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We have lots of measurements in this issue of the JDSO. Over 800 of them as many hard-working double star astronomers have sent in "annual reports".

Don't miss Jim Daley's article on our old friend Mizar, beginning on the next page. The photograph at right is of the beam interferometer used to achieve the first separation of Mizar, designated PEA Aa in the WDS. (photo courtesy of B. Mason)

Inside this issue:

Stargazers Corner: Focus on Zeta Ursae Majoris - Mizar

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Abstract: : This is a general interest article for both the double star viewer and armchair astronomer alike. By highlighting an interesting pair, hopefully in each issue, we have a place for those who love doubles but may have little interest in the rigors of measurements and the long lists of results. Your comments about these mini-articles are welcomed.

Introduction

My first view of a double star through a telescope was an inspiring sight and just as with many new observers today, the star was Mizar. As a beginning amateur telescope maker (1951) I followed tradition and began to use closer doubles for resolution testing the latest homemade instrument. Visualizing the scale of binaries, their physical separation, Keplerian motion, orbital period, component diameters and spectral characteristics, all things I had heard and read of, seemed a bit complicated at the time and, I might add, more so now! Through the years I found that simply sketching the telescopic appearance of doubles was great fun and my stargazing notes show many such entries. It is only recently that I began to measure doubles from my backyard observatory with homemade telescopes. Certainly, the sight of Mizar, some53 years ago, set the stage.

In this article we journey a little closer to Mizar. Even though the intricacies of this pair were known 100 years ago, it remains a fascinating modern-times object.

Mizar and Alcor

Mizar “the apron” is the 2nd magnitude star marking the bend in the Big Dipper’s handle and is visually partnered with 4th magnitude Alcor just 11.8 minutes of arc away. Alcor is listed in the Washington Double Star Catalog (WDS) as the C component of Mizar (STF 1744 AC) If Alcor “the rider”can be spotted with the naked eye you have reasonably sharp vision. The Arabs long ago named Alcor “Saidak” or “the proof” as they too used it as a test of vision. Alcor shares nearly the same space motion with Mizar and about 20 other stars in what is called the Ursa Major stream or moving cluster. The Big Dipper is considered the closest cluster in the solar neighborhood. Alcor’s apparent separation from Mizar is more than a quarter light year and this alone just about rules out this wide pair from being a physical (in a binary star sense) system and the most recent line-of-sight distance measurements give a difference between them of about 3 light years, ending any ideas of an orbiting pair. When observing Mizar and Alcor together at low power you will see a 7.6 magnitude star between them and somewhat south-southeast. Mizar’s proper motion will carry it to near optical alignment with this fainter star in about 2,600 years, giving future observers a beautiful telescopic triple!

Mizar Itself

The first double star discovered was Mizar. It was found by Benedetto Castelli[1] in 1617 and later independently by Riccioli in 1650 and has remained to this day one of the most popular “showpiece” pairs for the sky watcher. Because of the many discovery and technical “firsts” connected with Mizar, it was later informally dubbed the “pioneer star”. This double is designated STF 1744 AB in the WDS catalog. Its sky coordinates are 13 hours 23.9 minutes in right ascension and +54 degrees 56' in declination. In my 3-inch aperture 20 power finder, the primary (A) and secondary (B) are clearly seen with black sky between

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them. Through the 9-inch main telescope, Mizar is widely split even with the lowest power eyepiece. The 3.8 magnitude secondary is separated from the primary by 14.4 seconds of arc and the position angle is 152 degrees (2000), having slowly increased by 6 or 7 degrees since the first reliable measure by F. G. W. Struve in 1820. Even so, a much earlier measure by Bradley in 1755 is of rather good quality and must be figured in. It is the earliest entry for Mizar in the WDS catalog. My most recent separation measurement (2006) seems to support a very slow closing since 1820.

The orbital period is probably thousands of years, even so it will likely make thousands of orbital trips before the brighter component moves off the main sequence, thus starting its journey to the realm of the giants. This journey, as we shall see, has some unusual complications!

Under very clear skies, both components appear pretty much white to my eyes at 150 power. Sometimes the fainter component looks barely tinged with yellow, but I chock it up to an illusion! They are listed as spectral class A2V for A and A7V for B. This indicates an effective temperature of about 8,800 and 7,500 degrees Kelvin respectively. The V designation indicates that both are main sequence or dwarf stars. The sun is also a dwarf, but less massive and much cooler and would appear a rather dim 6th magnitude star if placed alongside Mizar. The actual distance to the pair is 78 light years and, according to Burnham's Celestial Handbook, the orbital diameter is 5 times bigger than Pluto's. Second in its string of firsts, Mizar was the first double to be photographed, an amazing achievement by Bond in 1857. He used wet plates and the Harvard College Observatory's 15-inch Merz & Mahler "Great Refractor". In a way, this ushered in the field of long focus photographic astrometry! Years ago, as part of Harvard's documentation of the instrument, I had the somewhat nervous pleasure of assisting in the measurement of the individual radii of curvature of this historic doublet .

The Spectrograph and Interferometer Team-Up

Through the Doppler effect, Mizar A was found to be a spectroscopic binary by E. C. Pickering in 1889 by the cyclic doubling of its spectral lines, just beating out H. C. Vogel's discovery of the spectroscopic duplicity of Algol and Alpha Virginis for the first detected example. Probably as an artifact of infrequent observation, Pickering arrived at a false interval of 52 days (orbital period of 104 days) using his objective prism instrument. In 1899-1900 Vogel turned the power of the newer and larger Potsdam double telescope on Mizar; publishing his findings in 1901. Employing a slit type prism spectrograph, Vogel found substantially the same differential radial velocity value as Pickering, however, he determined the interval to be ~10.25 days leading to the modern value of 20.5386 days for the orbital period or about one fifth of Pickering's. In 1925 Francis Pease resolved the pair using the 20- foot beam interferometer attached to the 100-inch at Mt. Wilson (see Figure 1) and determined their separation to be 0.01 arcsecond. The pair is now designated PEA 1 Aa in the WDS Catalog. This was an early example of a spectroscopic pair measured by visual methods, the first being Capella measured by Anderson in 1919 with an earlier interferometer

Figure 1: The 20 ft beam as seen in the Mt. Wilson Interferometer Museum. Photo: courtesy of Dr. Brian Mason.

having its double aperture plate located 24-inches inside focus on the 100-inch. The double star resolution of the stellar interferometer is more than twice that of a single circular aperture.

In the simplest system, two small, say, 6-inch sub apertures are placed over a single large telescope aperture and slowly and symmetrically moved apart until the fringe pattern in the focused star image completely disappears having taken care to align the apertures in the direction of the double's position angle by peaking fringe contrast along the way. At the point of fringe disappearance the resolution (separation of the observed double) is equal to lambda /2D where D is the separation of the duel apertures. If the point of fringe disappearance remains constant for any position angle then it is the star's diameter that is measured, a very rare occurrence and only with the nearest giants! The resolution can be further increased by attaching a long beam to the front of the main telescope and, now with four mirrors, gain greatly on the aperture spacing as was done with the 100-inch with the 20-foot beam.

These basic ideas are nowadays implemented in special interferometers with enormous mirror spacing such as the Navy Prototype Optical Interferometer (NPOI) located on Anderson Mesa in Arizona. To see beautifully reconstructed time-lapse images of Mizar A taken by NPOI see Sky & Telescope November 1996 page 40 and, later, a movie made with the same instrument which can be seen at: http://www.nofs.navy.mil/projects/npoi/science/mizarmov.gif. Both components of Mizar A are the same brightness, mass and spectral class, an optimum condition for top results with both the spectrograph and interferometer

The Evolution of Mizar A

Here we have the interesting situation of two identical stars orbiting only 18 million miles apart. Assuming they evolve synchronously, there will come a time when their expanding gaseous envelopes contact. What a challenging problem for the astrophysicist; will the evolutionary process be somehow altered as the two stars orbit in each others envelope? What occurs during orbit decay? Does one component gain an edge over the other, thus beginning a mass transfer cycle? What sort of giant is finally realized, assuming survival? If the two stars merge, doubling the mass, do we have the seeds of a neutron star?

More About the Doppler Effect

Spectroscopic doubles are revealed by the Doppler effect, which shifts a component's spectral lines redward when it is receding in its orbit and blueward when approaching. In the case of Mizar A the lines of both components are seen equally strong and the maximum differential shift is about two Angstroms or one half thousandth of the visible spectrum. This line doubling in the instance of Mizar and a number of other examples, is easily resolved in a good stellar spectrograph. For most spectroscopic doubles only one spectrum is seen because their companions are too faint. In these single-lined doubles, a relative reference wavelength is usually not observed, so a source, such as an iron arc in olden times, is admitted through the spectrograph slit to provide well known "at rest" spectral lines.

Nowadays various methods of introducing reference lines are employed. For instance, one may place an Iodine vapor cell or a Bromine cell in the optical path to produce extremely sharp and precisely known absorption features. These cells or chambers have thin optical quality windows on each end and are pretty much optically harmless to the spectrograph's image quality. In a pinch one may even use the near IR water vapor and oxygen absorption lines of our own atmosphere which are naturally superimposed on the doubles spectrum. These "telluric" lines (bands) generally tend to be too wide and asymmetrical for the highest precision, but, as an aside, do work reasonably well for amateur radial velocity studies of expanding nova shells.

One may conveniently introduce calibration lines in the traditional way using a low pressure spectral lamp such as Thorium-Argon, sending its light through the top and bottom of the spectrograph's slit with two tiny right angle prisms. Finally, it is possible to observe a close-by field star of non-varying radial velocity and use its lines as a reference for a differential velocity measurement. By bracketing the binary's spectrum with before and after reference star exposures (placed above and below the binary's spectrum) the corrections described below are quite small, however, extreme care must be taken that the "plate" and spectrograph optics are not disturbed during the three exposures.

In the absence of various optical techniques[2] to make the single-lined pair's radial velocity measure differential in nature, one must compensate for the variation in radial velocity caused by the earth's rotation and our rapid speed around the sun. The observation, thus corrected, is called heliocentric or sun centered.

For very short period spectroscopic binaries another correction must be made called "light time". Again, as with the radial velocity corrections, the orbital period is corrected for the moving earth to agree with the measures of a hypothetical sun-centered observer. Without this velocity of light correction the orbit for equatorial objects would be observed as much as 8-minutes early or 8-minutes late depending on our position around the sun.

As mentioned, the actual separation of our subject spectroscopic pair is only 18 million miles and the components are considered detached. Some pair's components are so close to each other that they exchange mass in a barbell or peanut shaped "semi-detached" or even "contact" configurations, one of the best examples being Beta Lyra, just about the most inexplicable double star known.

The Spectrograph and Astrometry Get a Test

Well, the story is not yet finished as Mizar B was also discovered to be a spectroscopic duo! This amazing discovery was by E.B. Frost in 1908. The period of this pair was measured to be about 182 days by various astronomers of the time, however, more recent results have pinned-down the period to 175.55 days. This required pretty sharp spectrographic work for that era.

To top all this off, it has been determined (or at least there are strong indications) through astrometric methods that another member is orbiting the B component at a greater distance with a period of 57 years with a semi-major axis of 0.13 arc seconds. Is Mizar quintuple?

Figure 2 shows a cropped CCD image taken with an SBIG ST-7 CCD camera in photometric I-band light at the 278.82-inch focus of LSO's 9-inch refractor as part of a two night measure of the pair. The seeing was only mediocre, typical of New England conditions.

So, the next time you view beautiful Mizar, form an imaginary image of the astonishing array of stars that make up this busy system.

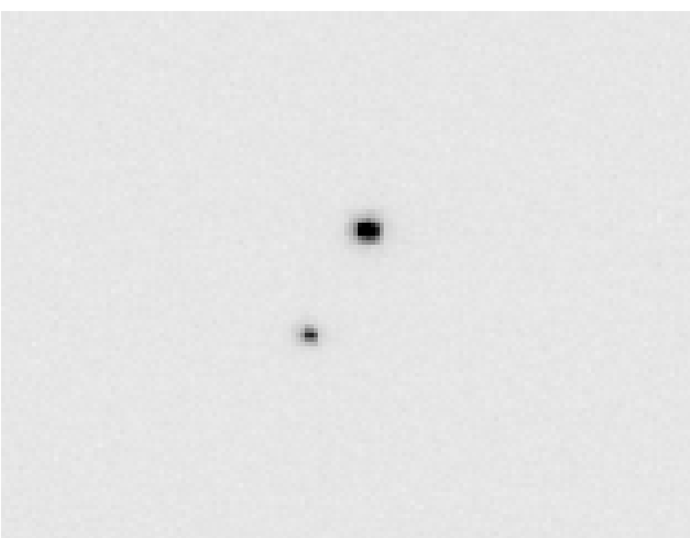

Figure 2: CCD images of Mizar's A and B components. North is up, East left.

Acknowledgements

I wish to thank Dr. Brian Mason for his generous help with many of the historical details in this article.

References

1) Leos Ondra, A new View of Mizar, Sky & Telescope, July 2004, pp 72-75.

2) Frank Gieseking, Measuring Radial Velocities with an Objective Prism, Sky & Telescope, February 1979, pp 142-145.s

Divinus Lux Observatory Bulletin: Report #9

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Abstract: This report contains theta/rho measurements from 85 different double star systems. The time period spans from 2006.345 to 2006.899. Measurements were obtained using a 20-cm Schmidt-Cassegrain telescope and an illuminated reticle micrometer. This report represents a portion of the work that is currently being conducted in double star astronomy at Divinus Lux Observatory in Flagstaff, Arizona.

The previous two articles, in this series, have included a discussion pertaining to the measuring program of 10th magnitude double stars, which has become more of a research priority at Divinus Lux Observatory. As has been mentioned before, many of these pairs have shown up on the "neglected doubles" list, which has been the rationale for targeting 10th magnitude double stars. While this particular emphasis has been in process, it has become apparent that there are many neglected 11th magnitude pairs that are also in great need of current measurements. These pairs appear in the Hipparcos/Tycho star charts, and some of them have been observed in the field of view of my telescope.

Several of these neglected double stars bear the "HJ" prefix, for example, and have not been measured since 1820! I must confess to a degree of frustration when I recover such pairs, because my instrumentation will not allow me to measure 11th magnitude double stars. The illumination from my reticle micrometer overpowers 11th magnitude pairs too intensely to permit these types of measurements with a 20-cm aperture.

Hence, the purpose for pointing this out is to encourage those, with the instrumental capabilities, to consider placing an emphasis upon measuring such pairs. I think that it would be unfortunate if these neglected double stars, which could be easily measured by researchers with larger telescopes, would never receive any attention. An even worse scenario would be for some of these double stars to eventually become lost from the record. As Ron Tanguay has previously stated, since most of the larger observatories are no longer dedicating resources towards this kind of research, it is going to be up to a few dedicated individuals to provide these greatly needed measurements. Because this is the current situation in the field of double star astronomy, I believe that this work could prove to be intrinsically rewarding, all the more, for those who are willing to commit to it.

As has been done in previous articles, the selected double star systems, which appear in this report, have been taken from the 2001.0 version of the Washington Double Star Catalog, with published measurements that are no more recent than ten years ago. There are also some noteworthy items that are discussed pertaining to the following table.

As has been mentioned in previous articles, this one contains measurements of several pairs that have shown significant theta/rho shifts because of proper motion. To begin with, a decrease in the rho parameter, amounting to 12.3% since 1996, has occurred for HJ 1339. Proper motion by both component stars is responsible for this change. Proper motion by the "A" component, in STF 2424 AB, has also caused a significant parameter shift. In this case, a 2 degrees increase in the theta value has occurred since 1996. In a like manner, proper motion by the reference point star, in S 756, has caused a noticeable parameter shift over the past 10 years. For this double star, a 3.2% increase in the rho value has occurred. In addition, proper motion by the "A" component, in BUP 27 AD, is responsible for a 9.4% decrease in the rho value since 1903.

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An increase of almost 3% in the rho value has also occurred for STF 85 AB, since 1991. Proper motions by both component stars, in opposite directions, are responsible for this shift. Also worthy of mention is that it appears STF 502 AB has displayed a decrease in the theta value of approximately 27 degrees since 1940. Proper motion by the "A" component appears to be the cause. Also pertinent to the STF 502 multiple star system is the fact that the entries in the WDS Catalog, for LDS 5514 AB and LDS 5514BC, seem to be duplications of the components for the STF 502 system. The coordinates, reported parameters, and magnitudes for these two multiple stars match up fairly closely.

Four systems are being noted as having possible anomalous measurements in the WDS catalog. For HJ 1582 AC, the theta/rho measurements that appear in this report more closely match those listed for 1896, rather than for those in 1996. In addition, the rho measurement for HJ 1529 lines up more closely with the listed measurement for 1892 than it does for the 1996 listing. Next, the rho measurement for BLL 51 is more in line with the measurement reported in 1879 than the one in 1996. The Hipparcos/Tycho catalogs seem to confirm the values that are listed in this report for these first three systems. Finally, the rho value in this report, for BU 839 AC, coincides more closely with the 1881 listing than it does for the listing in 1996. However, for this system, the Hipparcos/Tycho catalogs fail to lend support for this observation, even though the proper motion vector for the "A" component suggests a more moderate increase for the rho parameter. Because of these discrepancies, additional measurements by others would help to determine if these deviations are real.

The rho values for three additional double stars might also have anomalous catalog measurements. For KU 64 AB, the rho value in this report, in the Hipparcos/Tycho catalogs, and the 1894 catalog listing, suggest a separation of around 33".5, which contrasts with the 1996 catalog value of 35".7. Similarly, in regards to HJ 1834 AD, this report, the Hipparcos/Tycho Catalogs, and an 1895 catalog listing suggest a rho value of around 58".3, while the 1996 catalog value is 60".8. Thirdly, the 1996 rho measurement for STF 3037 AC is listed as 39".5, while this report and the Hipparcos/Tycho catalogs indicate a value of around 27".65. This rho value is more closely aligned with measurements in 1832 for this common proper motion pair. Once again, additional measurements by others would help in determining accurate rho values for these pairs.

This report lists two divergent theta measurements for which there are no apparent explanations. In regards to S 798AC, the theta measurement in the table is listed as 320.8 degrees, but the other catalogs, referenced above, indicate that this value is 318 degrees. The calibration of the micrometer was re-checked and additional measurements were made, but this discrepancy remained. It would be interesting to know the theta value that might be measured by others. The same comment also pertains to STT 20AB. In this case, the same referenced catalogs indicate a theta value of around 316 degrees, while the measurement listing in this report reflects a value of 318.8 degrees.

Orbital motion may be the cause of shifts in the theta value for two common proper motion pairs. A two degrees decrease is noted for STF 2429 since 1996, and a four degrees decrease has been measured for STF 2481 A-BC during the same time period.

Also included in this report are listings for three possible common proper motion pairs that do not appear to have been previously cataloged. The first, labeled as ARN 87, is located at 01563+3758. This double star appears in the same field of view, at low power, as the ES 228 multiple star system. The second pair, labeled as ARN 88, has coordinates of 01286+1440, and it is located near AG 18. The third double star, designated as ARN 89, can be located at 03150+5436.

One correction to the WDS catalog is also being pointed out. In reference to the STF 1999 system, the catalog theta measurement for the "AD" components is reversed. The measurement is actually for "DA," and the "D" component is also the "A" component for the STF 1998 system. Because STF 1998 and STF 1999 are listed as separate systems, and certainly appear that way telescopically, perhaps the "AD" measurement has little utility. This may be especially true since the rho measurement for "AD" is almost 280.0".

A second possible correction to the WDS catalog is being suggested for HJ 1721. The rho measurement listed in this report, and in the Hipparcos/Tycho catalogs, indicate a value of around 12.34" instead of the 17.4" value that is listed in the catalog for 1996. The proper motions of the component stars don't appear to be large enough to support this larger rho value. Perhaps a typographical error has occurred in this case.

Thirdly, an error exists for the catalog listing pertaining to ES 228 AB-C. The theta/rho measurements designated for this system are actually those for the “CD” components, rather than for the “AB-C” components. The current “neglected doubles” listing correctly shows the parameters as belonging to the “CD” components. The table below gives corrected theta/rho values for “AB-C.”

Fourth, a typographical error may have also occurred for STF 2982. The rho values in this report, in the Hipparcos/Tycho catalogs, and for the year 1831 all cluster around 32”.6. The WDS catalog value for 1996 is listed as 36”.6. Because this double star is a relatively fixed pair, it is unlikely that the 1996 listing is valid.

