 48.6	15.54		10.74	0.69	4.80	58	-138	M3V	11.83	54.3	39	0.26	0.01
FMR 142A	19 00 17.37	+64 59 08.0	16.62		13.10	0.82	3.52	-98	-118	M0VI					
FMR 142B	19 00 17.02	+64 59 16.3	17.22		13.49	0.79	3.73	-98	-118	M1VI	10.12	252.7	184	0.54	0.03
FMR 143A	19 06 57.51	+21 34 30.7	12.60		9.19	0.82	3.41	16	-182	K7V	7.98	76.4	66	0.67	0.06
FMR 143B	19 07 00.07	+21 34 25.4	18.21		12.22	0.85	5.99	16	-182	M4.5V	14.11	61.2	53	0.18	0.04
FMR 144A	19 09 19.19	+39 12 03.7	11.21	1.68	7.16	0.80	4.05	-113	-179	M2V	9.84	18.5	19	0.37	0.01
FMR 144B	19 09 31.70	+39 10 51.5	12.21	0.88	8.03	0.81	4.18	-105	-185	M0V	10.19	24.9	25	0.49	0.01
FMR 145A	19 14 05.54	+28 25 53.3	16.26		12.79	0.74	3.47	-299	-445	M0VI					
FMR 145B	19 14 06.06	+28 25 46.4	17.32		13.33	0.79	3.99	-299	-445	M1VI	10.54	208.8	531	0.54	0.06
FMR 146A	19 15 26.40	+54 24 30.7	10.68	1.44	8.25	0.67	2.43	-125	-147	K4V	7.02	53.0	48	0.62	0.01
FMR 146B	19 15 27.19	+54 24 15.0	14.74		11.33	0.79	3.42	-128	-149	K8V	8.32	182.2	170	0.63	0.03
FMR 147A	19 25 04.23	+22 47 56.4	11.09	0.90	8.89	0.56	2.20	49	281	K1VI					
FMR 147B	19 25 03.22	+22 47 55.2	15.56		12.59	0.75	2.97	67	285	K4/5VI					

Table 2 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2 (continued). Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
FMR 148A	19 32 56.04	+17 23 56.7	14.86		10.60	0.83	4.26	172	-198	M2V	10.08	83.7	104	0.37	0.05
FMR 148B	19 32 59.69	+17 21 35.5	18.18		12.86	0.80	5.32	165	-210	M3.5V	12.45	124.1	157	0.18	0.07
FMR 149A	19 32 57.27	+04 57 08.8	13.98		9.45	0.82	4.53	-62	-159	M2.5V	11.01	38.4	31	0.37	0.01
FMR 149B	19 32 58.72	+04 57 57.7	15.47		10.67	0.81	4.80	-62	-159	M3V	11.65	56.3	46	0.26	0.02
FMR 150A	19 35 39.88	+06 16 42.4	14.22		10.79	0.79	3.43	-142	-81	K8V	8.32	143.5	111	0.63	0.03
FMR 150B	19 35 39.76	+06 16 25.4	14.66		10.96	0.80	3.70	-142	-81	K9V	8.74	144.7	112	0.61	0.03
FMR 151A	19 38 12.41	+01 40 30.3	13.17		9.50	0.83	3.67	-18	-236	K9V	8.60	76.7	86	0.62	0.04
FMR 151B	19 38 15.83	+01 39 12.3	18.10		12.72	0.84	5.38	-18	-236	M4V	12.62	113.1	127	0.18	0.06
FMR 152A	19 42 07.35	+28 40 17.9	12.22	0.83	10.57	0.28	1.65	-115	-153	G VI					
FMR 152B	19 42 09.11	+28 41 10.0	14.29		11.35	0.69	2.94	-123	-156	K4/5VI					
FMR 153A	19 43 19.57	+54 33 45.5	13.63		9.14	0.85	4.50	89	162	M2.5V	10.94	34.0	30	0.37	0.01
FMR 153B	19 43 23.69	+54 33 37.3	15.36		9.74	0.86	5.62	89	162	M4.5V	13.57	22.5	20	0.18	0.01
FMR 154A	19 45 30.41	+46 50 07.5	17.77		15.25	0.59	2.52	-455	-414	wd					
FMR 154B	19 45 30.43	+46 50 16.1	17.49		15.48	0.40	2.02	-455	-414	wd					
FMR 155A	19 50 56.24	+04 34 55.3	12.82		11.20	0.37	1.62	-22	-199	G VI					
FMR 155B	19 51 04.65	+04 36 53.2	13.94		10.50	0.83	3.44	-31	-199	K8V	8.32	126.9	121	0.63	0.03
FMR 156A	20 03 00.32	+08 03 35.0	17.46					-117	-183	?					
FMR 156B	20 03 00.30	+08 03 44.4	11.94		8.73	0.81	3.21	-117	-183	K7V	7.98	60.2	62	0.65	0.02
FMR 157A	20 04 57.78	+25 25 39.1	12.17		9.11	0.75	3.06	-141	-140	K5V	7.30	83.7	79	0.59	0.07
FMR 157B	20 04 57.64	+25 26 03.6	16.93		11.74	0.82	5.19	-141	-140	M3.5V	12.18	79.4	75	0.18	0.07
FMR 158A	20 16 12.36	+19 27 12.0	14.76		11.19	0.76	3.57	88	-142	K8V	8.32	176.8	140	0.64	0.05
FMR 158B	20 16 13.39	+19 27 28.7	16.37		11.60	0.70	4.77	88	-142	M3V	11.61	85.5	68	0.26	0.03
FMR 159A	20 39 52.60	+42 20 33.5	15.09		10.88	0.77	4.21	367	124	M1.5V	9.96	97.7	179	0.37	0.05
FMR 159B	20 40 04.47	+42 21 06.8	17.44		12.04	0.73	5.40	381	130	M4V	12.99	73.8	141	0.18	0.03
FMR 160A	20 40 13.46	+29 15 35.4	16.53		10.89	0.82	5.64	28	-188	M4.5V	13.55	38.1	34	0.18	0.02
FMR 160B	20 40 10.82	+29 14 46.7	18.79		12.56	0.90	6.24	28	-188	M5V	14.58	65.9	59	0.12	0.03
FMR 161A	20 41 07.02	+16 30 55.7	13.47		9.63	0.79	3.84	243	116	M0.5V	9.24	68.8	88	0.56	0.01
FMR 161B	20 41 05.71	+16 31 19.3	18.42					243	116	?					
CRB 13A	20 56 51.17	+08 42 09.1	14.32		10.32	0.78	4.00	160	-13	M1V	9.70	81.6	62	0.54	0.02
CRB 13B	20 56 50.76	+08 44 20.5	17.03		12.28	0.79	4.75	155	-8	M3V	11.46	124.9	92	0.26	0.02
FMR 162A	20 57 45.93	+13 38 47.4	18.62		13.43	0.82	5.19	162	-52	M3.5V	12.38	165.6	134	0.18	0.04
FMR 162B	20 57 45.09	+13 38 51.9	18.79		13.52	0.84	5.27	162	-52	M3.5V	12.48	170.4	137	0.18	0.04
2106+5924A	21 06 18.29	+59 24 01.8	10.91	1.51	8.48	0.63	2.42	-110	-119	K2V	6.46	70.0	54	0.69	0.06
2106+5924B	21 06 10.99	+59 25 48.3	15.31		10.54	0.85	4.77	-108	-115	M2.5V	11.22	59.4	44	0.37	0.06
FMR 163A	21 25 05.84	+03 29 30.0	18.39		14.04	0.85	4.35	-72	-152	M2V	10.14	406.8	324	0.37	0.05
FMR 163B	21 25 06.05	+03 29 45.1	18.51		14.46	0.70	4.05	-72	-152	M2VI	10.69	339.0	270	0.37	0.05
FMR 164A	21 39 28.15	+05 44 06.9	13.59		10.26	0.83	3.33	-153	-63	K7V	7.98	127.6	100	0.67	0.02
FMR 164B	21 39 38.08	+05 44 11.3	15.11		11.11	0.76	4.00	-168	-67	M1V	9.70	116.2	100	0.54	0.02
2146+1550A	21 46 32.30	+15 50 38.9	16.54		15.53	0.40	1.01	309	116	wd					
2146+1550B	21 46 26.06	+15 52 44.9	16.56		12.04	0.76	4.52	304	121	M2.5V	10.77	132.7	206	0.37	0.05
FMR 165A	21 50 51.16	+12 43 21.5	10.67	0.84	8.47	0.55	2.20	158	-83	K1V	6.18	75.7	64	0.74	0.03
FMR 165B	21 50 49.04	+12 43 43.8	18.08		14.70	0.65	3.37	161	-98	K9VI					

Table 2 concludes on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 2 (concluded). Astrophysical properties for the stellar components.

ID	AR	DEC	V	B-V	K	J-K	V-K	μ(α)	μ(δ)	spT	Mv	Dist (pc)	Vtan (km/s)	Mass	E (B-V)
FMR 166A	22 03 11.60	+57 07 39.3	17.80		11.99	0.88	5.81	191	5	M4.5V	13.85	59.8	54	0.18	0.02
FMR 166B	22 03 12.86	+57 07 38.4	17.94		11.80	0.88	6.14	191	5	M5V	14.52	47.1	43	0.12	0.01
FMR 167A	22 04 14.78	+10 04 10.5	11.17	1.13	8.71	0.61	2.46	-126	-98	K3V	6.74	75.0	57	0.66	0.01
FMR 167B	22 04 13.97	+10 04 13.9	15.58		11.50	0.81	4.08	-126	-98	M1.5V	9.81	137.2	104	0.37	0.02
FMR 168A	22 05 32.99	+25 23 59.7	16.07		11.13	0.74	4.94	-13	-176	M3.5V	12.08	61.2	51	0.18	0.02
FMR 168B	22 05 28.02	+25 23 25.6	16.77		11.53	0.72	5.24	-13	-176	M4V	12.76	61.7	52	0.18	0.01
LDS4945A	22 08 32.20	+02 09 37.6	14.23		10.92	0.77	3.31	118	-182	K7V	7.98	170.7	175	0.67	0.02
LDS4945B	22 08 31.91	+02 09 05.7	18.12		12.63	0.77	5.49	118	-182	M4V	13.27	91.0	94	0.18	0.02
2211+1819A	22 11 43.89	+18 19 14.1	14.12		10.55	0.78	3.57	-68	-135	K9V	8.41	133.6	96	0.64	0.02
2211+1819B	22 11 44.08	+18 18 57.0	14.75		10.86	0.78	3.89	-68	-135	M0.5V	9.37	115.2	83	0.55	0.02
FMR 169A	22 16 40.97	+29 10 23.8	6.67	0.95	4.31	0.75	2.36	155	24	G8III	0.58	156.1	116	1.00	0.03
FMR 169B	22 16 29.44	+29 09 50.2	10.55	0.97	8.45	0.52	2.10	164	-1	K1V	6.18	72.7	57	0.74	0.02
CBL 540A	22 20 25.38	+05 19 57.5	16.95		12.34	0.81	4.62	-105	-108	M2.5V	10.92	146.3	104	0.37	0.06
CBL 540B	22 20 23.27	+05 19 58.2	18.62		13.42	0.94	5.20	-104	-108	M3.5V	12.09	181.1	129	0.18	0.06
2222+2309A	22 22 33.61	+23 09 49.6	13.91		9.88	0.82	4.03	-167	-122	M1.5V	9.83	64.0	63	0.37	0.01
2222+2309B	22 22 30.08	+23 08 01.0	16.10		11.38	0.82	4.72	-182	-111	M3V	11.47	82.2	83	0.26	0.01
FMR 170A	22 29 43.90	+24 23 29.2	9.38	0.87	7.38	0.51	1.99	165	-23	K0V	5.90	49.0	39	0.79	0.01
FMR 170B	22 29 44.41	+24 22 41.7	19.05					172	-29	?					
CRB 20A	22 35 01.25	+41 03 37.3	12.39	1.53	9.29	0.77	3.10	170	-33	K7V	7.98	72.4	59	0.52	0.03
CRB 20B	22 35 00.71	+41 03 14.7	18.02		12.48	0.80	5.54	170	-33	M4V	13.23	85.7	70	0.18	0.03
FMR 171A	22 58 05.84	+28 08 52.3	10.93	0.78	9.11	0.52	1.83	-96	-119	G7V	5.42	122.2	89	0.88	0.02
FMR 171B	22 58 09.72	+28 08 22.4	15.42		11.36	0.84	4.06	-90	-131	M1.5V	9.73	132.3	100	0.37	0.02
2312+2701A	23 12 47.00	+27 01 04.5	11.56	0.51	9.03	0.61	2.53	169	-24	K1V	6.18	112.5	91	0.74	0.04
2312+2701B	23 12 50.76	+27 00 46.8	19.30		13.62	0.95	5.68	161	-25	M4.5V	13.36	142.8	110	0.18	0.04
AZC 129A	23 22 49.17	+23 22 28.1	15.87		11.21	0.91	4.66	152	-36	M3V	11.21	82.9	61	0.26	0.02
AZC 129B	23 22 49.22	+23 22 15.5	16.58		11.13	0.91	5.46	152	-36	M4V	13.11	48.5	36	0.18	0.01
FMR 172A	23 28 13.66	+33 59 45.7	13.56		10.70	0.71	2.86	27	-215	K4VI					
FMR 172B	23 28 26.38	+34 00 24.5	18.01		13.51	0.74	4.50	31	-210	M2V	10.51	279.5	281	0.37	0.07
2335+6750A	23 35 38.00	+67 50 01.6	10.56	0.83	8.70	0.48	1.86	139	63	G3V	4.82	113.7	82	1.01	0.13
2335+6750B	23 35 26.50	+67 51 58.5	17.89		12.70	0.83	5.19	141	60	M3V	11.41	147.1	107	0.26	0.17
2343+1345A	23 43 18.10	+13 45 43.0	17.74		11.73	0.87	6.01	-29	-170	M5V	14.27	48.1	39	0.12	0.01
2343+1345B	23 43 27.74	+13 44 26.3	18.22		12.50	0.84	5.71	-27	-170	M4.5V	13.63	79.8	65	0.18	0.02
2349+1108A	23 49 17.66	+11 08 51.4	13.78		10.03	0.82	3.75	84	-154	M0V	8.94	88.5	74	0.59	0.03
2349+1108B	23 49 18.49	+11 09 03.2	18.89		13.05	0.82	5.84	84	-154	M4.5V	13.87	95.9	80	0.18	0.03
2352+4625A	23 52 15.05	+46 25 52.0	16.98		12.35	0.78	4.63	165	33	M2.5V	11.20	136.9	109	0.37	0.03
2352+4625B	23 52 13.83	+46 26 47.0	17.58		12.89	0.76	4.69	165	33	M3V	11.32	169.2	135	0.26	0.03

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 3. Binary Stars

Desig.	RA	DEC	V pri.	V sec.	SpT pri.	SpT sec.	ρ ["]	Δ(V-Mv)	E(a) [AU]	Δμ (mas yr^{-1})	M_{pri} + M_{sec} [M_{sun}]	Period [yrs]
FMR 29	00 11 41.96	+03 23 17.6	16.10	16.20	M1.5V	M1.5V	6.76	0.25	1370	0	0.74	59000
FMR 30	00 23 55.55	+16 46 45.9	16.41	16.56	K7VI	M2V	173.52		33582	9		
FMR 31	00 41 30.19	+07 28 34.8	15.10	19.39	M1V	M4.5V	32.10	-0.23	4608	0	0.71	370000
FMR 32	00 42 15.23	+07 31 18.6	14.85	19.32	G/KVI	M3VI	13.24		5862	0		
FMR 33	00 44 27.83	+19 35 05.3	15.03	15.83	M2.5V	M2.5V	9.10	0.45	932	0	0.74	33000
FMR 34BC	00 50 21.36	+59 23 19.4	14.00	18.01	M2.5V	K VI	15.75		763	0		
FMR 35	00 50 12.71	+62 34 58.8	16.76	17.41	M4.5V	M5V	20.29	-1.07	960	0	0.30	54000
FMR 36	00 53 11.05	+31 44 13.5	10.06	14.93	K1V	M2.5V	159.61	0.17	12265	13	1.11	1300000
FMR 37	00 56 17.47	+81 03 15.3	16.92	17.52	K9V	M0VI	63.89	-0.56	26175	0	1.09	4000000
FMR 38	00 59 51.55	+27 01 28.8	10.35	17.80	K1V	M4.5V	72.97	-0.04	6033	11	0.91	500000
FMR 39	01 00 30.94	+09 33 09.8	14.97	16.44	K9V	M3.5V	19.44	-2.44	3405	0	0.84	220000
FMR 40	01 05 16.73	+16 20 24.9	14.70	15.52	G VI	M2.5V	7.73		878	0		
FMR 41	01 07 43.48	+57 59 11.5	17.31	17.97	M0V	M3V	116.16	-1.64	39813	19	0.83	8700000
0111+4248	01 11 55.14	+42 48 02.4	11.23	14.50	G9V	M0V	115.16	-0.05	17653	12	1.39	1200000
FMR 42AB	01 15 50.17	+47 02 02.3	14.70	17.71	M4V	M5V	27.12	0.88	915	0	0.30	50000
FMR 43	01 21 32.50	+39 20 35.2	11.61	15.37	K5V	M3V	15.77	-0.46	1287	31	0.85	50000
FMR 44	01 31 01.43	+54 31 55.4	16.87	18.23	M3.5V	M4V	42.98	0.74	4472	0	0.36	500000
FMR 45	01 56 19.06	+37 28 48.7	17.20	17.22	M4.5V	M4V	6.73	0.34	485	0	0.36	18000
FMR 46	02 00 01.17	+07 32 46.8	15.12	18.00	M3V	M3.5V	18.23	2.45	2380	0	0.43	175000
FMR 47	02 00 20.14	+26 35 59.9	10.99	14.77	K8V	M3V	13.94	0.47	704	24	0.91	20000
0201+0218	02 01 15.09	+02 18 25.7	17.44	18.50	K7VI	M1VI	63.84		32014	0		
FMR 48	02 05 24.83	+17 09 22.1	12.85	16.69	G VI	K VI	11.90			0		
FMR 49	02 12 39.74	+01 18 31.7	14.90	17.06	M2.5V	M4V	7.28	0.42	604	0	0.55	20000
FMR 50	02 22 41.63	+56 27 03.1	16.27	16.63	?	M3V	30.28			0		
FMR 51	02 26 02.36	+53 24 49.3	17.86	18.29	M2V	M2.5V	114.74	-0.62	41718	0	0.74	10000000
FMR 52	02 27 41.12	+06 13 53.9	14.48	16.17	M2.5V	M4V	6.96	0.07	402	0	0.55	11000
FMR 53	02 30 55.18	+62 48 50.8	13.50	16.17	K2VI	K6VI	19.62			0		
FMR 54	02 31 33.05	+38 53 14.3	13.31	15.56	K2V	M2V	7.35	-1.41	1606	0	1.06	62000
FMR 55	02 32 29.68	+06 06 15.6	14.44	18.45	M0.5V	M3.5V	18.36	0.84	2751	0	0.73	169000
CBL 212	02 32 43.60	+74 08 54.9	18.42	18.61	K9VI	M1VI	14.77	-0.98	7094	0	1.04	584000
CBL 213	02 33 01.14	+01 05 38.9	15.69	16.16	M3.5V	M4V	29.13	0.16	1776	0	0.36	125000
FMR 56	02 34 03.02	+09 50 14.0	17.77	18.77	M0.5V	M3VI	6.70	-1.07	2831	0	0.80	170000
FMR 57	02 40 09.93	+14 38 47.6	15.28	17.53	M2V	M3V	9.73	0.87	1223	0	0.63	54000
FMR 58	02 44 21.78	+32 07 16.5	10.81	16.52	K0V	M3.5V	63.46	-0.87	5933	4	0.96	465000
FMR 59	02 51 07.90	+06 48 23.3	13.67	16.35	M0.5V	M3.5V	47.10	-0.27	4080	0	0.75	300000
FMR 60	02 51 30.43	+34 06 37.5	10.54	16.72	K2V	M4V	77.33	-0.06	6111	6	0.87	510000
FMR 61	02 53 59.42	+66 06 07.3	14.74	14.52	K9V	M2V	9.10	-2.09	1175	0	1.01	40000
FMR 62	03 17 26.20	+64 03 57.8	11.47	14.91	K5V	M3.5V	52.28	-1.36	3211	5	0.96	185000
GWP 453	03 20 52.06	+12 09 56.4	15.49	16.30	K6VI	K8/9VI	53.75			0		
0323+1506	03 23 27.30	+15 06 52.0	14.26	16.13	M1.5V	M3.5V	67.78	-0.33	5566	0	0.55	560000
GWP 512	03 47 07.04	+05 20 16.9	17.29	18.11	M3.5V	?	6.85			0		
FMR 63	03 50 50.19	+45 45 34.1	14.29	18.29	K8V	M3V	27.76	0.91	5969	0	0.89	490000

Table 3 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 3 (continued). Binary Stars

Desig.	RA	DEC	V pri.	V sec.	SpT pri.	SpT sec.	ρ ["]	Δ(V-Mv)	E(a) [AU]	Δμ (mas yr^{-1})	M_{pri} + M_{sec} [M_{sun}]	Period [yrs]
FMR 64	04 11 26.59	+54 24 02.9	10.38	15.89	K3V	M3V	172.09	0.83	13589	16	0.91	1660000
FMR 65	04 17 51.16	+51 43 36.7	14.98	15.23	M1.5V	M1.5V	13.10	0.46	1822	0	0.74	90000
FMR 66	04 24 49.26	+01 06 56.1	12.90	16.56	M2.5V	M4.5V	25.85	0.44	996	0	0.55	42000
0433+0013	04 33 17.84	+00 13 59.5	11.48	16.85	G6VI	M2V	19.05		4694	3		
FMR 67	04 48 06.47	+41 38 04.7	14.68	16.04	M2.5V	M1.5V	8.39	2.28	1292	0	0.74	50000
0509+1038	05 09 42.59	+10 38 43.8	14.70	18.99	K6V	M3.5V	45.43	-0.18	10699	0	0.73	1300000
FMR 68	05 19 34.13	+34 20 38.7	15.86	16.07	M3.5V	M3.5V	50.75	0.16	3842	0	0.36	400000
0524+0315	05 24 49.76	+03 15 15.4	10.71	14.70	K8V	G7VI	48.28		1806	19		
FMR 69	05 44 17.22	+30 38 31.6	10.68	15.61	K0V	M2.5V	50.03	-0.18	5402	11	1.16	370000
FMR 70	05 45 45.39	+66 38 30.2	12.51	14.06	K6V	M3V	11.17	-1.98	879	0	0.81	29000
0546+1116	05 46 17.26	+11 16 46.6	16.50	18.21	M4.5V	K2VI	53.81		2333	0		
0550+0939	05 50 11.74	+09 39 49.2	16.01	17.75	M4.5V	M6V	16.00	-0.97	487	0	0.26	21000
FMR 71	05 51 49.91	+18 04 29.4	17.49	17.98	M3V	M2.5V	20.35	1.31	4479	0	0.63	378000
GWP 736	06 05 03.52	+07 23 30.5	14.99	16.83	K4VI	M0VI	8.66		2387	0		
GWP 744	06 06 13.38	+06 48 22.3	16.73	18.90	M4.5V	M5.5V	9.22	0.53	510	0	0.26	22000
0610+2802	06 10 25.64	+28 02 23.6	10.80	13.41	K4V	M1.5V	160.99	-0.37	10266	3	0.99	1000000
0610+4439	06 10 43.98	+44 39 49.8	16.73	17.93	M0VI	M0VI	141.92		41161	14	0.46	12300000
FMR 72	06 10 48.30	+03 15 12.9	15.92	18.23	M2V	M3.5V	45.47	0.38	6622	0	0.55	730000
FMR 73	06 15 40.49	+34 27 03.8	16.75	18.16	M3V	M3.5V	7.48	0.35	1038	0	0.43	51000
FMR 74	06 18 10.57	+67 04 15.2	18.39	19.00	M5V	M5V	7.61	0.71	580	0	0.25	28000
0628+2829	06 28 28.26	+28 29 23.0	16.03	17.59	M0V	M3V	100.19	-0.73	24173	0	0.83	4100000
FMR 75	06 28 31.05	+59 06 23.1	17.19	19.00	M4.5V	M5V	36.68	0.98	2933	0	0.30	290000
0649+2942	06 49 53.22	+29 42 03.8	13.70	15.98	M2.5V	M3.5V	34.23	0.53	1942	0	0.55	115000
FMR 83	06 51 04.45	+18 43 43.1	17.65	18.07	M4V	M4.5V	111.77	-0.54	9826	0	0.36	1600000
FMR 76	06 58 34.34	+75 14 17.7	15.79	18.99	M3.5V	M4.5V	131.42	1.72	12810	49	0.36	2400000
0705+4129	07 05 32.54	+41 29 10.0	13.98	16.39	K8V	K9V	87.20	1.87	24510	0	1.26	3400000
GWP 876	07 10 52.54	+06 12 30.6	14.05	16.94	M0V	M3.5V	21.39	-0.68	2346	0	0.76	130000
FMR 77	07 15 21.11	+03 01 27.8	13.83	18.65	M0V	M4.5V	19.32	-0.25	2304	0	0.78	125000
0727+4228	07 27 50.77	+42 28 19.8	16.03	17.89	M3.5V	M4V	32.00	1.06	2759	0	0.36	243000
CBL 235	07 28 20.77	+31 00 13.0	15.11	17.91	M2V	M4V	9.48	0.30	1250	0	0.55	60000
FMR 78	07 38 12.77	+43 34 24.0	9.64	18.46	K2V	M0VI	177.17	5.42		65		
FMR 79	07 40 57.40	+06 41 04.8	15.90	16.00	M2V	M3.5V	6.95	-1.96	756	0	0.55	28000
0749+2435	07 49 54.56	+24 35 13.1	11.98	15.08	M0V	M3.5V	96.86	0.11	5128	0	0.77	420000
FMR 80	07 49 19.76	+49 50 31.2	10.40	18.00	G5V	M3.5V	66.65	0.22	9734	11	1.12	907000
0802+0019	08 02 50.06	+00 19 09.1	13.41	16.83	K9V	M3V	78.76	0.26	9969	0	0.88	1050000
FMR 81	08 20 39.80	+48 03 18.0	15.32	17.18	M3V	wd	166.78	-0.82	8303	4		
BVD 202	08 31 20.84	+44 24 07.1	12.75	18.84	K7V	M4.5V	34.77	0.23	4091	0	0.85	285000
CBL 263	08 37 33.75	+24 41 32.1	13.84	18.53	M0.5V	M4.5V	99.51	-0.19	9465	0	0.73	1075000
0840+6144	08 40 04.61	+61 44 44.4	18.68	19.09	M1VI	M0VI	84.73	0.81	57871	0	1.00	14000000
FMR 82	08 48 51.11	+17 17 32.3	17.04	19.70	M4V	M5.5V	168.37	-0.21		117		
0855+3732	08 55 59.87	+37 32 10.8	13.91	17.37	M0.5V	M3.5V	80.19	0.24	8626	0	0.73	935000
0900+0643	09 00 52.07	+06 43 31.5	13.53	16.14	M0V	M3.5V	44.65	-0.51	4005	0	0.76	290000

Table 3 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 3 (continued). Binary Stars

