

Astrometric Measurements of Seven Double Stars, September 2011 Report

Joseph M. Carro

Cuesta College
San Luis Obispo, California

Abstract: From my residence in Paso Robles, California, measurements of the separation and position angle of seven double stars were made. Listed in chronological order, the double stars were Zeta Ursae Majoris, Zeta Lyrae, Epsilon Delphini, SAO 105104 in Sagitta, STF 2840 in Cepheus, 61 Cygni, and 17 Cygni. The two goals of this project were to measure the position angle and separation of the aforementioned double stars, and to learn the necessary techniques to conduct this research.

Methodology

My observations were made from my home in Paso Robles, California (located at approximately 35°37'36" N and 120°41'24" W) using a Celestron model CPC 1100 telescope (Figure 1). The telescope is computerized, motorized, and was fitted with a Celestron Micro Guide 12.5 mm astrometric eyepiece. The telescope is of Schmidt-Cassegrain design, with aperture of 11 inches on an alt-azimuth mount. The manufacturer reports a focal length of 2,800 mm.

The Micro Guide eyepiece was oriented with the celestial coordinate system using the primary star of the double star under study. The primary star was positioned on the mark 30, the drive was disabled, and the star was permitted to drift to the outer circle. The scale was rotated until the star lay on the 270 degree mark. The accuracy of this setting was verified by positioning the primary star on the 90 degree mark of the outer circular scale, and allowing the star to drift to the 270 degree mark.

Following the orientation, drift times were measured by placing the primary star on the 0 mark of the linear scale, and measuring the drift time from the 0 to the 60 mark using a stop watch precise to ± 0.01 seconds. Measurements were made, and the average drift time was calculated. That average was used to calculate the scale constant Z , using the formula¹⁴:



Figure 1: The author with his Celestron telescope

Astrometric Measurements of Seven Double Stars, September 2011 Report

$$Z = \frac{15.0411 T_{ave} \cos \delta}{D}$$

where T_{ave} is the average time, δ is the declination angle, and D is the number of reticle divisions.

Separation measurements were made by placing the pair of stars on the linear scale at the zero mark, and then counting the number of scale divisions between the stars. Because the scale has 60 divisions, it was only possible to estimate to the nearest $\frac{1}{4}$ division. After each measurement, the double star was repositioned to the next major division. Measurements were made, and an average and standard deviation were calculated.

The position angle measurements were made by aligning both stars on the linear scale with the primary star at the 30 division and pointing to the 60 mark, disabling the tracking feature, and then allowing the stars to drift to the circular scales. The crossing of the primary star at the outer scale was approximated to the nearest degree as the scale has divisions of 5° . Following each measurement, the tracking feature was enabled and the process was repeated.

Zeta Ursae Majoris - Introduction

This double star is located in the constellation of Ursa Major (the Great Bear), and is known by its traditional name of Mizar with alternate spellings of Mirzar, Mizat, and Mirza. This double star has been known since ancient times, and was the first double star. On clear nights, the double star can be seen without the use of instruments. It was studied by Benedetto Castelli in 1617, and has been studied frequently since that time. Both stars are yellow with magnitudes of 2.0 and 4.0²². The colors reported for this pair vary considerably having been reported as both white, white and emerald, both green, blue, or yellow. For the AB components, Right Ascension is $13^h23^m56^s$ and the Declination is $+54^\circ55'31''$. What was once thought to be a double star is actually a complex of six stars which are all gravitationally bound²⁰.