Finally, it appears that HU 1651 (01283+5329) is a quadrant flip of STF 123 AB. The coordinates and magnitudes of the components are the same. Furthermore, the parameters are similar when proper motion and the apparent quadrant flip are taken into account. HU 1651 was last listed as measured in 1902 and does not appear in the table. STF 123 AB was last measured in 2003

NAME	RA DEC	MAGS	PA	SEP	DATE	N	Notes
STF1999 AB	16044-1127	7.4 8.0	98.9	11.85	2006.345	1n	1
STF1999 DA*	16044-1127	4.3 7.4	171.0	278.48	2006.345	1n	1
STF2056	16316+0526	7.7 9.2	313.1	6.91	2006.345	1n	2
STF2085	16424+2136	7.4 9.1	309.7	6.42	2006.345	1n	3
STF2165 AB	17262+2927	7.7 9.4	61.2	9.88	2006.345	1n	4
STF2165 AC	17262+2927	7.7 10.3	250.9	95.79	2006.345	1n	4
STF2246	17554+3930	9.3 10.0	99.8	5.43	2006.345	1n	5
STT 165 AB	18060+0434	8.4 8.5	141.9	66.66	2006.403	1n	6
STF2280 Aa-B	18078+2606	5.8 5.8	183.5	13.83	2006.345	1n	7
HJ 1339	18404+4606	8.5 10.0	321.8	22.71	2006.403	1n	8
STF2429	18584+3625	8.3 9.9	285.2	5.43	2006.403	1n	9
STF2424 AB	18591+1338	5.3 9.3	301.1	19.75	2006.403	1n	10
STF2481 A-BC	19111+3847	8.2 8.3	199.1	4.44	2006.403	1n	11
STF2534	19277+3632	8.2 8.4	65.0	6.91	2006.403	1n	12
STF2552	19379+1922	8.5 9.1	194.9	5.43	2006.460	1n	13
STT 384 AC	19438+3819	7.6 9.8	296.8	59.25	2006.403	1n	14
STT 194	19536+5943	6.1 9.0	356.3	68.14	2006.479	1n	15
STT 390 AB	19551+3012	6.7 9.5	22.2	9.38	2006.403	1n	16
STF2611	19588+4721	8.3 8.4	27.4	5.43	2006.403	1n	17
STF2655 AB	20141+2213	7.9 8.0	2.7	6.42	2006.479	1n	18
STF2655 AC	20141+2213	7.9 10.0	155.5	60.24	2006.479	1n	18
S 756	20313+4913	5.4 10.2	327.2	60.24	2006.460	1n	19
HJ 1529	20334-0613	7.0 10.4	110.2	37.03	2006.460	1n	20
SCJ 26	20348+0514	8.3 10.0	88.5	24.69	2006.460	1n	21
BLL 51	20431+1705	9.4 8.5**	339.4	56.29	2006.479	1n	22

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NAME	RA DEC	MAGS	PA	SEP	DATE	N	Notes
HJ 1582 AC	20498+3833	8.2 10.5	326.0	28.64	2006.460	1n	23
STT 212	20535+3057	7.9 10.1	155.1	65.18	2006.460	1n	24
STF2762 AC	21086+3012	5.7 10.1	229.2	59.25	2006.479	1n	25
STT 216	21143+3418	7.4 8.1	46.7	100.73	2006.479	1n	26
BU 839 AC	21203+4921	8.1 9.6	200.3	21.73	2006.479	1n	27
HJ 1647 AB	21290+2211	5.9 10.2	177.8	41.48	2006.521	1n	28
S 798 AC	21442+0953	2.4 8.7	320.8	144.18	2006.521	1n	29
HJ 1721	22057+2954	7.8 9.3	265.8	12.34	2006.521	1n	30
KU 64 AB	22227+2849	10.1 10.6	159.9	33.58	2006.521	1n	31
STT 232 AB	22235+0351	9.2 9.4	193.8	75.05	2006.597	1n	32
AG 422	22324+5313	9.2 10.0	35.1	9.38	2006.521	1n	33
STF2922 Aa-B	22359+3938	5.7 6.3	185.6	22.71	2006.521	1n	34
A 1469 Aa-D	22359+3938	5.7 9.1	144.8	80.98	2006.521	1n	34
A 1469 Aa-E	22359+3938	5.7 7.2	238.8	333.78	2006.521	1n	34
HJ 1834 AD	22582+3022	8.5 9.5	271.0	58.26	2006.521	1n	35
STF2982	23095+0841	5.1 10.0	197.5	32.59	2006.597	1n	36
STF3037 AC	23461+6028	7.2 9.8	187.1	27.65	2006.655	1n	37
STF3037 AD	23461+6028	7.2 10.7	232.5	51.84	2006.655	1n	37
STF3037 AE	23461+6028	7.2 9.7	63.4	109.61	2006.655	1n	37
STF3039 AB	23469+2825	7.2 9.3	29.8	35.06	2006.597	1n	38
STF3042	23519+3753	7.6 7.7	86.9	5.93	2006.597	1n	39
HJ 1927	00032+4508	9.1 10.1	73.7	10.37	2006.597	1n	40
LDS 860	00096+1145	10.6 10.6	43.6	289.34	2006.879	1n	41
STF 4	00099+0827	9.4 9.5	275.2	5.43	2006.655	1n	42
HDS 44	00203+5412	8.9 10.3	32.1	12.34	2006.597	1n	43
STF 42 AB	00360+2959	8.3 9.0	21.2	6.42	2006.597	1n	44
BUP 9 AD	00473+2416	4.1 10.7	260.2	155.53	2006.879	1n	45
STF 61	00499+2743	6.3 6.3	294.0	4.44	2006.597	1n	46
BU 232 AB-C	00504+5038	8.4 10.0	298.3	25.18	2006.597	1n	47
STF 80 AB	00594+0047	7.6 8.9	337.3	28.64	2006.655	1n	48
STF 85 AB	01044-0518	8.6 10.5	159.1	36.04	2006.655	1n	49
STF 86 AB	01048-0528	8.7 9.2	138.5	16.29	2006.655	1n	50
STF 97	01122+5132	8.7 9.1	101.6	4.44	2006.655	1n	51
ARN 88 *	01286+1440	9.6 10.7	253.4	23.70	2006.885	1n	52

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NAME	RA DEC	MAGS	PA	SEP	DATE	N	Notes
STT 554 AC	01368+4124	4.1 10.3	290.8	271.56	2006.885	1n	53
STT 20 AB	01376+2233	7.8 8.8	318.8	88.88	2006.732	1n	54
HU 531 AB-C	01409+4952	9.8 9.9	280.1	5.93	2006.745	1n	55
HJ 1088	01423+5838	6.4 9.8	169.0	19.75	2006.789	1n	56
STF 176	01495+2842	8.6 10.5	330.5	23.70	2006.885	1n	57
BUP 27 AD	01531+2935	3.4 10.7	174.2	276.50	2006.885	1n	58
HDS 259	01545+5954	8.3 10.1	211.8	16.78	2006.789	1n	59
ARN 87 *	01563+3758	9.0 10.5	284.2	56.29	2006.745	1n	60
ES 228 AB-C	01569+3759	8.9 9.1	192.2	37.53	2006.745	1n	61
PWL 1 AC	02020+0246	4.1 8.2	63.3	404.88	2006.888	1n	62
PWL 1 AD	02020+0246	4.1 8.5	334.5	434.50	2006.888	1n	62
KUI 118	02084+2819	9.9 10.6	181.1	20.74	2006.888	1n	63
STF 239	02174 +2845	7.0 7.8	212.1	13.83	2006.732	1n	64
STF 240	02174+2353	8.3 8.6	52.2	4.94	2006.732	1n	65
KU 76	02235+2623	9.8 10.4	349.4	32.09	2006.888	1n	66
STF 258 AC	02239+3330	7.9 10.1	150.7	71.10	2006.888	1n	67
STF 258 CD	02239+3330	10.1 10.5	30.2	6.42	2006.888	1n	67
STF 280	02341-0538	7.8 7.9	345.6	3.46	2006.732	1n	68
STF 291 AB	02411+1848	7.7 7.5**	119.0	3.46	2006.789	1n	69
STF 291 AC	02411+1848	7.7 9.5	242.1	65.18	2006.789	1n	69
LDS2816	02588+4322	6.6 9.5	281.5	243.91	2006.899	1n	70
STF 336	03015+3225	6.8 8.2	8.0	8.39	2006.732	1n	71
STF 354	03081+2435	9.2 10.4	51.8	35.55	2006.899	1n	72
AG 63 Aa-B	03138+3733	9.8 10.2	127.4	5.43	2006.732	1n	73
ARN 89 *	03150+5436	10.4 10.5	14.7	34.56	2006.899	1n	74
KU 80	03232+2412	10.2 10.4	181.1	27.65	2006.899	1n	75
STF 426 AB	03408+3907	7.8 9.3	343.1	19.75	2006.789	1n	76
STF 434 AB	03440+3822	7.6 8.2	82.8	33.08	2006.789	1n	77
S 437 AB-C	03463+2411	8.1 7.6**	308.3	39.50	2006.789	1n	78
HDS 486	03530+4557	8.5 10.2	311.5	16.79	2006.789	1n	79
STF 502 AB	04112+2630	8.8 10.1	246.3	16.29	2006.803	1n	80
STF 502 BC	04112+2630	10.1 10.1	299.5	10.86	2006.803	1n	80
STF 512	04158+4524	8.7 8.7	217.9	5.43	2006.789	1n	81
BU 86 AB	04158+2331	9.6 10.1	50.5	4.44	2006.789	1n	82

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NAME	RA DEC	MAGS	PA	SEP	DATE	N	Notes
STT 49	04189+0146	7.8 7.8	145.5	100.73	2006.803	1n	83
STF 533AB	04244+3419	7.3 8.5	61.6	19.75	2006.789	1n	84
STF 572AB	04385+2656	7.3 7.2**	189.7	4.44	2006.789	1n	85

* Not listed in WDS CATALOG.

** Companion star is the brighter component.

Notes

1. In Scorpius. AB = cpm; pa. dec. DA = sep. dec. Spect. K0, K0, F8.
2. In Hercules. Common proper motion; p.a. decreasing. Spect. A3, A3.
3. In Hercules. Separation slightly increasing. Spect. A0IV, A0.
4. In Hercules. AB = sep. & p.a. inc. AC = sep. dec. Spect. AB = F0, Am.
5. In Hercules. Position angle decreasing. Spect. G0, G0.
6. In Ophiuchus. Relatively fixed. Spect. K0III, A0.
7. 100 Herculis. Relatively fixed. Common proper motion. Spect. A3V, A3V.
8. In Lyra. Sep. & p.a. decreasing. Spect. M2.
9. In Lyra. Common proper motion; p.a. decreasing. Spect. F0V, F0V.
10. 11 Aquilae. Position angle increasing. Spect. F6IV.
11. In Lyra. Common proper motion; p.a. decreasing. Spect. G6V, G7V.
12. In Cygnus. Position angle increasing. Spect. B9III, A0.
13. In Vulpecula. Relatively fixed. Common proper motion. Spect. A2, A2.
14. In Cygnus. Relatively fixed. Spect. B5V.
15. In Cygnus. Sep. & p.a. decreasing. Spect. A3V.
16. In Cygnus. Relatively fixed. Spect. B6V, B6V.
17. In Cygnus. Relatively fixed. Common proper motion. Spect. K0, K0.
18. In Vulpecula. AB = relfix; cpm. AC = sep. & p.a. inc. Spect. A2V, A0, K.
19. Omega or 46 Cygni. Sep. & p.a. increasing. Spect. M2III, G.
20. In Aquila. Position angle increasing. Spect. M3III.
21. In Delphinus. Sep. & p.a. slightly increasing. Spect. M5, M.
22. In Delphinus. Sep. increasing; p.a. decreasing. Spect. M5, K5.
23. In Cygnus. Relatively fixed. Spect. M
24. In Cygnus. Relatively fixed. Spect. B9V, A5.
25. In Cygnus. Sep. & p.a. increasing. Spect. B9V.
26. In Cygnus. Relatively fixed. Spect. B8, A2.
27. In Cygnus. Sep. slightly increasing; p.a. increasing. Spect. M6III.
28. In Pegasus. Position angle slightly increasing. Spect. M4.
29. Epsilon or 8 Pegasi. Sep. increasing; p.a. decreasing. Spect. K2II, F8.
30. In Pegasus. Sep. increasing; p.a. decreasing. Spect. M0, G.
31. In Pegasus. Relatively fixed. Spect. M5.
32. In Pegasus. Sep. & p.a. increasing. Spect. G5.
33. In Lacerta. Common proper motion. Slight increase in p.a. Spect. M2, M5.
34. 8 Lacertae. Aa-B = relfix. Aa-D & Aa-E = sep. dec. Spect. B2V, A0, A0, F0.
35. In Pegasus. Relatively fixed. Spect. M0, M0.
36. 57 Pegasi. Relatively fixed. Spect M2.

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37. In Cassiopeia. AC = cpm. AD = p.a. inc. AE = relfix. Spect. AE = K0, A0.
38. In Pegasus. Sep. increasing; p.a. decreasing. Spect. M0.
39. In Andromeda. Common proper motion; p.a. slightly dec. Spect. F5V, F5.
40. In Andromeda. Sep. & p.a. decreasing. Spect. F8, F5.
41. In Pisces. Relatively fixed. Spect. G5, G5.
42. In Pisces. Common proper motion; p.a. increasing. Spect. G5, G5.
43. In Cassiopeia. Position angle increasing. Spect. B3, B3.
44. In Andromeda. Sep. inc; p.a. dec.; common proper motion. Spect. G2V, G2V.
45. Zeta or 34 Andromedae. Sep. decreasing; p.a. increasing. Spect. K1II.
46. 65 Piscium. Relatively fixed. Common proper motion. Spect. F5III, F5III.
47. In Cassiopeia. Sep. decreasing; p.a. increasing. Spect. F5, G.
48. In Cetus. Sep. & p.a. increasing. Spect. K0, G5.
49. In Cetus. Separation increasing. Spect. G0.
50. In Cetus. Sep. increasing; p.a. decreasing. Spect. F2.
51. In Cassiopeia. Common proper motion; p.a. slightly inc. Spect. A0, A0.
52. In Pisces. Common proper motion. Spect. K2, F5.
53. 50 Andromedae. Sep. decreasing; p.a. increasing. Spect. F8V, F2.
54. In Pisces. Sep. decreasing; p.a. increasing. Spect. F6V, F5.
55. In Andromeda. Relatively fixed. Common proper motion. Spect. K1V, K1V.
56. In Cassiopeia. Slight increase in p.a. Spect. B7III, B9.
57. In Triangulum. Increase in p.a. Spect. K0III.
58. Alpha or 2 Trianguli. Sep. decreasing. Spect. F6IV.
59. In Cassiopeia. Sep. slightly increasing. Spect. B9IV, B9IV.
60. In Andromeda. Possible common proper motion. Near ES 228. Spect. K0.
61. In Andromeda. Sep. slightly increasing. Spect. G, G.
62. Alpha or 113 Piscium. AC = relfix. AD = sep. dec. Spect. A0, F8, G0.
63. In Triangulum. Relatively fixed. Common proper motion. Spect. G5.
64. In Triangulum. Relatively fixed. Common proper motion. Spect. F5V, G2V.
65. In Aries. Common proper motion; p.a. increasing. Spect. F0, F0.
66. In Aries. Decrease in p.a. Spect. A5, F5.
67. In Triangulum. AC = p.a. inc. CD = p.a. inc., cpm. Spect. A0, G, G.
68. In Cetus. Common proper motion; p.a. decreasing. Spect. K1III, K1III.
69. In Aries. AB = sep. inc. AC = sep. & p.a. inc. Spect. B9.5V, B9, F0.
70. In Perseus. Sep. slightly decreasing. Spect K0, F8.
71. In Perseus. Relatively fixed. Common proper motion. Spect. A7IV, A7IV.
72. In Aries. Sep. increasing; p.a. decreasing. Spect. F5.
73. In Perseus. Relatively fixed. Common proper motion.
74. In Perseus. Possible common proper motion pair.
75. In Aries. Slight increase in p.a. Spect. G5.
76. In Perseus. Common proper motion; p.a. increasing. Spect. A3, A3.
77. In Perseus. Sep. increasing; p.a. decreasing. Spect. K5III, A5.
78. In Taurus. Sep. & p.a. increasing. Spect. A3, K2.
79. Relatively fixed. Spect. B9, B9.
80. In Taurus. AB = p.a. decreasing. BC= p.a. slightly decreasing. Spect. F8V.
81. In Perseus. Common proper motion; p.a. decreasing. Spect. G5, G5.
82. In Taurus. Relatively fixed. Common proper motion. Spect. F5.
83. In Taurus. Separation slightly decreasing. Spect. G5, A2.
84. In Perseus. Relatively fixed. Common proper motion. Spect. B8V, F8V.
85. In Taurus. Sep. increasing; p.a. decreasing. Spect. F2V, F2V.

Neglected Double Observations for 2006, No. 2

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Abstract: I report the observational results for 64 "neglected doubles" and 19 additional doubles found between 10.0hr and 16.59 hr RA and +0º and +40º DEC made with the AREO2 robotic telescope located at the RAS Observatory, Mayhill, NM, USA (http://www.remote-astronomical-society.org/). In addition to theta and rho values (and standard deviations), I report the UCAC2.0, Tycho 2, 2MASS, or GSC 2.2 catalog numbers of pairs, some of which lack precise positional information.

Introduction

In this paper, I report a total of 83 mean and standard deviations of theta and rho-values of double stars imaged with a Takahashi Mewlon 300 Dall-Kirkham cassegrainian reflector located at the GRAS Observatory in Mayhill, New Mexico. The instrument, with a focal reducer, works at F9.1, with an approximate focal length of 2730mm. It is equipped with a non-antiblooming ST8E CCD camera (9 micron pixels) and the combination has an approximate resolution of 0.6 arcseconds/pixel with a field of view of 11.5 x 17.3 arcminutes. The OTA is mounted on a Bisque Paramount 1100 GEM.

Methods

Methods largely follow Wiley (2006). Observing lists were requested from the USNO (Mason, 2006). Queries were conducted via VizieR Catalogue Service (Ochsenbein et al., 2000) at the CDS, Strasbourg, and the region visualized using Aladin, based on positional information in the Washington Double Star Catalog (Mason *et al*, 2001, *et seq*.). A search of the DSS plate was made for the pair by comparing data in the WDS catalog with the plate image. UCAC2.0 catalog numbers were harvested if associated with the pair in question and a hard copy of the region was printed to use as a finding aid. Pairs or components that lacked UCAC2.0 catalog information were then queried in Guide8 (Project Pluto, 2006) and matched with one or more additional catalogs: Tycho-2 (Schwekendiek and Wicenec, 2000), GSC 2.2 (STScI, 2001), or 2MASS (Skrutskie et al., 2006) via VizieR. Catalog numbers were harvested.

Exposures were carried out with a clear filter and the initial image was checked by downloading a JPEG of the FITS image to insure that the correct field was imaged. Exposures ranged from 12-30 seconds. If the exposure looked acceptable, then a minimum of three additional images were made. If not, then exposure times were adjusted and rechecked. MPO Canopus was used to reduce the images (Warner, 2006). It produces an astrometric solution to the image based on the UCAC 2.0 catalogue (Zacharias et al., 2004). The pair was measured using a convenient double star harvesting subroutine built into MPO Canopus. Figure 1 shows a Sloan Digital Sky Survey image of HJ 489, which is interesting because of its proximity to the spiral galaxy NGC 3344.

Results

Table 1 presents results for 64 neglected doubles not measured in the past 50+ years bounded by 10.0 hr to 16.59 hr RA and +0º to +40 º DEC. In addition, Table 1 also contains measures of 19 doubles thought to be neglected, but which have appeared in the WDS Catalog after the observing request was made. Catalog numbers are UCAC2.0 (no prefix), GSC2.2 (N prefix), Tycho-2 (T prefix) and 2MASS unique identifier

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Neglected Double Observations for 2006 No. 2

WDS Cat.	Desc.	Catalogue/p	Catalogue/s	Magnitudes	PA	PAsd	SEP	SEPsd	Epoch	No Obs	Notes
10002+2058	CHE 146	39146321	39146322	12.08, 13.54	35.6	0.14	29.51	0.069	2006.217	4	1,2
10026+2420	POU3070	N23110045	40351827	13.66, 14.92	264.9	NA	9.59	NA	2006.23	1	1
10064+0359	HJ 1175	33043755	33043757	11.79, 13.19	97.3	0.11	19.54	0.047	2006.315	5	1
10077+2255	POU3073	39849067	39849066	12.89, 14.55	347.6	0.78	10.90	0.082	2006.23	4	1
10125+0245	BAL2370	32703057	32703056	11.68, 12.61	352.2	0.14	19.79	0.043	2006.315	4	1
10129+0158	BAL1869	32369081	32369080	9.63, 13.13	256.4	1.93	8.63	0.182	2006.315	4	1, 3
10141+0145	BAL1871	T 245-00683-1	32369118	11.34, 12.48	168.3	0.17	14.50	0.053	2006.315	4	1
10157+1424	HJ 155	36824555	36824558	12.18, 12.52	147.3	0.06	14.30	0.039	2006.315	4	1
10202+2806	HJ 479	41713772	41713771	12.17, 12.96	200.4	0.03	32.62	0.058	2006.217	4	1, 4
10226+2238	POU3079	N203003156	N203003155	12.79, 13.59	29.7	0.4	9.65	0.07	2006.217	4	1
10250+3117	HJ 480	42755610	42755611	12.78, 13.11	71.8	0.35	14.63	0.039	2006.23	4	1
10302+3050	SEI 520	42582878	42582879	11.59, 11.82	2.3	0.33	7.76	0.081	2006.225	5	1
10385+2725	HJ 5481	41370088	N2011311207	10.03, 12.54	113	0.17	15.16	0.056	2006.217	4	1
10436+2455	HJ 489	40518599	40518597	10.0, 11.48	289.4	0.04	43.45	0.011	2006.211	4	1
10509+3143	MLB 846	N20112324069	N20112324070	13.29, 13.85	255.3	0.33	8.31	0.208	2006.291	4	1
11034+2145	ELS 1	39490758	39490757	12.85, 13.64	358.5	0.28	12.65	0.099	2006.225	5	1
11072+3204	SEI 523?	43102166	43102167	12.09, 12.55	77.9	0.06	23.29	0.029	2006.225	4	1, 5
11088+4815	ES 922 AC	T 3447-119-2	47825756	9.46, 12.30	169.1	0.05	45.97	0.08	2006.225	4	1
11390+1001	HJ 184	35399932	35399934	11.78, 12.25	156.7	0.07	21.9	0.069	2006.315	4	1
11412+0950	HJ 187	35216585	35216586	10.60, 11.74	11.4	0.13	9.35	0.061	2006.315	4	1
11448+1230	HJ 1195	N2001223130	N2001223129	11.86, 12.46	328.2	0.39	10.62	0.033	2006.315	5	1
11449+2346	POU3112?	40189882	N201202179	11.40, 13.26	317.7	0.3	22.12	0.072	2006.291	4	1
11485+0046	HJ 1199	32039235	32039237	10.93, 11.67	46.2	0.07	27.76	0.06	2006.315	4	1
11511+0407	HJ 1202	33226055	N2000322100	11.44, 13.18	260.9	0.15	17.02	0.061	2006.315	4	1
11582+0335	HJ 1204	33047912	33047913	11.40, 11.84	59.4	0.49	8.32	0.031	2006.315	5	1
12156+1454	HJ 3337	37006990	N120233316	11.28, 12.83	170.0	0.08	38.68	0.126	2006.324	4	1
12199+1519	LDS 936	37186725	37186729	11.20, 12.49	129.3	0.42	43.15	0.371	2006.324	4	1
12297+2837	HJ 3339	41889462	41889463	11.00, 12.90	157.4	0.12	19.85	0.067	2006.291	4	1
12519+0940	HJ 849	35218657	35218656	11.27, 12.17	257.8	0.15	11.32	0.017	2006.324	4	1

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Neglected Double Observations for 2006 No. 2

WDS Cat.	Desc.	Catalogue/p	Catalogue/s	Magnitudes	PA	PAsd	SEP	SEPsd	Epoch	No Obs	Notes
13032+2413	POU3132	40356567	40356565	13.32, 13.61	291.5	0.77	11.08	0.118	2006.291	4	1
13052+0912	GEL 1	Wolf 472	Wolf 473	13.18, 13.52	56.8	0.19	25.33	0.09	2006.324	5	1, 6
13202-0008	BAL1164	31691901	31691900	12.02, 12.38	248.4	0.16	19.41	0.022	2006.326	4	1
13232+4318	ES 1547 AB	46703551	46703550	11.56, 11.73	328.6	0.14	24.88	0.089	2006.291	4	1
13379+2421	POU3146	40357460	40357461	12.04, 12.87	54.7	0.47	12.04	0.054	2006.291	4	1
13422+2307	HJ 2672	40026241	40026240	11.48, 12.58	311.5	0.09	39.56	0.067	2006.291	5	1
13430+4710	HJ 2675	47642564	N130312020	12.13, 12.86*	294.4	0.32	14.24	0.026	2006.291	4	1
13460+1216	HJ 2678	36125543	36125545	11.31, 13.31	120.0	0.05	25.44	0.023	2006.326	4	1
13480-0047	BAL 878	31513824	31513825	11.47, 12.4	60.5	0.25	22.37	0.077	2006.326	4	1
13488+1244	LDS 949	36303769	B 0975-07296823	11.33, 12.34	29.1	0.18	16.62	0.111	2006.326	4	1
13494+0524	HJ 1242	33580479	33580481	10.70, 11.9	118.5	0.04	10.56	0.043	2006.326	4	1
13497+2328	POU3152	40026421	40026422	12.05, 12.25	0.8	0.16	13.77	0.054	2006.291	4	1
13569+0158	BAL1892	32376973	N 12121223646	11.12, 11.89	26.0	0.10	13.32	0.038	2006.326	4	1
14031+1154	HJ 2699 AB	35943320	N121321073	8.50, 12.07	9.5	0.09	35.02	0.061	2006.326	4	1
14031+1154	HJ 2699 BC	N121321073	N121321071	12.07, 12.29	297.4	0.24	13.94	0.026	2006.326	4	1
14042+2046	J 1128 A-BC	39152673	39152672	9.79, 10.99	190.4	0.22	62.41	0.124	2006.291	5	1
14143+3411	HJ 543	43796090	43796089	12.6, 12.84	241.9	0.31	13.4	0.095	2006.384	4	1, 7
14159+0041	BAL1464	32044654	32044653	10.84, 12.93	229.7	0.38	5.31	0.261	2006.326	4	1
14172-0012	BAL1171	31694116	31694113	10.69, 11.68	217.7	0.06	21.24	0.035	2006.384	4	1
14235+2621	HJ 2715	41030478	N133232180	11.45, 11.98	327.7	0.09	14.02	0.017	2006.384	5	1
14331+2526	HJ 2730	40695708	40695707	11.44, 12.80	303.1	0.06	27.14	0.035	2006.384	4	1
14344+1414	HJ 239	36831721	36831722	11.87, 12.80	100.1	0.22	17.35	0.035	2006.384	4	1
14365+1104	LDS 964	N1310203261	N1310203259	12.48, 12.76	14.2	0.36	11	0.128	2006.384	4	1
14410+0332	HJ 1257	33053658	33053655	10.49, 11.26	242.3	0.06	35.46	0.039	2006.384	4	1
14434+2014	STF3088 AD?	38982375	38982372	10.01, 11.99	297.0	0.15	22.66	0.044	2006.384	4	1, 8
14490+0321	BAL2400	32879432	32879431	11.97, 12.70	302.5	0.53	9.91	0.069	2006.384	4	1
14551+2323	POU3177	N 131300163	N 131300164	12.52, 13.00	174.0	0.08	8.05	0.125	2006.384	4	1
15010+0619	HJ 1265	N 3130322297	N 3130322296	11.96, 13.38	271.5	0.14	9.45	0.127	2006.384	4	1
15031+0421	BAL2866	33233399	N1310033364	11.44, 11.69	127.4	0.34	10.84	0.113	2006.384	5	1