Desig.	RA	DEC	V pri.	V sec.	SpT pri.	SpT sec.	ρ ["]	Δ(V-Mv)	E(a) [AU]	Δμ (mas yr^{-1})	M_{pri} + M_{sec} [M_{sun}]	Period [yrs]
FMR 84	09 00 26.61	+53 06 57.9	15.83	19.58	M3.5V	M4V	99.27	2.44		61		
0902+0600	09 02 51.27	+06 00 28.0	9.80	14.35	G0V	M0.5V	105.56	-0.42	14068	6	1.67	129000
0906+7226	09 06 56.14	+72 26 09.3	16.03	17.93	M3.5V	M4.5V	24.44	-0.11	1803	0	0.36	128000
FMR 85	09 16 22.75	+25 39 49.8	11.62	17.75	K9V	wd	44.06	-0.70	1660	20		
FMR 86	09 21 18.96	+24 43 32.3	16.36	17.62	M1V	M2V	7.14	0.33	1998	0	0.91	94000
0929+0350	09 29 09.81	+03 50 07.9	16.21	16.65	M3.5V	M4V	37.79	0.16	2844	0	0.36	254000
FMR 87	09 41 15.75	+07 07 43.4	16.09	16.75	M2.5V	M3V	22.74	0.18	2837	0	0.63	190000
CBL 288	09 42 22.64	+64 22 23.3	12.93	18.48	K0/1VI	M2V	14.81		6058	0		
FMR 88	09 47 44.84	+35 08 27.4	14.18	16.54	K3/4VI	M1.5V	138.71		36818	37		
FMR 89	10 01 21.81	+23 52 27.1	16.54	18.05	M3V	M4V	6.27	0.60	777	0	0.43	33000
CBL 304	10 13 59.78	+03 05 56.4	18.03	18.29	wd	wd	26.37	-0.19		0		
FMR 90	10 17 33.63	+26 10 37.1	18.48	18.98	M1VI	M4V	168.44	-2.34		66		
FMR 91	10 18 07.84	+54 22 48.6	13.93	16.66	K9V	M2.5V	72.18	0.36	11360	0	0.99	1220000
FMR 92	10 31 39.65	+43 51 15.4	11.64	15.26	G9V	M2V	129.78	-0.82	20848	12	1.24	2700000
FMR 93	10 34 36.13	+53 23 23.9	16.58	19.61	M3V	M4.5V	49.42	0.65	7703	0	0.43	1000000
FMR 94AC	10 45 21.40	+18 14 29.0	9.58	16.01	G6V	M3.5V	113.40	-0.24	9761	19	1.09	925000
FMR 95	10 46 33.43	+19 06 37.3	13.34	18.40	M1V	M4V	36.33	1.50	3832	0	0.71	280000
FMR 96	10 46 58.66	+24 36 52.4	13.31	14.64	M1V	M2V	9.88	0.75	784	0	0.91	23000
FMR 97	10 51 02.12	+38 57 37.7	18.28	19.49	M4V	M4V	8.71	0.86	1805	0	0.36	130000
GWP1473	10 51 03.61	+14 58 19.8	16.19	17.95	M3.5V	M4.5V	14.04	0.61	1075	0	0.36	59000
CBL 323	10 54 16.16	+00 02 59.5	12.64	17.02	K5V	M3.5V	42.07	-0.75	5128	0	0.77	420000
CRB 87	10 57 30.49	+30 08 29.8	16.64	17.50	M4V	wd	7.33	0.04	485	0		
1102+2353	11 02 01.98	+23 53 08.5	14.15	16.69	K8V	M2.5V	97.78	-0.29	16653	0	1.00	2150000
BVD 216	11 08 21.35	+47 51 38.5	13.97	16.44	M1V	M4V	22.98	-0.83	1764	0	0.71	88000
GWP1557	11 11 59.28	+04 02 42.0	18.15	19.39	M1VI	M1VI	25.59	1.20	17256	0	1.07	2190000
FMR 98	11 19 44.46	+06 11 24.9	9.20	19.48	G6V	M4.5V	147.88	2.05		102		
FMR 99	11 22 27.00	+52 46 46.7	14.99	15.38	M0.5V	M1.5V	15.51	-0.53	2556	0	0.95	130000
FMR 100	11 23 42.68	+65 54 31.7	13.65	18.95	K7V	M0VI	33.89	3.23	15560	0	1.12	1800000
FMR 101	11 31 49.44	+35 13 06.8	15.39	15.54	M0.5V	M1V	7.38	-0.17	1518	0	1.11	55000
1135+3109	11 35 11.94	+31 09 26.7	16.45	18.29	M3.5V	M3V	131.30	2.55	24744	6	0.43	5900000
CBL 346	11 35 40.36	+04 57 29.5	14.73	19.70	M0.5V	M5V	10.16	-0.77	1247	0	0.67	54000
FMR 102	11 39 07.20	+16 34 42.9	15.64	16.33	M2.5V	M3V	8.18	-0.51	923	0	0.63	35000
1147+1640	11 47 16.86	+16 40 07.4	16.57	16.63	M0VI	K8VI	8.38			0		
GWP1677	11 48 06.30	+03 06 20.2	14.93	17.04	M1.5V	M3.5V	22.54	-0.27	2746	0	0.55	190000
1148+0018	11 48 51.56	+00 18 03.8	15.13	18.04	K2VI	M1VI	4.58		2097	0		
BVD 221	12 02 37.52	+44 17 57.8	16.97	19.44	M3.5V	M4.5V	12.89	0.53	1766	0	0.36	125000
1206+1218	12 06 02.12	+12 18 19.0	13.23	16.53	G VI	K8VI	38.06			0		
1209+2818	12 09 41.82	+28 18 08.8	18.85	19.58	M3V	M3.5V	13.44	0.14	4863	0	0.43	515000
FMR 103	12 16 36.93	+40 57 36.2	18.56	18.72	K8VI	M4V	29.54		5998	0		
FMR 104	12 17 05.76	+07 42 30.2	15.25	18.14	K1VI	K8/9VI	11.54			0		
FMR 105	12 23 23.67	+39 20 15.7	18.27	19.32	M1VI	K9VI	9.15		4707	0		
1223+0625	12 23 43.48	+06 25 10.3	13.85	18.33	K4/5VI	M2.5V	23.38		8900	0		

Table 3 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 3 (continued). Binary Stars

Desig.	RA	DEC	V pri.	V sec.	SpT pri.	SpT sec.	ρ ["]	Δ(V-Mv)	E(a) [AU]	Δμ (mas yr^{-1})	M_{pri} + M_{sec} [M_{sun}]	Period [yrs]
FMR 106	12 27 45.45	+75 53 57.7	12.16	19.31	K1VI	M4V	35.35		6730	24		
1233+0824	12 33 13.45	+08 24 03.9	18.53	19.09	wd	wd	110.88	-0.18	11037	0		
FMR 107	12 35 52.36	+69 39 27.9	14.29	18.35	M2.5V	M1VI	8.05	4.99	2404	0	0.91	125000
1235+4402	12 35 54.41	+44 02 49.7	13.00	19.55	M0.5V	wd	36.88	0.45	3160	0		
1236+1457	12 36 13.40	+14 57 17.1	15.85	17.83	M2.5V	M4V	80.52	0.47	10121	0	0.55	1400000
FMR 108	12 36 16.09	+21 13 17.4	10.42	19.46	K3V	M5.5V	37.11	0.10	2548	6	0.74	145000
CBL 390	12 40 08.21	+37 21 46.8	14.08	17.31	M2.5V	M4.5V	32.99	0.23	1783	0	0.55	100000
FMR 109	12 43 07.93	+35 53 19.7	10.91	17.37	K2V	M3.5V	89.01	0.43	9569	3	0.87	1000000
FMR 110	12 44 50.98	+77 40 20.7	11.52	15.76	K1V	M1.5V	51.36	0.46	8175	16	1.11	700000
FMR 111	12 52 53.82	+28 35 45.9	14.66	20.31	M2V	M5V	125.87	1.25	16289	34	0.49	2950000
1310+3252	13 10 21.43	+32 52 58.4	14.33	17.30	M3V	M4.5V	66.47	0.64	3734	0	0.43	346000
1311+1106	13 11 41.81	+11 06 24.7	12.84	17.56	F VI	K8/9VI	146.65			9		
FMR 112	13 23 13.02	+36 33 39.1	13.01	17.78	K4V	M4V	27.96	-1.02	4457		0.80	330000
FMR 113	13 43 09.06	+25 53 06.4	12.11	18.20	K2V	M4V	130.83	-0.74	18754	9	0.87	2750000
1352+2806	13 52 02.28	+28 06 48.8	14.01	14.39	M1V	M2.5V	11.54	-0.69	901	0	0.91	28000
1358+3842	13 58 44.94	+38 42 32.8	14.15	18.55	K8V	M3.5V	39.77	0.56	8442	0	0.83	850000
LDS2333	14 00 23.58	+66 37 28.8	11.53	17.80	K1V	M3.5V	51.30	0.53	8474	24	0.91	820000
1424+1804	14 24 36.02	+18 04 14.0	16.53	18.84	M2.5V	M4V	33.33	0.46	5671	0	0.55	575000
CBL 461	14 35 45.90	+04 58 11.6	17.46	17.61	M2V	M2V	51.77	-0.03	17658	0	0.74	2700000
FMR 114	14 42 52.06	+07 23 56.3	9.60	17.23	F8V	M3.5V	111.13	-0.55	16002	31	1.41	1700000
CBL 468	14 46 08.44	+10 59 02.1	12.39	17.17	K1V	M2.5V	20.64	-0.14	4279	0	1.11	265000
FMR 115	14 52 21.74	+12 31 22.3	18.50	19.29	M2.5V	M4.5V	108.98	-1.93	26993	0	0.55	5980000
FMR 116	14 54 55.24	+23 06 47.1	17.72	19.38	M3.5V	M4.5V	6.66	-0.25	1077	0	0.36	59000
CBL 477	15 00 51.87	+13 14 47.4	15.68	15.95	M3.5V	M4V	19.29	0.08	1099	0	0.36	61000
FMR 117	15 11 46.72	+00 04 32.6	14.04	18.39	G VI	M0VI	128.10		72067	39		
CBL 485	15 17 22.83	+09 04 01.6	16.68	18.23	K2/4VI	K9VI	18.12			0		
FMR 118	15 17 36.63	+15 17 13.8	15.69	19.52	M3.5V	M5.5V	12.62	0.23	752	0	0.26	40000
FMR 119	15 19 49.96	+64 15 41.6	18.30	19.06	?	?	6.03			0		
FMR 120	15 42 33.51	+00 52 06.5	9.77	17.08	G5V	M3.5V	85.60	0.20	9167	21	1.12	830000
FMR 121	15 54 53.03	+48 52 28.9	14.09	18.13	G/K VI	M2.5V	31.15		9498	32		
FMR 122	16 01 49.43	+25 18 42.6	15.20	16.42	M3V	M3.5V	8.25	1.04	633	0	0.43	24000
FMR 123	16 12 02.59	+31 58 47.6	14.44	16.64	M3.5V	M4.5V	8.75	0.76	368	0	0.36	11800
FMR 124	16 12 38.93	+23 41 05.3	13.64	17.93	K1VI	M0VI	60.16			0		
FMR 125	16 21 38.86	+02 54 58.3	13.67	16.71	G VI	K9VI	32.10			0		
FMR 126	16 39 35.67	+41 24 55.1	13.52	16.91	M0V	M3.5V	83.43	-0.30	8604	0	0.78	905000
FMR 127	16 41 52.51	+10 34 33.8	13.68	18.50	M2.5V	wd	14.13		643	0		
FMR 128	16 54 42.98	+46 54 33.5	14.64	16.16	M2.5V	M3V	9.16	1.28	785	0	0.63	28000
CBL 511	16 58 09.97	+26 52 27.4	12.63	17.52	G/K VI	M1.5V	18.42		6632	0		
FMR 129	16 58 51.61	+32 11 46.5	17.76	17.92	M0VI	M3V	161.01	-1.44		57		
FMR 130	17 01 43.51	+38 06 58.0	17.73	18.92	M3V	M4V	9.87	-0.56	2054	0	0.43	141000
FMR 131	17 02 22.12	+16 47 32.2	15.70	16.43	M2.5V	M2.5V	9.31	0.80	1152	0	0.74	45000
1712+0132	17 12 43.18	+01 32 04.4	13.50	15.42	M1.5V	M1V	22.52	1.92	2517	0	0.91	135000

Table 3 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 3 (continued). Binary Stars

Desig.	RA	DEC	V pri.	V sec.	SpT pri.	SpT sec.	ρ ["]	Δ(V-Mv)	E(a) [AU]	Δμ (mas yr^{-1})	M_{pri} + M_{sec} [M_{sun}]	Period [yrs]
FMR 132	17 22 35.02	+29 31 03.9	14.57	19.29	M2V	M4.5V	31.55	0.83	3925	0	0.55	332000
FMR 133	17 32 51.62	+43 45 08.9	13.99	15.47	K7/8VI	M2.5V	147.02		15654	30		
FMR 134	17 33 10.94	+04 31 55.9	16.43	17.92	M1.5V	M2V	9.91	1.07	2870	0	0.74	180000
1734+4858	17 34 39.68	+48 58 04.9	13.87	13.95	K8V	K9V	55.42	-0.04	9086	0	1.30	760000
FMR 135	17 35 15.19	+81 19 05.8	14.77	14.91	M2V	M0V	162.98	1.50	21297	42	0.95	3190000
1738+3939	17 38 08.57	+39 39 15.4	16.66	19.94	M3.5V	M5V	21.16	0.40	2337	0	0.30	206000
FMR 136	17 38 33.26	+63 32 29.5	12.44	16.12	K8V	M3.5V	14.29	-0.13	1197	0	0.83	45000
FMR 137	17 39 46.45	+05 37 29.3	17.18	17.53	M0VI	K9VI	9.38		4712	0		
FMR 138	17 47 24.95	+40 08 52.2	16.16	16.59	M4V	K3/4VI	63.52		3864	34		
FMR 139	18 09 05.99	+53 13 41.5	18.32	20.30	M4V	M5V	22.23	0.18	3944	0	0.30	450000
BVD 262	18 15 16.20	+40 54 19.5	17.32	17.86	wd	?	21.03			0		
1823+0403	18 23 19.83	+04 03 16.4	16.52	17.57	M2.5V	M3V	78.99	0.57	13285	0	0.63	1900000
1823+2022	18 23 59.62	+20 22 48.7	18.13	18.73	wd	M5.5V	87.71		3984	0	0.09	860000
FMR 140	18 25 54.70	+53 37 43.4	15.28	18.85	M0V	M3.5V	16.13	0.32	3859	0	0.76	275000
FMR 141	18 54 05.07	+39 22 18.5	11.29	15.54	K4V	M3V	31.15	-0.56	2445	0	0.88	130000
FMR 142	19 00 17.37	+64 59 08.0	16.62	17.22	M0VI	M1VI	8.59		2734	0	0.54	195000
FMR 143	19 06 57.51	+21 34 30.7	12.60	18.21	K7V	M4.5V	36.09	-0.52	3128	0	0.85	190000
FMR 144	19 09 19.19	+39 12 03.7	11.21	12.21	M2V	M0V	162.47	0.65	4440	10	0.86	320000
FMR 145	19 14 05.54	+28 25 53.3	16.26	17.32	M0VI	M1VI	9.54		2511	0	0.54	170000
FMR 146	19 15 26.40	+54 24 30.7	10.68	14.74	K4V	K8V	17.21	2.76	2550	4	1.25	115000
FMR 147	19 25 04.23	+22 47 56.4	11.09	15.56	K1VI	K4/5VI	13.95			18		
FMR 148	19 32 56.04	+17 23 56.7	14.86	18.18	M2V	M3.5V	150.58	0.94	19715	14	0.55	3700000
FMR 149	19 32 57.27	+04 57 08.8	13.98	15.47	M2.5V	M3V	53.52	0.85	3193	0	0.63	230000
FMR 150	19 35 39.88	+06 16 42.4	14.22	14.66	K8V	K9V	17.18	0.02	3119	0	1.24	155000
FMR 151	19 38 12.41	+01 40 30.3	13.17	18.10	K9V	M4V	93.39	0.91	11167	0	0.80	1300000
FMR 152	19 42 07.35	+28 40 17.9	12.22	14.29	G VI	K4/5VI	57.01			9		
FMR 153	19 43 19.57	+54 33 45.5	13.63	15.36	M2.5V	M4.5V	36.77	-0.90	1310	0	0.55	64000
FMR 154	19 45 30.41	+46 50 07.5	17.49	17.77	wd	wd	8.65			0		
FMR 155	19 50 56.24	+04 34 55.3	12.82	13.94	G VI	K8V	172.43		27568	9	0.63	5750000
FMR 156	20 03 00.32	+08 03 35.0	11.94	17.46	K7V	?	11.14			0	0.65	
FMR 157	20 04 57.78	+25 25 39.1	12.17	16.93	K5V	M3.5V	24.56	-0.12	2524	0	0.77	145000
FMR 158	20 16 12.36	+19 27 12.0	14.76	16.37	K8V	M3V	22.16	-1.68	3661	0	0.90	235000
FMR 159	20 39 52.60	+42 20 33.5	15.09	17.44	M1.5V	M4V	135.78	-0.68	14670	15	0.55	2400000
FMR 160	20 40 13.46	+29 15 35.4	16.53	18.79	M4.5V	M5V	59.69	1.23	3912	0	0.30	445000
FMR 161	20 41 07.02	+16 30 55.7	13.47	18.42	M0.5V	?	27.95			0		
CRB 13	20 56 51.17	+08 42 09.1	14.32	17.03	M1V	M3V	131.63	0.95	17123	7	0.79	2500000
FMR 162	20 57 45.93	+13 38 47.4	18.62	18.79	M3.5V	M3.5V	13.03	0.07	2758	0	0.36	245000
2106+5924	21 06 18.29	+59 24 01.8	10.91	15.31	K2V	M2.5V	120.27	-0.36	9808	4	1.06	940000
FMR 163	21 25 05.84	+03 29 30.0	18.39	18.51	M2V	M2VI	15.40	-0.43	7236	0	0.74	715000
FMR 164	21 39 28.15	+05 44 06.9	13.59	15.11	K7V	M1V	148.32	-0.20	22779	16	1.21	3100000
2146+1550	21 46 32.30	+15 50 38.9	16.54	16.56	wd	M2.5V	154.99		25912	7		
FMR 165	21 50 51.16	+12 43 21.5	10.67	18.08	K1V	K9VI	38.23		3645	15	0.74	255000

Table 3 continues on next page.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 3 (concluded). Binary Stars

Desig.	RA	DEC	V pri.	V sec.	SpT pri.	SpT sec.	ρ ["]	Δ(V-Mv)	E(a) [AU]	Δμ (mas yr^{-1})	M_{pri} + M_{sec} [M_{sun}]	Period [yrs]
FMR 166	22 03 11.60	+57 07 39.3	17.80	17.94	M4.5V	M5V	10.31	-0.53	695	0	0.30	33000
FMR 167	22 04 14.78	+10 04 10.5	11.17	15.58	K3V	M1.5V	12.32	1.34	1647	0	1.03	66000
FMR 168	22 05 32.99	+25 23 59.7	16.07	16.77	M3.5V	M4V	75.50	0.02	5844	0	0.36	750000
LDS4945	22 08 32.20	+02 09 37.6	14.23	18.12	K7V	M4V	32.27	-1.40	5319	0	0.85	420000
2211+1819	22 11 43.89	+18 19 14.1	14.12	14.75	K9V	M0.5V	17.32	-0.33	2714	0	1.19	130000
FMR 169	22 16 40.97	+29 10 23.8	6.67	10.55	G8III	K1V	154.79	-1.72	22309	27	1.74	2500000
CBL 540	22 20 25.38	+05 19 57.5	16.95	18.62	M2.5V	M3.5V	31.54	0.49	6506	1	0.55	700000
2222+2309	22 22 33.61	+23 09 49.6	13.91	16.10	M1.5V	M3V	119.00	0.55	10965	19	0.63	1450000
FMR 170	22 29 43.90	+24 23 29.2	9.38	19.05	K0V	?	49.20			9	0.79	
CRB 20	22 35 01.25	+41 03 37.3	12.39	18.02	K7V	M4V	23.44	0.38	2334	0	0.70	135000
FMR 171	22 58 05.84	+28 08 52.3	10.93	15.42	G7V	M1.5V	59.42	0.18	9528	13	1.25	835000
2312+2701	23 12 47.00	+27 01 04.5	11.56	19.30	K1V	M4.5V	53.33	0.56	8579	8	0.91	830000
AZC 129	23 22 49.17	+23 22 28.1	15.87	16.58	M3V	M4V	12.59	-1.19	1043	0	0.43	51000
FMR 172	23 28 13.66	+33 59 45.7	13.56	18.01	K4VI	M2V	163.01		57402	6		
2335+6750	23 35 38.00	+67 50 01.6	10.56	17.89	G3V	M3V	133.84	0.73	21994	4	1.26	2900000
2343+1345	23 43 18.10	+13 45 43.0	17.74	18.22	M5V	M4.5V	160.04	1.12	12894	2	0.30	2700000
2349+1108	23 49 17.66	+11 08 51.4	13.78	18.89	M0V	M4.5V	16.98	0.18	1972	0	0.77	100000
2349+1108	23 52 15.05	+46 25 52.0	16.98	17.58	M2.5V	M3V	56.46	0.48	10889	0	0.63	1400000

Table 4. Spectral Type Comparison

Star	V mag.	SpT.phot	SpT. literature	#ref
FMR 81 B	15.32	wd	DA [wd]	2
FMR 85 B	17.75	wd	DZ [wd]	1
CBL 304 A	18.03	wd	DA [wd]	2
FMR 154 A	18.48	wd	DA9 [wd]	3
FMR 154 B	18.98	wd	DA10 [wd]	3
FMR 42 Aa,Ab	14.70	M4V	M4V, M4.5V+M5V	14, 4
FMR 47 A	10.99	K8V	K5	5
FMR 60 A	10.54	K2V	K4	5
FMR 85 A	11.62	K9V	K6	5
FMR 103 B	18.72	M4V	M4V	6
CBL 390 A	10.91	K2V	G8V	7
FMR 120 A	9.77	G5V	G8V	8
FMR 123 A	14.44	M3.5V	M3.5V	9
FMR 141 A	11.29	K4V	K4	5
FMR 144 A	11.21	M2V	M0, M1	5,9
FMR 145 A	16.26	M0VI	sdM0.0	10
FMR 145 B	17.32	M1VI	sdM1.5	10
FMR 147 A	11.09	K1VI	K2	11
2106+5924 A	10.91	K2V	K3	12
FMR 169 A	6.67	G8III	G8III, G7II-III, G7III-IV	13

References

1. Koester et al. (2011); **2**. Kilic et al. (2006); **3**. Reid (2003); **4**. Law, Hodgkin & Mackay (2008); **5**. Stephenson (1986); **6**. West et al. (2008); **7**. Malmquist (1960); **8.** Houk & Swift (1999); **9**. Reid (2004); **10**. Lépine, Rich & Shara (2003); **11**. Lee (1984); **12.** Alknis (1958); **13**. Several references; **14**. Reid, Cruz & Allen (2007).

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

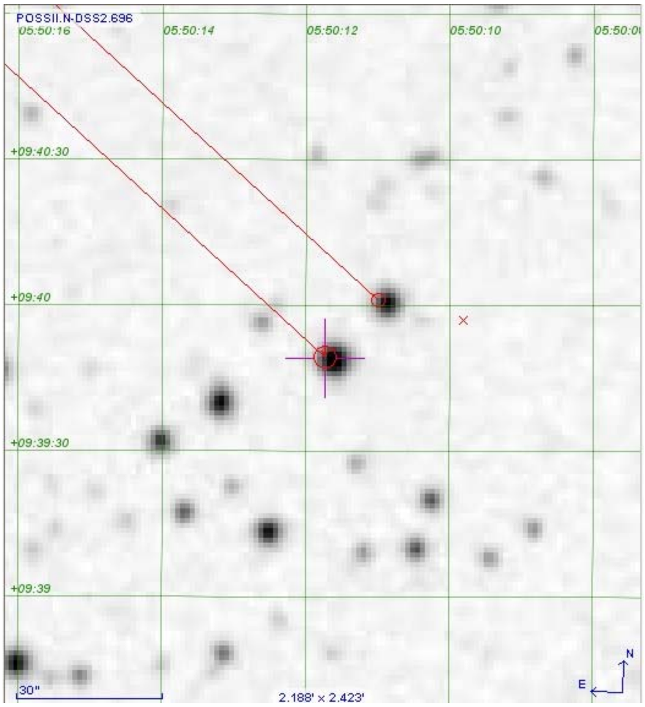


Figure 4: The binary 0550+0939 is composed of red stars M4.5V and M6V. The secondary is the coolest star in our sample. The red lines are the proper motions.

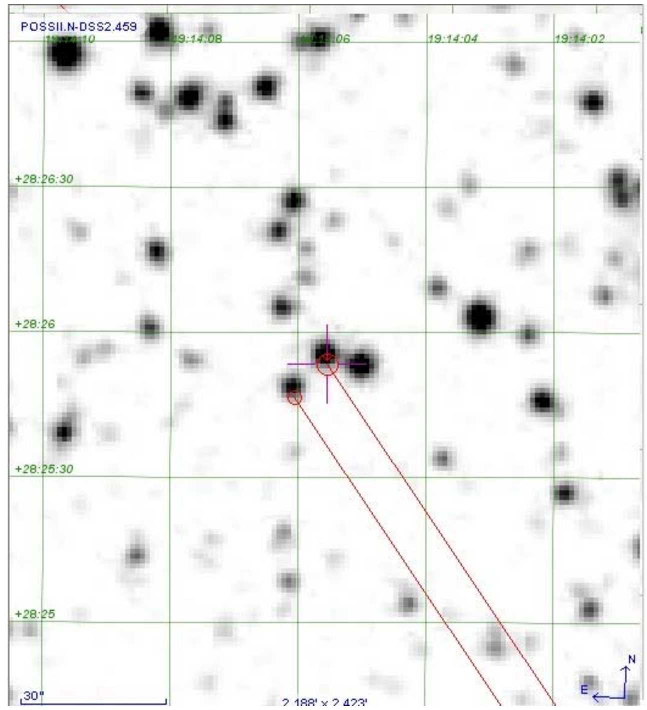


Figure 5: FMR 145 is a binary star composed of two cool subdwarfs of spectral type sdM0.0 and sdM1.5. In our sample, 75 cool subdwarfs were found, all of them but FMR 145 A and B, are new subdwarfs.

(Continued from page 264)

tral type (Figure 4). Sixty stars were classified as K dwarfs. The subdwarf stars are an important stellar population in our sample and about 75 cool subdwarfs (about a 16% of the total sample) were found. All these subdwarfs but two (FMR 145 A and B, see Figure 5) are not reported in literature before this publication.

After searching for spectral types in the literature, we found only 20 stars with known spectral types. Table 4 shows a comparison between our estimates and the data from literature. Column 1 lists the identification of the star and the stellar component, column 2 the V magnitude, in columns 3 and 4, the spectral types determined in this work and from the astronomical literature. In the last column is showed the bibliographic references for the spectral types. For determine the luminosity class several reduced proper motion diagrams (Jones 1972, Salim & Gould 2002, Nelson et al. 2002) were used. Our luminosity classes (giant star, normal dwarf, subdwarf, white dwarf) are in total agreement with those listed in literature. In the 76% of the cases, the difference was less than or equal to 2 subspectral types. For some of the references, especially those for brighter stars and older references, the errors in the published spectral type were of 1-2 subspectral types.

Finally this work presents 14 white dwarfs which 9 are new unreported white dwarfs (CBL 304 B, CRB 87 B, 1233+0824 A, 1233+0824 B, 1235+4402 B, FMR 127 B, BVD 262 A, 1823+2022 A, 2146+1550 A, see Figure 6a and 6b). Table 5 lists the SDSS photometry for some white dwarfs.

9.2.3 Distance Estimation

Photometric distances for 387 stellar components were estimated. Figure 7 shows a distribution of the distances estimated. The most distant star is GWP1557 B (see Figure 8), a weak (V = 19.39) cool subdwarf (M1VI) at a distance of 678 pc. This distance probably is overestimated since its tangential velocity is extremely large (637 km s^{-1}). The nearest star is a bright (V = 11.21) red dwarf (M2V) at 18.5 pc of distance. There are 5 stars nearer than 25 pc. One of them is a close double star (FMR 42 Aa,Ab = LAW 9 AB) studied by Law, Hodgkin & Mackay (2008) that determined a photometric distance of 18.7 $^{+9.3}/_{-3.6}$ pc, in excellent agreement with our result (see Figure 9). The others are red dwarfs with spectral types that

(Continued on page 296)

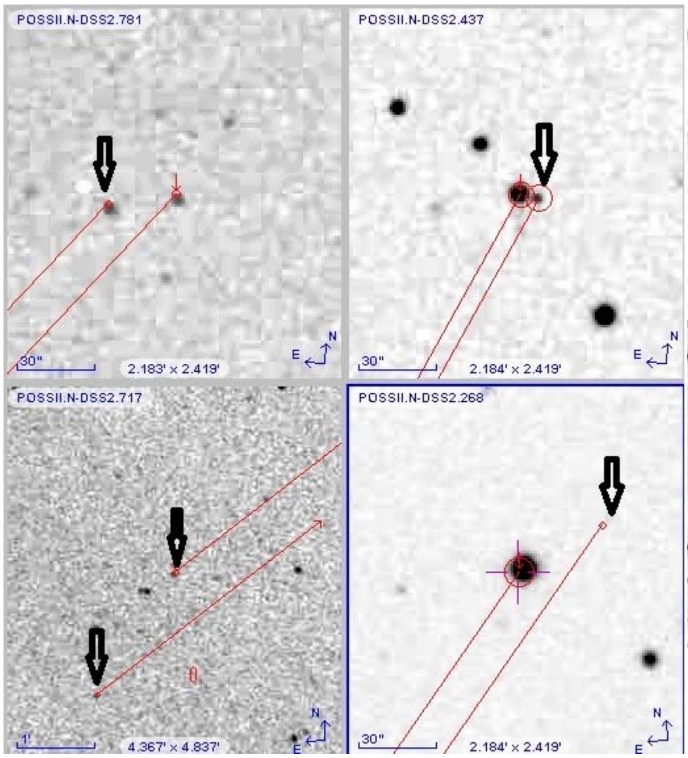


Figure 6a. New unreported white dwarfs (CBL 304 B, CRB 87 B, 1233+0824 A, 1233+0824 B, 1235+4402 B) are marked with an arrow.