The catalog identifiers for this double star include 79 Ursae Majoris, ADS 8891AB, BD+55 1598A, BGC 18133, FK5 497, HD 116656, HIP 65378, HR 5054, SAO 28737, STF 1744, and WDS 13239+5456. Its precise coordinates are $132355.42+545531.5$.²²

Zeta Ursae Majoris - Observations

The measurements were made on 11 May 2011 (Bessell date 2011.359) beginning at 9:50pm and end-

Table 1: Literature Search; Separation (arc seconds); Position angle (degrees) for Zeta Ursae Majoris

Reference name	Sep	PA
William Herschel Catalog 1779 data ¹⁹	14.3	153
Washington Double Star Cat. ³⁵ 1993 data	14.5	152
Eagle Creek Observatory ²⁴	14.4	151
Daley, 2009 ³⁷	14.3	152.5
<i>Measurements by the author 2011</i>	14.7	152.3

ing at 11:50pm Pacific Daylight Time. The night was clear and calm, and there was a $\frac{1}{2}$ moon. The temperature ranged from 60 to 50° F. There was a breeze of 5 – 10mph which affected the telescope and several measurements were repeated.

The linear scale of the Micro Guide eyepiece was oriented with the celestial coordinate system using the primary star. Once the orientation was completed, 12 drift time measurements were made, with an average value of 47.19 seconds, a standard deviation of 0.63 seconds, and a standard error of the mean of 0.18 seconds. The result was a scale constant of 6.8 arc seconds per division.

The primary star was placed on the linear scale, and 12 separation measurements were taken. The average value was 2.2 divisions with a standard deviation of 0.22 divisions, and a standard error of the mean of 0.06 divisions. When adjusted for significant figures, the calculated separation was 14.7 arc seconds.

The position angle measurements were made using the aforementioned methodology, and 18 position angle measurements were taken with an average value of 152.3° , a standard deviation of 1.5° , and a standard error of the mean of 0.27° .

The separation value of 14.7 arc seconds and position angle value of 152.3° compared well with the separation value of 14.5 arc seconds and the position angle value of 152° published in the Washington Double Star catalog.³⁵ See Table 1.

Zeta Lyrae – Introduction

Located in the constellation of Lyra (the Harp), the double star Zeta Lyrae has been known since ancient times. Its right ascension is $18^h44^m46^s$ and its declination is $+37^\circ36'18''$. The yellow primary and blue-white secondary stars have magnitudes of 4.4 and 5.7 respectively. Modern observations have

Astrometric Measurements of Seven Double Stars, September 2011 Report

shown that Zeta Lyrae is a spectroscopic binary (Wikipedia).

The catalog identifiers for this pair include 6 Lyrae, BD+37 3222, BU 968, CSV 101763, GSC 03118+02080, HD 173648, HIP 91971, HR 7056, PPM 81740, SAO 67321, STF 38, UBV 15954, and WDS 18448+3736. Its precise coordinates are 184446.34+373618.2.²²

Zeta Lyrae – Observations

The measurements were made on 11 July 2011 (Bessell date 2011.526) beginning at 10:15pm and ending at 11:50pm Pacific Daylight Time. The night was clear, and the moon was gibbous. The temperature ranged from 60 to 50° F. The wind was gentle at 1 – 5mph.

The linear scale of the Micro Guide eyepiece was oriented with the celestial coordinate system using the primary star. Once the orientation was completed, 12 drift time measurements were made, with an average value of 35.94 seconds, a standard deviation of 0.29 seconds, and a standard error of the mean of 0.08 seconds. The result was a scale constant of 7.13 arc seconds per division.

The primary star was placed on the linear scale, and 12 separation measurements were taken. The average value was 6.17 divisions with a standard deviation of 0.25 divisions, and a standard error of the mean of 0.07 divisions. When adjusted for significant figures, the calculated separation was 44.0 arc seconds.

The position angle measurements were made using the aforementioned methodology, and 18 position angle measurements were taken with an average value of 149.9°, a standard deviation of 2.18°, and a standard error of the mean of 0.4°.

The separation value of 44.0 arc seconds and position angle value of 149.9° compared well with the separation value of 43.7 arc seconds and the position angle value of 150° published in the Washington Double Star catalog²². See Table 2.

Epsilon Delphini - Introduction

Located in the constellation of Delphinus (the Dolphin), the double star Epsilon Delphini consists of a pair of yellow-white stars of magnitudes 7.1 and 7.4. For the AB components, the right ascension is 20^h31^m12^s and its declination is +11°15'34" ²². It does not have a traditional name.