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Neglected Double Observations for 2006 No. 2

WDS Cat.	Desc.	Catalogue/p	Catalogue/s	Magnitudes	PA	PAsd	SEP	SEPsd	Epoch	No Obs	Notes
15049+1014	WFC 161	35406828	35406831	10.48, 11.78	83.7	0.10	33.61	0.05	2006.428	5	1, 2
15104+2410	POU3180	40360230	40360228	11.03, 12.43	304.0	0.13	18.51	0.086	2006.518	4	1
15127+0326	HJ 3344	32880643	32880644	13.31, 13.94	127.4	0.46	9.54	0.054	2006.428	4	1
15141+0143	HJ 1269	32380812	N102003360	9.11, 12.18	243.4	0.06	26.93	0.067	2006.428	4	1
15299+0552	GAU 14	33765885	33765884	11.66, 12.32	264.1	0.13	9.03	0.064	2006.428	4	1, 9
15413+0007	BAL1177	31878666	31878665	11.57, 12.15	268.3	0.06	22.52	0.069	2006.428	4	1, 10
15413+0007	WLY 7 BC	31878665	2M980061819	12.15, 12.09	33.2	0.57	5.4	0.076	2006.428	4	1, 10
15420+0156	BAL1906	32382668	32382666	11.68, 12.44	254.3	0.06	16.77	0.012	2006.428	4	1
15503+3114	HJ 2792	42764153	42764152	11.58, 13.29	351.4	0.14	26.85	0.014	2006.518	4	1
16045+3226	HJ 581	43110234	43110235	11.65, 11.85	55.9	0.15	21.07	0.08	2006.518	4	1, 11
16087+0210	BAL1913	32553429	32553428	11.09, 12.09	343.1	0.10	12.18	0.027	2006.428	4	1
16104+1720	JRN 3 AB	37908389	37908388	13.05, 12.37	347.7	0.11	13.03	0.055	2006.428	6	1, 12
16104+1720	JRN 3 AC	37908390	37908380	13.05, 10.74	329.0	0.06	148.84	0.235	2006.428	6	1, 12
16106+1722	ROE 139 AB	37908380	37908378	10.74, 14.06	336.1	0.39	15.69	0.063	2006.428	5	1, 12
16106+1722	ROE 139 AC	37908380	37908374	10.74, 15.32	320.8	0.11	69.74	0.192	2006.428	5	1, 12
16177+3914	HJ 584	45514891	45514889	9.95, 12.53	203.4	0.44	15.18	0.131	2006.518	4	1
16269+01131	BAL147	32219465	32219470	11.54, 11.70	263.3	0.20	16.49	0.058	2006.518	4	1
16407+0547	J 447 AB	T 395-647-1	2M1010666347	9.348, 9.394	239.3	3.63	5.16	0.249	2006.518	4	1
16407+0547	J 447 CD	33771792	33771791	12.06, 12.07	226.9	0.21	10.63	0.014	2006.518	4	1, 2
16417+2338	POU3241	2m 1101838743	2M 1101838749	10.198,10.048	40.9	NA	3.17	NA	2006.518	2	1
16549+0318	BAL2429	32889374	32889380	11.28, 12.48	51.9	0.22	11.4	0.12	2006.518	4	1
16560+0224	BAL1928	32558886	32558885	11.57, 12.06	355.8	4.76	8.05	0.201	2006.518	4	1
16564+0227	BAL1930	32558940	32558941	11.77, 12.07	23.0	0.08	13.22	0.046	2006.518	4	1, 2
16580+0139	BAL1480	32390686	32390683	11.45, 12.26	283.5	0.23	16.04	0.1	2006.518	4	1, 2

Neglected Double Observations for 2006 No. 2

Notes to Table

1. 300mm Cassegrainian reflector, F9.1, CCD camera image analyzed using the astrometric/photometric program MPO Canopus.
2. PA in WDS reversed based on UCAC magnitudes..
3. UCAC 32369081's position in 1910 places it in the correct position relative to UCAC 32369080 (plotted in GUIDE 8). High proper motion of A and low proper motion of B suggest an optical pair. Pair is CCDM J10129+0158AB.
4. This pair is the best candidate for HJ 479 given original PA and Sep.
5. This is a candidate for SEI 523 but identification is uncertain. Precise position via Aladin (J2000) is RA 11h07m25.54s, DEC +32d11m31.4s. See remarks below.
6. blue magnitudes.
7. 1413+3412 ES 2416 is not this pair.
8. The STF 3088 and COU 186 systems need investigation. Identification of the measured pair as STF 3088AD should be treated with caution.
9. WDS notes confusion of GAU 14 and HJ 2782. More study is needed to resolve the identity of this pair
10. The B component of BAL 1177 is a double of unknown quality. It avoid confusion is it named WLY 7BC.
11. HJ 581 appears to be the same double as GYL 14, which is not neglected. Last measure recorded of GYL 14 was 1998; RA= 56º, SEP = 20.9".
12. Apparently JRN3C is ROE139A.

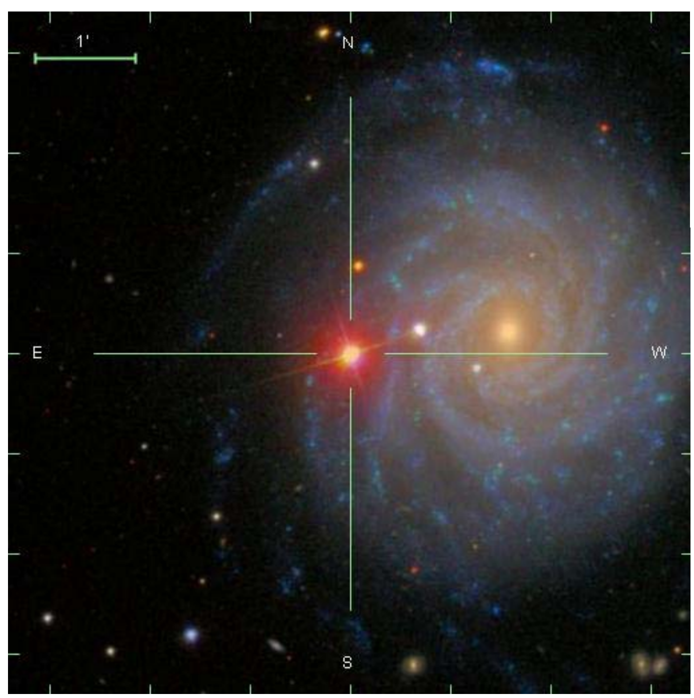
(Continued from page 62)
(2M prefix). Magnitudes follow catalog: UCAC2.0, GSC2.2 Rmag, and Tycho-2 Vmag, 2MASS Jmag. Theta and rho values of recently measured doubles agree closely with measures reported in this study.

Remarks

11072+3204 SEI 523?: The pair reported is most likely a common proper motion pair: RA proper motions for A and B are RA -30.0, and -29.1 ((*cos(Dec) and declination proper motions are +7.2, and +7.0 respectively. This seems the only candidate for SEI 523 in the immediate area, but this would require gross errors in the original reporting of this double as the 1894 measures are PA 149º, Sep. 13.8. If the original measures were accurate, then this pair is not SEI 523.

11449+23346POU3112: Identity of the pair is not certain. WDS reports single 1895 observation of a pair of equal magnitude, PA 244º, Sep 7.4". A search of the immediate vicinity with Guide8 and DSS images does not show a reasonable candidate, the best candidate being that reported here for magnitude. Both components have moderate proper motions in the same direction, so this would not explain the discrepancy in

(Continued on page 67)



Sloan Digital Sky Survey

Figure 1: SDSS image of HJ 489 (in cross hairs) and the spiral galaxy NGC 3344.

Neglected Double Observations for 2006 No. 2

(Continued from page 66)

theta and rho. The only other possibility is a faint star (N2012024857, Rmag 15.72) to the SW, but its 1895 position from the primary places it some 15" in separation. So, there are no good matches for this pair.

16002+1411AG 348: I was unable to find a reasonable match for the original measure of this pair near the coordinates reported in the WDS. Correspondence forwarded by Dr. Brian Mason from Dr. Bill Hartkopf, (both USNO) confirms that nothing in the field matches the original measure, which, according to Dr. Hartkopf originates from the IDS catalogue. The 2005 measure reported for AG 348 (RA=172, SEP=41) matches to UCAC2 36835486 and 36835491 and this match is confirmed by Dr. Hartkopf who matched the same stars independently (TYC 956-466-1 and 956-490-1). At any rate, the 2005 measure is not a measure of AG 348, which must be considered lost or bogus. My measures of the 2005 pair (probably an optical) are PA=170.4º±0.07; SEP = 40.91"±0.037", JD 2004.428, with N=5.

Acknowledgements

This research has made use of the SIMBAD database, The VizieR On-Line Catalogue, and the ALADIN Interactive Sky Atlas, all maintained at the Centre de Données Astronomiques de Strasbourg, France, and a number of catalogs cited in the text. Thanks to Drs. Brian Mason, Gary Wycoff, and Bill Hartkopf, U. S. National Observatory for their help with various parts of this research. Thanks to Arnie Rosner, Global Rent-A-Scope and its host, New Mexico Skies (http://www.global-rent-a-scope.com/) for their support of research to the Remote Astronomical Society Observatory.

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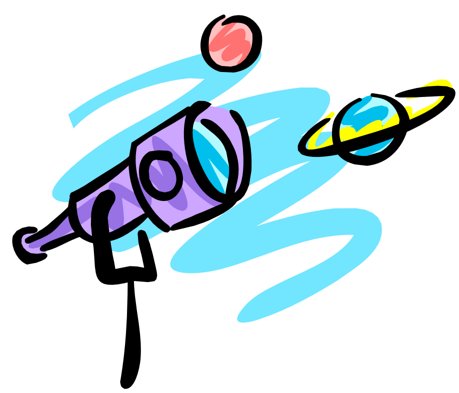

Double Star Measures for the Year 2006

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Abstract: This yearly report contains 200 measures, four of which are new discoveries. The instrumentation has remained unchanged over nearly four years. A review of the system characteristics is included.

Telescope

The telescope (see Figure 1) is a Schupmann medial of 9-inch clear aperture made by the writer. This form of refractor exhibits a longitudinal color residual only 1% that of the normal Fraunhofer doublet in the visual region and no refocusing is required over the wider spectral range of the CCD detector employed. The unamplified focal length is 100-inches. A high quality Barlow lens is employed to reach a focal length of 278.82-inches. The focal length stability is very high, varying only a few mm over the seasonal temperature spread. Atmospheric dispersion is easily compensated (while visually observing a "bright" field star) with handy adjustments that decenter the pupil image on the Schupmann corrector, giving precisely opposing spectra. The telescope is mounted on a robust German equatorial fitted with a declination circle. Using Guide 8 sky chart printouts, the instrument is set in declination and hand pushed to center the double in the 3.2-inch finder then, again by hand, fine centered in the CCD port. The AC synchronous motor driven RA worm wheel is engaged via a clutch, and the writer retires to a heated computer room where the observations are comfortably performed. This old fashioned pointing method is fast and enjoyable, no go-to required!

Figure 1: Telescope used in making the measurements reported in this study. See text for description of the telescope. Photo by the author.

CCD Detector

The CCD is manufactured by SBIG Astronomical Instruments. It is their ST-7XE model and was purchased without the usual anti-blooming gate, thus increasing both the sensitivity and dynamic range significantly. The pixel size is 9x9 microns (0.26 x 0.26 arcseconds for measurments) arranged in a 765x510 array (KAF0401E chip). The CCD camera operates with a

Double Star Measures for the Year 2006

high grade mechanical shutter. Cooling is by a single stage TE cooler.

Photometric Filters

Photometry is performed in the standard BVRI-bands. The filter manufacturer is Schüler Astro Imaging (now Astrodon) and are made to Micheal Bessel's formula as described in CCD Astronomy (Fall 1995). Spectral characteristics in nanometers when used with the above CCD as follows:

Center wavelength: B= 433, V= 548, R= 639, I= 811
Half bandwidth: B=100, V=110, R=147, I=179

General Information

Data is presented in a fairly standard way; the top row gives (left to right) the discoverer designation, WDS Epoch 2000 RA & Dec, WDS magnitudes (LSO mags bold-italicized), LSO measured position angle in degrees, LSO measured separation in arcseconds, Decimal date and number of nights object was observed. Lastly, a notes column where a variety of data is presented as well as the note numbers. In the notes section information on discoveries are also given. Delta m photometry results are shown as in the following example: V= 0.26 N9. This signify's that the difference in magnitude in V-band is 0.26 and 9 CCD frames were analyzed to obtain a mean value. Often included is the number of measures extant and time in years since the last measure as in this example: 2m105. Additional photometry data is included throughout the notes section. Astrometry values are the average obtained from at least 12 CCD frames.

Designation	RA & Dec	Mags	PA	Sep	Date	n	Notes
STF 60 AB	00491+5749	3.5 7.4	320.1	13.01	2006.022	1	Eta Cass
H 83 AC	01259+6808	4.7 9.2	124.4	20.78	2006.052	1	Psi Cass
BU 1101 AD	01259+6808	4.7 10.0	131.3	19.11	2006.052	1	
STF 117 CD	01259+6808	9.4 10.0	252.6	2.87	2006.052	1	31m23
STF 180 AB	01535+1918	4.5 4.6	1.0	7.46	2006.022	1	Gamma Ari
STF 262 Aa-B	02291+6724	4.6 6.9	230.6	2.66	2006.052	1	Iota Cass
STF 262 Aa-C	02291+6724	4.6 9.0	115.7	7.36	2006.052	1	
STF 262 BC	02291+6724	7.6 8.6	100.1	8.97	2006.052	1	
MLB 282 AB	02291+6207	10.4 11.9	145.8	3.82	2006.097	2	Trapezium-like
MLB 282 AC	02291+6207	10.7 11.2	42.5	4.69	2006.097	2	
ABH 12 AD	02291+6207	10.8 14.0	179.3	38.01	2006.090	1	
ABH 12 AE	02291+6207	10.8 14.9	156.4	47.58	2006.104	1	
ABH 12 AF	02291+6207	10.8 14.2	184.3	57.89	2006.090	1	
ABH 12 AG	02291+6207	10.8 14.9	92.9	37.70	2006.104	1	
ABH 12 AJ	02291+6207	10.8 13.6	267.0	67.52	2006.090	1	
DAL 29 AK	02291+6207	10.8 ***13.6***	267.5	3.77	2006.097	2	new component
DAL 29 AL	02291+6207	10.8 ***13.8***	158.7	2.77	2006.104	1	new component
HU 603 AB	02291+2252	9.4 11.3	230.9	5.85	2006.060	1	
HU 603 AC	02291+2252	8.8 ----	274.1	80.28	2006.060	1	2m90

Table continued on next page

Double Star Measures for the Year 2006

Designation	RA & Dec	Mags	PA	Sep	Date	n	Notes
STI1892	02292+5736	11.5 13.3	70.2	9.33	2006.074	1	
STI1893	02292+5700	11.6 13.3	166.3	10.56	2006.074	1	
STF 479 AB	04009+2312	6.9 7.8	127.2	7.43	2006.110	1	
STF 479 AC	04009+2312	6.9 9.4	242.5	57.56	2006.110	1	
STF 528	04226+2538	5.4 8.4	24.3	19.29	2006.126	1	Chi Tau
STF 534 AB	04240+2418	6.6 7.9	290.3	29.10	2006.126	1	
STF 534 BC	04240+2418	8.2 12.0	337.2	110.2	2006.126	1	
STI2051	04312+5858	11.4 12.1	62.0	9.41	2006.115	4	55 images measured
STF 716 AB	05293+2509	5.8 6.7	208.6	4.68	2006.129	1	
STF 748 Aa-B	05353-0523	6.5 7.5	31.1	8.84	2006.129	1	Trapezium
STF 748 Aa-C	05353-0523	6.5 5.1	131.6	12.80	2006.129	1	
STF 748 Aa-D	05353-0523	6.5 6.4	95.8	21.42	2006.129	1	
STF 748 Aa-E	05353-0523	6.8 11.1	349.7	4.47	2006.129	1	
STF 748 Ba-C	05353-0523	7.5 5.0	162.6	16.79	2006.129	1	
STF 748 Ba-D	05353-0523	7.5 7.2	120.1	19.37	2006.129	1	
STF 748 Ba-E	05353-0523	7.9 11.1	239.8	6.19	2006.129	1	
STF 748 Ba-F	05353-0523	7.9 11.5	154.1	20.31	2006.129	1	2m128
STF 748 Ca-D	05353-0523	5.6 6.4	61.6	13.32	2006.129	1	
STF 748 Ca-F	05353-0523	5.1 11.5	120.0	4.45	2006.129	1	
STF 982 AB	06546+1311	4.7 7.8	143.7	7.30	2006.192	1	38 Gem & a gem it is!
STI2200	08010+5615	12.1 12.7	244.8	3.17	2006.244	1	1m96, ~20-deg PA incr
STF1196 AC	08122+1739	5.3 5.8	70.2	6.45	2006.260	1	Zeta Cancri
STI2203	08136+5428	12.3 12.9	92.6	6.36	2006.241	1	fixed
STI2204	08140+5423	10.7 11.1	209.8	11.14	2006.241	1	
STI2206	08251+5603	10.9 11.9	-----	-----	2006.246	1	1m96, secondary not found
STI2208	08298+5631	11.3 11.9	271.5	7.00	2006.246	1	
STF1234	08331+5521	7.8 9.6	64.6	24.72	2006.252	1	
STI2209	08372+5557	11.6 11.6	65.7	12.08	2006.246	1	
STI2210	08379+5548	10.7 11.6	273.6	3.62	2006.246	1	
STI2211	08386+5830	11.1 12.3	328.9	7.15	2006.260	1	

Table continued on next page

Double Star Measures for the Year 2006

Designation	RA & Dec	Mags	PA	Sep	Date	n	Notes
STI2212	08395+5403	10.8 11.3	163.1	7.24	2006.260	1	note 1
STI2214	08495+5406	9.4 11.3	201.9	9.44	2006.271	1	
STI2215	08570+5527	11.6 13.2	256.9	13.21	2006.274	1	
STI2216	08595+5603	10.6 11.5	55.3	8.01	2006.277	1	little change
STI2217	09031+5704	11.5 11.5	127.4	9.03	2006.282	1	1m96, 39 deg PA incr
STI2218	09040+5656	11.5 12.1	298.8	4.48	2006.282	1	1m96, PA incr, opening
HJ 2478	09041+5541	10.7 11.4	199.7	18.07	2006.301	1	slow opening
LDS3852	09058+5532	8.0 15.5	51.9	56.82	2006.247	1	slight opening
STI2219	09063+5439	12.3 12.3	168.7	10.67	2006.247	1	
DAL 30	09065+5444	***9.4 11.5***	12.7	20.86	2006.247	1	discovery note
STI2221	09101+5513	11.1 12.3	192.6	11.01	2006.301	1	
STI2222	09102+5428	9.7 12.5	301.3	10.50	2006.301	1	
STI2223	09104+5441	9.8 11.9	33.5	11.52	2006.301	1	1m84, PA decr, opening ~2.6"
STI2224	09112+5631	12.1 12.1	106.7	5.34	2006.305	1	1m96, PA decr, opening
STI2225	09121+5357	11.9 11.9	159.9	5.37	2006.301	1	
STI2227	09188+5729	11.7 11.7	163.3	4.22	2006.305	1	
STI2229	09279+5824	11.3 12.5	206.4	7.93	2006.305	1	
STF1366	09357+5318	8.4 10.1	321.8	8.34	2006.305	1	slow binary,PA decr, opening
STF1368	09361+5318	8.9 10.4	220.7	21.59	2006.305	1	very slow binary
STI2231	09385+5404	12.0 12.0	28.3	11.70	2006.305	1	
STI2233	09403+5417	10.9 11.0	174.6	3.78	2006.305	1	
STI2235	09423+5543	11.1 12.6	153.8	8.68	2006.318	1	1m96, 37^0 PA incr, 4"opening
STI2236	09485+5537	11.1 12.6	61.5	5.83	2006.318	1	Fixed
STI2237	09522+5537	11.9 11.9	115.6	9.18	2006.318	1	
STI2239	10016+5424	9.8 11.4	144.0	5.24	2006.323	1	opening
STI2240	10068+5648	11.2 11.4	12.4	4.11	2006.326	1	PA increasing
STI2241	10069+5427	10.8 11.8	247.5	7.62	2006.323	1	closing
STI2247	10213+5355	10.6 11.8	168.9	9.68	2006.348	1	
STF1487	10556+2445	4.5 6.3	111.9	6.54	2006.348	1	very slow binary
STI2278	12014+5600	10.5 12.0	297.8	4.84	2006.400	1	
STF1603	12081+5528	7.8 8.3	82.8	22.23	2006.400	1	