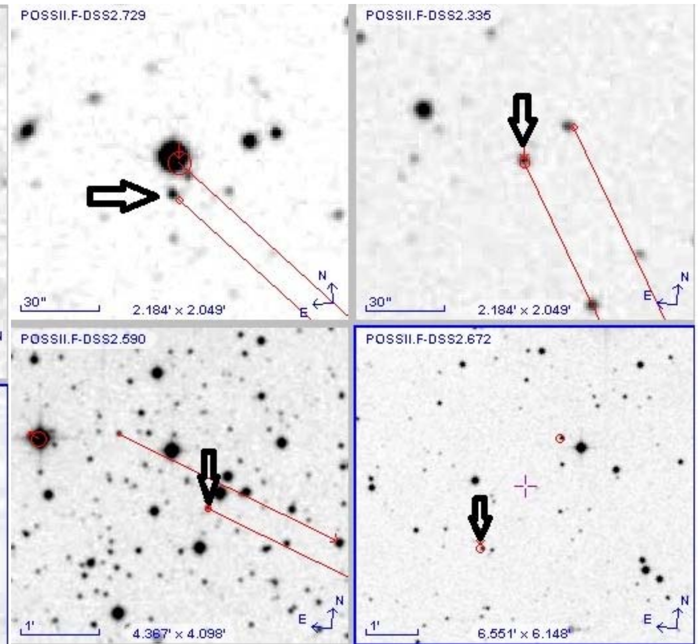


Figure 6b. New unreported white dwarfs (FMR 127 B, BVD 262 A, 1823+2022 A, 2146+1550 A) are marked with an arrow.

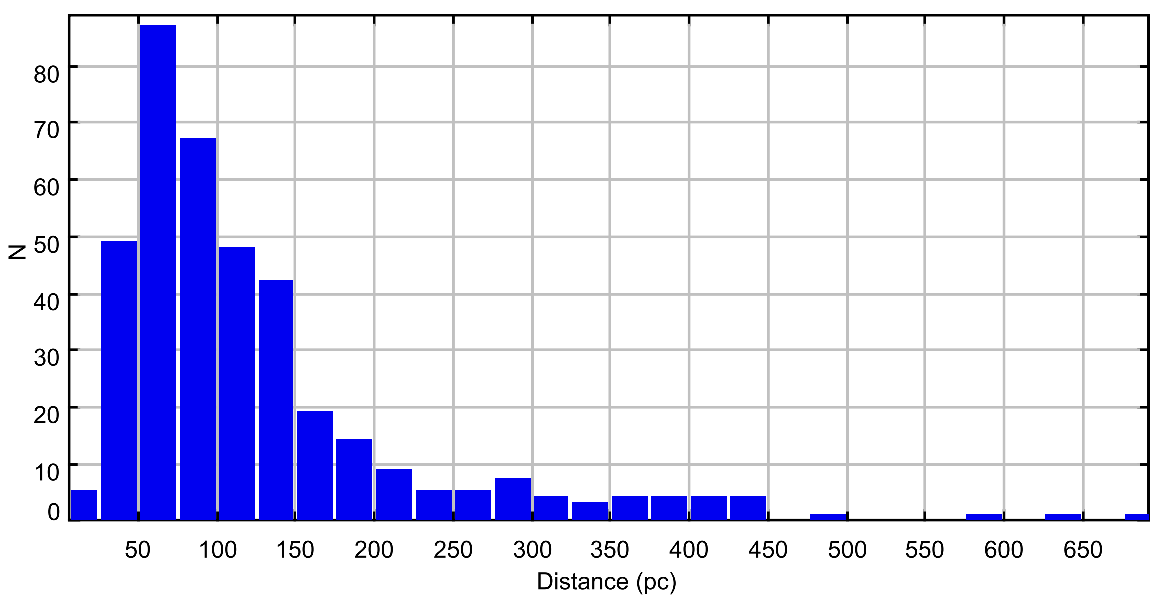


Figure 7. Distribution of the distances calculated.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

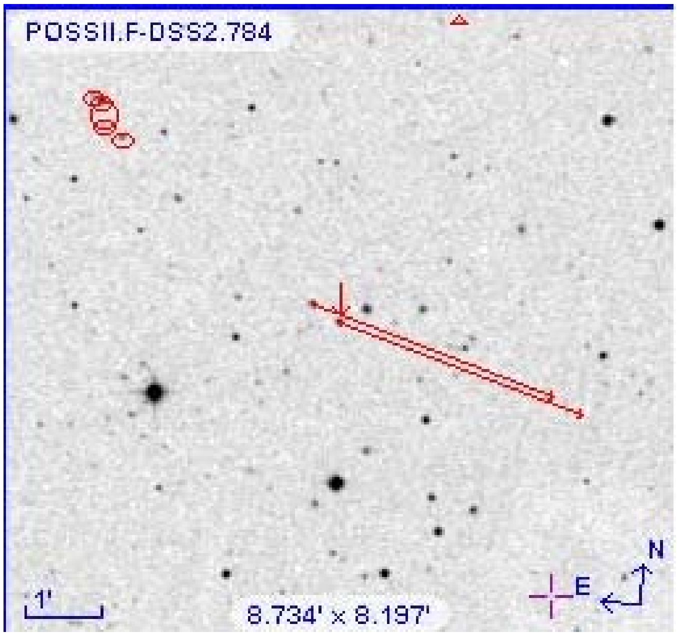


Figure 8: The secondary component of GWP 1557 is the most distant star in our sample. It is a weak (V = 19.39) cool subdwarf (M1VI) at a distance of 678 pc.

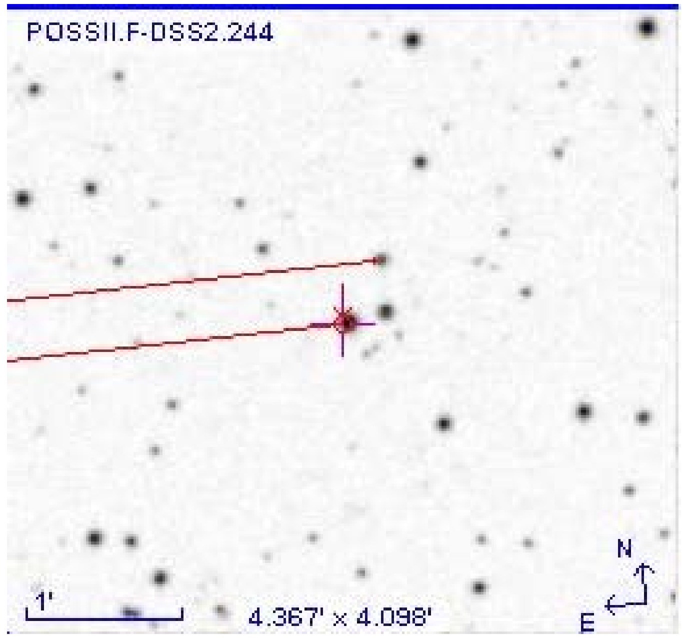


Figure 9: One of the star closer than 25 pc is FMR 42 Aa,Ab (= LAW 9 AB) located at a photometric distance of 18.7 pc.

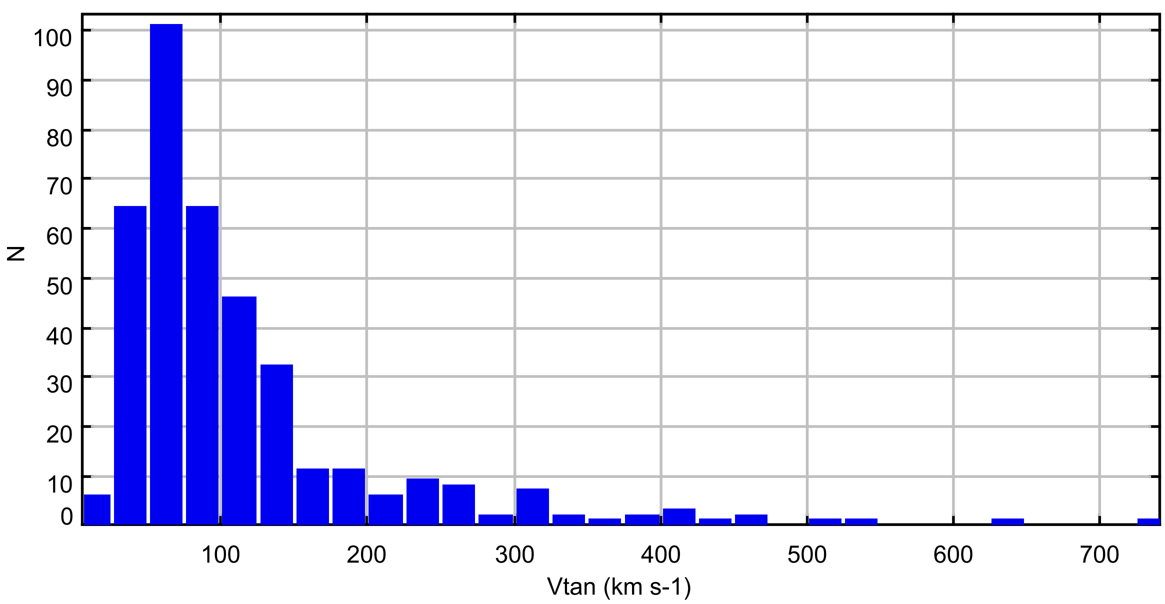


Figure 10: Distribution of the tangential velocities (V_{tan}) in km s^{-1}.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Table 5. SDSS Photometry for the New Candidate White Dwarfs

Star	u	g	r	i	z
CBL 304B	20.05	18.65	18.00	17.75	17.62
CRB 87B	18.27	17.63	17.38	17.32	17.32
1233+0824A	19.15	18.68	18.35	18.30	18.36
1233+0824B	20.42	19.37	18.84	18.65	18.65
1233+0824B	21.49	19.99	19.17	18.87	18.77

(Continued from page 293)

range from M0V to M6V and small tangential velocities (from 19 to 31 km s^{-1}). For G-K subdwarfs and white dwarfs, the photometric distance was not estimated due to the lack of an accurate color-luminosity relationship.

Table 6 shows a comparison between the estimates of the distances listed in this work and those obtained from the literature. Column 1 lists the identification of the star and the stellar component, column 2, the V magnitude, in columns 3 and 4 the photometric distance determined in this work and the distance from the astronomical literature. Column 5 and 6 list the bibliographic references and the notes.

The difference between my estimates and those from the literature is about 14% and so they are good estimations of distances. The Hipparcos trigonometric values listed in the Table 5 have a mean error of 11.5%.

9.3.3 Tangential Velocities

Figure 10 shows the distribution of the tangential velocity (V_{tan}). Forty-six stars have V_{tan} > 200 km s^{-1}. Many of them are normal dwarfs and therefore some of them could be subdwarfs with nearer distances and small V_{tan}. Ten stars have V_{tan} > 400 km s^{-1}. An overestimation of these distances is suspected. All of them are cool subdwarfs, therefore some of them could be extreme subdwarfs located at nearer distances. Another possibility is that the optical-infrared colors for some stars, used to determine luminosities and distances, is wrong. The V magnitude often was inferred from photographic catalogs and could be in error s much as 0.5 magnitude, distorting the optical-infrared colors (V - J, V - H and V - K).

The galactic escape velocity is estimated to be between 450 and 650 km s^{-1} (Leonard & Tremaine 1990). The local escape velocity of 522 km s^{-1} was derived from the Galactic gravitational potential of Allen & Santillan (1991). Assuming a zero radial velocity, in this work the total galactocentric velocity (V_{gal}) was calculated for those stars with V_{tan} > 400 km s^{-1}. Only three stars have V_{gal} > 400 km s^{-1}. 0840+6144 B has V_{gal} = 543 km s^{-1}, GWP 1557 B has V_{gal} = 473 km s^{-1} and FMR 145 B has V_{gal} = 478 km s^{-1}. Therefore if the distances listed here are accurate then these stars are possibly unbound to the Galaxy. It is important to obtain the radial velocities and the accurate distance for these stars.

Table 6. Distances Comparison

Star	mag. V	Rica's distance (pc)	Distance from literature (pc)	#ref	Notes
FMR 81B	17.18	43.2	42.9	8	
CBL 304A	18.03	49.7	42.0	8	
FMR 98A	9.20	59.1	61.4	Hipparcos	π = 16.28 ± 1.56 mas
FMR 120A	9.77	81.4	69.9	Hipparcos	π = 14.31 ± 1.58 mas
FMR 169A	6.67	156.1	187.0	Hipparcos	π = 5.35 ± 0.74 mas
FMR 38A	10.35	66.3	49+34-18	1	Photometric distance
FMR 42Aa,Ab	14.70	21.5	18.7+9.3-3.6	2	a)
0802+0019A	13.41	94.5	91	3	VRI photometric distance
BVD 216A	13.97	72.3	77	3	VRI photometric distance
FMR 103B	18.72	161.1	144	4	
FMR 111A	14.66	74.0	77	3	VRI photometric distance
FMR 123A	14.44	27.7	30.5	5	Spectrophotometric distances
FMR 128A	14.64	48.7	77	6	b)
FMR 164A	10.67	75.7	81	7	Photometric distance

References: (1) Ammons el at. (2006); **(2)** Law et al (2008); **(3)** Weis (1987); **(4)** West et al. (2008); **(5)** Reid et al. (2004); **(6)** Riaz, Gizis & Harvin (2006); **(7)** Ryan (1989); **(8)** Kilic et al. (2006).

Notes: a) Using V – K color-absolute magnitude relations of Legget (1992). Estimated error of 35%; **b)** It is the UV Cet named V 781 Her. Molecular index was used to estimate distances. (error of 37%)

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

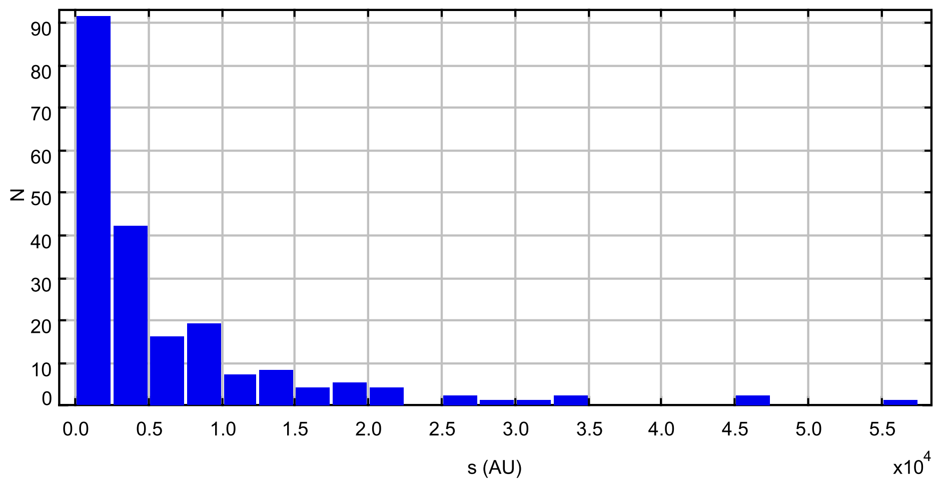


Figure 11. Distribution of the projected physical separations (in AU).

9.3.4 Stars with no 2MASS counterpart

There are 13 stars with no 2MASS counterpart. Five of them have SDSS counterpart and we determined a white dwarf nature for all of them using reduced proper motion diagrams. Likely other white dwarfs exists in this small sample of 8 stars with no 2MASS and SDSS counterpart or maybe are too dim to be listed in these catalogs.

9.4 Binaries

Table 3 lists the binaries presented in this work. Column 1 lists the designation name proposed for the stellar system. Columns 2 and 3 give the equatorial coordinate for Equinox 2000. Columns 4-7 list the V magnitudes and spectral types for the two stellar components. Column 8 shows the mean angular separation (in arcsec). Column 9 and 10 show the differential distance module (Δ(V-Mv) = $(V\text{-}Mv)_B$ – $(V\text{-}Mv)_A$) and the expected semimajor axis (in AU). The next columns list the relative motion (in arcsec yr^{-1}), the sum of the masses and the orbital period.

Twenty-five binaries are composed of two subdwarfs and three binaries are composed of two white dwarfs (CBL 304, 1233+0824, FMR 154).

Twenty-six binaries are composed of a dwarf and a subdwarf. This configuration is not possible and could be caused by several reasons (poor quality of the infrared or optical photometric data, luminosity class determined erroneously, etc.). Others binaries have stars near the limits for dwarf-subdwarf in the reduced proper motion diagrams and a different luminosity class could be assigned if small changes in the photometric data are applied, especially in the V magnitudes.

Of these dwarf-subdwarf pairs, there are six binaries that have difference in proper motions, $\Delta\mu = \mu_B - \mu_A$, greater than 50 mas yr^{-1}. These pairs of stars likely are optical pairs.

One evidence for binarity is that the two stellar components be at the same distance. My analysis of the values for secondary minus primary distance module determined that 12 pair of stars have $|\Delta(V\text{-}Mv)| > 2.0$. Four of these 12 pairs have $\Delta\mu > 50$ mas yr^{-1} and therefore surely are optical pairs. For the other cases, some of the causes of this situation are:

- V magnitude with large errors: many of the V magnitudes determined in this work were inferred from photographic catalogs so errors of ±0.5 magnitude could be possible. The optical-infrared color used here to the distance estimation then could have important errors in some of these pairs.
- The color-luminosity relation used could fail for stars with extreme metallicity.
- The determination of the distance for uncataloged variable stars is difficult.
- Close binary star not cataloged can cause erroneous distance estimation.

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

(Continued from page 297)

- Erroneous luminosity class determination can cause a significant error in distance.

9.4.1 Serendipitous discovery of a new common proper motion binary

During the course of this investigation and the editing of this article, the author found a new binary star with high common proper motion. In the same field of view for FMR 36 there is an uncataloged common proper motion pair which stellar members are listed in SIMBAD database. The primary component is located at 00h 53m 02.94s and +31º 43' 54.8" and the secondary component at 00h 53m 08.19s and +31º 44' 50.1". From the astrometric data of 2MASS a value of θ = 50.54 deg and ρ = 86.85" for 1997.917 was obtained.

9.4.2 Loosely-Bound Common proper motion binaries

Figure 11 shows the physical separation (s) distribution for the 220 binary stars. Of the 220 binaries, about 70 of them have projected separation, *s*, greater than 5,000 AU and 3 binaries have *s* > 40,000 AU. In the astronomical literature many works conclude in the real existence of a cutoff at *s* ~ 20,000 AU (~0.1 pc) in projected physical separation of binaries. But recent works found multiple systems in the solar neighborhood with *s* > 20,000 AU (e.g. J. Caballero (2009), J. Caballero (2010)). In the sample studied here, 13 binary systems have *s* > 20,000 AU.

The very wide, low-mass binaries are an important and a rare class of objects. Four binaries with Ma + Mb < 0.4 solar masses and *s* > 5,000 AU (FMR 82, FMR 83, FMR 84, 2343+1345) were found in this work. Their values of *s* range from 7,799 to 10,233 AU.

Appendix I: Notes for Stellar Components

FMR 36 B: V = 15.02; B - V = +1.55 ± 0.02 (Humphreys el at. 1991).

FMR 38 A: Ammons et al. (2006) calculated a photometric distance of 49 +34/-18 pc.

FMR 42 A: It is listed in the WDS catalog as the double star WDS 01158+4702 = LAW 9 (250º and 0.3" in 2005). Law et al. (2008) classified the stellar components as M4.5 and M5.0 stars at a distance of 18.7 +9.3/-3.6 pc. Reid, Cruz & Allen (2007) estimated a distance of 23.3 pc. The spectral types and distances from the literature are in good agreement with my data. ROSAT satellite detected an X-ray emission in 1991. The X-ray luminosity calculated in this work (Log Lx = 28.17 erg s^{-1}) corresponds to an age of about 1 Gyr which is in agreement with the small tangential velocity (18-28 km s^{-1}).

FMR 58 B: Luyten (1970-77) classified it as a candidate white dwarf. It is a red dwarf of M4V spectral type.

0550+0939 B: The ROSAT satellite detected in 1990 the X-ray source 1RXS J055009.7+093957 at 18" West to 0550+0939 B. Haakonsen & Rutledge (2009) calculated a probability of unique association of 49.7% and a probability of no association of 33.6%. The X-ray luminosity calculated in this work (Log Lx = 28.53 erg s^{-1}) corresponds to an age of about 1 Gyr.

0705+4129 B: Weis (1987) determined V = 14.07, V - R = +0.89 and R - I = +0.67

0802+0019 A: Weis (1987) determined V = 13.41, V - R = +0.94, R - I = +0.64 and a photometric parallax π = 0.011" (91 pc) in good agreement with my data.

FMR 81 B: Kilic (2006) classified it as a DA white dwarf with T_{eff} = 6388 ºK, M_{bol} = 13.79, M_{abs} (g) = 14.16, photometric distance = 42.91 pc and a V_{tan} = 48.37 km s^{-1}.

FMR 85 B: It is listed in *Luyten's White Dwarf Catalogues* (Luyten 1977). Koester et al. (2011) classified it as a cool and very metal-rich DZ white dwarf.

CBL 304 A: Kilic et al. (2006) classified it as a DA white dwarf with the followed astrophysical data: T_{eff} = 4964 ºK, M_{bol} = 14.90, M_{abs}(g) = 15.60, photometric distance = 42.00 pc, Vtan = 29.29 km s^{-1}.

FMR 90 B: This stellar component could be a common proper motion companion to 2MASS J10172692+2613343. Using 2MASS catalog the 2MASS star is located at 313.94" in direction 124.41 deg (1998.150).

FMR 94 A: It is listed in the WDS catalog as WDS 10454+1814 = TDS 7454 (245 deg and 0.4" in 1991).

FMR 96: The primary and the secondary components are listed in The Hamburg/RASS Catalogue of optical identifications. V3.0 (Zickgraf et al. 2003). ROSAT satellite detected the X-

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

ray source 1RXS J104658.7+243718. The X-ray luminosity calculated in this work (Log Lx = 29.44 erg s^{-1}) corresponds to an age of about 0.2-0.3 Gyr. The X-ray activity is similar to those stars of the Pleiades.

BVD 216 A: Weis (1987) determined V = 13.97, V - R = 1.02, R - I = 0.81 and a photometric parallax of 0.013". ROSAT detected an X-ray source at 1" of the primary star. The X-ray luminosity calculated in this work (Log Lx = 29.09 erg s^{-1}) corresponds to an age between the Pleiades and Hyades open clusters, of about 0.3 Gyr.

1206+1218 A: Marshall (2007) obtained V = 13.233, B - V = 0.521 and V - I = 0.694.

FMR 103 B: The catalog "*SDSS-DR5 low-mass star spectroscopic sample*" (West et al. 2008) lists a spectral type of M4V, a radial velocity of -53.4 km s^{-1}, photometric distance of 144 pc and a galactocentric velocity (U,V,W) = (-59.5, -110.8, -47.9) km s^{-1}. These data are in very good agreement with my data.

CBL 390: The primary or the secondary component is listed in the catalog *Variability in the ROSAT All-Sky Survey* (Fuhrmeister & Schmitt 2003)). ROSAT satellite detected the X-ray source at 10-11" from the secondary component and a 21.5" from the primary component. The positional error for the X-ray source is of 10". Most of optical counterparts of X-ray sources are located at an angular distance less than 2 times the positional error of the ROSAT catalog (Agüeros et al. 2009). At 40" from the X-ray source is only found the primary and secondary component of CBL 390. Numerous studies have shown that there is a typical range of X-ray-to-optical flux ratios for each stellar type. According with the Table 1 in Agüeros et al. (2009) for M stars the mean log f_X/f_J = -3.30 with a 2σ interval of $-2.22 \leq \log f_X/f_J \leq -1.15$. For CBL 390 A and B, Log f_X/f_J is -1.78 and -1.01. The secondary is out of the most probable range for Log f_X/f_J. The same result is obtained if we use the Log fx/fv. Therefore, the conclusion is that the X-ray optical counterpart is the primary component of CBL 390. The X-ray luminosity calculated in this work (Log Lx = 29.24 erg s^{-1}) corresponds to an age of about 0.2-0.3 Gyr.

FMR 109 B: ROSAT satellite detected an X-ray source near this star but there are many galaxies in the field that could be the optical counterpart.

FMR 111 A: Weis (1987) determined V = 14.66, V - R = +1.11, R - I = +0.92.

FMR 121 A: Weis (1987) determined V =13.30, V - R = +0.32, and R - I = +0.30. This star has a bluer H - K color that corresponds to a dwarf star.

FMR 123 A: Reid (2004) classified it as a M3.5V.

FMR 128: It is the UV Cet variable star V 781 Her. The ROSAT satellite detected an X-ray source at 1" of the primary component. The positional error is 22" and at twice this positional error there are four stars, the two stellar component of FMR 128 and two very weak stars. What is the optical counterpart of the X-ray source? Analyzing the Log fx/fv and Log f_X/f_J values, the two weak stars were rejected and retained the two stellar components of FMR 128. The primary component is more probable to be the optical counterpart of the X-ray source. The X-ray luminosity calculated in this work (Log Lx = 28.85 erg s^{-1}) corresponds to an age slightly younger than the Hyades, of about 0.4 Gyr. Riaz, Gizis & Harvin (2006) classified the primary component as a M3V star at a distance of 77 pc and with a tangential velocity of 108 km s^{-1}.

FMR 133 A: *The TASS Mark IV Patches Photometric Catalog* (Droege, Richmond & Sallman (2006)) lists photometric data (V = 13.83 ± 0.09 and I = 12.46 ± 0.10).

FMR 141 A: *The TASS Mark IV Patches Photometric Catalog* (Droege, Richmond & Sallman (2006)) lists photometric data (V = 11.45 ± 0.05 and I = 9.92 ± 0.04).

FMR 144 A: Reid, Hawley & Gizis (1995) determined a radial velocity of -32 ± 10 km s^{-1} while Gizis, Reid & Hawley (2002) determined Vrad = -24.3 ± 1.5 km s^{-1}. The *TASS Mark IV Patches Photometric Catalog* (Droege, Richmond & Sallman (2006)) lists photometric data: V = 11.48 ± 0.07 and I = 9.19 ± 0.04.

FMR 144 B: This star is listed in the *Kepler Input Catalog* with the followed data: Teff = 3713 ºK, log g = 4.385 cm/s2, [Fe/H] = +0.528, E(B-V) = 0.009 and a radii = 0.78 Rsun. The *TASS Mark IV Patches Photometric Catalog* (Droege, Richmond & Sallman (2006)) lists

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

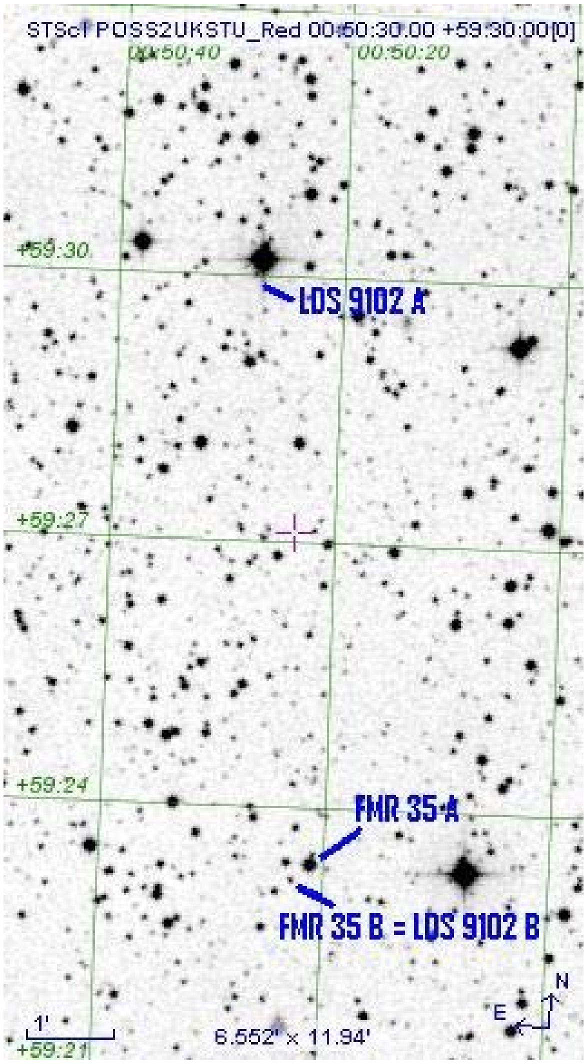


Figure 12. The stellar component FMR 34 B = LDS 9102 B.

photometric data: V = 12.44 ± 0.12 and I = 10.08 ± 0.04.