The catalog identifiers for this pair include ADS 13946BC, AG+11 2505, BD+10 4307B, CSI+10 4307 1, GC 28544, GCRV 12819, GEN+1.00195482, HD

Table 2 Literature Review: Separation (arc seconds) and Position angle (degrees) for Zeta Lyrae

Reference name	Sep	PA
Washington Double Star Cat. ³⁵ 1835 data	43.7	150
Bright Star Catalog ¹⁷	43.7	–
Burton, 2006 ¹⁰	43.6	150
Perez, 2005 ²⁷	43.7	150
Arnold, 2008 ⁶	43.9	149.8
Bell, 2011 ⁹	44	150
Schlimmer ³³ 2009 data	43.4	150.4
Washington Double Star Cat. ²² 2010 data	43.7	150
<i>Measurements by the author 2011</i>	44.0	149.8

195482, HIP 101233, IDS 20264+1055, PPM 138507, SAO 106195, SKY 38830, STF 2690, UBV M24917, and WDS J20312+1116BC. Its precise coordinates are 203111.94+111533.7.²²

Epsilon Delphini – Observations

The measurements were made on 1 August 2011 (Bessell date 2011.584) beginning at 9:30pm and ending at 11:00pm Pacific Daylight Time. The night was clear, with no moon. The temperature range was from 65 to 55° F. There was a 0 – 5mph breeze, and the humidity was 25%.

The linear scale of the Micro Guide eyepiece was oriented with the celestial coordinate system using the primary star. Once the orientation was completed, 12 drift time measurements were made, with an average value of 28.91 seconds, a standard deviation of 0.28 seconds, and a standard error of the mean of 0.08 seconds. The result was a scale constant of 7.11 arc seconds per division.

The primary star was placed on the linear scale, and 12 separation measurements were taken. The average value was 2.5 divisions with a standard deviation of 0.0 divisions, and a standard error of the mean of 0.0 divisions. When adjusted for significant figures, the calculated separation was 17.7 arc seconds.

The position angle measurements were made using the aforementioned methodology, and 18 position angle measurements were taken with an average value of 256°, a standard deviation of 1.5°, and a standard error of the mean of 0.28°.

The separation value of 17.7 arc seconds and the position angle of 256° compared well with the values

Astrometric Measurements of Seven Double Stars, September 2011 Report

Table 3: Literature Review, Separation (arc seconds) and Position angle (degrees) for Epsilon Delphini

Reference name	Sep	PA
Washington Double Star Cat. ²² 1777 data	15.0	281
The Hipparcos Catalog ²⁸ 1997 data	16.7	253
Eagle Creek Observatory ²⁴	16.7	256
Arnold, 2006 ⁵	17.8	254.8
Schlimmer, 2007 ³⁰	17.3	254.1
Schlimmer, 2009 ³²	17.7	254.8
Washington Double Star Cat. ²² 2009 data	17.3	255
Schlimmer 2010 ³³	17.3	255.1
The Tycho Catalog ¹⁵	17.4	254.8
<i>Measurements by the author 2011</i>	17.7	255.9

of 17.3 and 255° as given in the Washington Double Star catalog²². See Table 3.

SAO 105104 in Sagitta – Introduction

Located in the constellation of Sagitta (the Arrow) is this double star of which the primary star is yellow-orange and the secondary star is white. With magnitudes of 6.4 and 9.5, the secondary star approached the limit of the CPC 1100 telescope. Its Right Ascension is 19^h39^m25^s and its Declination is +16°34'16"²². This double star has no traditional name.

The catalog identifiers include AG+16 2018, BC+16 3936, GSC 01602-01582, HD 185622, JIP 96688, HP 7475, IRAS 19371+1627, PPM 136711, SAO 105104, TYC 1602-1582-1, V 0340, and WDS 1934+1634A. Its precise coordinates are 193925.33+163416.0.²²

SAO 105104 in Sagitta – Observations

These measurements were made on 3 August 2011 (Bessell date 2011.589) beginning at 9:30pm and ending at 11:00pm Pacific Daylight Time. The night was clear, with a ¼ moon in the southwest. The temperature range was from 65 to 55° F. There was a 0 – 5mph breeze. The humidity was 30%.