Table continued on next page

Double Star Measures for the Year 2006

Designation	RA & Dec	Mags	PA	Sep	Date	n	Notes
WNC 4	12222+5805	9.7 10.2	76.3	53.15	2006.400	1	
STI2284	12308+5352	10.7 11.6	159.3	9.30	2006.400	1	
STI2285	12309+5453	11.7 11.2	336.7	9.45	2006.400	1	3m26, little motion
STI2286	12339+5522	11.6 12.2	82.3	10.84	2006.408	1	1m89, inexplicable motion
STI2287	12352+5617	11.3 12.3	80.1	16.04	2006.408	1	
STI2289	12385+5755	10.5 11.2	285.6	10.82	2006.408	1	cpm pair, slow closing
STI2290	12402+5503	9.8 12.8	245.9	13.55	2006.411	1	
STI2293	13008+5545	11.9 12.3	114.7	9.73	2006.457	1	cpm pair
WOR 23	13048+5555	11.2 12.2	159.3	1.86	2006.457	1	18m15,fast, under measured
STF1744 AB	13239+5456	2.2 3.9	152.5	14.31	2006.445	2	Mizar, 36 images measured
STI2304	13587+5628	10.3 11.5	228.7	6.54	2006.468	1	slow PA decrease
COU 59 AB	14008+1754	9.9 12.2	168.8	8.47	2006.468	1	PA decreasing,, opening
GRV 877 AC	14008+1754	10.5 11.5	229.9	35.50	2006.486	1	cpm pair
STF1800 AB-C	14020+5713	7.8 10.4	21.2	28.55	2006.486	1	AB is A 1097, sep ~0.4"
SWI 1	14024+4620	10.0 10.3	23.8	3.73	2006.408	1	V=0.26N9, I=0.11N8
STF1962	15387-0847	6.4 6.5	189.6	11.82	2006.512	1	
STI2326	15416+5613	12.6 12.6	156.6	14.05	2006.518	1	note 2
STI2327	15428+5530	11.4 12.8	235.8	8.61	2006.521	1	
BU 946	15476+5523	5.9 9.5	130.7	2.25	2006.521	1	challenging pair
STI2331	16081+5605	11.2 11.6	17.8	6.47	2006.562	1	
STF2010 AB	16081+1703	5.1 6.2	12.9	27.16	2006.512	1	Kappa Her
STI2334	16140+5844	10.5 12.0	111.4	8.98	2006.562	1	
STF2032 AB	16147+3352	5.6 6.5	237.3	7.05	2006.515	1	Sigma CrB, 28 images measrd
STI2335	16160+5718	11.7 11.9	150.5	9.43	2006.578	1	
STI2336	16178+5730	11.9 11.9	161.2	3.25	2006.578	1	
STI2338	16194+5606	12.0 12.0	48.5	3.45	2006.578	1	R=1.03N1
STI2339	16241+5835	10.0 11.5	75.3	13.05	2006.562	1	cpm pair
STI2340	16248+5649	12.0 12.3	151.3	4.35	2006.595	1	2m96, PA decr, opening
ARG 102	16289+5636	8.3 9.7	53.6	80.90	2006.595	1	
STI2342	16306+5521	11.5 12.1	339.9	11.41	2006.592	1	1m96, PA incr, closing
STI2343	16334+5524	11.4 11.4	44.9	7.71	2006.592	1	

Table continued on next page

Double Star Measures for the Year 2006

Designation	RA & Dec	Mags	PA	Sep	Date	n	Notes
STI2345	16369+5618	12.2 12.2	75.3	4.25	2006.592	1	
STI2346	16490+5757	12.1 12.1	103.8	15.55	2006.595	1	
STI 820	17170+5932	11.0 12.2	65.8	12.02	2006.595	1	
SLE 81	17170+5612	10.3 11.8	15.8	17.54	2006.595	1	under measured cpm pair
STI2349	17173+5636	11.5 12.2	60.1	10.05	2006.595	1	
J 1033	17270+2243	9.5 10.5	248.8	6.27	2006.625	1	
KUI 82 AB-C	17293+2924	9.7 9.1	311.4	49.95	2006.614	1	"C" optical
BRT2434 AB	17299+2246	11.2 11.7	268.5	3.69	2006.625	1	
DAL 3 AC	17299+2246	11.2 ***12.5***	262.9	63.60	2006.625	1	
STF 35	17322+5511	4.9 4.9	310.9	62.54	2006.627	1	
STF A34 AB	17346+0935	5.8 7.6	190.1	41.44	2006.627	1	
STI2354	17373+5640	11.8 12.0	86.6	4.42	2006.603	1	
STI2355	17432+5744	11.6 11.6	45.6	7.83	2006.603	1	
STI2357	17462+5613	10.2 10.6	171.4	11.82	2006.603	1	
STI2359	17489+5805	9.5 12.5	88.7	8.48	2006.605	1	
STI2360	17510+5709	11.0 12.8	230.9	9.86	2006.605	1	
STI2361	17536+5816	10.8 11.7	13.3	4.34	2006.605	1	
STI2363	17571+5755	10.9 12.3	279.1	14.08	2006.611	1	
STI2364	18004+5704	11.2 12.0	297.6	16.48	2006.611	1	1m103, note 3
STI2366	18006+5841	9.9 11.4	297.0	8.90	2006.614	1	"fixed" pair
STI2369	18075+5514	12.3 12.6	188.2	15.31	2006.622	1	1m,89, flying apart
STF2280 Aa-B	18078+2606	5.8 5.8	182.9	14.27	2006.666	1	
STI2370	18106+5512	12.5 13.1	294.3	5.39	2006.622	1	
STI2372	18174+5433	11.6 12.6	103.2	8.67	2006.622	1	note 4
STI2375	18268+5633	10.2 10.8	177.2	4.45	2006.625	1	
STI2376	18329+5846	12.5 13.1	53.5	13.64	2006.638	1	secondary slightly fuzzy
STI2379	18351+5521	12.2 12.8	357.8	14.45	2006.638	1	
STI2380	18380+5722	9.8 10.8	3.2	10.43	2006.663	1	
STI2381	18414+5849	11.1 11.7	138.7	8.75	2006.638	1	motion indeterminate
STI2382	18426+5727	12.5 13.1	137.2	12.40	2006.663	1	little motion
STF2398 AB	18428+5938	9.1 10.0	175.5	12.26	2006.611	1	24 images measured

Table continued on next page

Double Star Measures for the Year 2006

Designation	RA & Dec	Mags	PA	Sep	Date	n	Notes
STI2383	18433+5637	11.1 11.2	342.3	14.58	2006.663	1	cute binary
STI2384	18440+5558	11.8 11.8	141.2	3.62	2006.666	1	
STI2385	18449+5759	12.1 13.1	142.8	12.53	2006.685	1	
STI2386	18459+5731	12.0 12.6	9.3	16.94	2006.685	1	1m103, flying apart
DAL 31	18463+5630	***11.0 11.5***	264.7	49.32	2006.663	1	cpm pair, discovery note
STI2387	18478+5826	10.1 13.0	82.0	12.35	2006.685	1	little motion
STI2389	18481+5721	12.3 12.9	226.8	13.67	2006.685	1	1m103, opening
STI2390	18483+5752	10.6 11.6	-----	-----	2006.690	2	1m103, no secondary found
STI2392	18494+5811	10.4 12.0	140.6	5.48	2006.696	1	
STI2393	18510+5713	10.0 13.1	203.6	11.32	2006.696	1	large motion
STI2395	18542+5535	11.4 11.4	163.5	12.23	2006.696	1	practically fixed
STI2397	18549+5823	11.7 12.7	234.2	14.53	2006.699	1	fixed
STI2400	18563+5713	11.7 12.2	136.7	12.91	2006.696	1	
STF2433 AB	18569+5645	7.2 10.1	123.6	7.47	2006.756	1	
STF2433 AC	18569+5645	7.0 11.9	138.7	39.50	2006.756	1	
STI2402	18590+5713	12.7 12.7	56.2	4.44	2006.699	1	1m103,25E PA decr, opening
STI2403	18596+5635	11.7 12.7	95.0	6.05	2006.699	1	
STI2406	19014+5720	12.2 12.2	106.4	4.19	2006.740	1	1m103, raw CCD Δm=1.19
ARG 33	19037+5727	8.5 9.3	57.3	10.63	2006.756	1	
STI2414	19070+5613	12.1 12.3	84.3	13.14	2006.734	1	1m89, opening
STI2415	19074+5618	11.3 11.7	349.6	3.73	2006.723	1	1m89, raw CCD Δm=2.77
STF2486 AB	19121+4951	6.5 6.7	205.5	7.36	2006.625	1	WDS calibration pair
DAL 27 AD	19508+0852	0.76 ***11.7***	96.0	32.15	2006.715	2	Altair
BU 469	19595+2443	8.3 11.1	189.0	14.64	2006.663	1	
STI2503	20084+5524	9.8 12.9	158.6	11.01	2006.783	1	
A 387	20151+4118	7.9 11.5	149.5	5.27	2006.767	1	
ES 1674	20181+4122	9.6 10.3	125.0	4.90	2006.767	1	note 5
STF2666 Aa-C	20181+4044	5.8 11.1	206.6	33.98	2006.764	1	
TAR 5 Aa-D	20181+4044	5.8 10.4	180.6	49.63	2006.764	1	
STI2543	20354+5435	12.4 13.0	209.9	3.17	2006.797	1	PA decr, closing
ES 991 AB	20358+5435	9.7 10.7	297.3	16.17	2006.797	1	

Table continued on next page

Double Star Measures for the Year 2006

Designation	RA & Dec	Mags	PA	Sep	Date	n	Notes
ES 991 AC	20358+5435	9.3 10.8	105.9	62.20	2006.797	1	
ES 991 CD	20358+5435	10.6 13.0	122.2	2.52	2006.797	1	PA decreasing,
STI2545	20369+5429	12.4 13.0	158.8	3.17	2006.838	1	1m101, closing
STI2547	20380+5522	12.4 12.4	85.5	2.53	2006.838	1	1m101, PA incr, opening
STF2727	20467+1607	4.4 5.0	266.0	9.10	2006.773	1	Gamma Del
STF2758 AB	21069+3845	5.3 6.1	151.0	30.97	2006.836	1	61 Cyg, 41images measured
STI2587	21429+5448	12.1 13.0	109.3	9.07	2006.849	1	1m89, slight closing
STI2606	22008+5802	11.1 11.1	127.0	9.20	2006.849	1	1m102, closing
STI2608	22029+5512	12.7 12.7	40.6	7.23	2006.860	1	1m89
STI2612 BC	22052+5502	12.7 12.7	31.2	6.90	2006.882	1	
STI2630	22105+5525	11.7 12.7	186.2	7.19	2006.888	1	1m89, Optical?
STI2649	22136+5514	12.1 12.1	114.5	12.20	2006.890	1	1m89, Optical?
STI2655	22142+5632	13.1 13.1	54.9	9.18	2006.889	1	1m89, PA decrease, opening
STI2664	22151+5555	12.5 12.5	186.1	3.97	2006.901	1	1m89, PA increase, opening
STI2662	22151+5457	12.6 12.6	26.5	4.59	2006.899	1	1m89, PA decreasing
STI2666	22154+5446	11.6 12.5	232.2	5.09	2006.899	1	1m89, PA decrease, opening
BU 377 AB	22159+5440	7.5 10.4	61.5	38.04	2006.889	1	
BU 377 AC	22159+5440	7.5 11.4	51.8	35.24	2006.889	1	
BU 377 Aa	22159+5440	7.5 12.8	158.2	22.18	2006.889	1	
BU 377 AS	22159+5440	7.5 12.4	335.7	55.35	2006.889	1	
GIC 177 AT	22159+5440	7.5 14.5	107.2	77.18	2006.889	1	
BU 377 BC	22159+5440	10.4 11.4	302.2	6.65	2006.889	1	
STI2680	22174+5555	12.5 13.1	161.1	2.79	2006.929	1	1m89, PA decreasing, closing
STI2681	22177+5444	12.5 12.5	105.3	7.98	2006.929	1	1m89, PA decrease ,opening
STI2688	22185+5525	13.1 13.1	4.4	8.30	2006.948	1	1m89, closing
STI2691	22187+5521	11.6 13.1	167.7	4.12	2006.948	1	
STI2690	22187+5507	11.3 13.1	254.0	11.91	2006.929	1	1m89, flying apart
STI2694	22191+5618	13.1 13.1	80.7	4.58	2006.929	1	1m89, PA increase, closing

Table notes on next page.

Double Star Measures for the Year 2006

LSO 2006 Notes

1) STI 2212 - This is a perplexing pair to say the least. Stein's use of blue plates just can't explain the disparity in magnitudes and magnitude difference of the discoverer's values and those measured at LSO. Delta m-wise, this pair is very difficult indeed. This is not suggested in Stein's measure where a Δm of only 0.5 is inferred. LSO Δm values are as follows: V-band 3.74 N3, I-band 3.63 N2. The measure of relative position, including the PA motion trend, is so close to past measures that misidentification is doubtful. The LSO V-band magnitude of 10.04 is very close to the Tycho- 2 catalog value for the primary. The secondary may possibly be a variable. If not, this star should perhaps be listed as ~10.1 and 13.8 to avoid confusion at the telescope. This double is relatively nearby at ~ 65 LY.

2) STI 2326 - Flying apart about 3 arc seconds over the last century, this pair is interesting because of their almost identical magnitude and color. The secondary seems ever so slightly the brighter with delta m values as follows: V= -0.06 N12, I= -0.04 N7, Unfiltered= -0.03 N6 . Nice mini-research project.

3) STI 2364 - No double star was found at WDS position for this pair, however, a likely candidate reported here is located at RA 17597 + 5704. The primary is GSC 3910 120, a star with sufficient proper motion in both magnitude and direction to account for the increase in PA and separation observed.

4) STI 2372 - Unfiltered images used for measurement showed the secondary to be the brighter component. Photometry indicates the secondary to be rather red. LSO Δm values follow: V-band = 0.29 N6, I-band = -0.93 N7. A rough measure of color index gives: V-I primary = 0.65, V-I secondary = 1.87! Is the primary a white dwarf? The PA has increased ~10 degrees since discovery, however, the separation has changed little, closing by about 0.3". All in all, a somewhat interesting STI pair.

5) ES 1674 - This pair is WDS listed having a spectral class B0, however, LSO color measures strongly suggest a very red primary with a closely matching secondary. LSO photometric measures: Δm V-band = 0.62 N8, R-band = 0.64 N8, I=band = 0.62 N8. V-I: primary = 1.72, secondary = 1.71.

2006 Discoveries

DAL 30 - 9h06m28.0019s +54d 43'57.741"- Easy object, found in very narrow acquisition field with STI 2219. A cpm pair with the following LSO photometric measures: Δm V-band = 2.07 N6, I-band = 1.81 N6, V-I primary = 0.65, secondary = 0.91.

DAL 31 - 18h46m20.6448s +56d 29'46.874" - A fairly wide cpm pair near STI 2383, the object for that night. LSO mags are listed in the results. LSO photometric measures: Δm V-band = 0.45 N4, I-band = 0.42 N4, V-I primary = 0.68, secondary = 0.71.

Observation Report 2005: Humacao University Observatory

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Abstract: We report on measurements of position angle and separation of binary stars using a 512 X 512 CCD camera coupled to a 31 inch telescope. The images where captured in the fall of 2005 at the NURO telescope. They where analyzed at the Humacao University Observatory as part of the ongoing research project on binary stars.

Introduction

We continue reporting measurements of separation and position angle of binary stars gathered from CCD images obtained at the National Undergraduate Research Observatory (NURO) telescope. The Humacao Campus of the University of Puerto Rico is a member of NURO, a consortium of primarily undergraduate institutions (www.nuro.nau.edu) with access to a 31 inch telescope, property of Lowell Observatory. It is located roughly 20 miles east of Flagstaff, Arizona at Anderson Mesa, at an altitude of 7200 feet. We use the NURO telescope twice a year, usually during the spring and fall. The data presented in this report was acquired on one trip in the fall of 2005, August 26 to 28. At the time of these trips the NURO telescope had a TEK 512 X 512 CCD camera with 27 micron pixels attached. The camera was cooled to -110 °C. to eliminate as much thermal electron noise as possible. A new CCD camera was installed last spring; we plan to report data with this new camera soon.

The CCD images where analyzed by students with undergraduate research projects at our department. The students used the pixelization of the CCD images to obtain the separation and position angle (see Muller, 2003 for details). Then the CCD images where analyzed a second time using the software that is included in *The Handbook of Astronomical Image Processing for Windows*, by Richard Berry and James Burnell, Willman-Bell, Inc, Virginia (www.willbell.com) 2000. The Handbook includes the CD *AIP for Windows*, which has a feature that, with some care, allows for measurement of separation directly from the CCD image (there is a new edition of this handbook on the market at present). Since the software does not provide for introducing your telescope's plate scale in the computations you have to make your final number crunching with a hand calculator. The software in the program is also mirror reversed as far as position angle is concerned, so you must be very careful when you figure the correct angle from the one given by the software. There is a systematic error in position angle that occurs when the CCD camera is inserted into the telescope. This error can be corrected by using well known binary systems and binary systems that "don't move". Binary systems that "don't move" can be found in the neglected section of the Washington Double Star catalog, as binary stars that have been measured for the last 100 years and show no change in position angle. There are many of them in the catalog. One can get detailed information on such systems by requesting the information from the database of the Washington Double Star (WDS) catalog. The procedure for doing so is simple and is outlined in Mason, 2006. By imaging a mix of well known binaries and fixed binaries (we use around 20 of them

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total) and comparing the value of position angle given in the WDS with the value obtained from our images, the systematic error in the position angle can be corrected. We call such error the offset error and is incorporated in the position angle values given in the accompanying table.

The table, with 76 entries, displays first the WDS name of the pair, then the coordinates from the WDS in the second column (both RA and Dec). After that, the table presents the visual magnitudes for the primary and the secondary. These magnitude values are also obtained from the WDS. Next we display our measurement of position angle (PA) and we further display the measured separation. Finally, in the NOTE column the number of images obtained in that particular night. We must stress that although sometimes more than one image was obtained of a binary in a particular night, in the analysis and calculations of PA and Separation only one image was used in all cases.

Acknowledgements:

This research has made use of the Washington Double Star Catalog maintained at the U.S. Naval Observatory and of the NURO telescope property of the Lowell Observatory. We would like to acknowledge support from the Puerto Rico Space Grant Consortium and the L.S.AMP of the University of Puerto Rico. We would also like to acknowledge support from the M.A.R.C. Program at the Humacao Campus of the University of Puerto Rico. We also thank Ed Anderson of NURO for his efforts on behalf of our students.

References

Mason, Brian , 2006, "Requested Double Star Data from the US Naval Observatory", Journal of Double Star Observations, **2**, 21-35.

Muller, Rafael, *et al.*, 2003, "Precise Separation and Position Angle Measurements using a CCD Camera", The Double Star Observer, **9**, 4-16.

NAME	RA	DEC	MAGS A	MAGS B	PA	SEP	DATE	NOTE
BAL1175	150023.7	+000644	10.8	11.2	198	14.6	2005.652	1
HJ 2758	150040.2	-173034	11.	13.	344	19.5	2005.652	1
STF1985	155554.63	-20951.3	7.03	8.65	348.6	5.8	2005.657	1
AG 348	160011.9	+141112	9.5	10.0	172	41	2005.652	1
HJ 1284	160036	-0030	10.	14.	185.7	22.2	2005.652	1
LDS4622	160147.	-044748	13.1	17.0	39.5	14.1	2005.652	1
HJ 580	160250.6	+370527	9.2	12.2	8.9	41	2005.652	1
STF1999 AB (Struve 1999)	160425.9	-112657	7.52	8.05	100.5	12	2005.652	1
H 3 7 AC (Beta Scorpii)	160526.2	-194819	2.59	4.52	24.3	13.1	2005.652	1
ARA 433	160635.8	-181911	11.6	14.1	55	10.2	2005.652	1
ALI 370	160726.8	+354829	13.7	14.1	148.2	13.2	2005.652	1
HJ 259	160742	+3549	12.	13.	156	35.7	2005.652	1
POU3214	16 0748.8	+230529	11.1	13.3	83.4	12.6	2005.652	1
STF2010 AB (Kappa Herculis)	160804.5	+170249	5.10	6.21	14.8	27.3	2005.652	1

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NAME	RA	DEC	MAGS A	MAGS B	PA	SEP	DATE	NOTE
H 5 6 Aa-C (Nu Scorpi)	161159.7	-192738.	4.21	6.60	338	41.3	2005.652	2
HJ 1288	161240.8	-164518	11.0	12.3	123.5	17.8	2005.652	1
STF 2032 AB (Sigma Corona Borealiss)	161440.85	+335131.	5.62	6.49	237.8	7.2	2005.652	1
ES 627	161835.7	+511951	9.6	10.8	288	11.9	2005.652	1
GRV 940	165136.98	+002841.9	9.29	10.69	342.7	44.3	2005.652	1
BAL2429	165451.2	+031841	10.5	11.5	51.3	11.5	2005.652	1
SLE 76	170015.7	+331220	14.3	15.0	14	9	2005.652	1
ES 1255	170100.5	+461627.	8.0	11.7	40.7	8.3	2005.652	1
LDS4718	170251.4	+091233	11.9	21.0	316.5	44.2	2005.652	1
WFC 186	170605.5	+432856.	11.4	13.0	16	18.2	2005.652	1
PTT 16	170642	+3839	8.8	13.0	53.6	22.6	2005.652	1
BEM 26	170836.7	+502245.	11.1	12.7	17	15.4	2005.652	1
STFA 35 (Nu Draconis)	173215.8	+551022	4.87	4.90	312	62.6	2005.652	1
STF2214 AB	174320.8	+434452.	9.61	10.15	212.3	19.9	2005.652	1
BU 1202 AB-C	180132.3	+033127	8.43	7.95	29.5	106.1	2005.652	1
BU 1202 AB-E	180132.3	+033127	8.67	10.20	139	89.7	2005.652	1
STF2293	180953.8	+482405	8.08	10.34	85	13.3	2005.652	1
SLE 343 AB	182733.4	+080342	8.8	12.8	345.7	12.8	2005.652	1
STF2330	183112.9	+131055	8.27	9.69	166.7	16.6	2005.652	1
STF2337	183455.1	-144210.	8.14	9.05	298.9	17	2005.652	1
STF2346	183715.2	+03143	7.93	10.0	300	29.6	2005.652	1
STF2398 AB	184248	+5933	9.11	9.96	177.6	12.3	2005.652	1
HJ 1349	184848.8	+331912	8.3	10.7	93.1	29.5	2005.652	1
STFA 39 AB (Beta Lyrae)	185004.7	+332145	3.63	6.69	150.5	47.4	2005.652	1

Table continued on next page

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NAME	RA	DEC	MAGS A	MAGS B	PA	SEP	DATE	NOTE
STF2417 AB (Theta Serpentis)	185613.18	+041212.9	4.59	4.93	105	22.6	2005.652	1
POU3652	190122.4	+250951	9.9	14.0	188.6	13.6	2005.652	1
BEM 37	190125.48	+532747.3	11.87	11.90	307	11	2005.652	1
STF2486 AB	191205.03	+495120.7	6.54	6.67	204.3	8.7	2005.652	1
AG 375	191413.4	+262628	9.6	10.5	297	18.9	2005.652	1
STE 1	192842	+001718			256	6.9	2005.652	1
STFA 43 Aa-B (Albireo)	193043.2	+275734	3.37	4.68	55.1	35	2005.652	1
GYL 17	193144.6	+334801	7.5	10.0	231	23	2005.652	1
STFA 44	193310.0	+600931	6.47	8.19	288	75.5	2005.652	1
ARN 48	194057.6	+232918	8.20	9.69	6.4	25.9	2005.652	1
STFA 46 Aa-B	194149.09	+503131.6	6.00	6.23	135.5	39.3	2005.652	1
HJ 603 AB	195033.9	+384320	5.38	10.54	115	56	2005.652	1
STFA 48 AB	195322.6	+202013	7.14	7.34	148.1	42.9	2005.652	1
ES 204	201413.9	+352142	7.6	10.5	277	16	2005.652	1
J 838	202056.77	+102658.4	9.6	9.6	117.6	6.3	2005.657	1
GRV 365	203759.39	+095141.5	11.7	11.8	106.4	28.5	2005.657	1
ES 89	203817.0	+480412	6.58	11.5	209.5	21.4	2005.657	1
STTA209 AC	204500.2	+124336	8.22	8.17	156.1	97	2005.657	1
STF2725	204613.31	+155426.4	7.54	8.20	13	6.2	2005.657	1
STF2727	204639.50	+160727.4	4.36	5.03	266	9.0	2005.657	1
STF2758 AB	210653.94	+384457.8	5.35	6.10	152.6	31.6	2005.657	1
SEI1422	210952.7	+365910	8.9	11.0	334	20.8	2005.657	1
HJ 1619 AB	211226.5	+143156	10.0	11.0	173.5	7.1	2005.657	1

Table continued on next page

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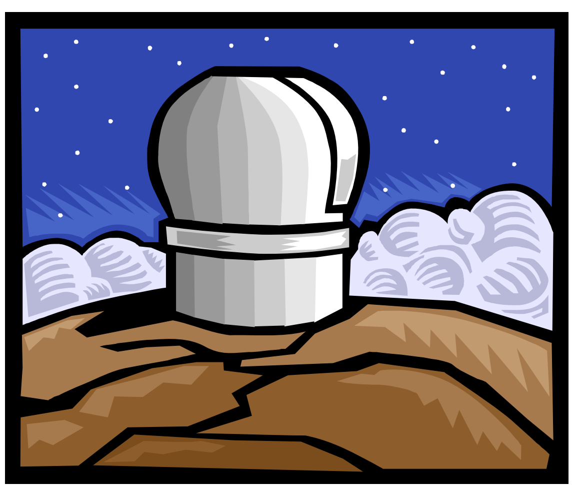
NAME	RA	DEC	MAGS A	MAGS B	PA	SEP	DATE	NOTE
BU 270 AB-C	211327.2	+071304	7.25	14.01	28.7	31.9	2005.657	1
MLB 424	211530.2	+371919	9.3	10.7	65	5.1	2005.657	1
STT 434 AB	211900.0	+394457	6.67	9.93	122	25	2005.657	1
STFB 11 AB	212205.1	+194815	4.20	7.56	313	36.5	2005.657	1
STFA 55 AR	212348.3	+372105	6.6	13.4	202.8	23.4	2005.657	1
BU 696 AC	220430.1	+155128	7.95	8.96	323.7	63.5	2005.657	1
HJ 1726	220651.5	+150501	11.0	11.5	24	19.2	2005.657	1
STI2720	222130.0	+583648	12.1	12.1	160.9	14.3	2005.657	1
STI2722	222159.1	+561952	10.6	13.0	71	14.6	2005.657	1
STI2728	222223.0	+551642	12.5	13.1	38.1	13.7	2005.657	1
BU 172 AB-C	222406.8	-045013	5.78	10.1	342.5	53.1	2005.657	1
STF2922 Aa-B (8 Lacerta)	223552.2	+393803	5.66	6.29	185.6	22.4	2005.657	1
AG 423	223615.6	+294443	8.3	9.7	154	23	2005.657	1
HJ 3189	232331.9	+001729	6.31	10.5	148	39.2	2005.657	1



Perrineville Observatory Report: Double Star Measurements for 2006

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Abstract: This is a report of my observations and measurements of double stars for the latter half of the year 2006. Many of the stars are from the WDS list of Neglected Northern Doubles and some are new discoveries. Others are well known doubles that I happened to encounter while pursuing the neglected doubles and may be useful to provide an estimate of the accuracy of my measurements.