FMR 145: Lépine, Rich & Shara (2003) determined a radial velocity, Vrad, of -80 ± 40 km s^{-1} a photometric distance, d, of 200 ± 110 pc and a galactocentric velocity of (U,V,W) = (404 ± 239, -314 ± 142, 48 ± 29) km s^{-1} for the primary component of this binary. For the secondary star they obtained Vrad = -120 ± 40 km s^{-1}, d = 160 ± 100 pc, (U, V, W) = (300 ± 218, -277 ± 116, -109 ± 62). They note the high space velocity for the members of FMR 145. The distance of 209 pc presented here for the secondary star is in good agreement with the distance of Lépine, Rich & Shara (2003), about 160 and 200 pc for the primary and secondary components. The tangential velocity for this binary is one of the largest of my sample.

FMR 147 A: Lee (1984) classified this star as a K2 star and Ammons et al. (2006) determined a distance of 15 ± 6 pc. *The Mark IV Patches Photometric Catalog* (Droege, Richmond & Sallman (2006)) lists photometric data: V = 11.12 ± 0.04 and I = 10.20 ± 0.04.

FMR 154 A: It was classified as a white dwarf by Reid (2003) in agreement with our result. Lépine, Rich & Shara (2003) classified it as a DA9 white dwarf at a distance of 30 ± 15 pc and with a galactocentric velocity (U, V, W) = (89 ± 39, -14 ± 9, 36 ± 14) km s^{-1}.

FMR 154 B: It was classified as a white dwarf by Reid (2003) in agreement with my result. Lépine, Rich & Shara (2003) classified it as a DA10 white dwarf at a distance of 60 ± 30 pc and with a galactocentric velocity (U, V, W) = (168 ± 79, -33 ± 19, 66 ± 29) km s^{-1}.

FMR 156 B: The *TASS Mark IV Patches Photometric Catalog* (Droege, Richmond & Sallman (2006)) lists photometric data: V = 12.15 ± 0.11 and I = 10.67 ± 0.05. The TASS catalog lists a Welch-Stetson (Welch & Stetson 1993, hereafter WS) of 2.58. The WS index is a normalized measure of the degree of correlation of V-band and I-band variations from their mean values. The variability index will be close to zero for stars with random variations which are independent in each passband, or stars which vary by less than the uncertainty of each measurement. It will be a large (greater than 2 or 3) positive value for stars which really do change significantly in brightness. Nothing is listed in *The International Variable Star Index (VSX)* so FMR 185 B could be an uncatalogued variable star.

2106+5924 B: Humphreys et al. (1991) determined V = 15.31 ± 0.03 and B - V = +1.51 ± 0.04.

FMR 164 A: Ryan (1989) determined photometric data (V = 10.68, B - V = 0.85, U - B = 0.51, V - I = 0.94) and a photometric distance of 81 pc. His reddening E(B-V) = 0.01 is in good agreement with my result (E(B-V = 0.03). At a 5 arc minutes north, a star (2MASS J21504703+1248415) listed in SIMBAD

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

seems to show similar proper motion that FMR 195 A. Using the 2MASS catalog in this work a value of θ = 349.31 deg, ρ = 325.65" (1997.687) was obtained.

FMR 169 A: The astronomical literature lists spectral types of G8III, G7II-III, G7III-IV and G5IV and radial velocities that ranges from -36.7 to -34.1 km s^{-1}. The secondary component must be a subgiant star at the same distance of the primary component.

Appendix II: Notes for Binaries

FMR 76, FMR 78, FMR 84, FMR 90, FMR 98: incompatible proper motions? Optical pairs?

FMR 34: The primary component of FMR 34 is LDS 9102 B (= WDS 00505+5930 B) and the secondary component of FMR 34 is a new physical component for the system WDS 00505+5930. LDS 9102 A is at 6.7 arcminutes North (AR = 00h 50m 27.49s and DEC = +59º 30' 08.4") to FMR 34 B. This star is listed in the *LSPM-North Catalog* as LSPM J0050+5930. Why was not the common proper motion to FMR 34 detected? The angular separation is wider that our cut of 360" so more ultrawide binaries could exist in the *LSPM-North Catalog*. See Figure 12.

References

Adelman-McCarthy J. K. *et al.* 2009, ApJS, 182, 543

Agudo A., 2012, OED, 9, 24

Agüeros M. A. et al., 2009, ApJS, 181, 444

Alknis A., 1958, TrRig, 7, 33

Allen C., & Santillan, A. 1991, RMxAA, 22, 255

Ammons S.M., Robinson S.E., Strader J., Laughlin G., Fischer D., Wolf A., 2006, ApJ, 638, 1004

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

Benavides R., 2012, OED, 9, 42

Caballero J. A., 2009, A&A, 507, 251

Caballero J. A., 2010, A&A, 514, 98

Caballero R., 2009, JDSO, 5, 156

Caballero R., 2010a, JDSO, 6, 97

Caballero R., 2010b, JDSO, 6, 160

Caballero R., 2012, JDSO, 8, 58

Caballero R., Collado B., Pozuelo S., Fernández A., 2010, JDSO, 6, 206

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

CMC, 2006, Copenhagen University Obs., Institute of Astronomy, Cambridge, UK,Real Instituto y Observatorio de la Armada en San Fernando

Delfosse X. et al., 2000, A&A, 364, 217

Droege T. F., Richmond, M. W., Sallman, M., 2006, PASP, 118, 1666

ESA SP-1200, ESA Noordwijk, 1997, catalogs HIPPARCOS and TYCHO

Fuhrmeister B., Schmitt J. H. M. M., 2003, A&A, 403, 247

Gizis J. E., Reid I. N., Hawley S. L., 2002, AJ, 123, 3356

González J. L., 2012, OED, 9, 33

Haakonsen C. B., Rutledge R. E., 2009, ApJS, 184, 138

Henry T. J. & McCarthy, 1993, AJ, 106, 773

Hog E. et al., 2000, AJ, 335, 27

Houk N., Swift C. <Department of Astronomy, University of Michigan, Ann Arbor Michigan (1999)>

Humphreys R. M., Landau R., Ghigo F. D., Zumach W., Labonte A. E., 1991, AJ, 102, 395

Jones E. M., 1972, ApJ, 173, 671

Kilic M. et al., 2006, AJ, 131, 582

Kirkpatrick J. D. & McCarthy D. W. Jr, 1994, AJ, 107, 333

Koester D., Girven J., Gänsicke B. T., and Dufour P., 2011, A&A, 530, 114

Law N. M., Hodgkin S. T. and Mackay C. D., 2008, MNRAS, 384, 150

Lee S. G., 1984, AJ, 89, 702

Legget S. K., 1992, ApJSS, 82, 351-394

Leonard P. J. T. & Tremaine, S. 1990, ApJ, 353, 486

Lépine S., Rich R. M., Shara M. M., 2003, AJ, 125, 1598

145 New Wide Common Proper Motion Binaries in the LSPM-North Catalog

Lépine S., Shara M. M., 2005, AJ, 129, 1483

Miret X., Tobal T., 2009, DSSC, 17, 67

Miret X., Tobal T., 2010, DSSC, 18, 56

Miret X., Tobal T., Bernal A., Bernal M., Novalbos I., Santos J. A., Miret ., DSSC, 2011, 19, 55.

Nelson C. A., Cook K. H., Axelrod T. S., Mould J. R., Alcock C., 2002, ApJ, 573, 644

Weis E. W., 1987, AJ, 93, 451

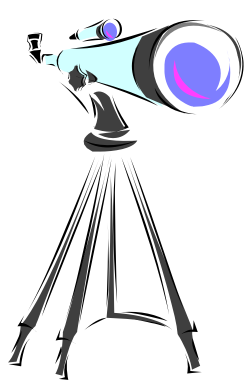
Welch D.L., and Stetson P., 1993, AJ 105, 1813

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

West A. A., Hawley S. L., Bochanski J. J., Covey K. R., Reid I. N., Dhital S., Hilton E. J., Masuda M., 2008, AJ, 135, 785

Zacharias N. et al., 2010, AJ, 139, 2184

Zickgraf F.-J., Engels D., Hagen H.-J., Reimers D., Voges W., 2003, A&A, 406, 535



Ludwig Schupmann Observatory Measures for the Year 2011

James A. Daley

Ludwig Schupmann Observatory
New Ipswich, NH

Abstract: Thirty-one CCD measures, of which twenty-one are large Δm pairs, are reported. Doubles of the greatest observational difficulty include Sirius AB (of course) and the highly neglected binary, o UMa (BU 1067AB). This last pair shows direct pa motion of about 5° with little change in separation since its discovery in 1889. Other large Δm objects presented challenges as well, and, as in the above mentioned pairs, often required special shaped-pupil masks (in combination with a stellar coronagraph) to removed diffracted light from the region in the pairs' position angle.

1. The Measures

The measures are presented in Table 1 in the conventional manner. From left to right: discoverer's designation, WDS identifier (Epoch 2000 RA&Dec), WDS magnitudes, LSO (Ludwig Schupmann Observatory) position angle in degrees, LSO separation in seconds of arc, decimal date of observation, number of nights the objects was observed and finally a column of brief notes and indicated numbered notes detailing objects of special interest.

Astrometry of the large Δm pairs employed a homemade stellar coronograph (Daley 2007). The telescope employed is a 9-inch Schupmann medial refractor which (in coronograph mode) operates with an effective focal length (EFL) of 164 inches. Measurements of "normal" doubles were made with the coronograph removed and the telescope EFL increased to 286 inches with a Barlow lens. An ST7 CCD camera was used for all measures.

2. Detailed Notes

1. H 6 39 - Components "B" & "C" have only the discovery measure of 1891, so this is a confusing observation. They are both trailing-off almost perfectly parallel to the proper motion vector of the primary with equal position shifts, so are clearly optical.

Component "D" is rather more interesting, as it is showing a large motion since the last measure of 1912. The path is angled widely (53°) to the proper motion direction of Betelgeuse itself and, when plotted with the first measure, appears slightly concave to the primary suggesting orbital motion. To confirm this will take some years but worth keeping up with!

The very wide component "E" shows a continuing, almost exact, southerly relative motion since discovery. LSO's measure confirms this drift when compared with a year 2000 result.

2. BU 690 - The primary star, μ Cephei, is one of the most extreme stars known with indications that its "surface" would reach almost to Jupiter if it were to replace the Sun. As with the H 6 39 objects above, the two faint Burnham components were measured using LSO's stellar coronagraph. The LSO measure of "B" shows little relative motion with about 1° of direct PA change since 1946. Component "C" may be a background star, as a small PA correction in the 1924 measure brings it in line with a trailed-off direction due to the primary's proper motion. Brightness-wise, component "C" was found to be rather faint, consistent with the WDS listed magnitude.

Component "B" is listed as 0.5 magnitudes brighter than "C". However, a direct comparison

(Continued on page 305)

Ludwig Schupmann Observatory Measures for the Year 2011

Table 1: LSO Measurements of Double Stars

Discoverer	RA+DEC	Mags	PA	Sep	Date	n	Brief Note
STF 180AB	01535+1918	4.52, 4.58	0.6	7.44	2011.981	1	γ Ari
BUP 64	04363-0321	3.93, 13.3	171.3	51.48	2011.082	1	ν Eri
BUP 66AB	04382+1231	4.3, 13.3	314.2	52.24	2011.082	1	90 Tau
BUP 66AC	04382+1231	4.3, 10.4	309.3	123.14	2011.082	1	
STT 560AB	04498+0658	3.22, 11.31	169.2	73.70	2011.079	1	π3 Ori
DAL 50AC	04498+0658	3.22, 13.1	3.3	22.17	2011.079	1	
STF 14AC	05320-0018	2.41, 6.83	0.2	52.25	2011.216	1	δ Ori
STF 738AB	05351+0956	3.51, 7.45	44.2	4.42	2011.222	1	λ Ori
STF 738AD	05351+0956	3.51, 9.63	271.6	77.50	2011.222	1	
BUP 81	05362-0112	1.7, 10.7	57.6	179.34	2011.085	1	ϱ Ori
STF 774AB	05407-0157	1.88, 3.70	164.1	2.34	2011.216	1	ζ Ori
H 6 39AB	05552+0724	0.9, 14.5	113.3	37.99	2011.115	1	Betelgeuse
H 6 39AC	05552+0724	0.9, 14.2	287.5	64.21	2011.115	1	
H 6 39AD	05552+0724	0.9, 13.5	345.0	71.16	2011.115	1	Note 1
H 6 39AE	05552+0724	0.9, 11.0	154.4	175.81	2011.109	1	
H 6 88AB	05595+4457	1.90, 10.86	155.1	13.38	2011.148	1	β Aur
BAR 29AC	05595+4457	1.90, 14.1	41.7	187.16	2011.148	1	
AGC 1AB	06451-1643	-1.46, 8.5	88.0	9.27	2011.183	1	Sirius
HL 3AE	06451-1643	-1.46, 14.5	47.0	188.32	2011.214	1	
BU 1411AF	06451-1643	-1.46, 13.8	60.8	125.71	2011.214	1	
DIC 1AD	07393+0514	0.46, 12.0	323.7	116.26	2011.244	1	Procyon
BU 1067AB	08303+6043	3.44, 15.3	195.8	7.12	2011.271	1	o UMa
HJ 2733AB	14275+7542	4.3, 13.4	128.3	23.87	2011.362	1	5 UMi
HJ 2733AC	14275+7542	4.3, 9.9	132.3	59.33	2011.362	1	
BU 616AB	14321+3818	3.0, 12.7	121.4	50.55	2011.364	1	γ Boo
STF2758AB	21069+3845	5.35, 6.10	151.7	31.33	2011.847	1	61 Cyg
BU 690 AB	21435+5847	4.2, 12.3	263.3	19.44	2011.836	1	μ Cep
BU 690 AC	21435+5847	4.2, 12.7	297.5	41.89	2011.836	1	Note 2
DAL 21	22343+5716	12.9, 13.8	306.9	7.26	2011.890	1	
STI 2826	22345+5717	12.6, 13.0	353.4	7.82	2011.890	1	
HJ 301 AB	22467+1210	4.2, 12.4	94.7	10.97	2011.882	1	ξ Peg

Ludwig Schupmann Observatory Measures for the Year 2011

(Continued from page 303)

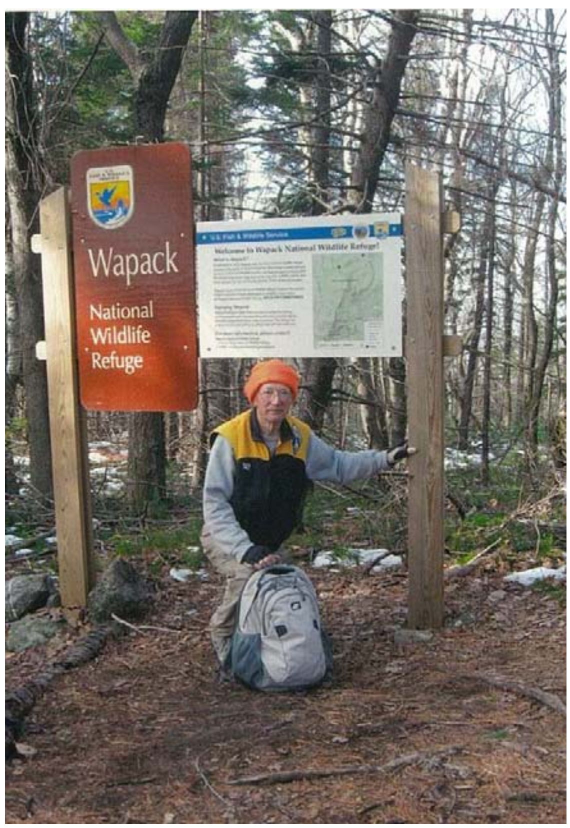
(unfiltered CCD) was performed which showed "B" to be 1.46 magnitudes brighter than "C" (4-plate average). In this unfiltered coronagraph mode the photometric response approximates R-band. Is "B" an orange or red star, thus accounting for the large instrumental magnitude difference?

To answer this a couple of nights were devoted to photometric measures of component "B" with standard VRI-bands in the long FL mode where these filters are available. To provide a zone free of diffracted light for "B", a shaped-pupil aperture mask was employed (Slepian 1965). This form of aperture provides two very dark, oppositely disposed, sectors close to the saturated primary, thus leaving "B" in the clear. I have found this type entrance pupil mask useful in large Δm work. Results of the photometric work are as follows: V − R = 0.65, R − I = 0.61. A V-band magnitude yielded 12.2. This is very close to Burnham's visual estimate. These photometric measures are made under non-optimum s/n values with few useful plates for a particular color, thus no error estimate can be provided. Taken at face value, I estimate that "B" is a K2II giant and possibly a physical companion to μ Cephei. To confirm this may take the work of a professional observatory; however, I will give the object more attention as time permits.

References

Daley, J.A. 2007, JDSO 3, 159

Slepian, D. JSOA 55(9); 1110-1116, 1965 (for practical details see http://www.orfe.Princeton.edu/~rvdb/tex/tpf/ApJOptimal.pdf)



Jim goes hiking in the Wapack National Wildlife Refuge in New Hampshire.

Jim's health, due to chemotherapy treatment of his non-Hodgkin's Lymphoma, is improving slowly and he has been running and hiking some.

This manuscript was mailed to the USNO and transcribed by Brian Mason who added this "about the author" portion and who, along with our many readers, wishes Jim a speedy and complete recovery.

A Possible New Star: Evidence of a Quaternary Star added to a Tertiary Star System May Have Been Found During the (336) Lacadiera Occultation of 3UC197-115376

Abstract: An occultation of 3UC197-115376 by the asteroid (336) Lacadiera on 2009 April 16 shows evidence of a possible new (quaternary) component of a previously known tertiary star. The new star has a separation of 7.5 (± 0.9) milliarcseconds (mas) and position angle (pa) of 124.9 (± 6.3) degrees.

Tony George, Umatilla, OR, USA , IOTA, triastro@oregontrail.net
Brad Timerson, Newark, NY USA, IOTA North American Coordinator
Scott Degenhardt, Santa Fe, NM USA
International Occultation Timing Association (IOTA)
Carl Bracken, Cedar Rapids, IA USA
Robert Cadmus, Grinnell, IA USA
Al Carcich, Wantage NJ USA
John Centala, Marion, IA USA
Robert Modic, Richmond Hts., OH USA
Doug Slauson, Swisher, IA USA

Observation

On 2009 April 16, six independent IOTA astronomers (Bracken, Cadmus, Carcich, Centala, Modic, and Slauson) observed the asteroid (336) Lacadiera occult the star 3UC197-115376 from six different locations in the USA. See Table 1 and predicted path map Figure 1.

The UCAC3 Catalog was used to identify the stars in this paper as all three stars in the known tertiary star system were already cataloged in UCAC3. The target star 3UC197-115376 is magnitude 10.218 (V). There is a nearby 10.457 (V) secondary (3UC 115373) and a closer 12.187 (V) magnitude tertiary (3UC197-115375). The expected magnitude drop at occultation was 3.5 magnitudes based on 3UC197-115376. This star, also identified as TYC 0819-00852-1U, is listed in the Fourth Interferometric Catalog and the Washington Double Star catalog as a triple star system as shown in Table 2.

The light curves obtained by the observers are shown in Figures 2A, 2B, 2C, 2D, 2E and 2F. In some but not all of the light curves a step decrease in brightness is visible in the disappearance part of the light curve. A corresponding step near the top of the reappearance part of the light curve is not readily apparent in any of the light curves due to the low signal-to-noise ratio in the data. Figure 2A is the most definitive evidence of the step event.

(Continued on page 310)

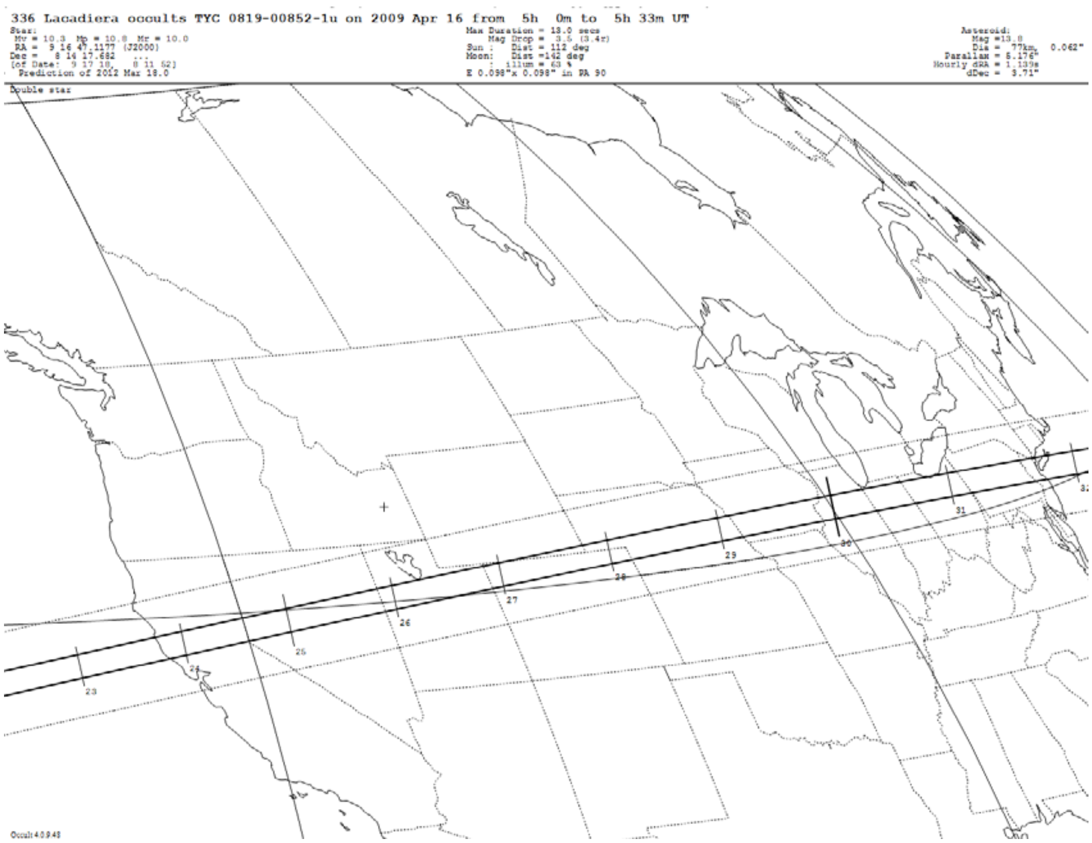


Figure 1. April 16, 2009 Lacadiera occultation of 3UC197-115375 Predicted Path Map

Table 1. Observers of the Occultation.

Observer	Location	Telescope Type	Telescope Diam (cm)	Observing Method
C. Bracken	EIOLC, Cedar Rapids, IA	Schmidt-Cassegrain	40	Video+GPS
R. Cadmus	Grinnell College, IA	Cassegrain	61	Photoelectric+radio
A. Carcich	Slate Hill, NY	Schmidt-Cassegrain	20	Video + audio signal
J. Centala	Marion, IA	Refractor	13	CCD Drift Scan
R. Modic	Richmond Hts., OH	Newtonian	20	Video+GPS
D. Slauson	Swisher, IA	Schmidt-Cassegrain	24	Video + audio signal

Table 2: WDS Entry of the Observed System

```
    Interferometric catalogue entries
       Date       PA            Sep                 M1           M2
     1991.50     208.5     .     23.581      .       10.34    .     10.60    .       530 100   1.4   1  TYC2000b Tty


    WDS entries

      RA  Dec Name          Y1   Y2     N  PA  PA   Sep   Sep  M1    M2
    09168+0814HJ  808AB    1880 2006   18 228 206  21.6  24.2 10.34 10.60 K         -009+001 +032-061 +08 2195   D
091647.12+081417.6
    09168+0814BRT2147AC    1897 2000    3 202 200   4.9   5.5 10.34 13.2  K         -009+001                     D
091647.12+081417.6
```

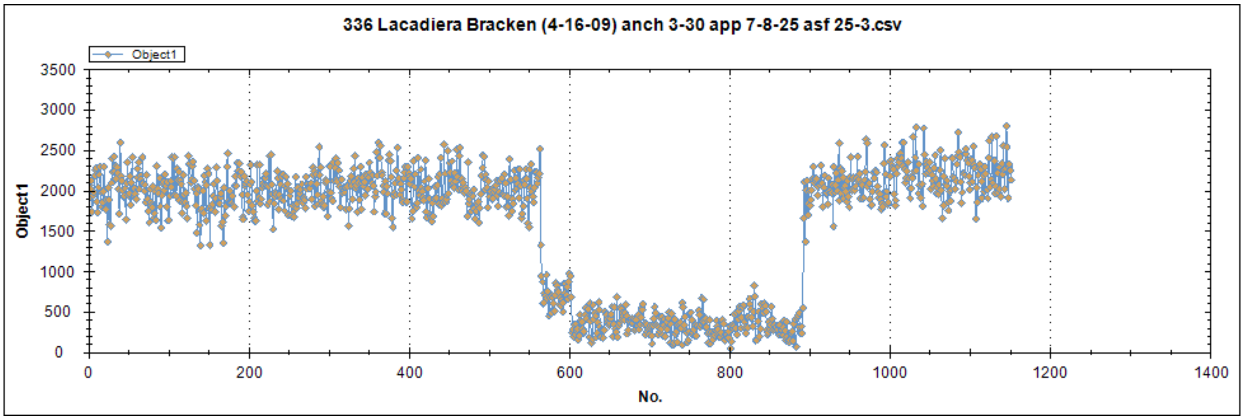


Figure 2A: Carl Bracken

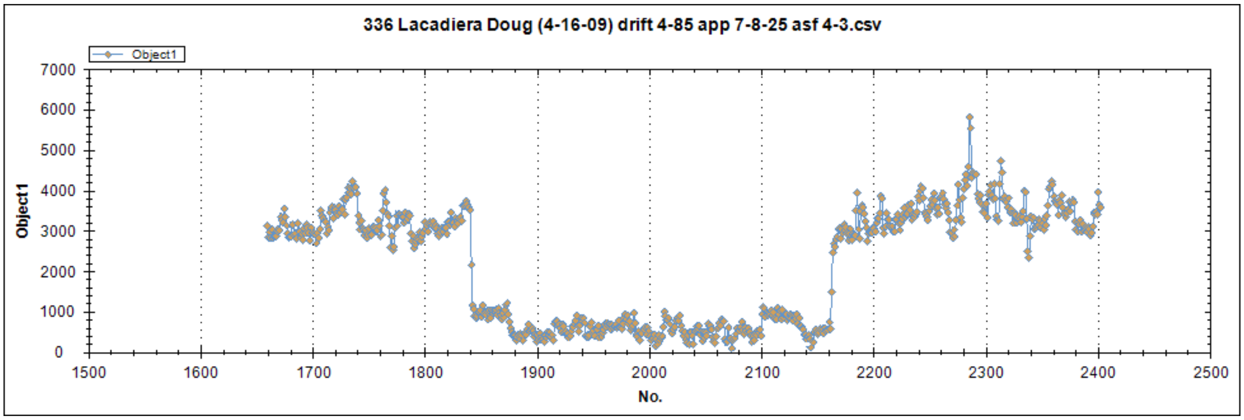


Figure 2B: Doug Slauson

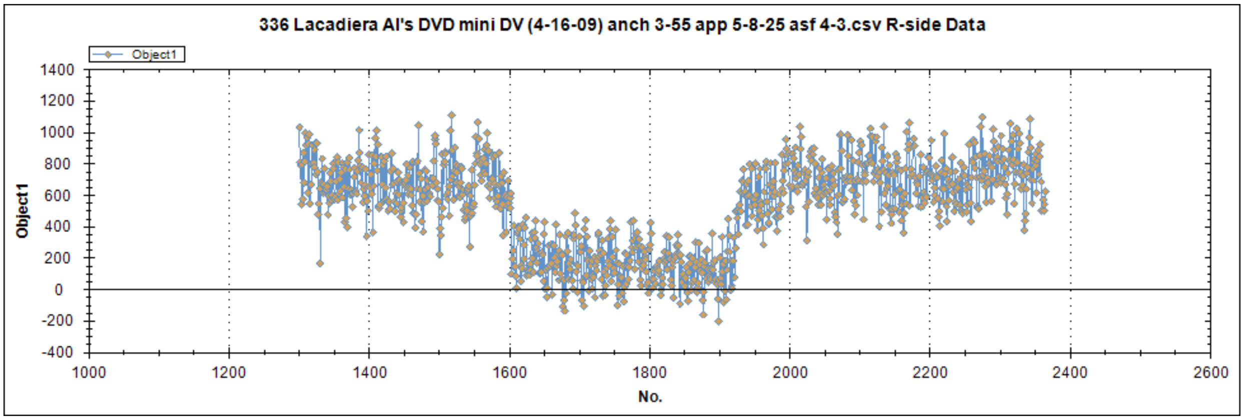


Figure 2C: Al Carcich

A Possible New Star: Evidence of a Quaternary Star ...

