

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 inches¹ 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 sub-pixel 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 program⁴), a 9x50 correct image finder⁵ 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, $\theta = 270^\circ$) 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):

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

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 dithering⁶ used to advantage in under-sampled CCD images.

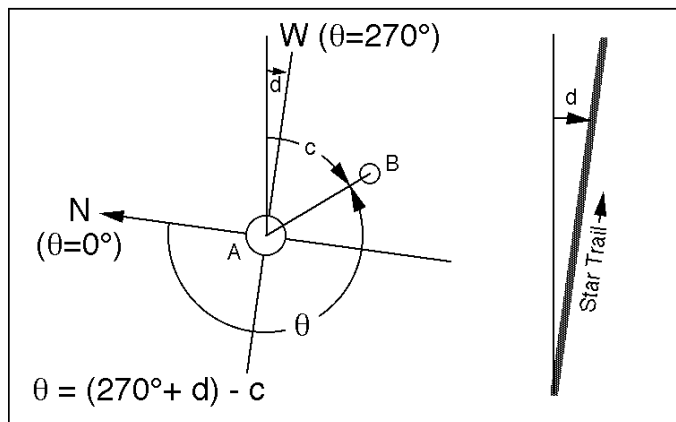


Figure 1: Measurement of position angle using the star trail.

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_faqwfp2_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 Δm_V
 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	

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Discoverer Designation	WDS Identifier	Magnitudes	PA (deg)	Sep (as)	$\Delta\mu\alpha$	$\Delta\mu\delta$	$\Delta\mu\alpha$	$\Delta\mu\delta$	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)	$\Delta\alpha$	$\Delta\alpha_r$	$\Delta\alpha_i$	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
STP2538 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	
STP2538 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
STP2758 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)	Δm_v	Δm_r	Δm_i	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	
SFF2894 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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Discoverer Designation	WDS Identifier	Magnitudes	PA (deg)	Sep (as)	Δm_v	Δm_r	Δm_i	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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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