Equipment and Computer Software

My observations were made using an SBIG ST-8 CCD camera coupled by a three element achromatic Barlow lens to my f/6 12.5" Newtonian reflector. The Barlow lens extends the focal length to 178.44 inches[1] to provide a more useful plate scale for the measurements. The camera is equipped with a set of photometric filters mounted in the SBIG 10 position color wheel and remotely operated by the program CCDOPS (supplied with the camera). The telescope aperture and focal length are entered into the program and are part of the parameter data saved with each image file. The double star measurements were done using the CCDOPS crosshair tool on the raw image files. The program computes centroids of the star images and measures distances and angles to subpixel precision.[2] An Excel spreadsheet was used for data logging and for calculating averages and standard deviations. A computer with Windows XT operating system running CCDOPS and the other programs needed was stationed in a cubicle adjacent to the observing area. Remote focus and telescope slow motion controls were also routed to this cubicle.

Experimental Procedure

I compiled my observation list by selecting stars from a seasonally appropriate range of right ascensions from the Neglected Northern Doubles list and then sorting the list by date of last observation and the separation of the double. Additional stars were included as observation targets as I happened to encounter them in the sky and in response to postings on the binary-stars-uncensored discussion group.[3]

Rather than relying upon setting circles, I located target objects with the help of the program Guide 8.0 (a desktop planetarium and charting program[4]), a 9x50 correct image finder[5] on my telescope, and the image on my computer screen from the CCD camera operating in focus mode. This mode provides a nearly "live" image of what the telescope is pointing at, which is updated every few seconds. The program Guide allows the user to select a circle the same angular diameter as the field of view of the finder and also provides a rectangle covering the same area of the sky and with the same field orientation as the CCD camera. The circle and rectangle are plotted to-scale on the star field. When zoomed out to a scale where constellations are visible, the program helps to roughly point the telescope using a zero power projected red dot finder. When zoomed in until the finder circle fills the computer screen, it supports close pointing using the 9x50 finder. And finally, when zoomed in until the CCD rectangle nearly fills the screen, it makes the final positioning of the object of interest in the center of the CCD field easy and unambiguous. The field orientation can be rotated to match either the finder view or the CCD field. In most cases, the field containing the double star could be quickly positioned on the camera CCD by simply pointing the telescope at a nearby field star and star hopping to the double by watching the "live" image from the camera in Focus Mode and the Guide sky chart next to it on the computer monitor. In all cases so far encountered there were sufficient field stars around the double to permit an absolute identification of the WDS location of the double by visual pattern matching. In some cases, there was no double star at the published location. These cases will be discussed individually.

Once the double was located in the CCD image, a

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series of 12 images was taken, four each through I, R and V photometric filters. In some cases, additional images were taken through other filters. Exposures were in the 0.5 to 10 second range depending upon the brightness of the stars. Guiding was unnecessary for these short exposures. Since atmospheric seeing affects the star images, I saved for subsequent measurement only the images in which the stars were as round and small as possible for the seeing conditions. When seeing was too bad to obtain decent images, I simply closed up and went to bed. Hand entries describing each observation were made in a dated and signed notebook at the time of observation.

Image measurement was done the next day using the "crosshair tool" provided in the program CCDOPS. The magnitude of each star and the angle and separation of each pair were logged into my Excel spreadsheet. It is unfortunate that the angle measured by the crosshair tool in CCDOPS is not actually the position angle. The program measures angles clockwise from a line pointing to the top of the image on the computer monitor. This is opposite to the convention for position angle, and the orientation of the zero direction is dependent upon the orientation of the camera relative to the telescope. This must be determined by observation using drift exposures. To do this I position a star near the eastern edge of the field and take a 40 second exposure with the telescope drive turned off. The star trail on the image is in the east-west direction (position angle 270°). In the camera orientation I normally use, north is to the left and the star trail (indicating the exact direction of west, θ = 270°) goes from the bottom of the image to the top. I carefully measure the angle this line makes with the vertical (angle *d*) and use it to convert the angle that crosshair provides (angle *c*) to the true position angle (see Figure 1):

$$\theta = (270^o + d) - c$$

I calculate the average of all 12 crosshair angle measurements before making this conversion. Similarly, the separation of the components of the double star is the average of all 12 measured separations. This method of obtaining the data compensates for distortion of the field geometry by atmospheric seeing effects and provides measurements that have sub-pixel scale accuracy. Since my telescope tracking is not perfect (periodic error, wind effects), it is similar in this respect to the technique of dithering[6] used to advantage in under-sampled CCD images.

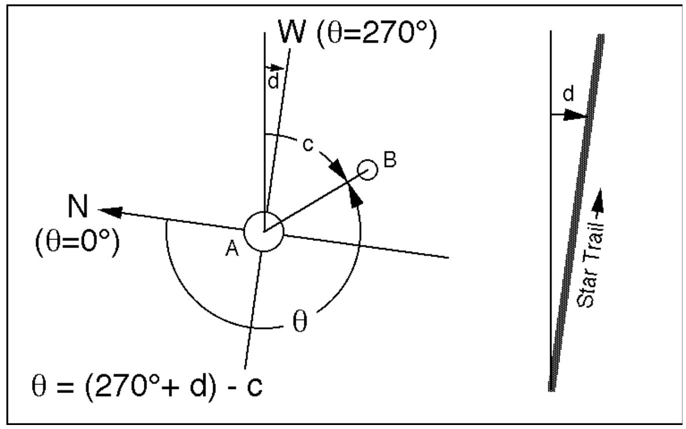

Figure 1: Measurement of position angle using the star trail.

The magnitude differences, $\Delta m = m_B - m_A$, were calculated for each image and averaged over the four values obtained for each filter. The standard deviations of each Δm value were also calculated.

Table 1 is a record of all my observations from the middle of August 2006 until the end of the year. The first column gives the discoverer designation and the second column the WDS identification number. The latter is a shorthand representation for the approximate right ascension and declination of the double star in hhmm.m±ddmm format with the decimal point omitted. Note that the items enclosed in < > signs are provisional designations of the author, not those of the WDS. The third column is in most cases the WDS magnitudes of the objects. In the case of new components (or new double star systems) the magnitudes are calculated from the magnitude of component A already in the WDS by adding the measured value of Δm_V, or by taking the magnitudes from the GSC (Guide Star Catalog) as provided by Guide. The fourth column is my measurement of the position angle in degrees. This is usually the average from twelve images taken through three filters (V, R and I, four images through each filter). In some cases, more or less images were used. These cases are noted. Similarly, the fifth column is the separation of the components in seconds of arc, also usually the average of the measurements from twelve images. The sixth, seventh and eighth columns contain the Δm values and their standard deviations through the V, R and I photometric filters. Each value is usually the average of four measurements. In a few cases (faint red companion stars), the star was not visible in the images taken through the V filter so no Δm_V is provided. In cases where no standard deviation is supplied, the

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star was visible on only one image. The ninth column is the date (year plus decimal fractional year), and the tenth column is the number of nights the object was observed. Note that even when n=1, the data provided are averages over a substantial number of images, usually 12. Finally, the eleventh column refers to the "Notes to Table" given below.

Some of the entries in the Table 1 contain no new data from my observation. These entries represent neglected doubles that are probably truly lost. In these cases there is nothing present in the field implied by the WDS identifier (or the precise coordinates, when available) that could possibly be the object described by the discoverer. In two cases (WRH 23 and D 33) I was able to find the object in a nearby field, but in most cases this was not possible. The story of finding WRH 23 and D33 will be presented in another JDSO article.

Footnotes to Text

1. Focal length determined by order spacing in an image of the spectrum of Vega taken with a coarse objective grating placed over the telescope aperture. See my pending paper in JDSO.
2. SBIG application note "Making Astrometric and Photometric Measurements with the SBIG Cameras" http://www.sbig.com/pdffiles/measuring.magnitudes.pdf
3. http://tech.groups.yahoo.com/group/binary-stars-uncensored/
4. http://www.projectpluto.com/
5. Right angle finder equipped with Amici prism so that right and left are not reversed.
6. For examples of dithering see: http://www.adass.org/adass/proceedings/adass99/O6-02/ http://www-int.stsci.edu/instruments/wfpc2/Wfpc2_faqwfpc2_dith_faq.html

Notes to Table

1. No star matching description found at WDS position
2. Same system as WDS 19448+2916 ISM 4. Exact coordinates: 19 44 48.7 +29 15 53
3. Magnitude of secondary calculated from magnitude of primary and ΔmV
4. New double star not presently in WDS
5. Only one image of the four taken through this filter showed this component, no standard deviation possible
6. "Sky Glow" anti-light pollution filter used for these faint companions, Δm values not meaningful
7. New component for a multiple star system already in the WDS
8. Magnitude of secondary questionable, probably fainter than listed in WDS
9. Stars not resolved
10. Position implied by WDS identifier for D 33 is incorrect. D 33 is identical with MLB 176 AB. Exact coordinates: 21 48 29.9 +61 36 54
11. Magnitude estimated, image very faint through V filter
12. WDS position for STF2462 is incorrect. RA is 19h10.7m
13. Δm using B filter was 4.74
14. Δm using B filter was 4.38
15. Δm using B filter was 3.02 ± 0.16
16. Δm using B filter was 2.66 ± 0.18
17. Star A is GSC 3565 1231, magnitude 7.259
18. Star A is GSC 2736 1376, magnitude 9.424
19. Star A is GSC 3242 496, magnitude 12.1
20. Star A is GSC 3642 348, magnitude 9.658
21. Star A is GSC 3238 944, magnitude 10.8
22. Star A is GSC 3651 586, magnitude 11.9
23. Star A is GSC 3651 486, magnitude 9.525
24. Star A is GSC 2763 2479, magnitude 14.4
25. Star closest to WDS position is 7th magnitude TYC 3623 850 which is also identified with HJ 1853 by Guide. Star is either not a double or is unresolved in my system. No 7.7 mag companion present.

Table of measurements begins on next page.

The author is a retired research chemist (Ph.D. from U. Cal, 40 years of chemical research for Union Carbide and Dow Chemical). He tells us, "It was a question of whether I would be an astronomer with a lab in the basement or a chemist with an observatory in the back yard." He lives in New Jersey with his wife and has 4 sons, 5 grandchildren, 4 great-grandchildren, and a dog (who works as his observatory assistant).

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Discoverer Designation	WDS Identifier	Magnitudes	PA (deg)	Sep (as)	Δmv	Δmr	Δmi	Date	n	Notes
STF2486 AB	19121+4951	6.54, 6.67	206.39	7.30				2006.633	1	1
STFA 39 AB	18501+3322	3.63, 6.69	148.59	45.55	4.03± 0.05			2006.644	1	β Lyrae
STFA 43 Aa-B	19307+2758	3.37, 4.68	54.56	34.36	3.34± 0.05			2006.644	1	β Cygni
STF2352 AB	18370+3452	8.10, 11.1	286.57	15.64		2.82± 0.04	2.84± 0.06	2006.644	1	
STF2441 AB	19028+3123	7.85, 9.78	264.38	5.89		1.58± 0.03	1.20± 0.08	2006.646	1	
STF2328 AB	18295+2955	9.00, 9.5	72.08	3.26		0.19± 0.13	0.16± 0.08	2006.649	1	
STF2333 AB	18311+3215	7.82, 8.57	331.98	6.36		0.80± 0.08	0.88± 0.07	2006.649	1	
STF2351	18362+4117	7.60, 7.64	160.06	4.93		0.11± 0.10	0.03± 0.08	2006.649	1	
STF2349 AB	18366+3328	5.40, 9.4	203.53	7.41		4.43± 0.10	4.02± 0.09	2006.649	1	
HJ 1423 AB	19372+2920	6.30, 11	126.59	20.49	5.64± 0.09	4.72± 0.32	3.98± 0.03	2006.696	2	
HJ 1423 AC	19372+2920	6.30, 12.9	348.33	27.66	7.95± 0.22	7.53± 0.22	6.62± 0.33	2006.696	2	
HJ 1423 AD	19372+2920	6.30, 12	1.14	35.14	7.58± 0.27	7.36± 0.25	7.22± 0.48	2006.696	2	
WRH 23 AE	19372+2920	6.40, 9.6						2006.696	1	1
WRH 23 AF	19372+2920	6.40, 8.9						2006.696	1	1
WRH 23 AG	19372+2920	6.40, 8.6						2006.696	1	1
SLE 650 AH	19372+2920	6.40, 11.7	185.15	111.89	5.02± 0.05	4.50± 0.16	4.15± 0.04	2006.696	2	
<WRH 23 Ia-J>	<19448+2916>	6.40, 9.6	288.45	24.81	4.43± 4.41	4.58± 0.04	4.72± 0.05	2006.696	2	2
<WRH 23 Ia-K>	<19448+2916>	6.40, 8.9	17.62	70.93	4.48	4.44± 0.04	4.38± 0.03	2006.696	2	2, 13
<WRH 23 Ia-L>	<19448+2916>	6.40, 8.6	87.03	75.92	3.53	3.12± 0.01	2.71± 0.05	2006.696	2	2, 14
H 5 137 AB	19459+3501	6.22, 8.18	24.45	38.49	2.39± 0.01	2.89± 0.00	3.37± 0.01	2006.704	1	
BOT 3 AC	19459+3501	6.10, 8.5						2006.704	1	1
<ACA 1 AC>	19459+3501	6.10, 11.6	35.86	223.01	5.48± 0.02	5.75± 0.03	5.94± 0.03	2006.704	1	3, 4
STF2578 AB	19457+3605	6.37, 7.04	124.25	14.73	0.76± 0.00	0.72± 0.01	0.68± 0.01	2006.704	1	
STF2578 AC	19457+3605	6.37, 11.52	356.02	44.30	6.13± 0.12	5.99± 0.05	5.60± 0.12	2006.704	1	
STF2578 AD	19457+3605	6.37, 9.22	70.36	94.98	6.02± 0.09	5.79± 0.05	5.49± 0.02	2006.704	1	
STF2578 AF	19457+3605	6.37, 9	249.73	144.86	2.74± 0.01	1.87± 0.01	0.85± 0.01	2006.704	1	
STF2578 Ca	19457+3605	11.52, 13.4						2006.704	1	1
GUI 21 Aa	18267+2627	6.48, 7.09	284.13	162.76	0.57± 0.02	0.58± 0.02	0.59± 0.01	2006.715	1	
BU 1326 AC	18267+2627	6.48,9.62	59.29	61.94	3.20± 0.02	3.11± 0.02	2.99± 0.02	2006.715	1	
GUI 21 PQ	18267+2627	7.09,11.91	344.31	22.81	5.83± 0.07	5.38± 0.04	4.74± 0.24	2006.715	1	

Table continued on next page

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Discoverer Designation	WDS Identifier	Magnitudes	PA (deg)	Sep (as)	Δmv	Δmr	Δmi	Date	n	Notes
<ACA 2>	<19509+4942>	10.90, 12.73	297.39	22.75	1.83± 0.28	1.66± 0.19	1.37± 0.45	2006.715	1	3,4,17
ES 2686	19540+4915	8.00, 11	302.75	18.63	4.26± 0.06	4.26± 0.06	4.25± 0.02	2006.715	1	
STF2557 AB	19396+2945	7.49, 10.23	102.02	11.00	2.82± 0.01	2.82± 0.02	2.78± 0.02	2006.718	1	
BU 54 AC	19396+2945	7.60, 11.3	302.41	21.83	5.16	5.44± 0.42		2006.718	1	5
ABH 124 AD	19396+2945	7.47, 10.92	146.04	47.70	3.42± 0.08	3.44± 0.06	3.38± 0.07	2006.718	2	
ABH 124 AE	19396+2945	7.47, 12.72	163.91	68.50		5.24± 0.10		2006.718	2	
ABH 124 AF	19396+2945	7.47, 10.33	178.69	89.04	2.92± 0.07	2.24± 0.01	1.53± 0.01	2006.718	2	
ABH 124 AG	19396+2945	7.47, 12.92	228.91	39.50				2006.718	2	
ABH 124 AH	19396+2945	7.49, 10.54	91.53	103.40	3.09± 0.12	3.07± 0.05	3.10± 0.07	2006.718	2	
ABH 124 AI	19396+2945	7.49, 12.1	114.94	100.03		4.99± 0.05		2006.718	2	
BKO 77 AJ	19396+2945	7.47, 14	123.84	27.60				2006.718	1	6
BKO 77 AK	19396+2945	7.47, 14.6	95.98	68.93				2006.718	1	6
BKO 77 AL	19396+2945	7.47, 15	219.61	30.20				2006.718	1	6
BKO 77 AM	19396+2945	7.47, 15.3	119.39	111.56				2006.718	1	6
GYL 17	19317+3348	7.50, 10	230.18	22.90	3.38± 0.06	3.38± 0.03	3.38± 0.03	2006.718	1	
STF2483 AB	19124+3021	7.97, 9.09	317.01	9.93	1.18± 0.02	1.21± 0.02	1.23± 0.02	2006.720	1	
STF2483 AC	19124+3021	7.97, 9.72	235.93	70.93	1.70± 0.01	1.02± 0.01	0.30± 0.01	2006.720	1	
GLP 16 AD	19124+3021	7.97, 11.47	196.93	74.11	3.67± 0.06	2.95± 0.07	2.31± 0.06	2006.720	1	
STF2483 BC	19124+3021	9.09, 9.72	227.92	69.93	0.52± 0.01	-0.19± 0.02	-0.93± 0.01	2006.720	1	
GLP 16 BD	19124+3021	9.09, 11.47	190.76	79.92	2.48± 0.05	1.74± 0.07	1.08± 0.07	2006.720	1	
GLP 16 CD	19124+3021	9.72, 11.47	129.99	48.65	1.97± 0.06	1.93± 0.07	2.01± 0.07	2006.720	1	
HO 437 AC	18405+3139	7.80, 10.7	270.03	39.59	5.10± 0.05	4.35± 0.03	3.24± 0.01	2006.726	1	
HO 437 Aa	18405+3139	7.70, 13.9	288.13	22.08	8.95	8.51± 0.33	7.72± 0.44	2006.726	1	5
HO 437 CD	18405+3139	10.70, 11.2	343.92	4.33		3.04± 0.06	3.85± 0.06	2006.726	1	
HJ 1352 AB	18501+2949	6.48, 7.09	249.42	13.69	4.19± 0.15	3.52± 0.03	2.97± 0.05	2006.729	1	
STF2298 AC	18126+4123	8.00, 10.4	39.91	73.26	4.07± 0.12	3.84± 0.04	3.55± 0.05	2006.744	2	
WAL 89 AB-D	18126+4123	8.00, 10.4	71.21	46.62	4.86± 0.29	4.75± 0.10	4.43± 0.13	2006.744	2	
STT 379 <AB>	19380+3354	8.10, 9.4	83.97	24.96	1.67± 0.01	1.61± 0.01	1.55± 0.03	2006.778	1	
<ACA 3 AC>	19380+3354	8.10,13.4	123.79	29.03	5.29± 0.09	4.52± 0.16	3.69± 0.05	2006.778	1	3, 7