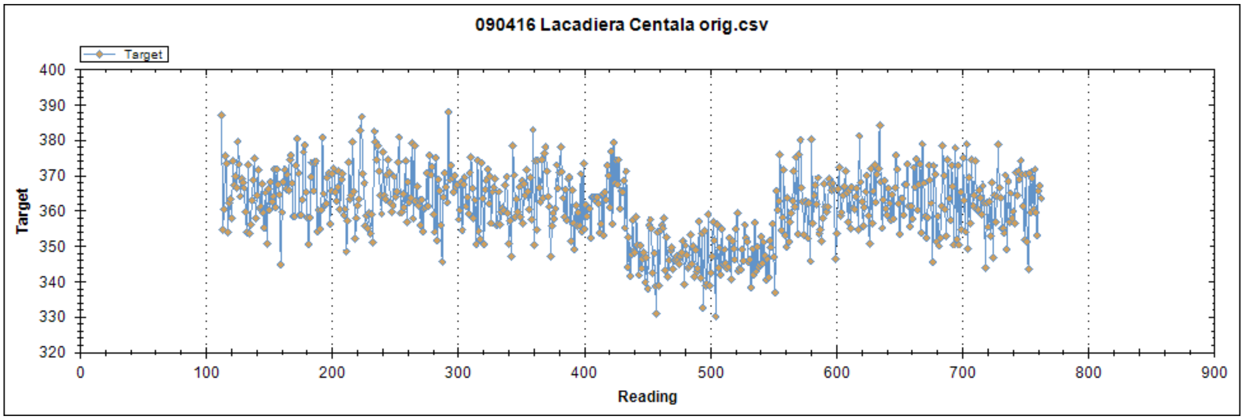


Figure 2D: John Centala

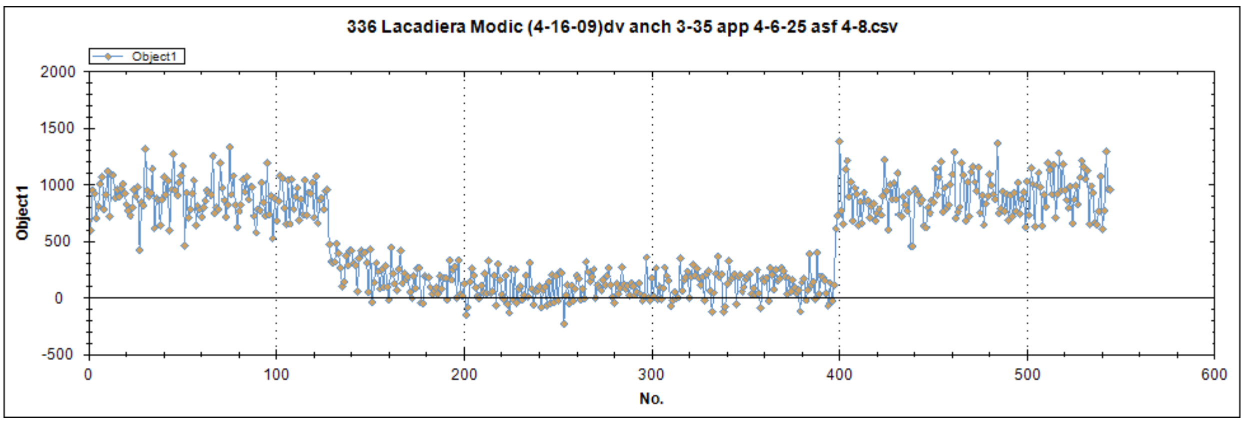


Figure 2E: Robert Modic

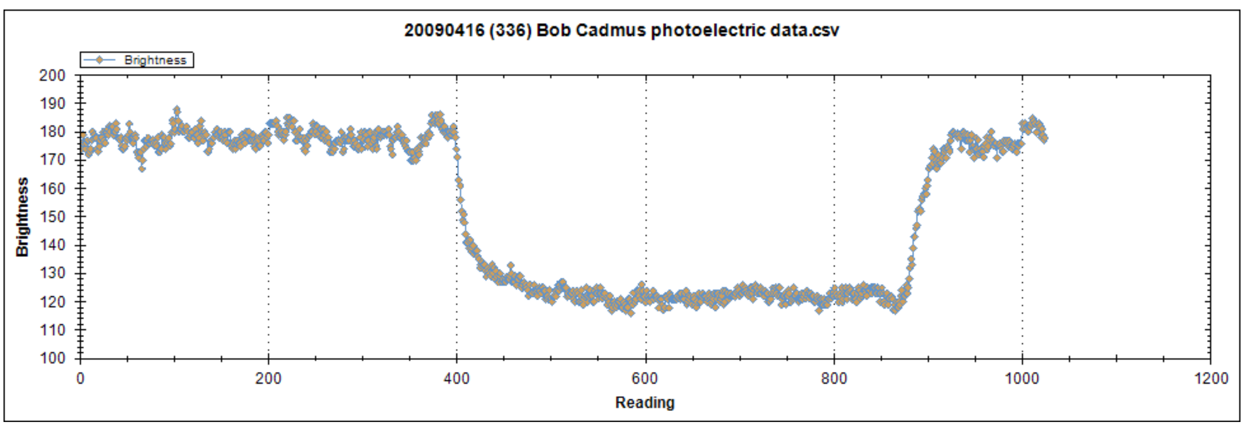


Figure 2F: Robert Cadmus

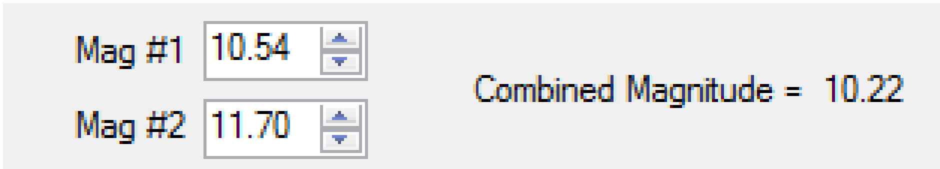


Figure 3: Documentation of calculated component magnitudes (from Occult4).

Table 3 – Double Star Idenfication and Properties

Star	3UC197-115375 UCAC2 34650672 TYC 0819-00852-1U Nomad 0982-0010277 PPMXL 4051009846414370790 PPMX 091647.1+081417
Coordinates (J2000)	09:16:47.12 +08:14:17.7
Mag A	10.218 (V) 3UC 10.54 (V) from occ. obs
Mag B	11.7 +/- 0.1 (V)
Separation	7.5 mas ±0.9 mas
Position Angle	124.9° ± 6.3°
Epoch	2009.288

(Continued from page 306)

Timing of the event disappearance and reappearance was obtained through either:

1. GPS time inserted in each frame,
2. GPS time inserted at the start and end of video and then inserted by frame based on frame count
3. WWV or WWVB time recording/ simultaneous video recording with frame times interpolated from WWV or WWVB time tones.

A detailed discussion of these timing techniques is given in Nugent [1].

The observations from all six chords were analysed in the standard manner described by Herald [2]. Assuming the asteroid had an elliptical profile, the double star characteristics are shown in Table 3.

The magnitude for each component was determined separately. See Figure 3 for documentation of the primary and quaternary component magnitudes. The magnitudes of the two stars are estimated to be 10.54 (V) and 11.7 (V).

The pair might be detectable through interferometry. Due to the uncertainty of the quaternary star, further interferometric analysis is recommended. The solution for the double star is shown in Figures 3 and 4. The solution for the entire quaternary system is summarized in Figure 5.

Acknowledgements:

The authors would like to acknowledge Dave Herald, Murrumbateman, Australia for his help in resolving the component profile issues and establishing disappearance and reappearance weighting factor for each chord used in the profile plot. We would also like to thank David W. Dunham, Greenbelt, MD USA for his review comments.

This research has made use of VizieR and Aladin.

(Continued on page 312)

A Possible New Star: Evidence of a Quaternary Star ...

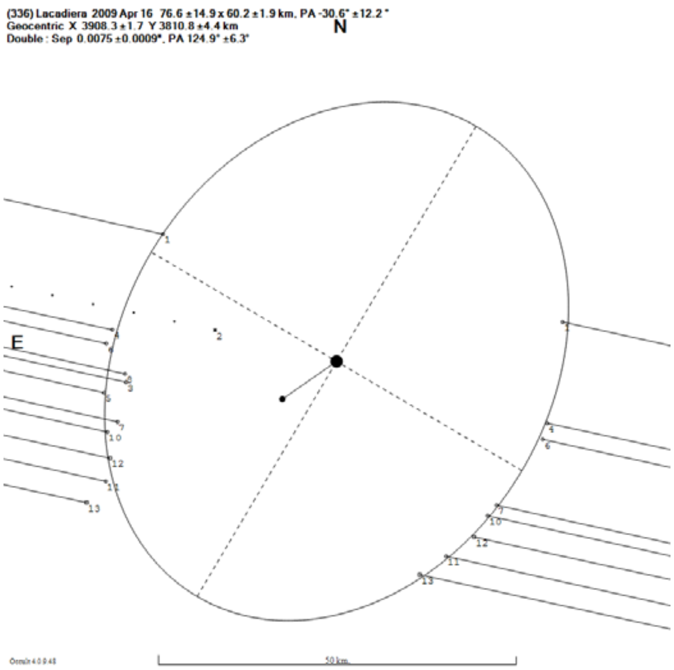


Figure 4A: Asteroid profile plot – primary and secondary stars aligned

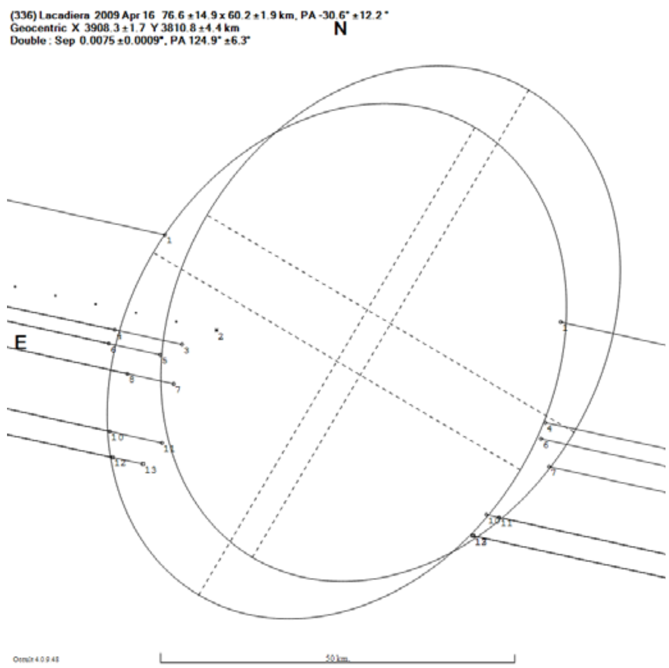


Figure 4B: Asteroid profile plot – primary and secondary stars separate

Key to Observer Chord Numbers

1 J Centala,Marion, IA
2(P) Predicted Centerline w/Time
3 A Carcich,Slate Hill, NY
4 A Carcich,Slate Hill, NY
5 C Bracken, EIOLC., IA
6 C Bracken, EIOLC., IA
7 D Slauson,Swisher, IA
8 D Slauson,Swisher, IA
10 R Cadmus,Grinnell, IA
11 R Cadmus,Grinnell, IA
12 R Modic,Richmond Hts., OH
13 R Modic,Richmond Hts., OH

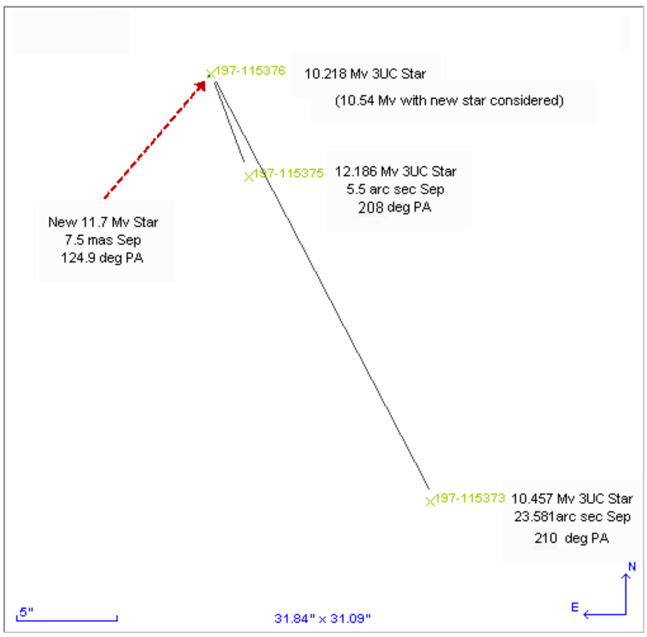


Figure 5: Relative positions and magnitudes of quaternary star system

(Continued from page 310)

References

1. "Chasing The Shadow: The IOTA Occultation Observer's Manual, The Complete Guide to Observing Lunar, Grazing, and Asteroid Occultations", Richard Nugent, April 2007.

2. Herald, D. et al., "New Double Stars from Asteroidal Occultations, 1971 - 2008", JDSO Vol. 6, No. 1, pp. 88-96, January 2010

Lunar Occultation Observations of Double Stars – Report #3

Brian Loader, Darfield, New Zealand (BL)
Royal Astronomical Society of New Zealand (RASNZ)
International Occultation Timing Association
Y. Asada, Otsu, Shiga, Japan (YA)
J. Bradshaw, Samford, Qld, Australia (JB)
D. Breit, Morgan Hill, California, USA (DB)
J. Fuertes, León, Spain (JF)
D. Gault, Hawkesbury Heights, NSW, Australia (DG)
T. George, Umatilla, Oregon, USA (TG)
P. Graham, Martinborough, New Zealand (PG)
D. Herald, Murrumbateman, NSW, Australia (DH)
B. Holenstein, Malvern, Pennsylvania, USA (BH)
E. Iverson, Lufkin, Texas, USA (EI)
M. Ishida, Moriyama, Shiga, Japan (MI)
H. Karasaki, Nerima, Tokyo, Japan (HK)
M. Kashiwagura, Oe, Yamagata, Japan (MK)
K. Kenmotsu, Soja, Oakyama, Japan (KK)
S. Kerr, Rockhampton, Qld, Australia (SK)
D. Lowe, Brisbane, Qld, Australia (DL)
J. Manek, Prague, Czech Republic (JM)
S. Messner, Northfield, Minnesota, USA (SM)
K. Miyashita, Azumino, Nagano, Japan (KM)
T. Oono, Kurashiki, Okayama, Japan (TO)
A. Pratt, Leeds, England (AP)
V. Priban, Prague, Czech Republic (VP)
R. Sandy, Missouri, USA (RS)
A. Scheck, Maryland, USA (AS)
H. Togashi, Oe, Yamagata, Japan (HTg)
H. Tomioka, Hitachi, Ibaraki, Japan (HT)
V. Tsamis, Athens, Greece (VT)
S. Uchiyama, Kashiwa, Chiba, Japan (SU)
H. Watanabe, Inabe, Mie, Japan (HW)
H. Yoshida, Obihiro, Hokkaido,Japan (HY)
Email: brian.loader@clear.net.nz

Abstract: Reports are presented of lunar occultations of close double stars observed using video including cases where a determination of the position angle and separation of the pair can be made and other cases where no duplicity has been observed. A number of double stars discovered as a result of an occultation are included together with light curves for the events.

Lunar Occultation Observations of Double Stars – Report #3

This paper continues the series of reports of double star measurements made during lunar occultations. The principle and general method of calculation are explained in Herald (2009) and Loader (2010).

All occultations used for this paper have been observed using video cameras, with either 25 frames (50 fields) per second (Australasia and Europe) or 30 frames (60 fields) per second (USA and Japan). The start and end times of each field of the videos were time stamped to milli-second accuracy. The limit of timing accuracy is usually about ±0.02 seconds where analysis has been carried out using video frame measures and ±0.01 seconds using field measures. An error of 0.01 seconds in time will typically translate to an angular error of 4 milli-arcseconds.

All events have been analyzed using the Limovie program developed by K. Miyashita and a light curve of the occultation has been generated. From this analysis an estimate of both the time interval between the occultations of the pair of stars and the relative brightness of the stars has been obtained.

Occultations of double stars result in a stepped light curve, see Herald (2009). The relative size of the step enables an estimate of the magnitude difference of the two stars to be made. Observations are normally made with an unfiltered camera.

Normally the separate occultations of the two stars of a pair will take place at slightly different points on the moon's limb. An angular separation of 1" at the mean distance of the moon is about 1.86 km. The heights of the moon's limb at the two points of occultation may differ. Any difference will have an effect on the interval between the two events.

For each observation an estimate of the effective slope of the moon's limb between the two points of occultation is therefore needed for calculations of the position angle and separation angle of a pair of stars. For this paper use has been made of the Kaguya satellite data. Whilst this gives a more detailed view of the moon's limb than the Watt's corrections, some uncertainty remains. An estimate of these has been built into the uncertainty of the resulting PA and separation.

The Observations Reported

Table 1 continues the series of measures of known double stars for which occultations have been observed from more than one locality. In most cases the occultation observations have been made on different dates, with an interval between them sufficiently short for any change in relative position of the pair of stars to be small. An estimate of the change, derived from WDS data, is given in the notes.

Table 2 gives details of similar observations, but of previously unknown double stars discovered as a result of stepped lunar occultations. Two or more observations of the same star enables a determination of the position angle and separation of the pair to be made. In some cases the star had been previously reported as double as a result of a visual observation of an apparently prolonged occultation event.

Table 3 presents a further series of discoveries for which only one observation has been made. In this case only a vector separation can be determined along with an estimate of magnitude difference. Only cases where the resulting light curve shows a clearly defined step have been included.

Table 4a continues a series of observations of stars which are listed in the WDS, but where the double nature has not been detected at lunar occultations. Only cases where at least two such observations have been made are included.

The most likely reasons for the failure to detect a companion star are:

- the vector separation was too small so that the interval between the two events was too short to detect;
- the magnitude difference of the two stars is too large for the circumstances of the event.

Table 4b continues a similar series of observations of stars which have been reported as possibly double as a result of visual occultation observations, but which subsequently have shown no sign of being double as a result of the observation of occultations using a video system. Only cases with two or more observations with event PAs (the vector angle) separated by at least 10° have been included. The stars in table 4b all have an entry in the Interferometric Catalog, but are not listed in the WDS.

In addition to the possible reasons for not observing a companion star given above, in this case there is a strong probability that the purported companion simply does not exist.

Names of observers are listed at the head of this paper and are referred to by the two letter code in the table.

Light curves, are presented for events involving the discovery of a double star presented in tables 2 or 3.

(Continued on page 316)

Lunar Occultation Observations of Double Stars – Report #3

Table 1: Known double stars: PA and separation measured

WDS name	XZ	RA Dec	PA	+/-	Sep.	+/-	Mag. diff.	Date	Observers	Note
STF 333AB	3943	02592+2120	195.6	4.5	1.48	0.05		2010.141 2011.188	JM PG	1
CHR 11Aa,Ab	4786	03437+2339	222.0	2.3	0.045	0.003		2009.694 2009.918 2010.068	HK, MI HK HK, HT	
WSI 52Da,Db	4895	03473+2408	112.5	7.8	0.33	0.08	1.1	2010.068	HK,KK,TO	2
STF 520	5566	04182+2248	86.4	1.8	0.608	0.008	0.18 n/a	2011.192 2011.267	VT EI	
STT 139	9016	06256+2227	257.0	1.7	0.736	0.02	Mean 1.7 ±0.1	2010.898 2011.048 2011.198	HK TG AS	3
COU 925	10639	07118+1953	65.31	3.08	0.508	0.015		2011.350	HK,HW,HY, KK,YA,MI	
A 2874	11387	07362+1815	49.65	1.23	0.275	0.007	0.9	2011.351 2011.650	VP,JM,JF JM	4
HO 247	11655	07491+2107	247.3	2.8	0.531	0.032		2009.779 2010.303	MI BL	5
A 2546	13255	08437+1654	215.5	1.3	1.70	0.15	0.7	2009.782 2010.306	MI BL	6
STF1426AB	15514	10205+0626	311.39	0.90	0.935	0.010	0.7 0.64	2009.487 2010.386	EI DH	7
BU 1117	22820	16568-2309	304.7	2.0	1.013	0.01	0.3	2011.528	JB,DL,BL	
B 351	23758	17383-2312	251.6	3.0	0.665	0.019		2011.230	DH,BL	
OCC9022	24055	17504-2704	190.6	2.4	0.086	0.012	0.5 0.3	2008.390 2009.511 2009.586 2009.660	DH JM RS, SM HTg, MK	8
BU 172AB	30645	22241-0450	38.48	2.07	0.427	0.009	0.38	2011.769	MI,KM,YA,HW	
A 2100	32105	23568+0444	260.67	1.42	0.366	0.010	1±0.3	2011.849 2011.924	AP DB	9

Notes

1. Expected change from 2010.1 to 2011.2: PA +0.08°, separation 0.006”
2. PA on the moon’s limb of the three occultations were close resulting in a relatively poor solution
3. Expected change from 2010.9 to 2011.2: PA +0.05°, separation +0.001”
4. Expected change from May to August 2011: PA ca -0.03°, separation -0.000”
5. Expected change from 2009.8 to 2010.3: PA +0.39°, separation +0.003”
6. Expected change from 2009.8 to 2010.3: PA +0.02°, separation +0.003”
7. Expected change from 2009.5 to 2010.4: PA +0.25°, separation -0.001”
8. OCC9022 originally discovered by RS at occultations in 2003.
9. Expected change from 2011.85 to 2011.93: PA -0.10°, separation +0.001”

Lunar Occultation Observations of Double Stars – Report #3

(Continued from page 314)

WDS refers to the Washington Double Star Catalog and IF to the Interferometric Catalog both published by United States Naval Observatory, Washington. XZ refers to the XZ80 catalog originally published by the USNO. It includes all stars to magnitude 12.5 within 6°40' of the ecliptic, that is all stars which can be occulted by the moon.

References

Herald, D. "SAO97883 – a new double star", JDSO, Vol 5, No 4, 2009.

Loader B. "Lunar Occultations of Known Double Stars – Report #1", JDSO, Vol 6, No 3, 2010

Loader B. "Lunar Occultations of Double Stars – Report #2", JDSO, Vol 7, No 3, July 2011

The program "Limovie" by K. Miyashita can be downloaded from: http://astro-limovie.info/limovie/limovie_en.html

Table 2: Occultation Discoveries: PA and separation measured

Star Name	XZ	RA Dec	PA	+/-	Sep.	+/-	Mag. diff.	Date	Observers	Figure & Note
SAO 77358	7286	05395+2146	184.2	7.2	0.094	0.038	0.8 0.6	2011.869 2012.091	JM JM	Fig. 1 10
SAO 183650	21531	15386-2136	31.3	3.5	0.083	0.013	0.2	2011.225 2011.599	DG DH, JB	Fig. 2 11

Notes

10. SAO 77358 was originally reported as double 1926 March 20 by E I Johnson as a result of an occultation observation.
11. 11. SAO 183650 was also observed again by DG on 2011 August 7. The light curve is inconclusive due to variable amounts of cloud.

Table 3: Occultation Discoveries: Vector separation only measured

Star name	XZ	RA Dec	Vector Angle	Vector Sep.	Mag. diff.	Date	Observer	Figure
SAO 93224	3948	02595+2004	98.60	0.022"	n/a	2012.010	DH	Fig. 3
TYC 1279-00730-1	6134	04469+2226	65.20	0.082"	0.1	2011.642	JM	Fig. 4
TYC 1863-01688-1	79015	05519+2303	114.47	0.345"	0.34	2011.197	HK	Fig. 5
TYC 1877-00575-1	83756	06095+2236	86.18	0.092"	ca 0.2	2011.272	EI	Fig. 6
TYC 1879-00217-1	88015	06267+2258	300.66	0.188"	0.2	2011.273	DH	Fig. 7
SAO 78416	9140	06288+2325	138.73	0.121"	1.65	2010.674	MI	Fig. 8
TYC 1392 01057-1	111160	08423+1506	47.85	0.015"	1.5	2011.429	DH	Fig. 9
SAO 118501	16193	10481-0218	182.79	0.109"	0.6	2011.585	BL	Fig. 10
SAO 183232	20996	15098-2031	328.08	0.060"	1.24	2011.448	BL	Fig. 11
SAO 164563	29940	21402-0948	132.12	0.037"	0.54	2011.392	JM	Fig. 12

Lunar Occultation Observations of Double Stars – Report #3

Table 4a: Companion not observed (definite double star, listed in WDS)

Star name	XZ	RA Dec	Vector angle	Resolution limit	Limiting Mag. diff.	Date	Observer
STF 453Aa,Ab	4957	03492+2403	51.6° 78.2° 82.2° 267.6°	0.025″ 0.027″ 0.026″ 0.035″	- 3.0 2.5 2.3	2009.611 2010.069 2010.069 2010.592	BH SU MI DL
CHR 125Aa,Ab	4958	03492+2408	60.0° 56.6°	0.025″ 0.024″	2.8 3.2	2010.067 2010.067	SU HT
HDS 541	5514	04154+2405	115.3° 46.6° 111.6°	0.035″ 0.030″ 0.025″	2.0 2.3 2.7	2010.219 2010.294 2011.117	HK JM JB
HEI 146	13271	08443+1428	132.1° 102.3°	0.036″ 0.036″	3.5 3.5	2010.322 2010.322	DH JB
A 2975	14121	09190+1057	104.7° 86.3°	0.026″ 0.023″	3.0 2.7	2011.281 2011.282	KK HT
MCA 36	17739	11510-0520	256.4° 173.9° 255.7°	0.026″ 0.024″ 0.022″	2.0 2.3 2.5	2010.166 2010.316 2010.989	JM JM HK
LAB 3	21917	16003-2237	294.9° 317.2°	0.032″ 0.028″	3.5 3.5	2011.151 2011.151	DG DL
CHR 182	23426	17220-2500	230.9° 234.9°	0.027″ 0.028″	3.5 3.5	2010.322 2010.322	DH DG

[The 'Resolution limit' is set at no less than two frame intervals [0.080s (PAL) or 0.067s (NTSC)] times the vector rate of motion.]

Table 4b: Companion not observed (possible double star, listed in Interferometric Cat.)

Star name	XZ	RA Dec	Vector angle	Resolution limit	Limiting Mag. diff.	Date	Observer
BD+13 207	1956	01243+1354	112.1° 82.9°	0.022″ 0.028″	2.6 2.6	2010.136 2012.004	SM DG
HD 93102	16106	10452+0229	121.5° 127.2° 130.9° 63.0° 178.8° 167.7°	0.032″ 0.032″ 0.030″ 0.019″ 0.020″ 0.024″	2.7 2.4 2.5 2.0 2.5 3.2	2010.313 2010.313 2010.313 2010.387 2011.361 2011.361	HK MI KK JM JB SK
BD-13 5904	29553	21193-1303	64.7° 263.7°	0.023″ 0.020″	3.2 3.2	2009.822 2010.420	BL MI

[The 'Resolution limit' is set at no less than two frame intervals [0.080s (PAL) or 0.067s (NTSC)] times the vector rate of motion.]

Lunar Occultation Observations of Double Stars – Report #3

The figures show light curves for lunar occultations of double stars. The horizontal axes, effectively time, show the frame number of the video. The vertical axes show the measured light intensity of the star in arbitrary units. Measures have been made of the light intensity for each frame of the video recording, unless otherwise stated.

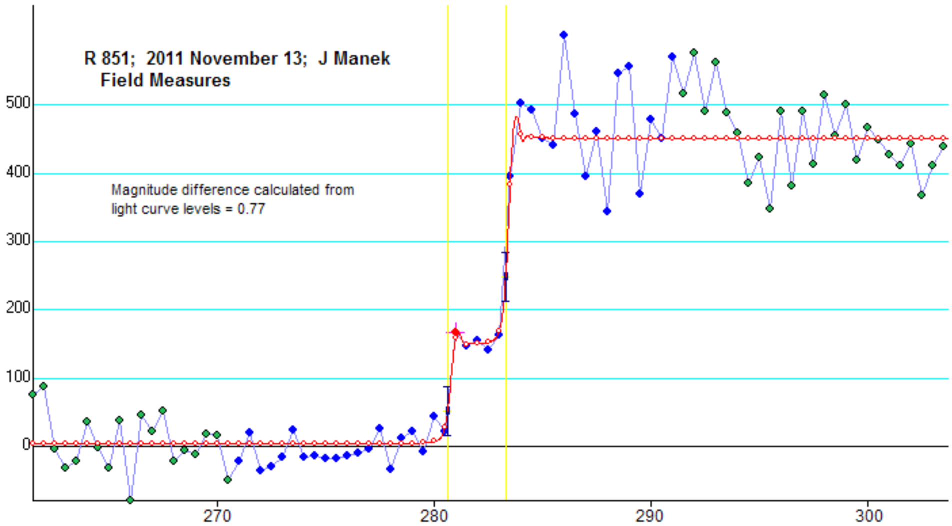


Figure 1: Light curve for the occultation of SAO 77358 obtained by J. Manek.. Intensity measures were made for each field of the video, giving a time resolution of 50 fields per second. The step lasts 0.11 seconds, between 5 and 6 fields. The vertical height of the steps suggests a 0.77 difference in magnitude for the two stars. At this event the fainter star was the first to reappear from occultation.