The linear scale of the Micro Guide eyepiece was oriented with the celestial coordinate system using the primary star. Once the orientation was completed, 12 drift time measurements were made, with an average value of 30.36 seconds, a standard deviation of 0.15 seconds, and a standard error of the mean of 0.04 seconds. The result was a scale constant of 7.3

Table 4: Literature Review, Separation (arc seconds); Position angle (in °) for SAO 105104 in Sagitta

Reference name	Sep	PA
W. Herschel (McEvoy 2011) ¹⁹ 1796 data	28.2	302
Hipparcos Catalog ²⁸	30.0	301.2
SKY2000 Master Catalog ²⁵	28.2	302
C C D M Catalog ¹³	28.2	302
Arnold 2010 ⁸	28.6	301.3
Washington Double Star Cat. ²² 2010 data	28.6	301
<i>Measurements by the author 2011</i>	29.0	301

arc seconds per division.

The primary star was placed on the linear scale, and 12 separation measurements were taken. The average value was 4.0 divisions with a standard deviation of 0.0 divisions, and a standard error of the mean of 0.0 divisions. When adjusted for significant figures, the calculated separation was 29.0 arc seconds.

The position angle measurements were made using the aforementioned methodology, and 18 position angle measurements were taken with an average value of 301°, a standard deviation of 1.7°, and a standard error of the mean of 0.31°.

The separation value of 29.0 arc seconds and position angle value of 301° compared well with the separation value of 28.6 arc seconds and the position angle value of 301° published in the Washington Double Star Catalog²². See Table 4.

STF 2840 in Cepheus – Introduction

Located in the constellation of Cepheus, this pair of yellow stars has magnitudes of 5.6 and 6.4. STF 2840 in Cepheus has been well studied, but little has been written about this pair. The WDS gives its Right Ascension is 21^h52^m01^s and its Declination is +55°47'48"²², however, the Cambridge Double Star Atlas lists an R.A. of 21^h52^m19^s and a Dec. of +55°50'10", and the data from the Hipparcos Catalog²⁸ is an R.A. of 21^h52^m00^s and a Dec. of +55°47'31".

The catalog identifiers include ADS 15045, AG+55 1503, BD+55 2638, HD 208063, HIP 107929, IDS 21486+5519B, PPM 39938, SAO 33817, SKY 41670, TYC 3972-2737-1, UBV 187420, and WDS 21520+5548B. Its precise coordinates are 215201.02+554748.3²²

Astrometric Measurements of Seven Double Stars, September 2011 Report

Table 5: Literature Review: Separation (arc seconds); Position angle (degrees) for STF 2840 in Cepheus

Reference name	Sep	PA
Washington Double Star Cat. ²² 1782 data	21.2	192
Hipparcos Catalog ²⁸ 1993 data	17.9	197
Eagle Creek Observatory ²⁴	18.3	196
Arnold 2010 ⁸	17.8	196.8
Washington Double Star Cat. ²² 2010 data	17.8	197
<i>Measurements by the author 2011</i>	18.1	196

STF 2840 in Cepheus – Observations

The measurements were made on 9 August 2011 (Bessell date 2011.605) beginning at 10:20 pm and ending at 11:30 pm Pacific Daylight Time. The night was clear, calm, with a gentle breeze of 1 – 5 mph. The moon was 2/3 full in the southwest. The temperature ranged from 60 to 50° F. The humidity was 65%, and seeing was 3 - 4.

The linear scale of the Micro Guide eyepiece was oriented with the celestial coordinate system using the primary star. Once the orientation was completed, 12 drift time measurements were made, with an average value of 51.55 seconds, a standard deviation of 0.25 seconds, and a standard error of the mean of 0.08 seconds. The result was a scale constant of 7.3 arc seconds per division.