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Discoverer Designation	WDS Identifier	Magnitudes	PA (deg)	Sep (as)	Δmv	Δmr	Δmi	Date	n	Notes
<ACA 3 AD>	19380+3354	8.10, 14.8	99.57	38.34	6.65± 0.52	6.15± 0.38	6.02± 0.08	2006.778	1	3, 7
SEI 629 <AB>	19336+3229	8.20, 10.4	112.09	19.52	4.41± 0.01	4.94± 0.02	5.49± 0.06	2006.778	1	
<ACA 4 AC>	19336+3229	8.20, 13.8	150.28	14.27	5.62± 0.48	5.85± 0.17	5.94± 0.07	2006.778	1	3, 7
<ACA 4 AD>	19336+3229	8.20, 12.1	75.95	21.84	3.92± 0.26	3.74± 0.03	3.65± 0.11	2006.778	1	3, 7
HJ 1349	18488+3319	8.30, 10.7	91.97	29.20	3.57± 0.10	3.39± 0.03	3.16± 0.03	2006.792	1	
BU 438 AB	19314+3643	7.90, 13	20.11	4.87		4.44	4.24	2006.803	1	5
STF2538 AC	19314+3643	8.99, 8.02	246.51	53.24	-0.07± 0.15	-0.09± 0.04	-0.22± 0.05	2006.803	1	
STF2538 AD	19314+3643	8.99, 9.24	248.63	46.76	0.28± 0.04	0.24± 0.05	0.15± 0.05	2006.803	1	
BU 438 AE	19314+3643	7.90, 13	240.06	21.35	4.16	3.76± 0.10	4.10± 0.97	2006.803	1	5
STT 388 AB	19524+2551	8.32, 8.45	136.70	3.53	0.06± 0.04	0.11± 0.02	0.12± 0.02	2006.803	1	
STT 388 AC	19524+2551	8.32, 9.49	128.92	31.53	1.54± 0.04	1.29± 0.06	1.08± 0.04	2006.803	1	
STT 388 AB-C	19524+2551	7.54, 9.6	128.80	29.79	2.12± 0.01	1.88± 0.02	1.64± 0.01	2006.803	1	
STT 388 BC	19524+2551	8.45, 9.49	127.93	27.93	1.48± 0.03	1.17± 0.06	0.96± 0.03	2006.803		
<ACA 5 AC>	19421+3132	8.38, 13.68	185.71	30.39	5.30± 0.12	5.40± 0.11	4.79±0.34	2006.811	2	3, 7
<ACA 5 AD>	19421+3132	8.38, 12.3	243.86	21.52	3.92± 0.26	3.82± 0.03	3.78± 0.09	2006.811	2	3, 7
<ACA 5 AE>	19421+3132	8.38, 13.1	36.64	34.51	4.72± 0.08	4.53± 0.08	4.46±0.14	2006.811	2	3, 7
SMA 85	19127+4945	9.04, 10.01	210.83	30.83	1.07± 0.02	1.35± 0.02	1.11± 0.02	2006.813	1	
SEI 661 <AB>	19421+3132	8.38, 11.44	137.59	13.06	4.33± 0.23	4.20± 0.11	4.220.11	2006.833	1	8
STT 451	21510+6137	7.74, 8.61	217.94	1.96	0.60± 0.32	0.17± 0.06	0.13± 0.09	2006.852	1	
D 33	21510+6139	10.20, 10.4						2006.857	1	1
MLB 176 AC	21485+6137	9.70, 11.7	276.43	10.55	2.50± 0.18	2.66± 0.01	2.53± 0.09	2006.852	1	1
<D 33 AB>	21510+6139	10.20, 10.4	129.82	2.85	0.19± 0.07	0.67± 0.09	0.62± 0.08	2006.857	2	10
STF2758 AB	21069+3845	5.35, 6.1	149.97	31.06	0.81± 0.05	0.71± 0.04	0.58± 0.06	2006.862	1	61 Cyg
HJ 1531	20319+3920	10.10, 10.9	317.05	6.25	0.89± 0.03	0.82± 0.03	0.74± 0.04	2006.863	1	
SEI1311	20550+3929	9.50, 9.5								1
SEI1093	20206+3726	9.70, 9.7								1
POU5755	22514+2421	9.50, 10.7								1
HJ 2999 AB	20467+2044	9.40, 10.2	220.11	9.95	1.34± 0.07	1.21± 0.02	1.06± 0.03	2006.904	1	
<ACA 6 AC>	20467+2044	9.40, 12.03	269.79	19.54	2.63± 0.14	2.06± 0.02	1.49± 0.11	2006.904	1	3, 7
BAR 64 AB	23448+5627	8.17, 8.4						2006.904		1

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Discoverer Designation	WDS Identifier	Magnitudes	PA (deg)	Sep (as)	Δmv	Δmr	Δmi	Date	n	Notes
BAR 64 BC	23448+5627	8.40, 8.6						2006.904		1
HJ 1808	22454+4903	10.60, 10.7						2006.904		1
HJ 1853	23108+4531	7.00, 7.7						2006.904		25
ES 249	20468+3424	9.00, 10						2006.904		1
STF2894 AB	22189+3746	6.21, 8.85	194.23	15.60	2.64± 0.05	2.53± 0.06	2.28± 0.09	2006.906	1	
ES 385 AB	22069+3335	9.30, 10.8						2006.907		9
ES 385 AC	22069+3335	9.50, 10.5						2006.907		1
CHE 401	22440+3047	9.28, 10.3	254.92	17.36	1.89± 0.08	1.89± 0.02	1.90± 0.10	2006.907	1	
CHE 405	22442+3048	11.50, 11.6	54.73	14.45	1.24± 0.11	1.65± 0.40	1.67± 0.20	2006.907	1	
CHE 369 AB	22417+3047	10.50, 12.4	149.77	17.35	1.81± 0.18	1.83± 0.28	1.84± 0.15	2006.909	1	
CHE 369 AC	22417+3047	10.50, 10.9	279.53	23.76	1.33± 0.09	1.59± 0.07	1.89± 0.11	2006.909	1	
<ACA 7>	<22418+3051>	9.42,13.624	324.70	13.90	4.20± 0.29	3.86± 0.23	4.15± 0.34	2006.909	1	3,4,18
DOO 90	22066+4156	9.50, 9.7						2006.926		1
HJ 1666	21368+4332	10.10, 10.8						2006.926		1
HJ 943	21472+2648	10.00, 10						2006.926		1
HJ 1633	21184+4802	10.10, 10.5						2006.926		1
ES 2731	23413+5006	10.40, 10.9						2006.926		1
SMA 156	22003+4423	10.40, 10.6						2006.926		9
DOO 77	20054+2716	9.20, 9.9	138.32	10.55	0.13± 0.04	0.13± 0.02	0.08± 0.04	2006.931	1	
A 770 AB-D	21308+4827	10.00, 11.2	42.02	6.95	1.19± 0.06	1.19± 0.04	1.17± 0.02	2006.931	1	
HJ 1711 <AB>	21576+6708	9.20, 10.8	253.81	9.08	2.90± 0.10	3.02± 0.04	3.24± 0.13	2006.934	1	
<ACA 8 AC>	21576+6708	9.20,~14	323.31	71.86		4.44± 0.13	1.89± 0.11	2006.934	1	7, 11
BUP 222 AB	21007+3353	9.62, 13.3	311.73	11.11	3.22± 0.26	3.26± 0.07	3.31± 0.30	2006.936	1	
BUP 222 AC	21007+3353	9.62, 12	5.19	118.00	2.29± 0.05	2.21± 0.03	2.28± 0.10	2006.936	1	
BUP 222 AD	21007+3353	9.62, 12.9	260.25	18.66	4.10± 0.13	3.89± 0.05	4.18± 0.37	2006.936	1	
BUP 222 AI	21007+3353	9.62, 14	125.29	33.12	3.97± 0.26	3.60± 0.07	3.96± 0.14	2006.936	1	
<ACA 9 AK>	21007+3353	9.62, 13.98	49.64	58.36	4.36± 0.48	4.59± 0.12	4.47± 0.37	2006.936	1	3, 7
<ACA 9 AL>	21007+3353	9.62, 13.52	310.82	69.17	3.90± 0.19	4.22± 0.06	4.08± 0.48	2006.936	1	3, 7
<ACA 9 AM>	21007+3353	9.62,~14	199.53	80.80		5.81± 0.12		2006.936	1	3, 7
ROE 56	23393+4730	10.30, 10.9	79.79	2.68	0.13± 0.06	0.34± 0.13	0.28± 0.05	2006.937	1	
<ACA 12>	<23392+4728>	9.66,12.708	96.69	8.53	3.05± 0.13	3.21± 0.08	3.07± 0.16	2006.937	1	4,3,20

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Perrineville Observatory Report: Double Star Measurements for 2006

Discoverer Designation	WDS Identifier	Magnitudes	PA (deg)	Sep (as)	Δmv	Δmr	Δmi	Date	n	Notes
CHE 475	23278+4309	8.16,10.5	86.22	31.16	4.53± 0.15	4.14± 0.05	3.68± 0.04	2006.942	1	
<ACA 10>	<23299+4308>	12.10,13.09	194.19	8.65	0.99± 0.07	1.03± 0.11	0.79± 0.05	2006.942	1	3,4,19
STF2462 AB	19092+0325	10.30,10.3	168.52	8.32	0.04± 0.03	0.10± 0.03	0.30± 0.04	2006.945	1	12
STF2462 AC	19092+0325	10.30,13.6	235.96	11.90		2.15	1.74± 0.08	2006.945	1	5, 12
<ACA 11 AE>	19107+0325	10.30,~14	188.93	36.88			0.79± 0.05	2006.945	1	7, 11
DOB 16 <AB>	22435+3813	10.00,10.5	79.96	23.48	2.28± 0.08	1.90± 0.03	1.46± 0.03	2006.945	1	15
<ACA 13 AC>	22435+3813	10.00,12.54	109.72	54.47	2.54± 0.21	2.25± 0.06	1.88± 0.04	2006.945	1	7,3,16
STO 1	23092+5137	9.50,9.8						2006.945		1
WFC 239 <AB>	22154+5104	9.80,11	221.81	7.14	1.10± 0.09	0.96± 0.04	0.84± 0.04	2006.948	1	
<ACA 14 AC>	22154+5104	9.80,12.99	327.77	16.16	3.19± 0.46	2.42± 0.07	2.18± 0.05	2006.948	1	7, 3
<ACA 14 AD>	22154+5104	9.80,12.45	26.13	22.71	2.65± 0.24	2.62± 0.05	2.60± 0.05	2006.948	1	7, 3
CHE 462	23264+4245	10.20,10.98						2006.948		1
ES 1113	22149+5110	10.10,10.5						2006.948		9
CHE 448	23237+4155	10.27,10.79						2006.950		1
CHE 467	23270+4304	10.30,10.8	66.36	16.46	0.57± 0.20	0.76± 0.49	0.18± 0.12	2006.951	1	
CHE 497	23293+4152	10.40,11	50.03	4.01	0.09± 0.22	0.37± 0.11	0.51± 0.10	2006.964	1	
CHE 492 <AB>	23288+4144	9.73,10.3	67.41	18.16	2.30± 0.01	2.92± 0.05	3.38± 0.14	2006.964	1	
<ACA 15 AC>	23288+4144	9.73,13.01	178.47	42.18	3.28± 0.18	4.22± 0.17	3.26± 0.18	2006.964	1	7, 3
<ACA 15 AD>	23288+4144	9.73,12.21	135.74	82.45	2.48± 0.14	2.99± 0.02	3.35± 0.11	2006.964	1	7, 3
<ACA 16>	<23286+4144>	10.80,13.44	195.49	46.50	2.64± 0.23	2.13± 0.05	1.54± 0.20	2006.964	1	4,3,21
CHE 438	23225+4211	10.40,10.6	269.60	12.74	0.78± 0.27	1.01± 0.29	1.37± 0.31	2006.964	1	
CHE 442	23227+4215	9.70,10.8	303.64	26.57	1.41± 0.19	1.06± 0.15	0.70± 0.06	2006.964	1	
H 6 24 AB	23248+6217	5.16,9.88	226.06	96.00	4.52± 0.04	4.59± 0.07	5.20± 0.14	2006.977	1	
H 6 24 AC	23248+6217	4.98,8.7	258.71	215.67	7.45± 0.11	7.35± 0.12	8.18± 0.54	2006.977	1	
H 6 24 CD	23248+6217	8.70,9.7	39.00	8.19	0.80± 0.17	0.84± 0.07	0.77± 0.17	2006.977	1	
<ACA 19 AE>	23248+6217	5.16,12.35	23.54	122.00	7.19± 0.35	5.70± 0.10	4.05± 0.14	2006.977	1	7, 3
<ACA 19 AF>	23248+6217	5.16,14.18	227.65	191.50	9.02± 0.50	6.94± 0.17	4.56± 0.13	2006.977	1	7, 3
<ACA 19 AG>	23248+6217	5.16,13.68	147.69	151.83	8.52± 0.24	8.39± 0.16	8.97± 0.32	2006.977	1	7, 3
<ACA 19 GH>	23248+6217	13.68,13.69	167.89	14.35	0.01± 0.02	0.13± 0.05	0.09± 0.04	2006.977	1	7, 3
STTA251 AB	23536+5131	6.89,9.14	207.74	47.55	2.77± 0.05	2.66± 0.04	2.55± 0.03	2006.978	1	
STTA251 AC	23536+5131	6.89,11.8	134.38	46.55	5.42± 0.04	5.59± 0.01	5.86± 0.12	2006.978	1	

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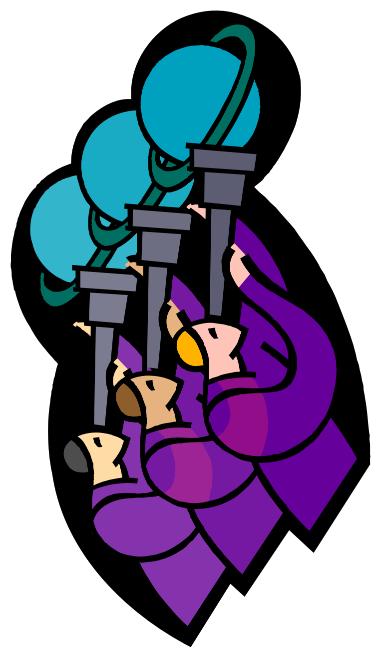
Perrineville Observatory Report: Double Star Measurements for 2006

Discoverer Designation	WDS Identifier	Magnitudes	PA (deg)	Sep (as)	Δmv	Δmr	Δmi	Date	n	Notes
STTA251 AD	23536+5131	6.89, 13.4	165.01	14.15	4.82	4.93± 0.16	4.39± 0.62	2006.978	1	
<ACA 17>	<23536+5136>	11.90, 11.73	87.34	56.55	-0.17± 0.06	1.13± 0.03	3.29± 0.16	2006.978	1	4,3 22
<ACA 18>	<23535+5134>	9.53,13.165	39.13	72.25	3.64± 0.06	3.16± 0.09	2.59± 0.10	2006.978	1	4,3,23
ENG 88 Aa-B	23435+5805	7.21, 10.55	215.34	160.00	3.39± 0.02	2.59± 0.10	2.79± 0.06	2006.986	1	
ENG 88 Aa-C	23435+5805	7.21, 10.77	163.83	140.75	3.81± 0.02	3.35± 0.09	3.10± 0.06	2006.986	1	
ENG 88 Aa-D	23435+5805	7.21, 9.8	197.83	220.75	2.59± 0.02	2.22± 0.09	2.05± 0.06	2006.986	1	
ENG 88 Aa-E	23435+5805	7.10, 9.6	145.32	166.00	3.93± 0.03	3.78± 0.10	3.85± 0.07	2006.986	1	
ENG 88 Aa-F	23435+5805	7.21, 9.03	197.02	274.00	1.95± 0.01	1.99± 0.08	2.25± 0.06	2006.986	1	
ENG 88 BD	23435+5805	10.55, 9.8	251.47	83.08	-0.80± 0.00	-0.77± 0.01	-0.74± 0.01	2006.986	1	
ENG 88 CE	23435+5805	10.77, 10.9	180.50	55.43	0.13± 0.01	0.44± 0.01	0.76± 0.02	2006.986	1	
ENG 88 DF	23435+5805	9.80, 9.03	282.55	53.50	-0.64± 0.06	-0.23± 0.01	0.20± 0.02	2006.986	1	
HJ 5531	23087+3627	10.00, 10.5	66.14	7.66	-0.39± 0.08	-0.14± 0.07	-0.18± 0.04	2006.994	1	
ACA 20	23089+3624	14.40, 14.5	182.33	10.64	0.00± 0.40	0.68± 0.29	0.53± 0.16	2006.994	1	4,3,24
STF2298 AB	18126+4123	8.76, 9.94								9
MLB 587	23137+2959	10.00, 10.5								1



Double Star Measures Using a CCD Camera

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Abstract: Double star measurements using a CCD camera are reported.

Following are 2006 measures of double stars using a CCD camera from my home driveway in light-polluted Larchmont, NY, 17 miles east of New York City (40.55.26N, 73.44.45 W). The method used is the same as described in my paper in Fall 2006 JDSO, Vol. 2, Num.4, pp. 154-155.

The telescope used is a Celestron 9.25" SCT at 2350 mm focal length. The camera is a SBIG ST2000XM, yielding .68"/ per pixel for plate solutions. A photograph of my set up is shown in Figure 1.

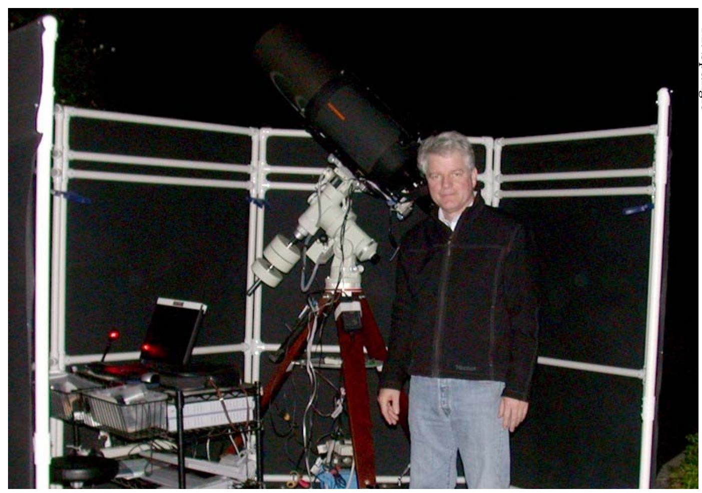
M. Spangle

Figure 1: Photograph of the author with the telescope and camera used in this report.

Name	RA	Dec	Mag 1	Mag 2	PA	SEP	Date	n	Notes
ALI 869	18h 15m 24s	+38°36'	11.8	13.6	42.2	8.9	2006.529	10	
ALI 870	18h 15m 30s	+38°22'	11.9	13.4	242.3	8.7	2006.529	4	
ES 1420 AB	18h 15m 36s	+44°17'	9.6	10.8	65.9	8.3	2006.529	6	
ES 1420 AC	18h 15m 36s	+44°17'	9.6	13.6	8.9	14.8	2006.529	6	
ALI 871	18h 15m 38s	+38°42'19"	10.9	12	180.8	13.1	2006.529	7	
ES 2664	18h 15m 42s	+37°23'	10	10.1	88.2	9.4	2006.540	5	
SEI 563	18h 17m 30s	+34°03'	9.4	10.7	94.1	13.3	2006.529	5	
HJ 1321	18h 21m 18s	+39°20'	10	11	77	9.6	2006.529	5	
HO 432 AB	18h 23m 57s	+38°44'21"	6.4	12.9	285.2	17.2	2006.54	5	
HO 432 AC	18h 23m 57s	+38°44'21"	6.4	11.5	42.3	60.5	2006.529	6	

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Double Star Measures Using a CCD Camera

Name	RA	Dec	Mag 1	Mag 2	PA	SEP	Date	n	Notes
MLB 648	18h 27m 00s	+28°32'	9.7	11	21.6	10.1	2006.529	5	
ES 475	18h 28m 00s	+27°08'	9.6	10.6	222.4	10.3	2006.529	4	
HJ 1326	18h 29m 12s	+32°20'	10	10	6.9	11.3	2006.529	4	
SLE 182	18h 29m 48s	+39°30'	9.8	10.1	252.6	11.3	2006.529	8	
STF2338 CD	18h 30m 52s	+38°38'25"	8.6	13.1	68.9	60.7	2006.529	4	
STF2338 AB	18h 30m 55s	+38°39'33"	9.9	11.2	300.7	12.2	2006.529	8	
STF2338 AC	18h 30m 55s	+38°39'33"	9.6	9.3	206.5	76.6	2006.529	8	
STF2338 AD	18h 30m 55s	+38°39'33"	9.9	13.1	154.3	51.9	2006.529	8	
ES 1261	18h 32m 24s	+45°10'56"	9.6	12.2	208.9	7.4	2006.54	4	
SLE 201	18h 33m 18s	+32°03'	10.1	11.7	259.1	22.6	2006.529	4	
SLE 208 AB	18h 33m 29s	+39°34'17"	9.1	12	79.7	13	2006.529	7	
SLE 208 AC	18h 33m 29s	+39°34'17"	9.1	10.8	3.2	63.4	2006.529	6	
SLE 209	18h 33m 54s	+32°08'	9.1	10.2	22.7	10.2	2006.529	4	
ES 2668	18h 34m 18s	+45°11'	9.2	11	225	12.6	2006.529	6	
SLE 210	18h 34m 18s	+38°32'	11.8	12.5	235.7	9.9	2006.529	8	
SLE 211	18h 34m 41s	+31°57'33"	10.6	11	271.2	9.2	2006.529	4	
SLE 95	18h 36m 30s	+40°08'	10.9	11.6	110	10.8	2006.529	8	
SLE 220	18h 37m 07s	+32°01'05"	10.1	10.9	238	18.1	2006.529	4	
SLE 230 AB	18h 38m 30s	+38°37'	10.5	11.6	220	9.1	2006.529	6	
SLE 230 AC	18h 38m 30s	+38°37'	10.5	11.3	158.2	39	2006.529	5	
ES 1159 AC	18h 38m 36s	+47°00'	9.9	11.1	345.8	19.5	2006.529	5	
AG 225 AB	18h 39m 46s	+40°34'40"	10.3	10.4	354.7	6.5	2006.529	6	
AG 225 AC	18h 39m 46s	+40°34'40"	9.2	13.5	235.8	12.5	2006.529	7	
SLE 92	18h 40m 24s	+40°28'	9.8	12	99.1	15.8	2006.529	7	
SEI 570	18h 42m 00s	+35°05'	10.5	11	130.6	9.3	2006.529	4	
ES 478	18h 43m 37s	"+42°36'40"	10.3	10.8	184.3	9.3	2006.529	6	
HJ 1342	18h 44m 00s	+43°28'	8.8	11.8	185.6	18.5	2006.529	6	
ES 1424	18h 45m 00s	+44°22'	7.9	13	90.3	7.7	2006.529	6	
SEI 574	18h 45m 42s	+32°18'	9	11	263	18.7	2006.529	4	
ES 1560	18h 47m 42s	+41°59'	9.9	12	345.6	9.8	2006.529	9	

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Double Star Measures Using a CCD Camera

Name	RA	Dec	Mag 1	Mag 2	PA	SEP	Date	n	Notes
HJ 1352	18h 50m 06s	+29°49'	7.8	10	250.5	13.4	2006.529	4	
HJ 1354	18h 53m 00s	+36°21'	9.7	9.8	5	10.2	2006.529	4	
HJ 1355	18h 54m 06s	+27°18'	10	10.5	222.8	12.1	2006.529	4	
ES 2670 AB	18h 58m 12s	+30°11'	9.9	10.3	70.3	11.1	2006.529	4	1
ABH 110 AD	19h 07m 49s	+30°43'36"	10.8	14.9	77.4	52.7	2006.54	3	
ABH 110 AE	19h 07m 49s	+30°43'36"	10.8	14.7	111.6	64.2	2006.54	3	
ABH 110 AF	19h 07m 49s	+30°43'36"	10.8	15.7	288.5	33.9	2006.54	3	
ABH 110 AH	19h 07m 49s	+30°43'36"	10.8	14.6	316.3	91.1	2006.54	3	
ABH 110 AI	19h 07m 49s	+30°43'36"	10.8	15.3	24.7	55.9	2006.564	3	
ABH 110 AJ	19h 07m 49s	+30°43'36"	10.8	15.9	225.5	82.9	2006.54	3	
HLM 16 AB	19h 07m 49s	+30°43'36"	10.5	12.7	311.3	8	2006.54	3	
J 2945 AC	19h 07m 49s	+30°43'36"	10.4	14.1	191.9	9.4	2006.54	3	
STF2467	19h 08m 06s	+30°47'34"	10.1	10.3	262.5	10.4	2006.54	3	
WFC 218	19h 12m 29s	+44°47'18"	9.8	10.2	352.1	9.4	2006.529	4	
HJ 1375	19h 12m 30s	+28°12'	10	11	85.4	12.2	2006.529	4	
AG 375	19h 14m 12s	+26°26'	9.6	10.5	295.5	18.6	2006.529	4	
CHE 217	20h 13m 41s	+14°52'	9.4	10.2	132.6	26.4	2006.715	4	
CHE 218	20h 13m 48s	+14°50'	10.1	11	221.1	26.3	2006.712	4	
CHE 226	20h 14m 18s	+14°51'	10.3	10.6	285.6	12.9	2006.712	4	
CHE 235	20h 14m 36s	+14°52'	10	11.5	28.5	13.8	2006.712	4	
CHE 246	20h 15m 36s	+15°26'	7.9	10	86	16.1	2006.715	5	
CHE 248	20h 15m 42s	+15°20'	9.7	0	324.6	14.4	2006.715	5	
CHE 253	20h 16m 00s	+15°21'	0	0	321.5	31.9	2006.715	5	
ABH 137 AD	20h 16m 54s	+13°03'	12.2	15.7	43	25.5	2006.712	5	
ABH 137 AE	20h 16m 54s	+13°03'	12.2	14.1	289.5	86	2006.712	3	
ABH 137 AF	20h 16m 54s	+13°03'	12.2	15.6	37.8	81.7	2006.712	5	
ABH 137 AG	20h 16m 54s	+13°03'	12.2	15.1	111.8	117.9	2006.712	5	
J 1879 AB	20h 16m 54s	+13°03'	9.6	9.8	232.6	10.9	2006.712	5	
J 1879 AC	20h 16m 54s	+13°03'	9.6	13	271.9	13.7	2006.712	5	