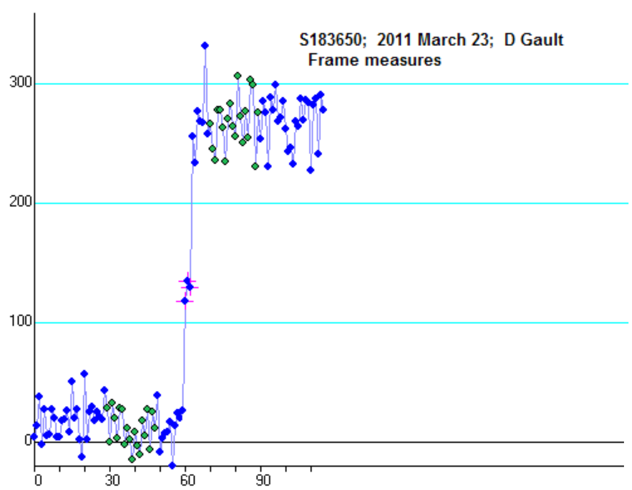


Figure 2: Light curve for the occultation of SAO 183650 obtained by D. Gault. The step lasts about 0.12 seconds, 3 frames. The height of the steps suggests a 0.2 difference in magnitude, with the fainter stars reappearing first.

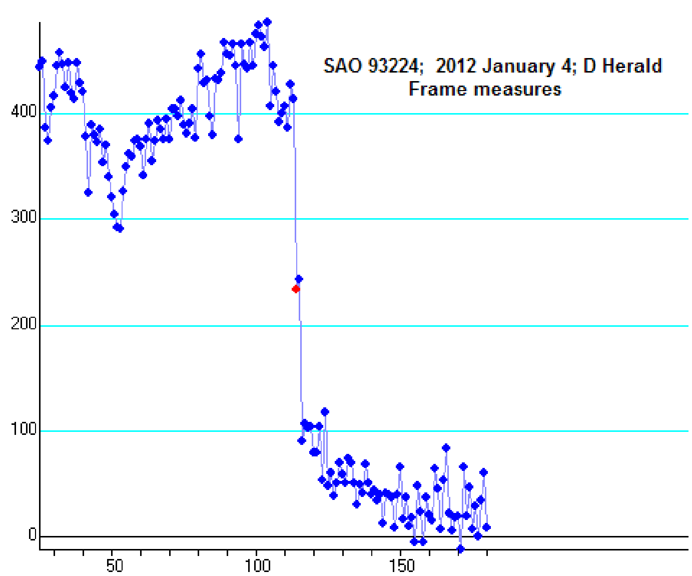


Figure 3: Light curve for the lunar occultation of SAO 93224 obtained by D. Herald, 2012 January 4. The two point step indicates a duration of 0.08 seconds, equivalent to a minimum separation of 22 arc-milliseconds for the components of the double star. The level of noise does not allow an accurate estimate of the magnitude difference.

Lunar Occultation Observations of Double Stars – Report #3

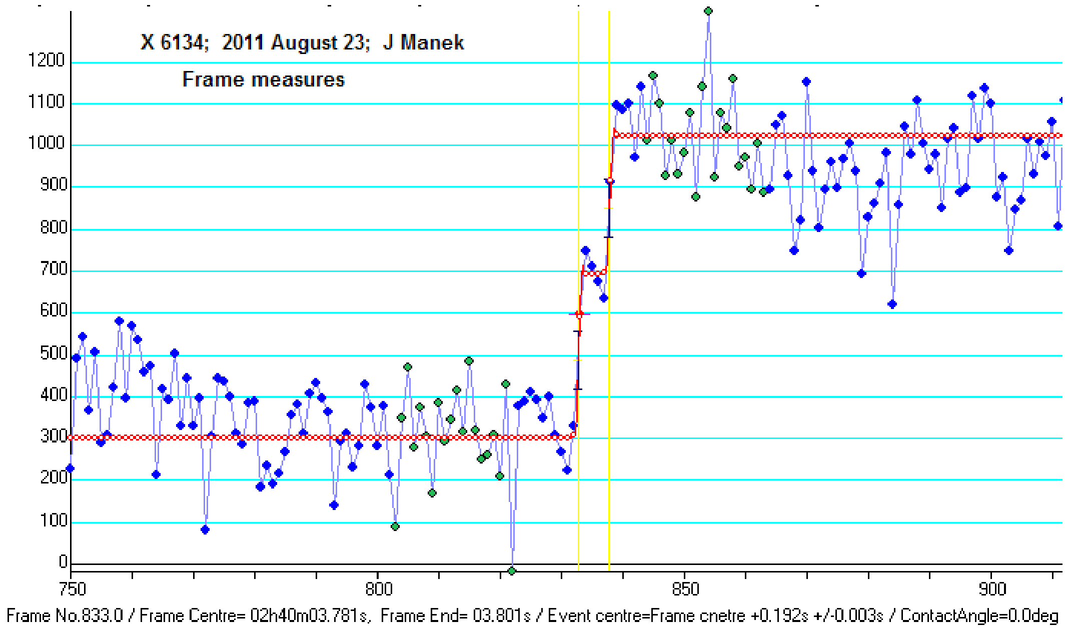


Figure 4: Light curve for the occultation reappearance of XZ 6134 obtained by J. Manek, 2011 August 23. The 0.20 second step equates to a minimum separation of 82 arc-milliseconds for the pair.

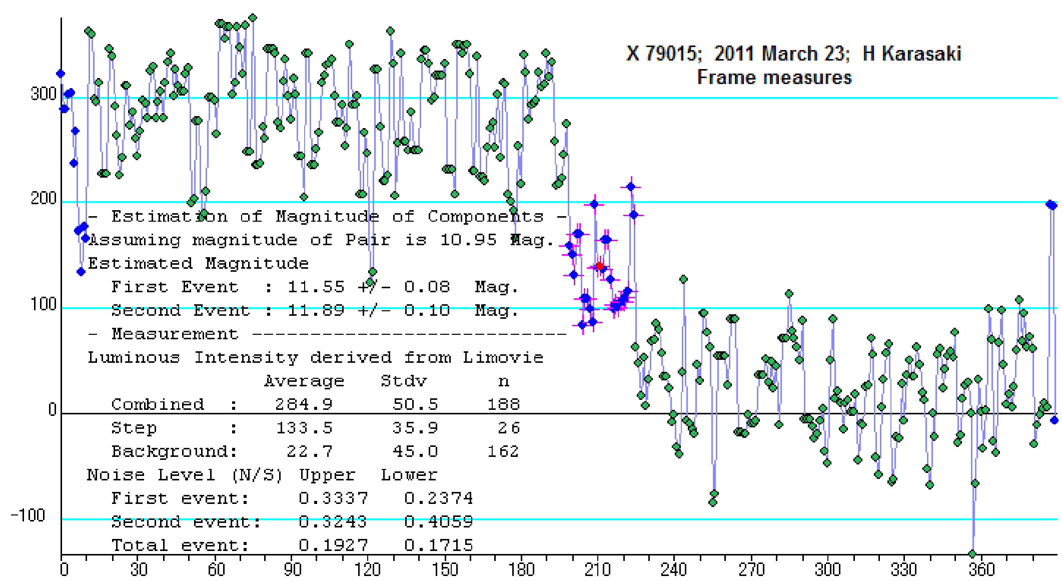


Figure 5: Light curve for the occultation disappearance of XZ 79015 obtained by H. Karasaki, 2011 March 23. The 0.87 second step equates to a minimum separation of 345 arc-milliseconds for the pair.

Lunar Occultation Observations of Double Stars – Report #3

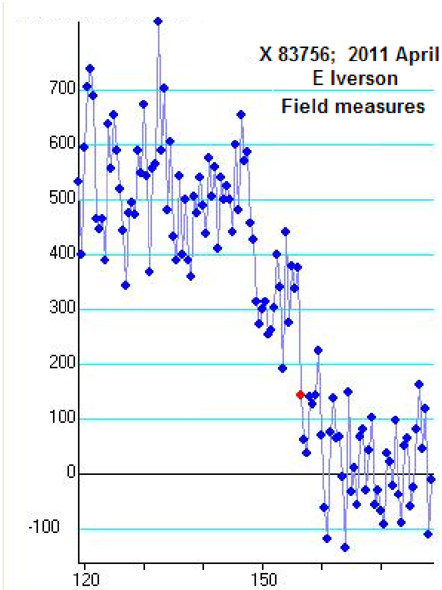


Figure 6: Light curve for the occultation disappearance of XZ 83756 obtained by E. Iverson, 2011 April 10. Light intensity measures have been made for each field (60 per second). The 0.25 second step is equivalent to a minimum separation of 92 arc-milliseconds.

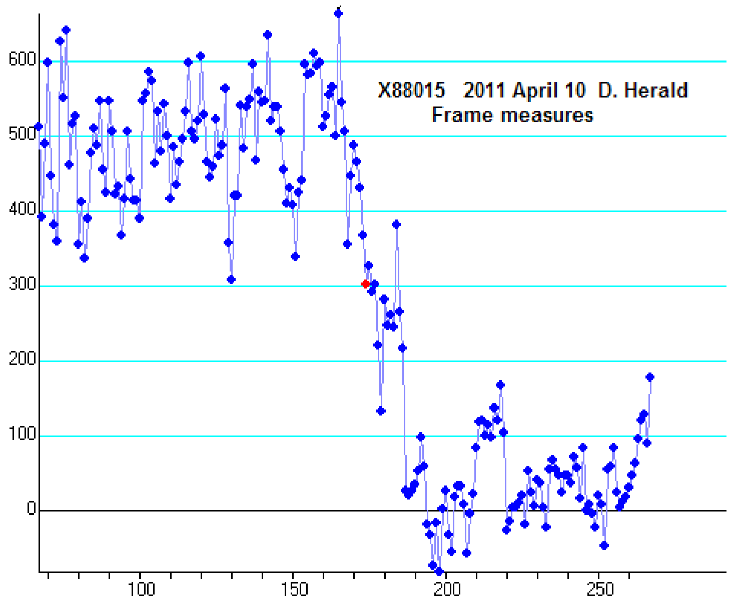


Figure 7: Light curve for the occultation disappearance of XZ 88015 obtained by D. Herald, 2011 April 10. The 0.52 second step equates to a minimum separation of 188 arc-milliseconds. The magnitude difference of the pair of stars appears to be about 0.2 with the fainter star occulted first.

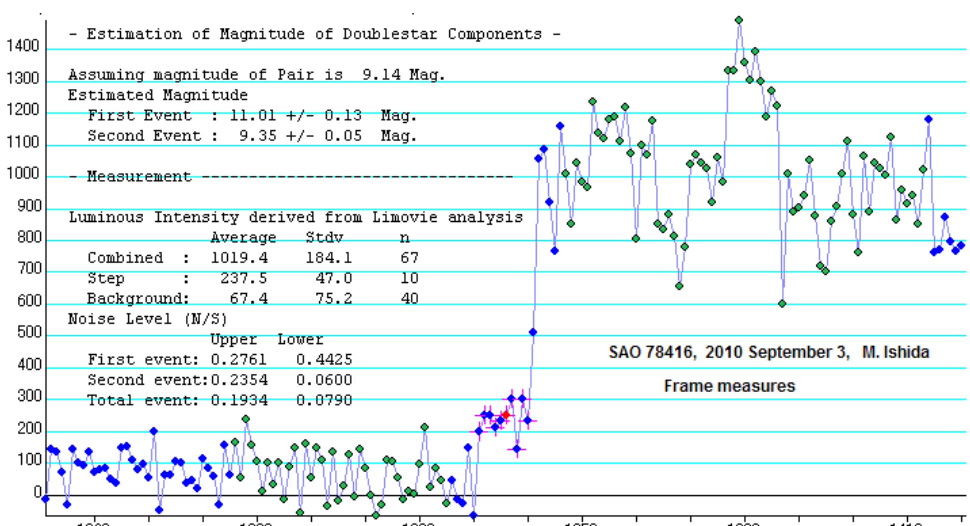


Figure 8: Light curve for the occultation reappearance of SAO 78416 obtained by M. Ishida, 2010 September 3. The 0.35 second step equates to a minimum separation of 121 arc-millisecond for the pair.

Lunar Occultation Observations of Double Stars – Report #3

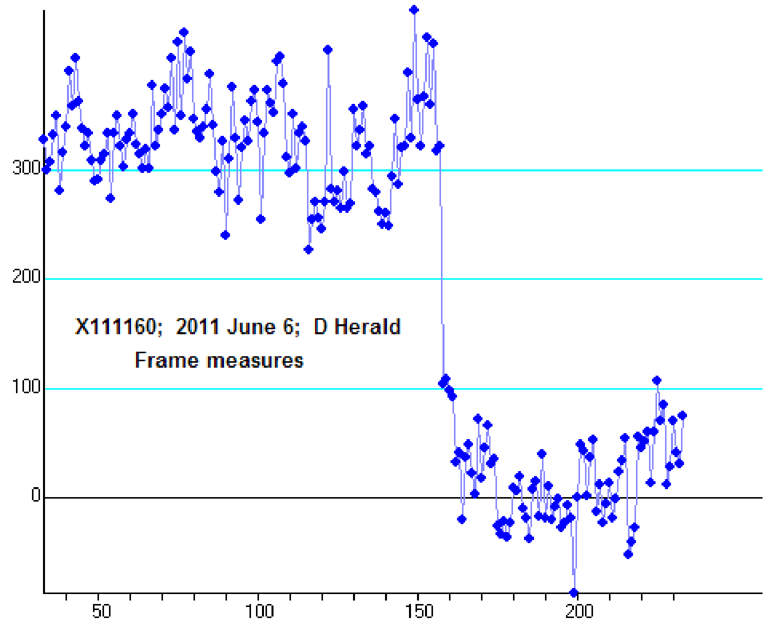


Figure 9: Light curve for the occultation disappearance of XZ 111160 obtained by D. Herald, 2011 June 6. Herald estimates the duration of the step to be 0.12 seconds which is equivalent to a minimum separation of 15 arc-milliseconds. The fainter star clearly was the second to be occulted, the estimated magnitude difference being 1.5

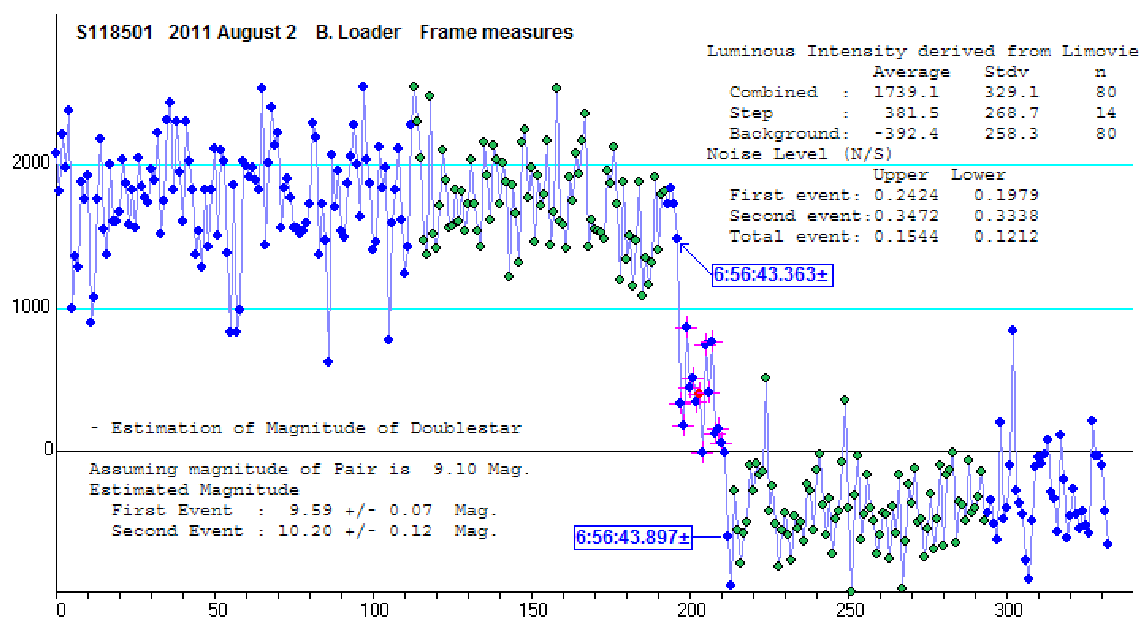


Figure 10: Light curve for the occultation disappearance of SAO 118501 obtained by B. Loader, 2011 August 2. The step lasts for 0.49 seconds which is equivalent to a minimum separation of 109 arc-milliseconds.

Lunar Occultation Observations of Double Stars – Report #3

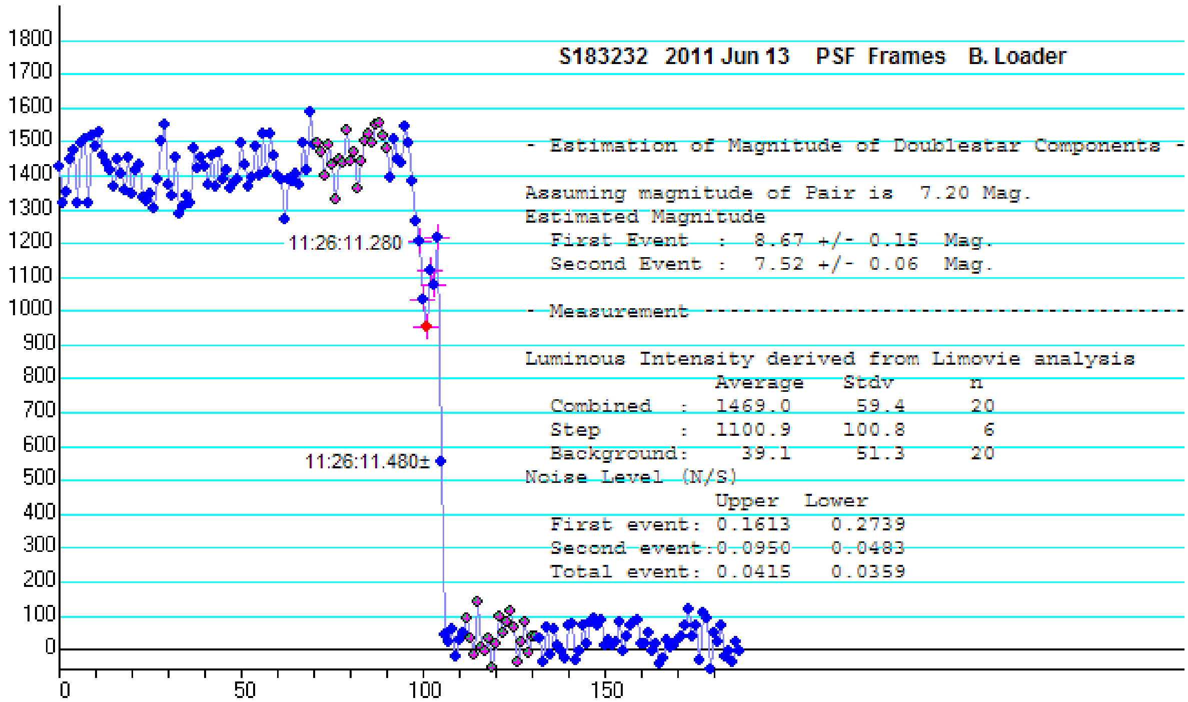


Figure 11: Light curve for the occultation disappearance of SAO 183232 obtained by B. Loader, 2011 June 13. The step lasts for 0.20 seconds which is equivalent to a minimum separation of 60 arc-milliseconds.

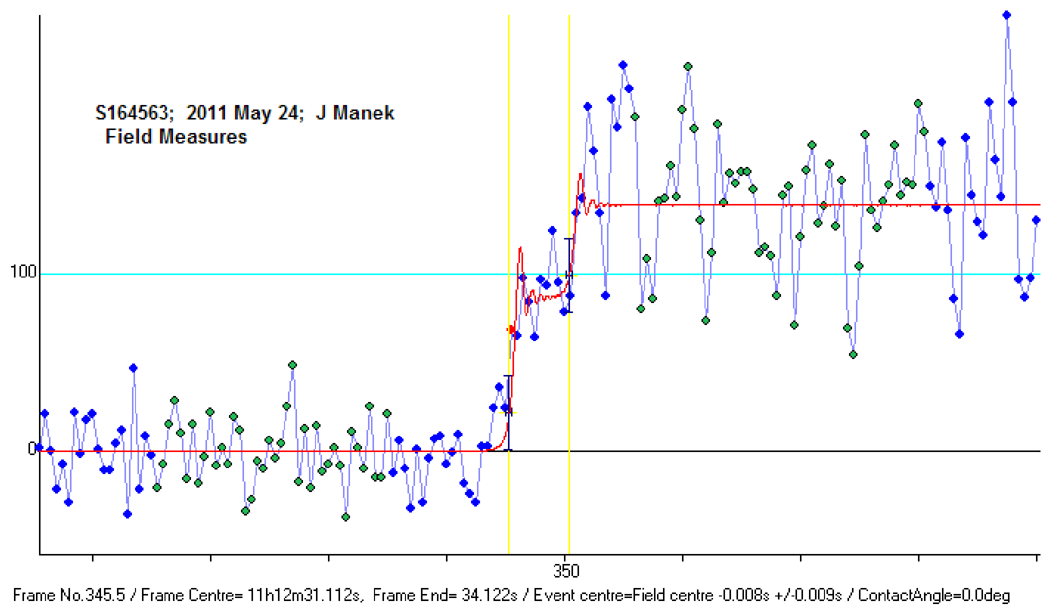


Figure 12: Light curve for occultation reappearance of SAO 164563 obtained by J. Manek, 2011 May 24. The step lasts 0.21 seconds with measures taken each video field and equates to a minimum separation of 37arc-milliseconds.

Study of a New CPM Pair 2Mass 17474909 + 0621022

Israel Tejera Falcón

Vecindario Urban Astronomical Observatory
Canary islands, Spain
www.Astrovecindario.es
TWILIGHTALLEHOUSE@hotmail.es

Abstract: **:** In this paper I present the results of a study of 2Mass 17474909 + 0621022 as components of a common proper motion pair. I used the PPMXL catalog's proper motion data to select this system which presents high RA and Dec proper motion. On the other hand, with the absolute visual magnitude of both components, I obtained distance modulus 7.98 and 7.98, which put the components of the system at a distance of 394.5 parsecs. Taking into account errors in determining the magnitudes, this means that the probability that both components are situated at the same distance is 100%. I suggest that this pair be included in the WDS catalog .

Introduction

The main purpose is to study the pair 2Mass 17474909 + 0621022 (Figures 1, 2) to determine some important astrophysical features such as distance, spectral type of the components, etc. Then, using kinematic, photometric spectral and astrometrical data, obtaining enough information to determine if there is a gravitational tie between both components and its nature.

In this study I used Francisco Rica Romero's spreadsheets [1] that makes many astrophysics calculations.

Methodology

Proper motion

I started obtaining the proper motions for the pair given in the PPMXL catalog (a catalog that provides positions and proper motions), Table 1 shows the results that I obtained. I also obtain the resulting tangential velocity calculation (Table 2).

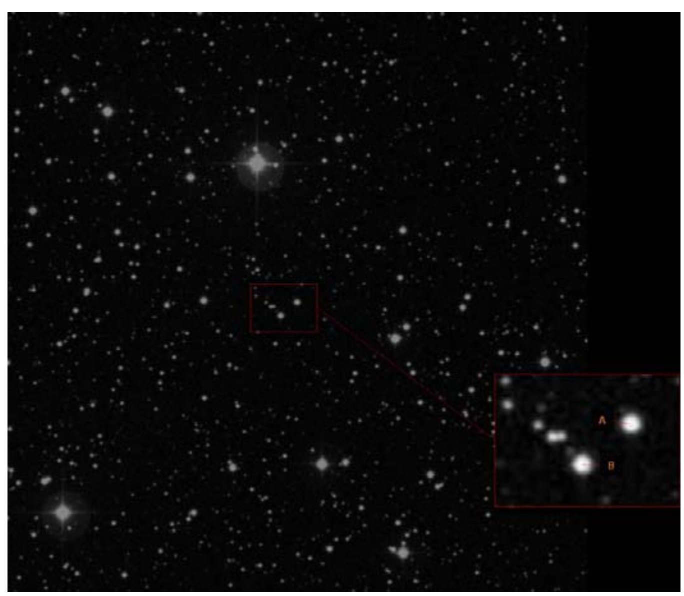


Figure 1: Picture based on a POSS plate that shows the system under study with the components identified in the inset.

Study of a New CPM Pair 2Mass 17474909 + 0621022

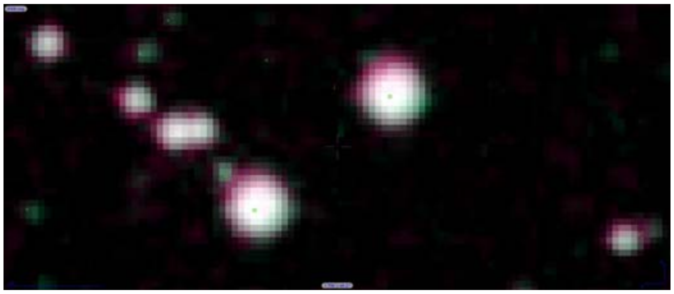


Figure 2: This image is an RGB superposition where each channel represents a different date. The result shows the common proper motion of the system.

Table 1: Proper motion of the pair described in this study

Component	Proper Motion RA	Proper Motion DEC
A	-14.5 ± 3.9	-22.8 ± 3.9
B	-17.3 ± 3.9	-23.1 ± 3.9

Relative Astrometry

Relative astrometry measurements were based on plates from different dates with resolution: 1.1", obtained from Aladdin software, I used Astrometrica software for obtaining angle deviation and applying that value on Reduc software calibration parameters for each plate. Reduc also let me obtain Theta and Rho values for each plate (see Table 3).

Table 2: Tangential velocity calculation based on PPMXL proper motions

Tangential Velocity Calculation	A	B
Mu (alpha) =	- 0.015	- 0.017
Mu (delta) =	- 0.023	- 0.023
Pi (") =	0.0025	0.0025
Ta (km/s)	- 27	- 32
Td (km/s)	- 43	- 43
Vt (Km/s)	51	54

Photometry / Spectral type of the components

I retrieved all plates with plate resolution around 1 arcsecond/pixel and catalog data of the image field from 2MASS, CMC 14, UCAC3 and USNO B1.0 catalogs. Table 4 shows the photometric magnitudes obtained. Using Francisco Rica Romero's astrophysics spreadsheet "SDSS-2MASS-Johnson conversions", I obtained the results shown in Table 5.

With this set of photometry in bands J,H,K, the deduced B,V,I and using the Francisco Rica Romero's "Astrophysics" spreadsheet, I can evaluate and calculate the spectral type of each component from photometric data. I obtained K0V and K0V for the primary and secondary respectively.

Using the same spreadsheet, I obtained the reduced proper motions for the companions presented in Table 6 and for JHK Photometry shown in Table 7. The Reduced Proper Motion [3] and JHK Photometry [4] diagrams (Figures 3, 4) show that both components are situated in the dwarf/subdwarf region.

The results suggest that the primary component as well its companion are main sequence stars.

The absolute visual magnitude of both components allow us to calculate the distance modulus, I used Francisco Rica Romero's spreadsheet "Astrophysics", the results is shown in Table 8.

Distance modulus obtained for each component were quite similar, Which means that taking into account the errors in determining the magnitudes, I con-

(Continued on page 326)

Table 3: Theta / Rho measurements obtained with Reduc Software

Besselian Date	Theta °	Rho "
1953.6121	129.93	28.558
1988,3649	129.99	28.298
1993.6238	130.17	28.577
1997.3178	130.2	28.718

Table 4: Photometric magnitudes pulled from 2MASS (infrared), CMC14, UCAC3 and USNO B1.0 catalogs

	J	H	K	r'	f	B2	R2
A	11.939	11.565	11.465	13.305	13.501	14.36	12.78
B	11.931	11.551	11.454	13.307	13.538	14.21	12.89

Study of a New CPM Pair 2Mass 17474909 + 0621022

Table 5: Based on JHK (2MASS), r' (CMC14), f (UCAC3), B2 - R2 (USNO-B1) photometric magnitudes and using Francisco Rica Romero's "SDSS-2MASS-Johnson conversions", I obtained color index (B-V), (V-I), Magnitude V and later with "Astrophysics" spreadsheet, Bolometric correction shown below.