The primary star was placed on the linear scale, and 12 separation measurements were taken. The average value was 2.5 divisions with a standard deviation of 0.0 divisions, and a standard error of the mean of 0.0 divisions. When adjusted for significant figures, the calculated separation was 18.1 arc seconds.

The position angle measurements were made using the aforementioned methodology, and 18 position angle measurements were taken with an average value of 196°, a standard deviation of 1.3°, and a standard error of the mean of 0.24°.

The separation value of 18.1 arc seconds and position angle value of 196° compared well with the separation value of 17.8 arc seconds and the position angle value of 197° published in the Washington Double Star catalog²². See Table 5.

61 Cygni – Introduction

Located in the constellation of Cygnus (the Swan) is 61 Cygni, a famous pair of orange stars. First studied by Piazzi in 1792, the pair has a large proper motion

Table 6: Literature Review, Separation (arc seconds) and Position angle (degrees) for 61 Cygni

Reference name	Sep	PA
W. Herschel (MacEvoy 2011) ¹⁹ 1753 data	35	19.6
Bright Star Cat. ¹⁷	28.7	-
Washington Double Star Cat. ³⁵ 1993 data	30.4	149
The Hipparchos Catalog ²⁸ 1993 data ²²	31.6	151.2
Arnold 2006 ⁴ 2004 data	31.1	150.9
Muller 2007 ²³ 2005 data	31.6	152.6
Perez 2006 ²⁷	36	140
Schlimmer 2009 ³¹ 2008 data	31.0	151.3
Heijen 2008 ¹⁶	31.1	151
Anton 2011 ² Oct 9	31.2	151.3
Anton 2011 ² Oct 12	31.35	151.6
Washington Double Star Cat. ²² 2010 data	31.4	152
<i>Measurements by the author 2011</i>	31.9	151

of about 5 arc seconds per year, and is sometimes called the “Flying Star”³⁹. In 1838 Bessell measured the parallax and distance from the Earth for this pair, which was the first double star to be so measured³⁸. The orange pair is distinct, but the surroundings lack any prominent stars. The pair has magnitudes of 5.2 and 6.1. Its Right Ascension is 21^h 06^m 54^s and its Declination is +38° 44' 58”²².

The catalog identifiers include BD+38 4343, FK5 793, HD 201091, HIP 104214, HR 8085, GC 29509, GJ 820, PPM 86045, SAO 70919, STF 2758, UBV 18287, and WDS 21069+3845. Its precise coordinates are 210653.94+384457.8.²²

61 Cygni – Observations

The measurements were made on 14 August 2011 (Bessell date 2011.619) beginning at 8:45pm and ending at 9:30pm Pacific Daylight Time. The night was clear and calm with no moon. The temperature ranged from 75 to 65° F. The humidity was 25%, and seeing at 4 – 5. The wind at 5 - 10mph affected the measurements, and many were repeated.

The linear scale of the Micro Guide eyepiece was oriented with the celestial coordinate system using the primary star. Once the orientation was completed, 12 drift time measurements were made, with an average value of 36.17 seconds, a standard deviation

Astrometric Measurements of Seven Double Stars, September 2011 Report

Table 7: Literature Review, Separation (arc seconds) and Position angle (degrees) for 17 Cygni

Reference name	Sep	PA
W. Herschel (MacEvoy 2011) ¹⁹ 1822 data	25.5	73
Starland Catalog (Olcott 1909) ²⁶	26.2	69
Washington Double Star Cat. ³⁵ 1993 data	26.3	69
Hipparcos Catalog ²⁸	26.2	67.5
Eagle Creek Observatory ²⁴	26	70
Astrogeek (Burton 2011) ¹⁰ 2006 data	26.3	67
Arnold 2010 ⁷	26.2	69
Washington Double Star Cat. ²² 2009 data	26.2	69
<i>Measurements by the author 2011</i>	25.5	69

tion of 0.37 seconds, and a standard error of the mean of 0.09 seconds. The result was a scale constant of 7.07 arc seconds per division.