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Double Star Measures Using a CCD Camera

Name	RA	Dec	Mag 1	Mag 2	PA	SEP	Date	n	Notes
CHE 269	20h 17m 00s	+15°38'	9	9.9	284.1	27	2006.712	5	
CHE 272	20h 17m 06s	+15°36'	10.2	10.4	105	17.8	2006.715	4	
CHE 274	20h 17m 12s	+15°15'	10.2	10.3	148.2	27.4	2006.715	3	
J 1880	20h 17m 12s	+13°04'	9.4	11.5	245.8	13.5	2006.715	3	
CHE 276	20h 17m 24s	+15°22'	11	11.5	261	18.1	2006.715	4	
CHE 278	20h 17m 42s	+15°39'	10	11.5	90.6	10.2	2006.712	5	
CHE 279	20h 17m 42s	+15°03'	11.2	11.5	181.2	6.6	2006.712	4	
CHE 281	20h 17m 48s	+15°20'	8.9	10.2	315.2	17.6	2006.712	3	
CHE 290	20h 18m 06s	+15°19'	9.7	10.1	153	10	2006.712	4	
SMA 116	20h 18m 06s	+15°19'	10	11.5	158.9	9.6	2006.712	5	
CHE 291	20h 18m 12s	+16°04'	9.8	11.5	274.2	8.4	2006.712	3	
CHE 294 AB	20h 18m 18s	+15°09'	10	10.5	357.3	14.1	2006.712	5	
CHE 294 AC	20h 18m 18s	+15°09'	10	11.5	237.9	15.8	2006.712	5	
HJ 2959	20h 24m 30s	+09°16'	9.4	11.2	262.7	7.3	2006.712	4	
BU 664	20h 24m 36s	+05°31'	7.2	12.7	287.7	8.6	2006.712	3	
HJ 1507	20h 24m 42s	+14°38'	9.5	11.3	63.9	10.3	2006.712	5	
HJ 1508	20h 24m 42s	+14°43'	10.4	10.7	58.9	13.7	2006.712	4	
HJ 268	20h 27m 00s	+11°16'	10	12	248.1	20.3	2006.712	5	
BRT1343	20h 27m 24s	+14°57'	11	11	334.6	4.4	2006.715	4	
A 1674 AC	20h 27m 30s	+14°54'	9.2	12.2	290.3	8.1	2006.712	4	
BU 297 AC	20h 30m 18s	+10°54'	5.9	14.1	339.9	16.9	2006.712	5	
BAL2538	20h 30m 54s	+04°00'	9.8	11.5	201.5	10.8	2006.712	5	
BU 363 AB	20h 30m 58s	+20°36'	6.2	10	80.8	7.1	2006.712	6	
BU 363 AC	20h 30m 58s	+20°36'	6	12.8	206	54.1	2006.712	5	
STF2696 AC	20h 33m 30s	+05°27'	7.7	13.7	347.9	13.5	2006.712	5	
HJ 2981	20h 35m 18s	+02°39'	10	12	5	12.8	2006.712	6	
J 3096 AB	20h 36m 30s	+20°44'	9.4	11.5	1.7	21.9	2006.712	5	
J 3096 BC	20h 36m 30s	+20°44'	11.5	12	8.5	8.3	2006.712	5	
STF2703 AC	20h 36m 48s	'+14°44'	9.1	9.1	233.9	77.2	2006.715	5	
STF2703 BC	20h 36m 48s	+14°44'	9.1	9.1	215.4	66.5	2006.715	5	

Table continued on next page

Double Star Measures Using a CCD Camera

Name	RA	Dec	Mag 1	Mag 2	PA	SEP	Date	n	Notes
STF2703 AD	20h 36m 48s	+14°44'	8.3	0	347.1	85.2	2006.715	5	
STF2703	20h 36m 49s	+14°43'	8.3	8.4	289.9	25.3	2006.715	5	
HJ 5545 AB-C	20h 37m 30s	+14°36'	0	13.1	131.9	13.9	2006.712	5	
LBZ 1	20h 37m 33s	+14°35'	3.7	11.6	271.4	110.8	2006.712	4	
STF2704 AB-D	20h 37m 33s	+14°35'	3.2	11	318.3	47.2	2006.715	4	
BU 288 AB	20h 39m 06s	+15°50'	6	12.4	153.7	5.2	2006.712	3	
BU 288 AC	20h 39m 06s	+15°50'	5.9	10.8	122.5	40.2	2006.712	3	See Note 1 For PA
BU 288 AD	20h 39m 06s	+15°50'	5.9	14.3	145.9	29.2	2006.712	4	
BU 288 AE	20h 39m 06s	+15°50'	5.9	14.3	33.7	23.1	2006.712	4	
SCJ 27 AC	20h 39m 12s	+10°59'	8.4	0	79.4	14.2	2006.712	5	
SCJ 27	20h 39m 13s	+10°58'	8.7	10	262.2	6.1	2006.712	5	
J 3104	20h 39m 42s	+14°06'	9.9	11.2	286.1	6.3	2006.712	4	
J 192	20h 41m 36s	+10°58'	9.4	13.1	0	0	2006.712	5	not there
J 193	20h 42m 00s	+18°21'	8.8	11.8	83.1	5.3	2006.712	4	
COU 424	20h 44m 48s	+19°43'	8	13	234	5.3	2006.712	4	
A 2285 AB	20h 45m 42s	+04°30'	9.2	14.2	221.2	7.5	2006.712	5	
A 2285 AC	20h 45m 42s	+04°30'	9.2	12.7	115.6	33.5	2006.712	5	
BAL2544	20h 46m 00s	+03°44'	9.4	11.4	14.6	17	2006.712	5	
BAL2545	20h 46m 36s	+03°44'	11	11.2	281.3	12	2006.715	9	
BRT1348	20h 47m 54s	+17°32'	9.5	11.5	123.5	5.7	2006.712	4	
J 2321	20h 48m 48s	+05°12'	9.9	11.1	151.3	6.6	2006.712	4	
BAL2547	20h 52m 54s	+03°37'	10	12	220.3	8.5	2006.712	4	
HO 597	20h 53m 36s	+19°35'	7.6	11.9	234.4	10.2	2006.712	5	
BAL2548	20h 53m 41s	+03°35'	9.9	10.8	257.8	7.5	2006.715	6	
BAL2040	20h 55m 12s	+03°14'	9	11.1	67.7	8.3	2006.712	5	
J 3118	20h 58m 30s	+16°07'	9.4	11.2	73.6	5.7	2006.712	4	
HJ 1608	21h 04m 54s	+12°27'	7.6	11.4	257.1	20.1	2006.712	5	
J 3155 AB	21h 57m 42s	+43°56'	10	10.4	130.6	5.8	2006.737	4	
ES 2527	21h 58m 48s	+37°45'	10.5	10.7	321.9	8.2	2006.737	4	
MLB1022	21h 59m 03s	+40°01'21	10	12	245.4	8	2006.737	4	

Table continued on next page

Double Star Measures Using a CCD Camera

Name	RA	Dec	Mag 1	Mag 2	PA	SEP	Date	n	Notes
MLB 789	21h 59m 06s	+39°00'	10.5	11	359	10	2006.737	4	
MLB1023	21h 59m 30s	+39°59'	10.5	10.6	236	5.2	2006.737	8	
MLB1024	22h 00m 06s	+40°01'	10.1	10.5	221.9	23.5	2006.737	7	
ES 2529	22h 03m 36s	+38°25'	11	11	272.5	4.8	2006.737	4	
BRT1157	22h 04m 37s	+46°24'02"	11.5	12	223.8	6.9	2006.742	3	
DYL 4	22h 04m 46s	+45°07'56"	11.5	13	171.8	12.1	2006.742	3	
HJ 1724	22h 04m 48s	+51°25'	10.9	11	45.5	13.4	2006.737	4	Correct PA, Cat wrong
DYL 6	22h 05m 18s	+44°58'09"	14	14.5	345.9	11.9	2006.748	2	
ES 532	22h 06m 24s	+47°16'	10.4	10.5	241.7	9.8	2006.737	5	
MLB 791	22h 07m 24s	+39°06'	9.8	9.9	125.8	4.3	2006.737	4	
MLB 903	22h 08m 06s	+39°54'	10	10.5	197.1	4.9	2006.737	4	
MLB 793	22h 08m 24s	+39°19'	9.8	10.3	208.8	6.5	2006.737	4	
HO 470	22h 08m 32s	+39°22'18"	7.8	13.8	341.9	13.5	2006.737	4	
HJ 1735	22h 09m 15s	+44°50'47"	6.7	9.7	109.3	27.3	2006.737	4	
HJ 1735 AC	22h 09m 15s	+44°50'47"	6.7	14.7	137.9	43	2006.737	4	
HJ 1735 AD	22h 09m 15s	+44°50'47"	6.7	6.8	285.7	109	2006.737	4	
HJ 1735 BC	22h 09m 18s	+44°51'	8.3	10.8	170	22.7	2006.737	1	
MLB 963	22h 11m 06s	+40°32'	10.5	11	9.3	6.7	2006.737	4	
BRT1158	22h 11m 48s	+47°11'	10.8	10.9	147.7	5.3	2006.737	4	
BRT1159	22h 13m 48s	+45°20'	10	10.3	235.1	4.3	2006.737	4	
ES 1113	22h 14m 54s	+51°10'	10.1	10.5	46.9	10.9	2006.748	2	
STF2890 AB	22h 15m 12s	+49°53'	9.3	9.5	10.9	9.4	2006.737	4	
STF2890 AC	22h 15m 12s	+49°53'	8.6	9.7	277.4	73	2006.737	4	
WFC 239	22h 15m 24s	+51°03'32"	9.8	10.9	220.9	6.9	2006.737	4	Same as ES 1113?
ES 2530	22h 15m 36s	+38°11'	10.1	10.6	304.9	5.1	2006.737	4	Same as ALI 700?
MLB 794	22h 17m 42s	+38°51'	9.5	10	349.1	6.8	2006.737	8	
MLB 795	22h 17m 48s	+38°57'	10	10.5	80.9	6.6	2006.737	7	
ES 534 CD	22h 18m 24s	+49°40'	10.2	10.5	102.8	7.1	2006.737	4	
ES 534 AC	22h 18m 26s	+49°39'43"	9.4	10.4	68.6	47.9	2006.737	4	

Table continued on next page

Double Star Measures Using a CCD Camera

Name	RA	Dec	Mag 1	Mag 2	PA	SEP	Date	n	Notes
ES 534 AB	22h 18m 26s	+49°39'43"	9.7	12.7	245.0	13.3	2006.737	4	
HJ 1753 AB	22h 20m 24s	+45°14'	10.7	10.7	183.1	5	2006.737	4	
HJ 1753	22h 20m 25s	+45°14'59"	11	11.7	175.3	42.2	2006.737	4	
ES 1589 AB	22h 21m 12s	+42°27'	9.2	103	177.4	9	2006.737	4	
ES 1589 AC	22h 21m 13s	+42°26'55"	8.9	12.3	222.9	26.7	2006.737	4	
MLB 904	22h 24m 00s	+38°55'	10	119.5	103.8	5.4	2006.737	4	
POP 176	22h 24m 30s	+42°42'	9.5	11	100.9	12.4	2006.737	4	
HJ 1766 AB	22h 26m 36s	+50°19'	10.2	10.7	269.8	14.5	2006.737	4	
ES 1180	22h 26m 37s	+50°18'26"	10.7	14.3	276.5	4.2	2006.737	4	
MLB 796	22h 29m 24s	+39°16'	10	10.5	318.1	5.6	2006.737	4	
MLB 905	22h 29m 53s	+39°11'44"	12.8	13	231.1	3.8	2006.737	4	
MLB 964	22h 30m 36s	+39°38'	10	11	32.6	6.2	2006.737	4	
ES 2072 AB	22h 30m 42s	+37°29'	9.7	9.8	327	13.4	2006.737	4	
ROE 47 DE	22h 32m 21s	+39°45'26"	9.4	9.8	176.3	6.5	2006.737	4	
ROE 47 AD	22h 32m 26s	+39°46'47"	5.8	9.4	217.4	101.8	2006.737	4	
ROE 47 AC	22h 32m 26s	+39°46'47"	5.8	10.1	342.5	33.5	2006.737	4	
ROE 47 AB	22h 32m 26s	+39°46'47"	5.8	9.8	155.3	42.9	2006.737	4	
ES 1468	22h 34m 12s	+43°41'	9.4	9.7	326.4	5.9	2006.737	4	
STI2828	22h 34m 47s	+56°53'24"	10.9	12	354.1	12.8	2006.737	3	
ES 2532	22h 34m 54s	+37°02'	9.7	10.2	224.5	6.6	2006.742	3	found at 223532+370439
J 3175 AB	22h 35m 00s	+45°27'	10.5	10.5	137.7	4.4	2006.737	2	
J 3175 AC	22h 35m 00s	+45°27'	10.5	10.5	19.8	9.2	2006.737	2	
ES 1469	22h 35m 37s	+43°07'13"	8.8	11.9	33.8	6.8	2006.742	1	
HJ 1791 AC	22h 35m 39s	+56°51'40"	7.6	10.9	140.7	89.6	2006.737	3	
HJ 1791 AB	22h 35m 39s	+56°51'40"	7.6	9.7	59.4	17.2	2006.737	3	
SMA 175	22h 37m 18s	+53°21'	10.5	10.6	56.4	11.2	2006.737	3	
ES 1470	22h 37m 24s	+43°23'	10.3	10.6	335	5.8	2006.737	3	
HJ 1793	22h 38m 17s	+47°03'01"	11.4	12.4	288.8	15.5	2006.737	3	
ES 843	22h 39m 48s	+48°43'	10.4	10.5	206.9	8.2	2006.737	4	
SMA 178	22h 40m 48s	+52°59'	10	11	181.3	16.7	2006.737	4	

Table continued on next page

Double Star Measures Using a CCD Camera

Name	RA	Dec	Mag 1	Mag 2	PA	SEP	Date	n	Notes
DOB 16	22h 43m 30s	+38°13'	10	10.5	79	23.9	2006.737	8	
ES 1997	22h 43m 36s	+38°11'	10.2	10.5	90.5	4.3	2006.737	7	
MLB 995	22h 43m 42s	+40°15'	10	10.1	303.6	4.7	2006.737	4	
HJ 1805	22h 44m 48s	+47°00'	9.6	10.1	158.2	7.4	2006.737	4	
ES 847	22h 44m 59s	+46°57'19"	9.8	12.7	255.7	10.7	2006.737	4	
AG 287	22h 45m 18s	+40°02'	8.9	10	193.6	14.5	2006.737	4	
ES 1700	22h 45m 34s	+40°03'56"	10.6	10.7	241.8	4.2	2006.737	4	
HJ 1813	22h 48m 36s	+41°36'	10.1	10.2	61.2	9.4	2006.737	3	
HJ 1815	22h 49m 24s	+45°28'	9.5	9.8	30.9	10.1	2006.737	4	
HJ 1816	22h 49m 55s	+46°19'52"	10.6	10.7	134.5	6.9	2006.737	4	
MLB 966	22h 50m 42s	+40°05'	10	11	120.5	7.2	2006.737	4	
ES 2534	22h 51m 18s	+37°14'	10	10.1	67.1	5.6	2006.737	4	
ES 851	22h 51m 48s	+48°04'	9.9	10.6	262.9	8.5	2006.737	4	
ES 852	22h 52m 12s	+47°34'	8.7	10.3	327.6	7.2	2006.737	4	
HEI 87	22h 52m 30s	+48°28'	10.5	10.8	280.6	5.1	2006.737	4	
HJ 1827	22h 53m 00s	+52°07'	10.7	11	322.5	9.8	2006.737	4	
HJ 1830 AC	22h 54m 24s	+55°38'	9.8	10.3	82.8	13.6	2006.737	4	
ES 691 AD	22h 54m 25s	+55°39'45"	9.8	13.5	272.3	20.5	2006.737	4	
ES 691 AB	22h 54m 25s	+55°39'45"	9.8	12.5	275.6	6.9	2006.737	4	
ES 691 DC	22h 54m 25s	+5539'45"	10.3	13.5	269.1	34	2006.737	4	
ES 2721	22h 55m 30s	+36°40'	10.1	10.9	105.8	9.3	2006.737	4	
SMA 181	22h 55m 48s	+45°08'	9.5	10	280.4	10	2006.737	4	
MLB 801	22h 56m 54s	+39°45'	10.5	10.6	357.6	6	2006.737	4	

Observational Results of LIADA for 2003: Binary Stars Detected

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Abstract: LIADA's (Iberoamerica League of Astronomy) Double Star Section studied 103 neglected visual double stars during 2003. BVIJHK photometries, astrometric and kinematical data were used/obtained to determine their nature using several criteria and classifying them as optical, physical or common origin pairs. Only 12 % were physical double stars or common origin pairs, i.e. binaries. Their angular separations range from 4.01" to 47.89". In this work I comment in detail on these binaries and determine their expected semimajor axis and orbital period.

Introduction

Nowadays the nature of many double and multiple stellar systems remain unknown and probably several tens of thousands of stellar systems could be optical. This situation hampers a better understanding of the formation of stars and stellar systems. One of the main goals of LIADA's Double Star Section is to determine the nature of visual double stars. BVIJHK photometries, astrometric and kinematical data were used/obtained to determine their nature using several criteria classifying them as optical, physical or common origin pairs. In 2003 we studied 103 neglected visual double stars. Only 12 % were physical double stars (i.e. with components orbiting each other around the center of mass) or common origin pairs (i.e. stars that have born together, travel with the same velocity and direction at the same distance from us, but they don't orbit each other). In this article I will name these two types of double stars as binaries. The angular separation for these binaries range from 4.01" to 47.89". In this work I will describe them in detail and determine their expected semimajor axis and orbital periods.

Notes about wide binaries detected in 2003

In what follows I comment on the results for each binary under a heading that includes its name and WDS identifier, the position angle and angular separation, the epoch, magnitudes and spectral types. Figures 1-6 show parts of photographic plates from Digitized Sky Surveys where the physical pairs are located. Table 1 shows orbital data for the physical pairs studied. The projected separation (in A.U.), the expected semiaxis major (in A.U.), the orbital period (in years) and the relative motion (in mas/yr) for the system are listed. The details about the process to estimate spectral types and luminosity classes for the members, the nature for the stellar systems, the expected semiaxis major and the orbital period were explained in detail in Rica (2005).

HJ 2075 (WDS 01487+7528): [230.7º and 30.67" (2003.074); 9m98 (G8V) and 11m29 (K6V)]

This system (shown in Figure 1) is composed of two stars with 9.98 ± 0.03 and 11.29 ± 0.09 magnitudes (Tycho-2, Hog et al. 2000). This pair has 6 measures and was discovered by John Herschel (1833) in 1831 (229º8 and 20") and the last in 1999 (230º8 and 30.73").

The annual proper motion for the primary component is μ(a) = +0.142 ± 0.002" and μ(d)= -0.047 ± 0.002" and for the companion μ(a) = +0.143 ± 0.002" and μ(d)= -0.043 ± 0.002". HJ 2075 is a common proper motion pair.

According to the spectral distribution of energy in BVJHK bands and the kinematical data (reduced proper motion) of the components, HJ 2075 is composed of G7/8V and K6V stars. According to several

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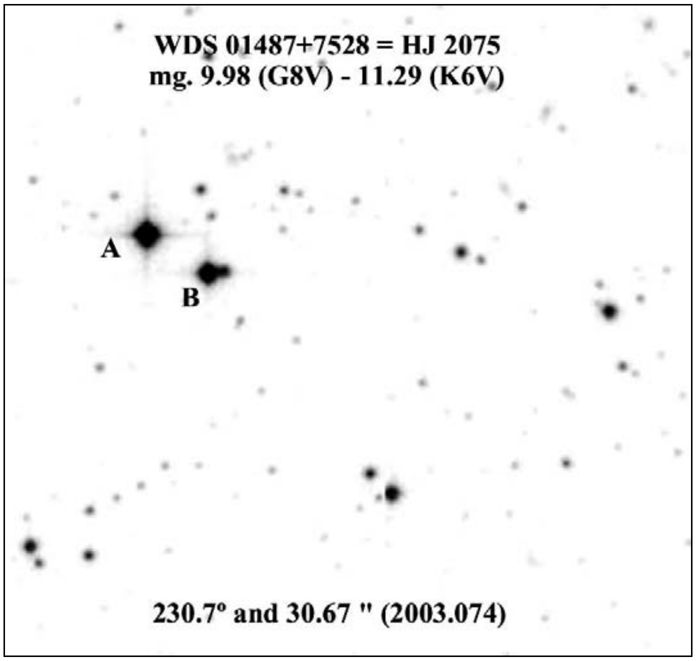

Figure 1: Digitized Sky Survey image of WDS 01487+7528.

criteria HJ 2075 is surely a physical double star.

LDS 9084 (= WDS 00023+0732): [127.9° and 15.25" (1991.699); 18m1 and 18m2]

This double star was discovered by Luyten (1962) with a separation of 15" in direction 128°. The year of the discovery is not listed in the WDS catalog. According to the WDS catalog (Mason, Wycoff, & Hartkopf 2003), it is composed of two stars with 18.1 and 18.2 magnitudes. The last measurement was performed in 1992 (Jaworski 2006), 127.8° and 14.8" .

The annual proper motion for the primary component is $\mu(\alpha)$ = -0.106" and $\mu(\delta)$= -0.060"; for the secondary it is $\mu(\alpha)$ = -0.108" and $\mu(\delta)$= -0.060". Using the USNO-B1.0 proper motions, the relative proper motion was calculated: $\mu(\alpha)$ = +2 mas. So, LDS 9084 is a common proper motion pair. If the Jim Jones measures are used then the relative motion is 10 m.a.s. which seems too large. The 1955 measure performed by Jim Jones, in the LIADA group, using DSS plates must be confirmed.

We could not obtain more astrophysical properties due to the lack of photometric data.