	Color B-V	Color V-I	Magnitude V	Bolometric correction
A	0.76	0.85	13.55	- 0.216
B	0.76	0.85	13.55	- 0.216

Table 8: Reduced Proper Motion

BAND	Mag (A)	H(A)	Mag (B)	H(B)
V	13.55	10.7	13.55	10.9
K	11.465	8.6	11.454	8.8

Table 9: JHK Photometry

COMPONENT	J-H	H-K
A	0.43	0.07
B	0.43	0.07

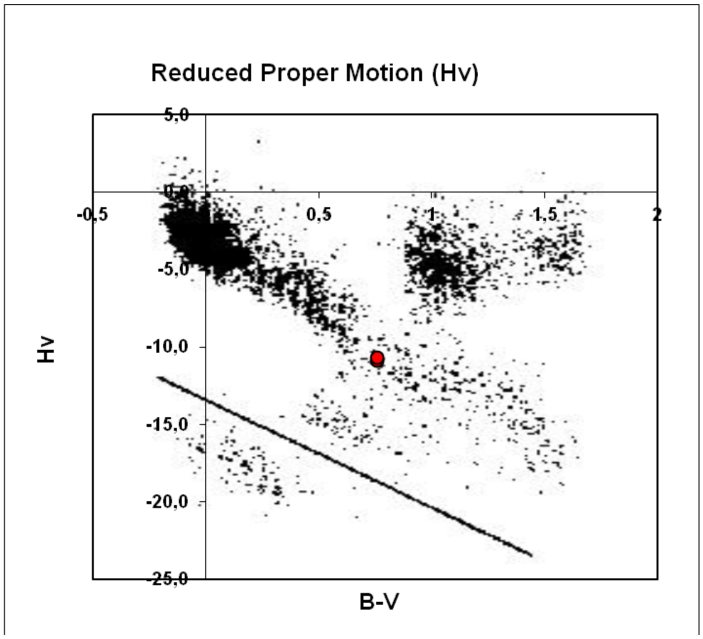


Figure 3: Reduced-Proper diagram. This diagram shows that both components are situated in the dwarf/subdwarf region.

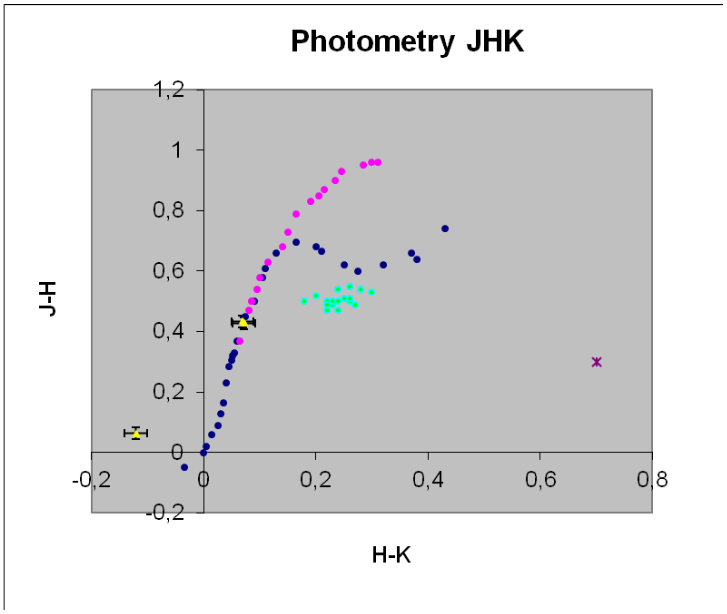


Figure 4: Photometry JHK diagram. This diagram shows that both components are situated in the dwarf/subdwarf region.

Study of a New CPM Pair 2Mass 17474909 + 0621022

(Continued from page 324)

clude that the probability that components are at the same distance is 100%

Conclusions

If the spectroscopy obtained above is reliable, the sum of the masses is estimated to be 1.82 solar masses at a distance calculated based on the data mentioned above. Wilson and Close criteria [2] indicates a physical system.

The distance modulus calculated above, put both components at the same distance 394.5 (primary) and 394.5 (secondary) parsecs Which means that the probability that both components are at the same distance is 100%, that value it's a good indicator about the possible physical relation between their components.

Respect to the kinematics, RA/DEC proper motion of this system are medium-high and quite similar, indicating that system is CPM. I used PPMXL catalogue values on this study.

The latest image available from aladdin software (1997.3178) gives astrometry values: $\Theta = 130.2°$ $\rho = 28.718''$. According to these data and using the Francisco Rica Romero's spreadsheet "Astrophysics", I estimate the parameter (p/μ) representing the time it takes the star to travel a distance equal to their angular separation with its motion μ. This gives T = 1024 years, which would give us a 78% probability to be a physical system.

In summary with the present information I think that we could consider this pair as a binary and I suggest that this pair be included in the WDS catalog.

Acknowledgements

I used Florent Losse's "Reduc" software for relative astrometry and Herbert Raab's "Astrometrica" software to calculate plate's angle deviation.

I used Francisco Rica Romero's "Astrophysics" and "SDSS-2MASS-Johnson conversions" with many useful formulas and astrophysical concepts.

The data analysis for this paper has been made possible with the use of Vizier astronomical catalogs service maintained and operated by the Center de Donnès Astronomiques de Strasbourg (http://cdsweb.ustrasbg.fr)

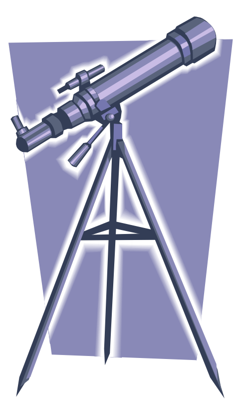
References

1 – Rica's Spreadsheet "Astrophysics" and "SDSS-2MASS-Johnson conversions" (private communication)

2 – Wilson & Close Criterions "Close SM et al (2003, Apj, 587, 407C)" , "A search for L dwarf binary systems", Neid Reid et al (2001), AJ, 121, 489

3 - "Reduced Proper-Motion Diagrams. II. Luyten's White-Dwarf Catalog", Eric M. Jones (Aj, 177, 245 -250 -1972-)

4 - "JHKLM Photometry: Standard systems, Passband and Intrinsic Colors", PASP, 100,1134-1151, 1988



Double Star Measurements Using a Webcam, Annual Report of 2011

J. S. Schlimmer

Seeheim-Jugenheim, Hessen, Germany
Email: js@epsilon-lyrae.de

Abstract: I report on the measurements of 113 double stars of 2011 using a standard webcam. For 3 double stars I recommend companions not yet listed in the WDS catalog.

For my observations I use a small 8 inch Newtonian telescope with a webcam described in my previous reports (Schlimmer 2007a, Schlimmer 2008b). No system change has been made. The reproduction scale of the optical system (focal length 1500 mm) is about 0.79 as/pxl or 0.34 as/pxl if a focal length of 3000 mm is used. For analyses of the webcam records I use the REDUC software package, written by Florent Losse.

In some observations I found components which are not yet listed in WDS catalog. These observations are discussed below.

STF 721AB, GUI 7AD

STF 721AB was discovered in 1783 by William Herschel. In 1878 Burnham found a third component C close to B. Guillaume found in 1904 a fourth component D in a distance of 132 as with an angle of 165 degree. Since its discovery in 1904 no further observation of AD was made.

In my observations of AD I measured a distance of 145 as and an angle of 146 degree. The relative proper motion between AD given in WDS catalog is very small and doesn't match with results which can be calculated of both observations. In a distance of 10 as from D a further component can be observed. The angel is about 267 degree the brightness is about 11 mag (Figure 1).

WDS05545+1146, KUI 21

WDS05545+1146, KUI 21 was discovered in 1901. Brightness of the primary component is 6.6 mag, the secondary component has a brightness of 10.9 mag. In a distance of 78 as a third component can be found. The angle is 276 degree. A fourth component can be found in a distance of 82 as. The angle is 355 degree. The brightness of these components is about 11 mag (Figure 2). Both components are not yet listed in WDS catalog.

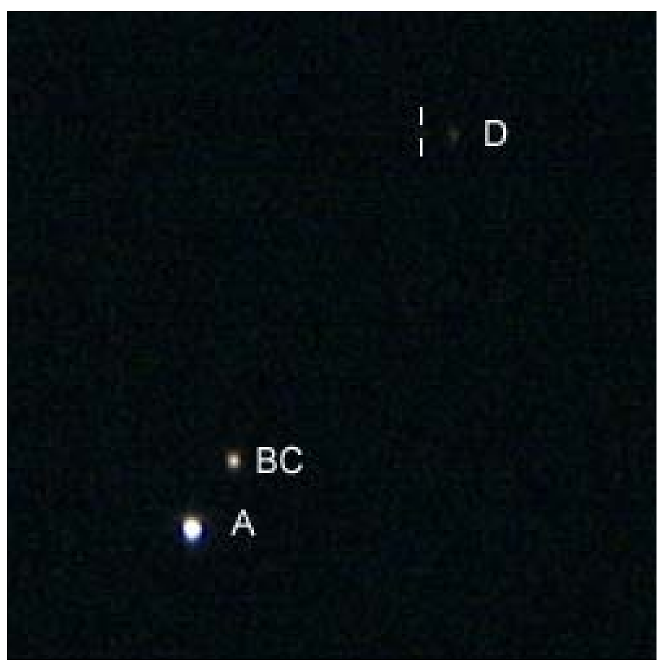


Figure 1: STF 721AB and GUI 7AD with a new component near D. This component is not yet listed in WDS catalog.

Double Star Measurements Using a Webcam, Annual Report of 2011

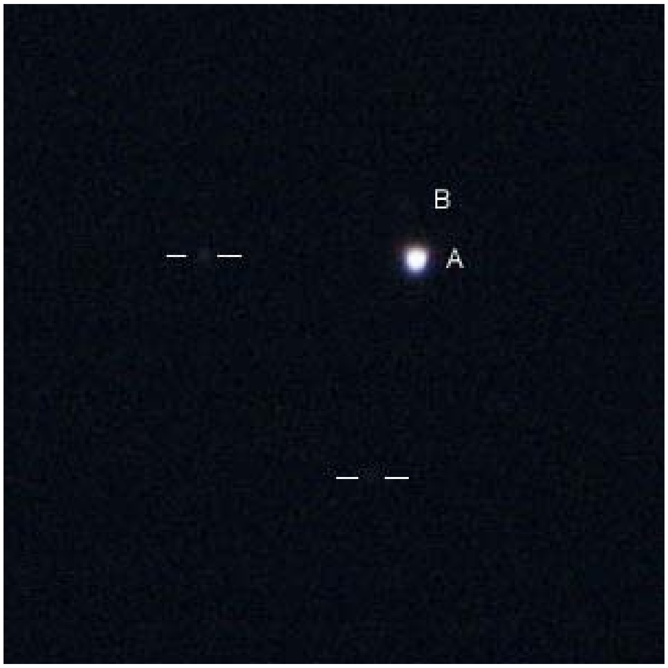


Figure 2: Near KUI 21 there are two further components which are not listed in WDS catalog. Both components are marked with lines.

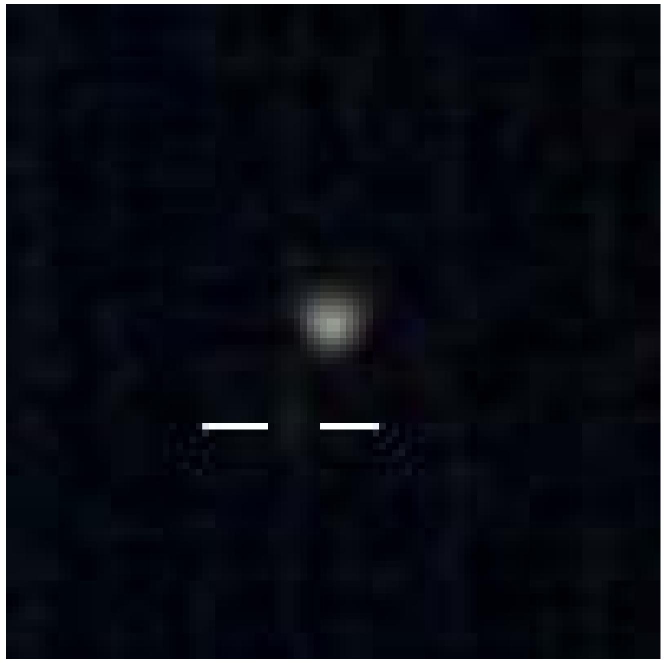


Figure 3: The section of the webcam image was magnified of two times. Near BD+282195 is a small star which is not yet listed in WDS catalog. This component is marked with lines.

BD+282195

BD+282195 is an optical double star in constellation Comae. The FK5 coordinates in Simbad database are 131232.903 +274154.56**.** On poss2 photos BD+282195 looks like a double star, but it is not listed as double star in SINBAD astronomical database. To get more information about distance between BD+282195 and its neighbor star it was observed by the author. BD+282195 can be found at a distance of 856 arc seconds from beta Comae. Its visual magnitude is 10.6. The magnitude of the neighbor star on poss2 photos can be estimated at about 11.6. There is no significant variation in the red, blue or ir picture. The distance is about 12 as, the position angle is 345 degrees.

Acknowledgements

This research has made use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory.

This research has made use of the SIMBAD database, operated at CDS, Strasbourg, France

References

Schlimmer 2007a: Double Star Measurement Using a Webcam, Journal of Double Star Observations,Vol. 3 No. 3, Pages 131-134

Schlimmer 2007b: Christian Mayer's Double Star Catalog of 1779, Journal of Double Star Observations,Vol. 3 No. 4, Pages 151-158

Schlimmer 2008a: The proper motion of HLD120AB (WDS14527+0746), Journal of Double Star Observations, Vol. 4, No. 2, Pages 56-58

Schlimmer 2008b: Double Star Measurement Using a Webcam - Annual Report of 2007, Journal of Double Star Observations, Vol. 4 No. 2 Pages 81-83

Schlimmer 2009: Double Star Measurement Using a Webcam - Annual Report of 2008, Journal of Double Star Observations, Vol. 5 No. 2 Pages 112-118

Schlimmer 2010: Double Star Measurement Using a Webcam - Annual Report of 2009, Journal of Double Star Observations, Vol. 6 No. 3 Pages 197-205

Schlimmer 2011: Double Star Measurement Using a Webcam - Annual Report of 2010, Journal of Double Star Observations, Vol. 7 No. 4 Pages 233-239

SIMBAD Astronomical Database, http://simbad.u-strasbg.fr/simbad/

WDS Catalog, The Washington Double Star Catalog, Mason, Wycoff, Hartkopf, Astrometry Department, U.S. Naval Observatory

Double Star Measurements Using a Webcam, Annual Report of 2011

Name	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
H 5 32AB	00084+2905	2.22 11.11	285.3	90.81	2011.914	1	α And
STFA 3AB	01144-0755	5.19 7.85	331.3	48.98	2011.895	1	37 Cet
STF 151	01460+6113	10.59 10.98	42.1	7.28	2011.695	1	NGC 663
STI 288	01461+6112	10.56 12.43	138.7	13.66	2011.695	1	NGC 663
STF 152	01461+6114	9.04 11.20	110.6	9.07	2011.695	1	NGC 663
ES 1950AB	01464+6116	8.60 12.39	253.9	28.08	2011.695	1	NGC 663
STF 153	01466+6116	9.36 10.38	72.1	7.75	2011.695	1	NGC 663
ENG 8	01496-1041	4.69 6.81	250.9	183.91	2011.895	1	ξ Cet
STF 281	02359+0536	4.97 9.08	80.3	8.41	2011.914	1	ϖ Cet
PLQ 32AC	02361+0653	5.93 11.66	110.1	164.36	2011.914	1	FK1073
STF 589	04448+0517	8.78 8.92	276.2	4.72	2011.060	1	
STTA 55	04491+0513	8.22 9.24	16.8	37.41	2011.060	1	
STFA 1	00464+3057	7.25 7.43	46.7	47.25	2011.914	1	note 1
STF 60AB	00491+5749	3.52 7.36	321.4	13.17	2011.695	1	eta Cas
STF 60AE	00491+5749	3.52 10.15	125.1	79.34	2011.695	1	
SMR 2AI	00491+5749	3.5 11.6	74.1	90.96	2011.695	1	
STT 560AB	04498+0658	3.22 11.31	170.5	73.08	2011.060	1	Pi 3 Ori
H 6 83	04503+0657	7.24 10.14	6.2	94.68	2011.060	1	
STF 627AB	05006+0337	6.59 6.95	260.6	21.13	2011.060	1	
STF 697AB	05235+1602	7.27 8.10	286.1	25.93	2011.076	1	Ori
WAL 38AC	05235+1602	7.27 10.83	284.8	97.59	2011.076	1	Ori
SMR 3AD	05235+1602	7.3 10.1	285.0	249.02	2011.076	1	Ori
STF 721A BC	05296+0309	7.09 9.14	148.3	25.20	2011.079	1	
GUI 7AD	05296+0309	7.09	146.3	144.59	2011.079	1	
DE	05296+0309		267.2	10.26	2011.079	1	note 2
STFA 14AC	05320-0018	2.41 6.83	0.5	52.55	2011.060	1	δ Ori
KUI 21	05545+1146	6.58 10.91	200.9	20.86	2011.101	1	
	05545+1146	6.58	275.6	78.60	2011.101	1	note 3
	05545+1146	6.58	354.5	82.21	2011.101	1	note 4
STF 815AB	05546+0521	8.35 9.82	136.3	12.94	2011.079	1	
STF 815AC	05546+0521	8.35 9.75	309.1	85.07	2011.079	1	
STF 816	05549+0552	6.90 9.27	285.6	4.43	2011.079	1	
ARG 63AB	05571+1014	8.69 9.09	67.3	32.35	2011.101	1	
STF1254AB	08404+1940	6.44 10.37	54.2	20.35	2011.271	1	
STF1254AC	08404+1940	6.52 7.61	343.1	63.19	2011.271	1	
STF1254AD	08404+1940	6.52 9.20	44.1	82.07	2011.271	1	
S 571AC	08399+1933	7.31 7.47	156.9	44.80	2011.271	1	
S 571AD	08399+1933	7.31 6.67	62.1	92.22	2011.271	1	
BKO 34DE	08399+1933	6.67 11.0	3.2	35.75	2011.271	1	
STF1424AB	10200+1950	2.37 3.64	128.3	4.62	2011.350	1	Algieba

Table continues on next page.

Double Star Measurements Using a Webcam, Annual Report of 2011

Name	RA+DEC	MAGS	PA	SEP	DATE	N	NOTES
STF1424AC	10200+1950	2.37 9.64	288.8	335.33	2011.350	1	AD Leo
STF1424AD	10200+1950	2.60 10.0	302.5	367.29	2011.350	1	
STF1424CD	10200+1950	9.64 10.62	4.8	89.51	2011.350	1	
STF1659AB	12357-1201	7.94 8.34	351.3	27.49	2011.336	1	
STF1659AC	12357-1201	7.94 10.95	69.7	42.46	2011.336	1	
STF1659AE	12357-1201	7.94 6.78	275.4	152.30	2011.336	1	
STF1659AF	12357-1201	7.94 6.64	140.1	208.30	2011.336	1	
STF1659EF	12357-1201	6.86 6.70	121.4	331.26	2011.336	1	
STF1670AB	12417-0127	3.48 3.53	19.2	1.53	2011.336	1	g Vir
STF1670AE	12417-0127	3.48 8.94	168.2	258.62	2011.336	1	
STF1670AF	12417-0127	3.48 9.53	267.9	420.95	2011.336	1	
STF1659AB	12357-1201	7.94 8.34	351.3	27.49	2011.336	1	
STF1659AC	12357-1201	7.94 10.8	69.7	42.56	2011.336	1	
STF1659AE	12357-1201	7.94 6.78	275.4	152.30	2011.336	1	
STF1659AF	12357-1201	7.94 6.64	140.1	208.30	2011.336	1	
STF1659EF	12357-1201	6.78 6.64	121.4	331.26	2011.336	1	
STFB 6AB	10084+1158	1.40 8.24	307.6	174.06	2011.350	1	Regulus
STT 578	13119+2753	4.26 10.1	181.6	124.57	2011.350	1	b Comae
BD+282195	13123+2742	10.6	345.0	11.91	2011.350	1	note 5
STF1873	14448+0742	7.96 8.35	91.7	6.95	2011.583	1	
HLD 120AB	14527+0746	8.05 10.84	224.3	16.28	2011.583	1	note 6
STTA171AB	18329+3850	7.02 8.12	328.7	149.98	2011.583	1	note 7
STTA171AG	18329+3850	7.02 11.1	134.4	81.08	2011.583	1	
H 5 39AB	18369+3846	0.09 9.5	183.3	81.11	2011.583	1	Vega
STFB 9AE	18369+3846	0.09 9.5	39.2	88.54	2011.583	1	Vega
BLL 35	18433+3918	6.64 10.35	192.8	60.64	2011.583	1	
STF2382AB	18443+3940	5.15 6.10	347.3	2.34	2011.484	1	eps lyr
STFA 37AC	18443+3940	4.67 4.56	172.2	208.83	2011.583	1	eps lyr
STFA 37AI	18443+3940	5.15 10.43	137.3	150.38	2011.583	1	eps lyr
STF2383CD	18443+3940	5.25 5.38	75.3	2.31	2011.484	1	eps lyr
STF2383CE	18443+3940	5.25 11.71	333.1	63.44	2011.583	1	eps lyr
STFA 37CI	18443+3940	5.25 10.43	36.9	120.05	2011.583	1	eps lyr
EI	18443+3940	11.71 10.43	68.4	108.94	2011.583	1	eps lyr
SHJ 277EF	18443+3940	11.71 11.2	38.5	45.06	2011.583	1	eps lyr
ES 2028AB	18545+3654	4.30 11.2	350.2	87.29	2011.670	1	d Lyr2
SMR 13AD	18545+3654	4.30 8.8	210.6	192.40	2011.670	1	
SMR 13AE	18545+3654	4.30 10.3	238.9	399.69	2011.670	1	
SMR 13AF	18545+3654	4.30	246.0	368.71	2011.670	1	
SMR 13AG	18545+3654	4.30	261.9	335.45	2011.670	1	
SMR 13AH	18545+3654	4.30	285.2	229.04	2011.670	1	

Table continues on next page.

Double Star Measurements Using a Webcam, Annual Report of 2011

Name	RA+DEC	MAGS		PA	SEP	DATE	N	NOTES
SMR 13AJ	18545+3654	4.30		250.3	279.73	2011.670	1	
SMR 13AK	18545+3654	4.30		237.3	304.32	2011.670	1	
SMR 13HI	18545+3654	4.30		250.7	25.97	2011.670	1	
STFB 10AB	19508+0852	0.95	9.82	285.3	194.67	2011.583	1	Altair
STFB 10AC	19508+0852	0.95	10.3	107.7	188.63	2011.583	1	Altair
SMR 5AE	19508+0852	0.95	11.0	354.0	153.21	2011.583	1	Altair
SMR 5AF	19508+0852	0.95	10.3	46.7	295.79	2011.583	1	Altair
SMR 7	20000+1736	10.1	11.4	261.9	4.06	2011.583	1	
S 730AB	20001+1737	7.16	8.45	14.1	113.38	2011.583	1	
S 730AC	20001+1737	7.16	10.21	337.6	78.92	2011.583	1	
S 730AD	20001+1737	7.16	9.9	198.1	40.81	2011.583	1	
STF2758AB	21069+3845	5.35	6.10	151.8	31.38	2011.703	1	61 Cygni
STF2758AE	21069+3845	5.20	9.63	269.1	320.36	2011.670	1	61 Cygni
STF2758AF	21069+3845	5.20	11.32	240.7	346.39	2011.670	1	61 Cygni
STF2758AG	21069+3845	5.20	10.84	236.3	235.50	2011.670	1	61 Cygni
STF2758AH	21069+3845	5.20	10.89	279.9	92.51	2011.669	3	61 Cygni
BU 1502AB	21186+6235	2.46	11.46	17.4	196.59	2011.791	1	
ES 137AB	21191+6152	6.70	10.30	73.8	45.58	2011.791	1	
STF2806AB	21287+7034	3.17	8.63	248.8	13.65	2011.791	1	
STF2816AC	21390+5729	5.73	7.48	119.1	11.75	2011.703	1	
STF2816AD	21390+5729	5.73	7.53	337.6	19.77	2011.703	1	
STF2819	21404+5735	7.44	8.64	57.9	12.80	2011.703	1	
STT 461AB	22039+5949	6.66	11.4	297.1	10.99	2011.791	1	
STT 461AC	22039+5949	6.66	10.03	39.6	89.91	2011.791	1	
STT 461AD	22039+5949	6.66	7.84	71.8	184.29	2011.791	1	
STT 461AE	22039+5949	6.66	6.96	36.9	237.37	2011.791	1	
STT 461EF	22039+5949	6.96	8.14	33.3	192.64	2011.791	1	
ENG 83AB	22118+5650	5.30	10.70	19.2	51.24	2011.791	1	
ENG 84AB	22150+5703	4.21	9.18	355.9	118.11	2011.791	1	e Cephei
H 4 31AB	22284+5825	8.54	10.52	3.5	25.01	2011.791	1	
ARN 79AC	22284+5825	8.54	9.46	320.7	78.63	2011.791	1	
STFA 58AC	22292+5825	4.21	6.11	191.8	40.90	2011.791	1	d Cephei
STF3050AB	23595+3343	6.46	6.72	331.7	2.12	2011.914	1	note 8

Notes:

1. STFA 1 = Mayer 1 (Schlimmer 2007b)
2. Not yet listed in WDS catalog, see figure 1
3. Not yet listed in WDS catalog, see figure 2
4. Not yet listed in WDS catalog, see also figure 2
5. In a distance of 856 arcsec from beta Comae, not yet listed in WDS catalog, see figure 3
6. HLD120AB, proper motion star, see (Schlimmer 2008a)
7. Near Vega
8. STF3050AB = Mayer 80 (Schlimmer 2007b)

A New Common Proper Motion Double Star in Cetus

Abdul Ahad

Bedfordshire, United Kingdom
aa_spaceagent@yahoo.co.uk

Abstract: In this paper, I report a new visual binary star in the Constellation of Cetus that is not in the current edition of the WDS catalog, the components of which share a common proper motion. On a number of different binarity tests, the two stars seem likely a gravitationally connected pair, showing evidence of orbital motion between the 1950's and 1990's Palomar Observatory Sky Surveys.

Introduction

This pair first came to my attention on May 15th 2012, whilst studying DSS images from the Palomar Observatory Sky Survey (POSS). The primary has the Henry Draper designation of HD10327 and is of visual magnitude 9.94. The secondary appears at least 3 magnitudes fainter, at V magnitude ~13.5. The primary is at ICRS coordinates: 01 40 29.1, -24 12 39 (Epoch 2000.0).

Distance and Proper Motion

From the UCAC3 catalog[5], we find the two stars share very similar proper motions in both RA and Dec, in both magnitude and in sign, see Table 1.

The pair as a whole, has a total proper motion of: $([(63.7)^2 + (68.8)^2]^{½} + [(66.3)^2 + (68.0)^2]^{½}) / 2 = \sim 94.3$ milliarcseconds per year.

In my report in the Webb Society DSSC 19 [1], I showed for purposes of illustration the distances and proper motions of a number of binary systems, and the basic correlation that exists between these two parameters. Referring to that scale, this figure of 94.3 mas/year suggests the pair is located in the region of about a 100 light-years away from the Earth. For example, the star η Herculis has a total proper motion of 92 mas/year and it lies at a distance of ~112 light-years away, measured on Hipparcos parallax.

Table 1: Proper Motions of the Studied Stars

Component	RA Proper Motion	Dec. Proper Motion
A	+63.7 mas/year	+68.8 mas/year
B	+66.3 mas/year	+68.0 mas/year

Since both stars in this double star have virtually identical proper motions in both RA and Dec and are also positioned within a mere 15" from each other in the sky, on a balance of probabilities it seems more than likely that they are physically connected.

Photometry

In the "spectral distance" method of binarity testing that I had applied in previous papers[2] if two stars genuinely reside within a bounded binary system, then we expect them to display particular kinds of photometric attributes in relation to one another. The Two Micron All-Sky Survey (2MASS) gives reliable J and K-filter magnitudes for all point sources and I have found it to be an excellent resource for gauging the individual colors and spectral classifica-

A New Common Proper Motion Double Star in Cetus

Table 2: Approximate Relationships Between 2MASS (J - K) Color Indices and Spectral Classifications for Main Sequence Stars

2MASS(J - K)	Spectral type	Example star
-0.04	B3 V	Eta Ursae Majoris
0.00	A1 V	Sirius
+0.21	A7 V	Altair
+0.23	F2 V	Sigma Bootis
+0.31	G0 V	Beta Comae
+0.43	K5 V	61 Cygni A
+0.86	M2 V	Lalande 21185

tions of visual double stars. Based on an average taken over a small sample, I have derived Table 2 to be a basic fit of J and K magnitudes, the color index (J - K) and spectral classifications for seven stars scattered across the visible spectrum.