HJ 435 (= WDS 08020+2532): [284.5° and 12.86" (2003.364); 10m8 (F3/4) and 11m2 (F4)]

This double star was discovered by John Herschel (1829) in 1820 (θ = 295° and ρ = 12" with magnitudes of 11.1 and 11.1). It is composed of two stars with magnitudes of 10.84 and 11.24 (Tycho-2). WDS lists 6 measures performed between 1820 and 2000.

The annual proper motion for primary component (from Tycho-2) is $\mu(\alpha)$ = +0.005" and $\mu(\delta)$ = +0.002"; for the secondary is $\mu(\alpha)$ = +0.006" and $\mu(\delta)$ = +0.003". Using the measures made by LIADA, in addition to the historical data from WDS which cover 105 years, we calculated the relative proper motion for this system: $\mu(\alpha)$ = -2.0 mas.* yr^{-1} and $\mu(\delta)$ = -2.0 mas. * yr^{-1}.

According to the spectral distribution of energy in BVJHK bands and the kinematical data, HJ 435 is composed of F3/4 and F4 stars (if they belong to the main sequence). Astrometric and photometric data suggest that there are possibilities that both components be giant stars.

The kinematics is very similar for both members and the photometric distances for both components could be the same, within the error margins. If we take into account several criteria used by us, this system HJ 435 likely is a common origin pair.

LDS 201 AB (= WDS 08039-3133): [236.9° and 47.89" (2000.236); 8m73 (G4V) and 9m64 (G6V)]

This double star was discovered by Luyten (1941). It is a common proper motion pair found by comparison of Bruce proper motion plates. First and second plates epochs were 1898-1904 and 1928-1936, so a "default" mean date of 1920 was assigned to all measures.

It is composed of two stars with magnitudes of 8.73 and 9.64 (Tycho-2). WDS lists 7 new measures performed between 1911 (237° and 47.7") and 2000 (236.5° and 47.86").

The annual proper motion for the primary component (from Tycho-2) is $\mu(\alpha)$ = -0.074" and $\mu(\delta)$ = +0.149"; for the secondary is $\mu(\alpha)$ = -0.073" and $\mu(\delta)$ = -0.146". Using the measures made by LIADA in addition to the historical data from WDS, which cover 89 years, we calculated the relative proper motion for this system: $\mu(\alpha)$ = +2.0 mas.* yr^{-1} and $\mu(\delta)$ = -7.0 mas. * yr^{-1}. So this system is a common proper motion pair.

According to the spectral distribution of energy in BVJHK bands and the kinematical data, LDS 201 AB is composed of a primary G4V (in good agreement with the G3V spectral type from literature) and a

Observational Results of LIADA for 2003: Binary Stars Detected

secondary G6V.

The HIPPARCOS (ESA 1997) obtained trigonometric parallaxes for the components corresponding to 79 and 75 pc. We obtained a photometric distance of 71 pc for the primary. The HIPPARCOS absolute magnitude for the primary is 0.8 magnitudes brighter for its spectral type so LDS 201 A could be an unresolved pair composed of stars of similar magnitudes.

The kinematics are very similar for both members and the photometric distances for both components could be the same (if the primary was a binary star). According to several criteria used by our group this system it is not a bounded system and then we can conclude that LDS 201 AB surely is a common origin pair.

B 2164 CD (= WDS 08039-3133): [58.9º and 4.01" (2000.236)]; 10m9 (B9) and 11m5 (A4V)]

This double star discovered by van den Bos (reference unpublished, manuscript or reference not found) in 1828. It is composed of two stars with magnitudes of 10.9 and 11.5 (inferred by JHK photometry). WDS lists four measures performed between 1913 and 1983. θ and ρ seems not to change during 87 years.

The annual proper motion for primary component (from Tycho-2) is $\mu(\alpha)$ = -0.002" and $\mu(\delta)$ = +0.002". Using the measures made by LIADA in addition to the historical data from WDS, which cover 87 years, we calculated the relative proper motion for this system: $\mu(\alpha) = 0.0$ mas * yr^{-1} and $\mu(\delta) = -2.0$ mas * yr^{-1}.

According to the spectral distribution of energy in BVJHK bands and the kinematical data, B 2164 CD is composed of B9 and A3.5V stars located at about 900 and 1200 pc.

According to several criteria that tested the binarity of this system we can conclude that B 2164 CD likely is a common origin pair.

ES 2569 (= WDS 18107+3903): [274.0º and 9.77" (1989.505); 11m0 (F6) and 12m6 (G8)]

ES 2569 (see Figure 2) is composed of two stars with magnitudes of 11.04±0.11 (Tycho-2) and 12.5. The V magnitude for the secondary was inferred using 2MASS JHK photometry (Cutri et al. 2000). No information about proper motion was found in the literature. Using the measures made by LIADA, in addition to the historical data from WDS, we calculated the relative proper motion for this system: $\mu(\alpha)$ = 4.0 mas* yr^{-1} and $\mu(\delta) = 0.0$ mas * yr^{-1}.

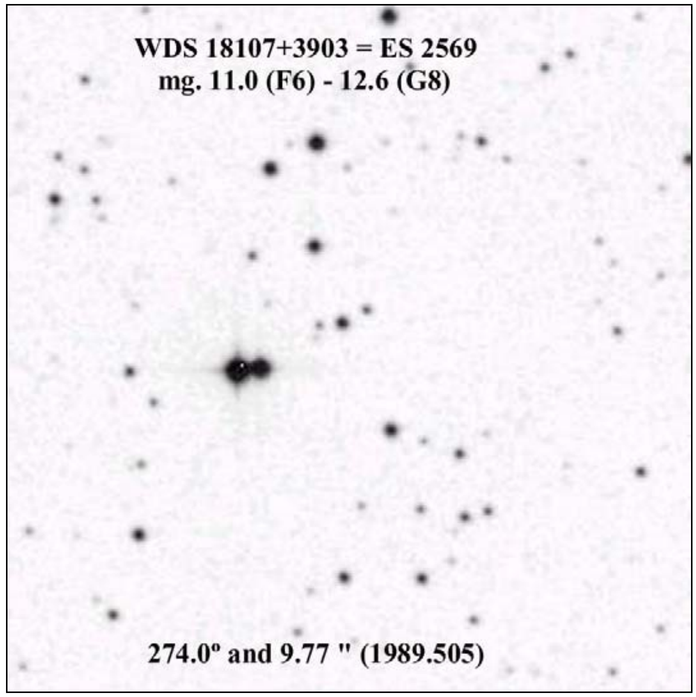

Figure 2: Digitized Sky Survey image of WDS 18107+3903.

According to the spectral distribution of energy in BVJHK bands and the kinematical data, this pair is composed of F6 and G8 stars (if they are on the main sequence). It is likely that both components could be at the same distance.

According to several criteria that tested the binarity of this system we can conclude that this pair could be a physical pair.

LDS 624 (= WDS 18091-6154): [269.7º and 19.30" (2000.512); 15m3 (K7VI) and 15m7 (K8VI)]

LDS 624 is composed of two stars with magnitudes of 15.3 and 15.7. The V magnitude for the secondary was inferred using GSC-II B and R photometry (Morrison et al. 2001). This double star was discovered by Luyten (1941). It is a common proper motion pair found by comparison of Bruce proper motion plates. The first and second plates' epochs were 1898-1904 and 1928-1936, so a "default" mean date of 1920 was assigned to all measures. WDS lists only 2 measures, the last one in 2000. We think that the magnitudes listed are blue sensitive.

The component that Luyten observed, like the brightest one, is really about 0.3/0.5 magnitudes weaker in BVRIJHK photometric bands. We reversed the quadrant listed in the literature. According to the measures performed by LIADA since 1975, θ is fixed and ρ seems to increase about 0.3".

The annual proper motion for the system, from "*LDS Catalogue: Doubles with Common Proper Motion"* (Luyten 1940-1987), is μ(α) = -0.158" and μ(δ)= -0.064". Proper motions for the individual components were not known in the literature, so we decided to determine them using Digitized Sky Survey (hereafter DSS) photographic plates. The result was a proper motion for the primary of μ(α) = -0.184" and μ(δ) = -0.054" and for the secondary of μ(α) = -0.184" and μ(δ) = -0.043". Using the measures made by LIADA, which cover 25 years, the relative proper motion was μ(α) = +13 mas* yr^{-1} and μ(δ) = +1 mas * yr^{-1}.

The spectral types were obtained from the spectral distribution of energy in BVIJHK bands and the kinematical data (reduced proper motion) of the components. We are not completely sure about the luminosity class of both components, but likely this pair is composed of two subdwarfs of K7VI and K8VI spectral types. The photometric distance of both components is about 275 pc.

According to several criteria, LDS 624 is surely a common origin pair.

The accurate coordinates for LDS 624 listed in WDS catalog identify a primary component of a pair composed by weak stars separated by 32" in direction of 100º. But the small proper motion for both components don't match the high proper motion listed in the WDS for the primary (-158 and -64 mas*yr^{-1}).

The true high common proper motion pair is located at 35.5 arcsecs east of the WDS accurate position. See Figure 3.

The corrected position from 2MASS for 1999 epoch is RA: 18h 09m 05.34s and Dec: -61º 54' 14.5". Due to the large motion of both components they have moved about 1.2 arcsecs from 1999 to 2007.

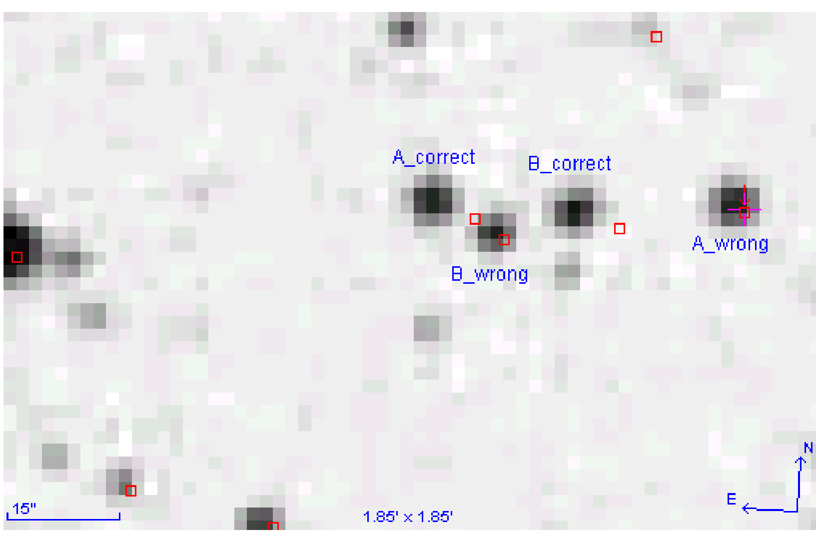

Figure 3.- Photographic plate taken in 1975.659 (DSS). LDS 629 components are marked by *A_correct* and *B_correct* labels. Red square are 2MASS position for 1999 which show the motion for both component in direction SW.

LDS 735 (= WDS 21141-5428): [61.2º and 15.30" (1999.852); 12m3 (K9V) and 13m2 (M1V)]

This system (shown in Figure 4) is composed of two stars with magnitudes of 12.3 and 13.2 (inferred from 2MASS JHK photometry). It was discovered by Luyten (1941). It is a common proper motion pair found by comparison of Bruce proper motion plates. First and second plates epochs were 1898-1904 and 1928-1936, so a "default" mean date of 1920 was assigned to all measures. WDS lists only two measures, the last one in 1958. We think that the magnitudes listed are blue sensitive.

The annual proper motion for the primary is μ(α) = -0.203" and μ(δ) = +0.020". The motion for the secondary is μ(α) = -0.202" and μ(δ) = +0.016". The secondary proper motion was calculated from the relative motion of the secondary to a near star with known proper motion, while the primary proper motion was calculated from the relative motion of LDS 735 and the secondary proper motion previously calculated. Using 9 measures made by LIADA which cover 24 years, the relative motion of the system was determined: μ(α) = -1 mas* yr^{-1} and μ(δ) = +4 mas * yr^{-1}.

According to the spectral distribution of energy in BVIJHK bands and the kinematical data (reduced proper motion) of the components the spectral types were obtained. LDS 735 is composed by K9V and M0.5V stars.

The Halbwachs' criterion determined that the probability to be physical is about 95%. The photometric distance of both components (55 pc) are very similar. According to other several criteria, LDS 735 is surely a physical pair.

The projected separation is 840 A.U. and the expected semiaxis major is of 21.4". The orbital period is about 42,000 years (assuming circular and face-on orbit).

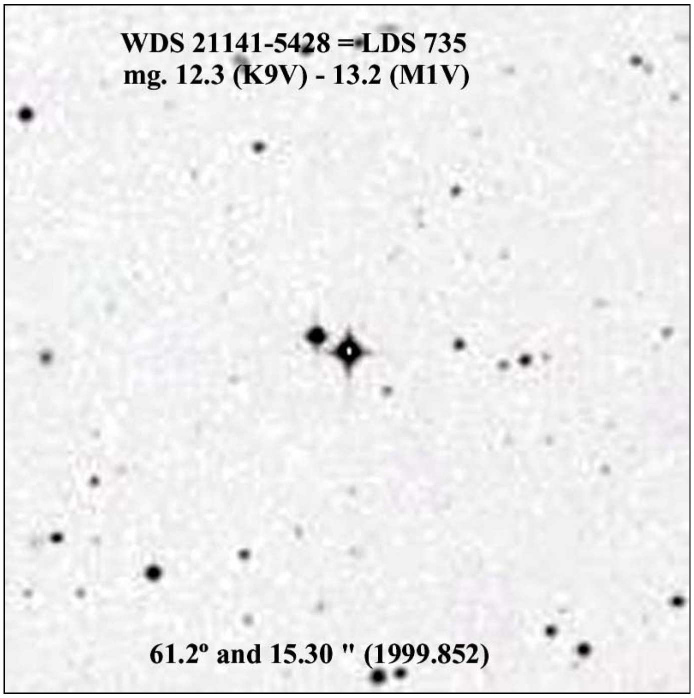

Figure 4: Digitized Sky Survey image of WDS 21141-5428.

This system seems to have an erroneous identification in WDS catalog. The WDS identification is located 10.5 minutes of arc west of the correct position while the accurate WDS position is at 15 minutes of arc. So an update of the accurate coordinate for this binary must be done in WDS catalog. The position of LDS 735 is 21h 12m 55.12s and –54º 28' 14.3".

HJ 1637 (= WDS 21226+3158): [104.0º and 13.55" (1998.461); 8m63 (F6V) and 12m0 (K3V)]

This double star (Figure 5) was discovered by John Herschel (1826) in 1828 (106º and 8" with magnitudes of 8.7 and 11.7). How can it be measured in 1828 and published in 1826? I think that there is an error in WDS database. It is composed of two stars with magnitudes of 8.63 (Tycho-2) and 12.0 (inferred by JHK photometry). WDS lists 4 measures, the last one performed by James Daley (2004) in 2003 (103.2º and 13.29"). Since 1910, θ has decreased one degree and ρ has increased about 0.2". James Daley (2004) found a weak companion of 14.4 magnitude at a separation of 8.52" in direction 142.9º. The new pair AC was named DAL 15 AC.

The annual proper motion for primary component (from Tycho-2) is μ(α) = +0.011" and μ(δ) = -0.038"; for the secondary is μ(α) = +0.015" and μ(δ) = -0.040" (from UCAC-2, Zacharias et al. 2004). Using the measures made by LIADA, which cover 93 years, we calculated the relative proper motion for this system: μ(α) = +4.0 mas* yr^{-1} and μ(δ) = +2.0 mas * yr^{-1}.

According to the spectral distribution of energy in BVJHK bands and the kinematical data, the primary is surely a dwarf F6V, in good agreement with literature which lists F5. The secondary is a K3V star.

The kinematics is very similar for both members and the photometric distances for both components could be the same (111 and 115 pc), within the error margin. The modified Halbwachs' criterion indicates a probability to be physical of 76 %. If we take into account the other criteria we used, HJ 1637 likely is a physical pair.

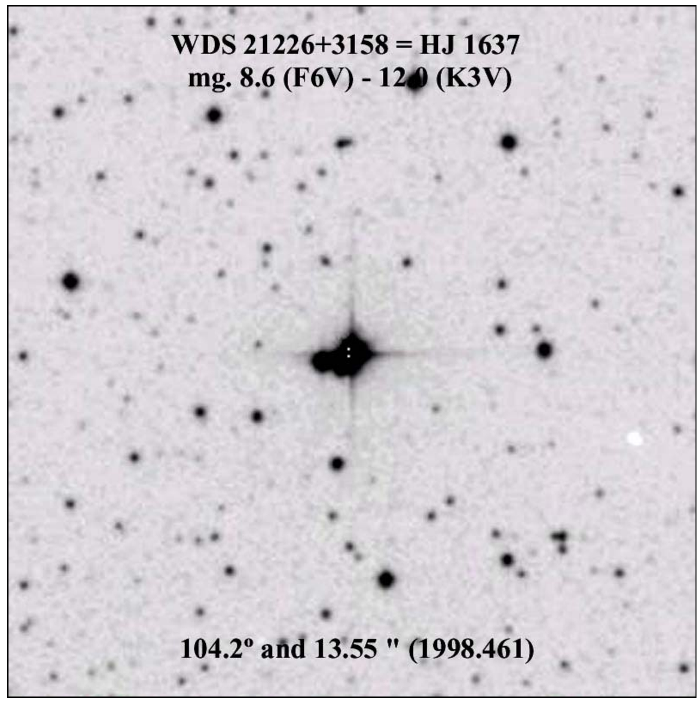

Figure 5: Digitized Sky Survey image of WDS 21226+3158.

The projected separation is 1,485 A.U. and the expected semiaxis major is of 18.4". The orbital period is about 67,000 years (assuming a circular and face-on orbit).

HJ 3036 (= WDS 21337-1444): [91.7º and 6.04" (1999.412); 12m1 (K3V) and 12m1 (K3V)]

This double star was discovered by John Herschel

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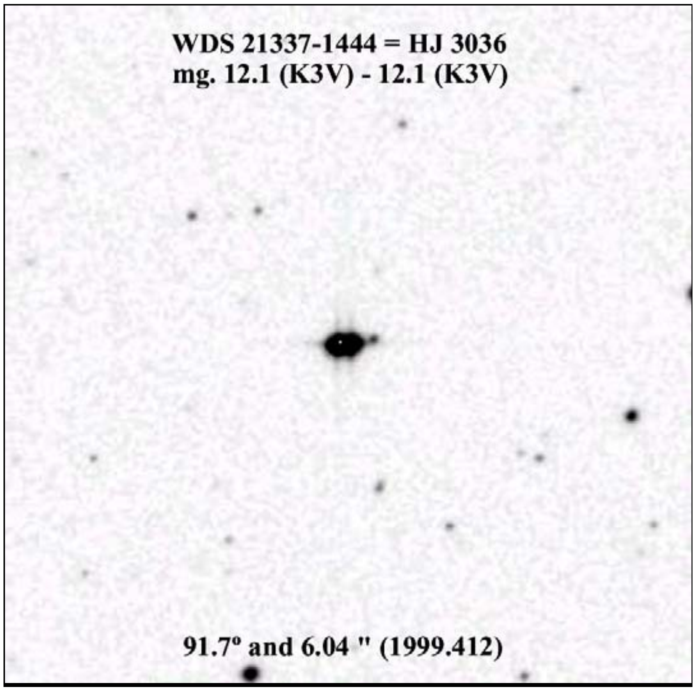

Figure 6: Digitized Sky Survey image of WDS 21337-1444

(1833) in 1830 (90º and 2" with magnitudes of 11 and 11). It is shown in Figure 6. It has been measured two times more, the last one performed by Mason (2001) at 2001.7875 (91.3º and 5.85") using speckle interferometry. It is composed of two stars with magnitudes of 12.1 and 12.1. Since 1905 θ has increased one degree and ρ didn't change significantly.

The annual proper motion for primary component (from Tycho-2) is μ(α) = +0.064" and μ(δ) = -0.011"; for the secondary is μ(α) = +0.065" and μ(δ) = -0.013". The secondary proper motion was calculated from AC2000 (Urban et al. 1998) and 2MASS astrometry for 1905.604 and 1999.412 epochs. Using the measures made by LIADA in addition to the WDS historical measures, which cover 99 years, we calculated the relative proper motion for this system: μ(α) = -0.4 mas* yr^{-1} and μ(δ) = -0.9 mas * yr^{-1}.

According to the spectral distribution of energy in BVJHK bands and the kinematical data, the components are K3V stars located at 115 pc.

According to several criteria used, this pair is likely a physical pair. The projected separation is 672 A.U. and the expected semimajor axis is 8.2" (940 A. U.). The orbital period is about 25,000 years (assuming circular and face-on orbit).

A near star with K magnitude of 14.06 located at 21h33m37s96 and -14º45'49"9 was studied. The J, H and K photometry were consistent with a M5.0/5.5V star at a distance of 107 pc. The distance is very similar with that of the stellar system but the very different proper motion of this third companion suggests that it not related to the system.

Acknowledgements

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

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TABLE I. PHYSICAL PAIRS ORBITAL DATA

WDS identifier	Desig.	θ, ρ (epoch)	mag. spT.	E(a) (A.U.)	Period (yrs)	$\Delta\mu_x$ (mas*yr^{-1})	$\Delta\mu_y$ (mas*yr^{-1})
01487+7528	HJ 2075	230.7 - 30.67 (2003.074)	9.98 - 11.29 G8V - K6V	2,510	106,000	+1	+4
18107+3903	ES 2569	274.0 - 9.77 (1989.505)	11.0 - 12.6 F6 - G8	3,374	139,000	+4	0
21141-5428	LDS 735	61.2 - 15.30 (1999.852)	12.3 - 13.2 K9V - M1V	1,177	42,000	-1.3	+4.1
21226+3158	HJ 1637	104.2 - 13.55 (1998.461)	8.63 - 12.0 F6V - K3V	2,113	67,000	+3	+2
21337-1444	HJ 3036	91.7 - 6.04 (1999.412)	12.1 - 12.1 K3V - K3V	940	25,000	-0.4	-0.9

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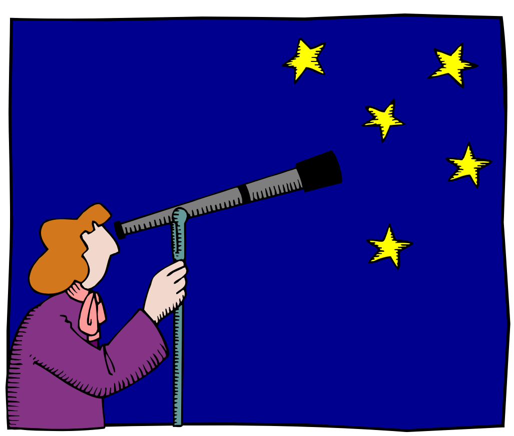

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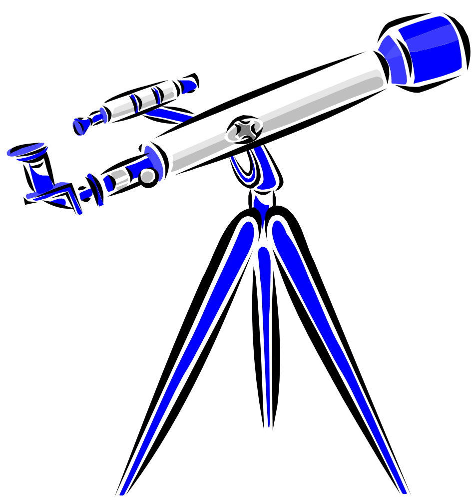

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