Photometry in the 2MASS All-Sky Catalog of Point Sources [4] (Cutri+ 2003), queried via Vizier, gives values for the two components in this Cetus double star presented in Table 3.

From these we deduce color indices of (J – K) = +0.49 for the primary component and (J – K) = +0.90 for the secondary component in this double star. Interstellar reddening in the J and K magnitudes can sometimes be a factor that distorts the apparent color of a star from its true (intrinsic) color. In the case of this particular double star, such reddening will be negligible, since the pair is located at a high galactic latitude of -78 degrees, and far removed from the obscuring gas and dust clouds typically found along the band of the Milky Way in the night sky.

Table 3: Photometry of the component stars.

	J-magnitude	K-magnitude
A-component	8.566	8.076
B-component	11.199	10.301

Given these (J – K) values, referring to Table 2, spectral types can be readily inferred of late K for the primary and a very low-mass, M-type red dwarf for the secondary. These are roughly consistent with the distance/proper motion fit described earlier, again hinting thaat the pair is physically connected. The primary star (A component) in this pair is likely to be of comparable in mass/luminosity to the star 61 Cygni A. This can be confirmmed by applying the distance mod formulae [3]. 61 Cygni A has an absolute magnitude, M, of +7.5. If 61 Cygni A were hypothetically placed at the same distance of this Cetus double star (~100 light-years), it would shine at an apparent visual magnitude of +9.91, which is virtually the same as the A component. Through a similar set of deductions, we find the B-component in this double star to be of absolute magnitude +11.1, and of comparable mass/luminosity as the nearby red dwarf star, Lalande 21185 (of absolute mag +10.5).

Orbital Motion?

From the POSS1 and POSS2 surveys, historical astrometry on this Cetus binary shows the position angle to be slowly increasing and the separation de-

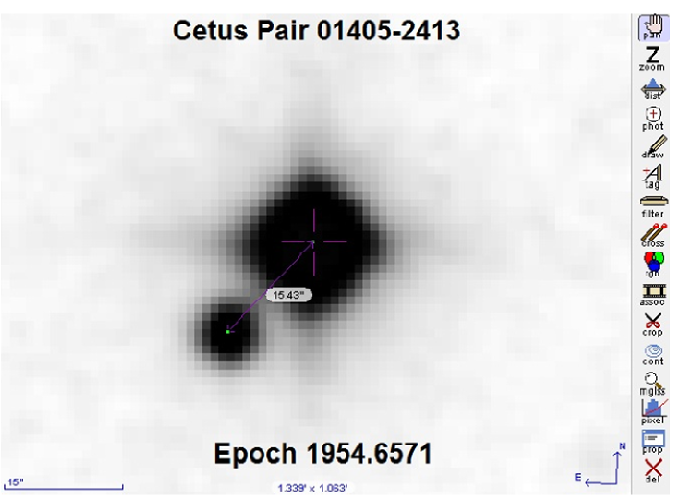


Figure 1 – Image from 1950s POSS 1

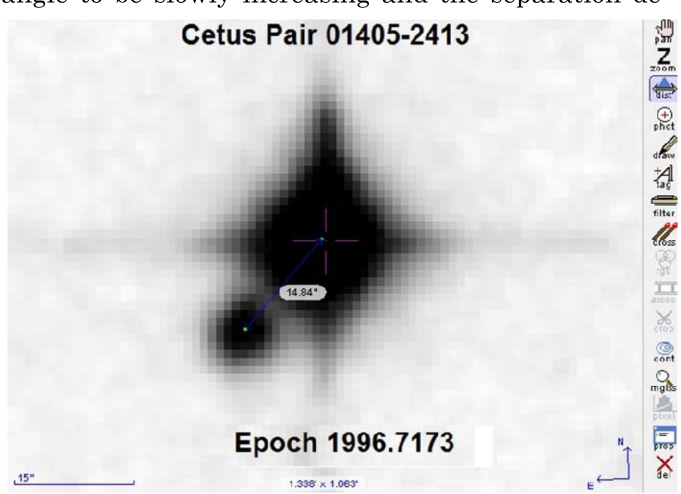


Figure 2 – Image from 1990s POSS 2

A New Common Proper Motion Double Star in Cetus

creasing, hinting at likely orbital motion (Figures 1 and 2).

POSS 1 (RED) PA=137.3, Sep = 15.43" (Epoch: 1954-08-28)

POSS 2 (RED) PA=138.6, Sep = 14.84" (Epoch: 1996-09-18)

Conclusion

In the various methods of fitting the observed photometric values to physical properties, distance and proper motions of this pair discussed in this paper, it seems likely that this is an orbital binary. Measurements over an extended time period going into the future will therefore enable the determination of its orbit in 3D space.

References

1. Ahad, A. 2011 Webb Society Double Star Section Circulars, **19**, 48

2. Ahad, A. 20102 Webb Society Double Star Section Circulars, **20**, 14

3. Ahad, A. 2010 Webb Society Double Star Section Circulars, **18**, 49

4. 2MASS All-Sky Catalog of Point Sources (Cutri+ 2003)

5. UCAC3 Catalog (Zacahrias+ 2009)

Near IR Measurements of Double Stars, I

George Gatewood and Carolyn Gatewood

Sirius Two Observatory
665 Forest Pine Drive
Ball Ground GA, 30107

Gatewood9@att.net
http://www.pitt.edu/~gatewood/

Abstract: We present position angles, separations, and magnitude differences of 28 double stars, including several new systems.

Introduction

After enjoying 37 years at the University of Pittsburgh's Allegheny Observatory, we retired to a small home in the warmer climate of northern Georgia. Our interest in double stars extended throughout our careers and was not quenched by retirement. Within a few years we found ourselves back at the telescope. In the following we list measurements of double stars we have observed from our backyard Sirius-Two (Gatewood and Gatewood 1978) Observatory.

Facility

We made the 16-inch primary mirror for our F/6.63 Newtonian telescope decades ago. The tube and excellent mount were built by Parallax-Instruments. We constructed the building for the telescope from a shed-kit we modified to have a roll-off roof opened with a garage-door opener. The facility includes a floor-level window-fan that brings ground level air into the building beginning early in the day and running until the end of observing. To further control the seeing, two computer-case fans exhaust air from below the primary mirror. A two-inch Barlow lens provides a scale of 0.1952 arc seconds per pixel on a SIBG 402 CCD. The latter includes photometric B, V, and I_C band pass filters with which the delta magnitudes in Table 1 were acquired. The SBIG 402 was chosen because of the optional photometric filters, it's fast shutter speed, and it is relatively inexpensive. The KAF-0402ME sensor is also quite responsive at 0.81 microns (the central wavelength of the I_C filter).

Procedure

Exposures times, of the double stars we observe, range from 0.04 to 16 seconds. CCDOPS is used to control the CCD camera and acquire the images. ASTROPLANNER is used for observational planning and telescope control. ASTROSURF's REDUC is utilized for the determination of the astrometric parameters while Difraction Limited's MAXIM DL 5 is used for photometry. For further guidance we find GUIDE-8 to be an indispensable reference. Because the seeing is somewhat better at longer wavelengths (Fried 1965), the I_C filter is used for most observations. Thus, all of the observations listed in Table 1 include estimates of the magnitude differences of the components in the I_C band (dM_I). In the following we will refer to observations made in the B, V, and I bandpasses only by those letters.

We measure only those images in which the double star is well resolved and the stellar images are compact and round. The program REDUC includes a feature that sorts exposures by the maximum-count in the image of the primary star. For a set of images acquired within seconds of each other and with the same exposure time, this is an excellent measure of the quality of the seeing during each individual exposure. The program next makes available small images of each exposure for visual inspection. This process allows us to select the images acquired during moments of the best seeing. We only observe when "Clear Sky"(http://cleardarksky.com/) predicts the astronomical seeing will be better than average. Only 5 to 20 percent of the images taken are actually reduced, but those selected are competitive with images obtained at very good astronomical sites. The astrometric parameters are computed from the selected images with the program REDUC. The same images are next stacked with MaxIM DL5 and aperture photometry is used to obtain the magnitude difference in each measured band pass. Generally the I_C images produce both the best and the highest percentage of excellent images. The images acquired with the V filter are seldom of the same quality and produce a smaller fraction of useful images. Thus, the results the V band measurements have only about 0.6 times the weight of those obtained with the I_C filter. The B images are generally more difficult and, because the KAF-0402ME sensor is less sensitive in that part of the spectrum, require a significantly longer exposure. Image quality decreases with increased exposure. Thus, the B band produces relatively few useful images and the B magnitude differences are only observed during the best of conditions.

Magnitude Differences

The V magnitude differences, dM_V, are also included for most of the observed double stars. B magnitude differences are listed in the notes for a few systems. We are particularly aware of the value of accurate measurements of the difference in the magnitudes of the components of double stars. For example, studies of the astrometric orbit of a binary star require observations extending over long periods of time. Thus, they often include material from observatory plate files. On these plates the images of the binary star are often blended and the analysis requires knowledge of the magnitude difference of the components at the wavelength of the optical system with which the plates were taken (van de Kamp, 1967).

The value dM_V - dM_I also hints at the nature of the double star system itself and can be useful when combined with additional information about the system. Where A and B represent the brighter and fainter component of the double star respectively, and $dM_V = V_B - V_A$ and $dM_I = I_B - I_A$, a little algebra shows that:

$$dM_V - dM_I = (V\text{-}I)_B - (V\text{-}I)_A \qquad (1)$$

Equation 1) thus yields the value we would get if we could measure the V-I magnitude of each component, of the double star, directly and then find their difference. Since the quantity (V-I) is larger for a cooler star, equation 1) will usually yield a positive value for a binary star composed of a pair of main-sequence stars. If equation 1) yields a significantly negative value, the fainter star is hotter than the primary. This could happen if the primary star is a red giant, or the companion is a white dwarf, or if the companion is a bright background star. For example the primary star of the first three Praesepe doubles (WDS 08404+1940) listed in Table 1 is a red giant and cooler than the secondary star. A similar set of possibilities arise if equation 1 yields a much larger positive value than expected. For example STT268 AB in which the components are so widely separated that they are unlikely to form a physical pair.

Since the difference in the temperature of two stars is related to their difference in absolute magnitude, a positive value resulting from equation 1) usually indicates that, as expected, the fainter star has a lower absolute magnitude. In a study of stars within 8 parsecs of the Sun, at the Space Telescope Institute (http://www.stsci.edu/~inr/8pc.html), the relationship between a star's V-I magnitude and its absolute magnitude was shown to be roughly linear, Fig 1.8. Over a broad range the slope is a little less than 5. Unfortunately the relationship is only approximate, and except in the broadest terms, is dependent upon several things that are usually unknown at this point in their investigation.

Results

Because many of the observations listed in Table 1 are based on less than a statistically significant sample, we have chosen to list weights instead of

(Continued on page 338)

Near IR Measurements of Double Stars, I

Table 1

NAME	WDS	PA	SEP	W	Va-Vb	Ia-Ib	W	DATE	N	notes
STF1066	07201+2159	227.76	5.600	2.4	4.66	4.03	1.1	2012.202	2	1
STF1110AB	07346+3153	56.28	4.831	2.3	0.99	0.87	1.4	2012.115	2	2
HEI 131	07349+1435	20.59	2.685	1.5	0.59	0.58	0.8	2012.203	1	
HEI 51	07436+1445	101.39	2.935	1.8	1.22	1.30	1.2	2012.203	1	
GAT 1	08239+6610	93.45	4.030	1.7	2.40	2.21	1.1	2012.079	2	3
HEI 144	08289+1550	145.48	2.182	2.0	0.67	0.63	0.9	2012.220	1	
STF1254AB	08404+1940	54.42	20.544	1.9	4.04	4.37	1.6	2012.236	1	4
STF1254AC	08404+1940	342.75	63.413	2.4	1.24	2.04	1.6	2012.231	3	5
STF1254AD	08404+1940	43.96	82.710	1.9	2.94	3.46	1.6	2012.236	1	6
S 572CD	08404+1940	90.80	76.227	1.9	1.70	1.41	1.6	2012.236	1	7
HJ 2494	09244+5813	27.56	6.097	2.4	1.99	2.09	1.8	2012.236	1	8
STF1374AB	09414+3857	309.94	2.835	2.6	1.23	1.21	1.0	2012.232	2	
COU2502	09428+4350	134.46	1.848	1.2		0.94	0.7	2012.236	1	
new		208.91	2.379	1.4		2.64	0.8	2011.290	2	9
new		209.76	2.454	1.4		2.61	0.9	2012.203	2	10
STF1472	10470+1302	37.06	43.225	1.7	1.02	0.96	1.2	2012.329	1	
STT 231AB	11111+3027	262.58	34.196	2.3	1.67	1.10	1.0	2012.079	3	11
HJ 1196AB	11456+0354	204.25	45.727	1.7	1.09	0.54	1.0	2012.329	1	12
new, Aa,Ab	11456+0354	157.32	0.809	1.2	0.15	0.04	1.0	2012.329	1	13
STF1579AB,C	11551+4629	41.80	3.863	4.0	1.91	1.98	1.1	2012.237	4	14
STF1579AB,D	11551+4629	113.88	63.047	4.1	0.31	0.37	1.0	2012.239	4	15
HJ 1210	12069+0548	115.45	6.992	2.1	2.36	1.58	1.4	2012.220	1	
COU2103	12185+5037	136.42	2.534	1.8	-0.04	-0.02	1.2	2012.267	1	16
STT 268AB	13309+2414	75.87	19.597	0.5		4.33	0.3	2011.423	1	
STT 268AB	13309+2414	75.82	19.584	3.2	6.01	4.34	1.8	2012.267	1	
H 5 70AC	13309+2414	256.43	76.677	0.6	0.62	0.20	1.8	2011.423	1	
GAT 2Ba,Bb	13309+2414	36.43	1.460	0.5		0.05	0.3	2011.423	1	17
GAT 2Ba,Bb	13309+2414	36.63	1.529	2.7	0.10	0.07	1.8	2012.301	2	18
STF2055	16309+0159	39.28	1.397	5.8	1.028	1.057	2.5	2012.401	1	19
GAT 3AB	18483+5752	113.12	2.270	1.7	5.42	1.69	0.9	2011.594	2	20
stI2390AC	18483+5752	97.79	5.090	1.7	2.85	2.24	0.9	2011.594	2	

<u>NOTES</u>

1. Wasat
2. Castor
3. Russell, J., Gatewood, G., Stein, J.W. 1976, A.J., Vol. 81, 545
4. member of the Praesepe open star cluster
5. member of the Praesepe open star cluster
6. member of the Praesepe open star cluster
7. member of the Praesepe open star cluster
8. the observations of this star approximate a straight line
9. newly discovered companion to Hip 49544
10. 2nd year of observations of new companion of Hip 49544
11. incomplete orbit
12. A is a well resolved double making it difficult to measure dMv or dMi
13. newly discovered companion to STF1579 A
14. A and B are not resolved. dMb=1.952 magnitudes with a weight of 1.0
15. dMb = 0.373 magnitudes with a weight of 0.8
16. the B component is slightly brighter in both V and I
17. newly discovered
18. the newly discovered star is brighter than B
19. Lambda Oph, dMb = 1.053 with a weight of 1.0
20. newly discovered companion, dMv is based on only 2 images

Near IR Measurements of Double Stars, I

Table 2

WDS	NAME	Va-Vb	SIMBAD	Residual
08404+1940	STF1254AB	4.04	3.93	0.11
08404+1940	STF1254AC	1.24	1.26	-0.02
08404+1940	STF1254AD	2.94	2.94	0.00
08404+1940	S 572CD	1.70	1.68	0.02
11111+3027	STT 231AB	1.67	1.64	0.02
11551+4629	STF1579AB,D	0.31	0.45	-0.14
13309+2414	H 5 70AC	0.62	0.55	0.07

(Continued from page 336)

standard errors. We have arbitrarily set a weight of 1.0 to equal the average internal standard error of 5 good images. This value was chosen because we suspect that systematic errors will become an increasingly significant factor in the application of data with a much higher precision. The values reflected by the weights are internal errors only. Our estimate at this time is that a weight of 1.0 indicates a photometric precision of approximately 0.03 magnitudes or better. Similarly a weight of 1.0 indicates astrometric standard error of approximately 0.035 arc seconds or better. We believe that these numbers reflect the short duration of the exposures more than the limitations of the instrumentation or software (Gatewood, G.D. 1987, Gatewood, G. 1991). Since the position angle and separation are derived from measurements made in Cartesian coordinates, the geometrical relationship between the errors of separation and position -angle apply.

Table 1 lists the discovery designation of each star followed by its WDS (Mason, B., G. L. Wycoff, W. I. Hartkopf, online) number. The observed, not adjusted for precession, position angle and separation are followed by the astrometric weight. Next are the observed differences in the V and I magnitudes followed by their weight. As noted above the V magnitudes are usually based on less data. Thus the internal error of the I data is somewhat better than that of the V measurements. Where B magnitude differences are given, in the notes, a weight estimate is also given for that measurement. The epoch of observation, weighted if there is more than one night of observations within a given year, is in fractional Besselian years. The number of nights of observation and a column of note numbers are on the far right of the Table. Individual notes are listed by number at the end of the Table.

As the first in what we hope is a series of papers on double stars, the present work does not contain enough data to determine the systematic or external errors of our observations. Table 2 and Table 3 are a first attempt to put a range on the outcome of more detailed future investigations. Since one of our goals is to provide magnitude differences in the photometric B, V, and I_C bands we compare our data with that found on the SIMBAD http://simbad.harvard.edu/simbad/sim-fid data base for the wide double stars in the present work. The value we list in Table 2 is the difference in the straight mean of the V values listed in the UBV data, on that site for each of the components. We find that this reference material has an average standard error of approximately 0.025 magnitudes. Table 2 lists the WDS number of each double star followed by the dM_V listed in Table 1 and that calculated as noted. The last column is the difference. The average difference is +0.009 magnitudes and the standard deviation is 0.079 magnitudes. We note that both of the largest differences are for stars with a component within 20 arc seconds of the primary and that each photoelectric estimate in these two cases is based upon only one reference. We believe that the magnitude differences in the B, V, and I_C have similar accuracies.

Table 3 is a comparison of the measured position angle and separation with that predicted in the ephemeris listed either in the Sixth Catalog of Orbits of Visual Binary Stars (Hartkopf, W.I. and Mason, B.D. (online) or the Catalog of Rectilinear Elements (Hartkopf, W.I. and Mason, B.D. 2011). We note that the average standard deviation of the differences in the position angles and separations is 0.051 arc seconds. Table 3 lists the WDS number, the discovery designation, and the Besselian epoch date of our observation. This is followed by the observed position angle and separation. Next we list the residual to each of these respectively. The last column is the reference code used in the respective catalog.

Table 3

WDS	NAME	DATE	PA	SEP	O-C PA	O-C SEP	Reference
07201+2159	STF1066	2012.202	227.76	5.600	0.12	0.044	Hop1960a
07346+3153	STF1110AB	2012.115	56.28	4.831	-0.05	0.016	DRs2012
10470+1302	STF1472	2012.329	37.06	43.225	0.11	0.004	Hrt2011c
11456+0354	HJ 1196AB	2012.329	204.25	45.727	0.02	-0.076	Hrt2011c
13309+2414	H 5 70AC	2011.423	256.43	76.677	-0.05	0.079	Hrt2001c
16309+0159	STF2055AB	2012.401	39.28	1.397	0.36	-0.044	Hei1993b

Our ability to estimate the precision and the accuracy of our data will improve as our data base increases. No attempt has been made to adjust any of the data listed in the present manuscript for any suspected systematic error.

Acknowledgements

We would like to thank Brian Mason and William Hartkopf of the US Naval Observatory for their advice and guidance. We would also like to thank Florent Losse for his guidance and the use of his free software REDUC. We have made use of the *Catalog of Rectilinear Elements,* the SIMBAD data base, the *Sixth Catalog of Orbits of Visual Binary Stars*, and the *Washington Double Star Catalog*. We thank the institutions and people who support these ongoing efforts.

References

Fried, D.L. 1965, *J. Opt. Soc. Am.*, **55**, 1427.

Gatewood, George D., and Gatewood, Carolyn V. 1978, *Ap.J,*. **225**, 191

Gatewood, G.D. 1987, AJ, **94**, 213

Gatewood, G. 1991 BAAS, **23**, 1433

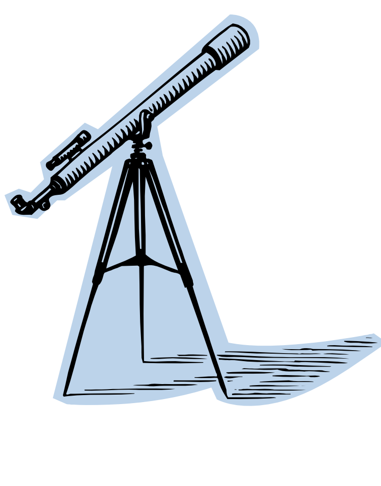
Hartkopf, W.I. and Mason, B.D. (online), *Sixth Catalog of Orbits of Visual Binary* Stars website: http://ad.usno.navy.mil/wds/orb6.html

Hartkopf, W.I. and Mason, B.D. 2011 (online), *Catalog of Rectilinear Elements* website: http://ad.usno.navy.mil/wds/lin1.html

Mason, B., G. L. Wycoff, W. I. Hartkopf (on line), *Washington Double Star Catalog* website: http://ad.usno.navy.mil/wds/

SIMBAD astronomical data base website: http://simbad.harvard.edu/simbad/sim-fid

van de Kamp, P. 1967, *Principles of Astrometry*, W.H. Freeman, San Francisco, page 142



CCD Astrometry of the Multiple Star System Beta 321 in Lepus

Rebecca Church[1], Kakkala Mohanan[1], and Russell Genet[2, 3]

1. University of Hawai'i, Leeward Community College
2. California Polytechnic State University
3. Cuesta College, San Luis Obispo, CA

Abstract: A program of student measurements of visual double stars was initiated at the Leeward Community College with CCD astrometry of the multiple star system Beta 321 in Lepus. Our measurements of the AC component indicated a separation of 89.3 arc seconds and a position angle of 135.5 degrees. We also measured the position angle and separation of three additional components.

In early February 2012, the authors initiated a program of visual double star astrometry at Leeward Community College (LCC). LCC is one of the seven community college campuses of the University of Hawai'i System. LCC has over 6200 students and is located to the west of Honolulu over looking Pearl Harbor about 50 feet above sea level.

The LCC Kilohoku Hale observatory (Figures 1 and 2) is equipped with an Optical Guidance Systems 0.5 meter f/8.2 telescope and an Apogee Alta U6 CCD camera with 24 micron pixels. Our observations were made without any filter (clear). The camera was cooled to -20^{0}C to reduce electronic noise level.

The multiple star systems Beta 321 in Lepus (also known as HD 37624, HIP 26591, SAO 150650, and WDS 05393-1751) was chosen for our initial "learning" observation. Although the AB component was too close for us to resolve (just 0.4 arc seconds), we were able to obtain measurements of the AC, AE, AF and AG components. A 10 second image (Figure 3), obtained on the night of February 2, 2012, had enough stars for an astrometric solution, and we used this frame in our analysis even though the AB and DE components were overexposed.

CCD Soft V5 was used for our astrometric analysis. The astrometric solution included 19 stars. The very bright AB and DE components of Beta 321 were not included in the 19-star astrometric solution as their cores were overexposed.

The .fits image was printed, scanned as

Figure 1: The LCC observatory is not far from Pearl Harbor.

Figure 2: Left to right: Rebecca Church, a student at LCC; Kakkala Mohanan, the astronomy instructor at LCC; and Russ Genet, a visiting astronomer from California.

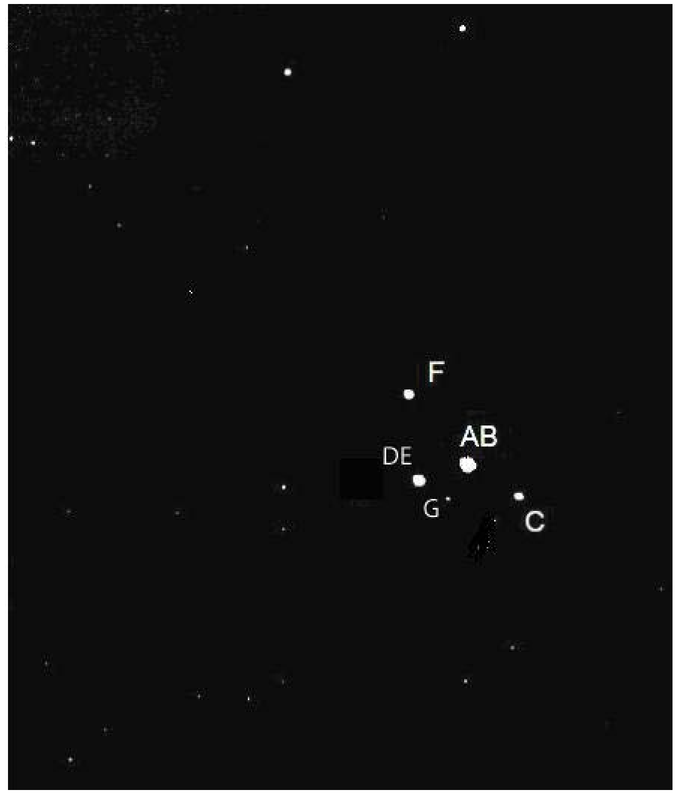


Figure 3: Image of Beta 321 in Lepus used in the analysis.

a .jpeg, and the contrast and brightness were adjusted. It was then pasted into Power Point for the addition of the labels, converted to a .pdf, and finally pasted into a word document. The astrometric solution gave the center of the image as RA 5h 39m 8.410s, and Dec -17d 50m 2.59s, with an image scale of 1.206 arc seconds/pixel and a camera position angle of 100.87 degrees from north.

CCD Soft has a feature (view cursor) that provides the separation and position angle on any two stars clicked in succession that were included in the astrometric solution. For stars not part of the astrometric solution, CCD soft calculates the centroid, although this calculation is not entirely repeatable. We compared our measurements with those reported by Sissy Haas (2006, *Double Stars for Small Telescopes,* Sky Publishing: Cambridge, MA).

Acknowledgements

We thank Tom Smith for his help with CCD Soft, and Joseph Carro for help with labeling the double stars in the CCD image. We are pleased to acknowledge reviews of this paper by John Baxter, Joseph Carro, Sarah Collins, Tom Smith, and Vera Wallen. This research has made use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory.

Table 1: Our measurements of beta 321 as compared with those reported in Haas.

Star Pair	Our Sep (a.s.)	Haas Sep (a.s.)	Delta Sep (a.s.)	Our PA (deg.)	Haas PA (deg.)	Delta PA (deg.)
AC	89.3	89.9	0.6	136.5	138	1.5
AE	75.6	76.0	0.4	8.6	8	-0.6
AF	133.9	132.3	-1.6	299.5	299	-0.5
AG	59.6	N/A	N/A	50.7	N/A	N/A

Journal of Double Star Observations

October 1, 2012
Volume 8, Number 4

The Journal of Double Star Observations is an electronic journal published quarterly by the University of South Alabama. Copies can be freely downloaded from http://www.jdso.org.

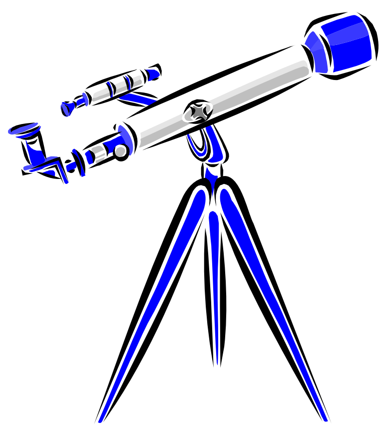
Questions, comments, or submissions may be directed to rclark@southalabama.edu or to rmollise@bellsouth.net

The *Journal of Double Star Observations* (*JDSO*) publishes articles on any and all aspects of astronomy involving double and binary stars. The *JDSO* is especially interested in observations made by amateur astronomers. Submitted articles announcing measurements, discoveries, or conclusions about double or binary stars may undergo a peer review. This means that a paper submitted by an amateur astronomer will be reviewed by other amateur astronomers doing similar work.

Not all articles will undergo a peer-review. Articles that are of more general interest but that have little new scientific content such as articles generally describing double stars, observing sessions, star parties, etc. will not be refereed.

Submitted manuscripts must be original, unpublished material and written in English. They should contain an abstract and a short description or biography (2 or 3 sentences) of the author(s). For more information about format of submitted articles, please see our web site at www.jdso.org

Submissions should be made electronically via e-mail to rclark@southalabama.edu or to rmolise@bellsouth.net. Articles should be attached to the email in Microsoft Word, Word Perfect, Open Office, or text format. All images should be in jpg or fits format.



We're on the web!

http://www.jdso.org