The primary star was placed on the linear scale, and 12 separation measurements were taken. The average value was 4.5 divisions with a standard deviation of 0.1 divisions, and a standard error of the mean of 0.03 divisions. When adjusted for significant figures, the calculated separation was 31.9 arc seconds.

The position angle measurements were made using the aforementioned methodology, and 18 position angle measurements were taken with an average value of 150.8°, a standard deviation of 1.3°, and a standard error of the mean of 0.31°.

The separation value of 31.9 arc seconds and the position angle value of 151 degrees compared favorably with the values of 31.4 arc seconds and 152 degrees as published in the Washington Double Star Catalog (Mason+ 2011)²². See Table 6.

17 Cygni – Introduction

Located in the constellation of Cygnus (the Swan), 17 Cygni is a yellow pair of stars with magnitudes of 5.1 and 9.3. Its right ascension is 19^h 46^m 26^s and its declination is +33° 43' 39".²²

The catalog identifiers include ADS 12913A, BD+33 3587, CSI+33 3587 1, GC 27369, HD 187013, HIP 97295, HR 7534, PLX 4654, PPM 83516, SAO 68827, STF 2580AB, TYC 2660-4227-1, and WDS 19464+3344. Its precise coordinates are 194625.60+334339.3.²²

17 Cygni – Observations

The measurements were made on 15 August 2011 (Bessell date 2011.622) beginning at 8:30 pm and ending at 10:30 pm Pacific Daylight Time. The night was clear with moonrise at 9:30pm. The temperature ranged from 75 to 65° F. The wind was 1 - 5mph, humidity 30%, and seeing 3 – 4.

The linear scale of the Micro Guide eyepiece was oriented with the celestial coordinate system using the primary star. Once the orientation was completed, 12 drift time measurements were made, with an average value of 33.84 seconds, a standard deviation of 0.2 seconds, and a standard error of the mean of 0.06 seconds. The result was a scale constant of 7.1 arc seconds per division.

The primary star was placed on the linear scale, and 12 separation measurements were taken. The average value was 3.6 divisions with a standard deviation of 0.10 divisions, and a standard error of the mean of 0.03 divisions. When adjusted for significant figures, the calculated separation was 25.5 arc seconds.

The position angle measurements were made using the aforementioned methodology, and 18 position angle measurements were taken with an average value of 68.9°, a standard deviation of 1.35°, and a standard error of the mean of 0.25°.

The separation value of 25.5 arc seconds and the position angle value of 69 degrees compared well with the values of 26 arc seconds and 69 degrees from the Washington Double Star Catalog²². See Table 7.

Acknowledgements

The generous assistance of Russell Genet was instrumental in the execution of this work. Grateful thanks to John Baxter for his review of this paper.

References

1. Anton R., "Double and Multiple Star Measurements", *The Journal of Double Star Observations*, vol 6 no 3, July 2010
2. Anton R., "Double and Multiple Star Measurements", *Journal of Double Star Observations*, vol 7 no 2, 2011
3. Arnold D. "Divinus Lux report #16", *Journal of Double Star Observations*, vol. 5 no. 1 Winter 2009
4. Arnold D., "Divinus Lux Observatory: Report #3", *Journal of Double Star Observations*, vol 2 no 2, 2006

Astrometric Measurements of Seven Double Stars, September 2011 Report

5. Arnold D., "Divinus Lux Observatory: Report #6", *Journal of Double Star Observations*, vol 2 no 3, 2006
6. Arnold D., "Divinus Lux Observatory: Report #15", *Journal of Double Star Observations*, vol 4 no 4, 2008
7. Arnold D., "Divinus Lux Observatory: Report #20", *Journal of Double Star Observations*, vol 6 no 1, 2010
8. Arnold D., "Divinus Lux Observatory: Report #23", *Journal of Double Star Observations*, vol 6 no 4, 2010
9. Bell, R., 2011, Stargazer Online, www.richardbell.net
10. Burton J., 2011, Astrogeek Observatory (www.astrogeek.org)
11. Daley J., "Double Star Measures for the year 2005", *The Journal of Double Star Observations*, vol 2 no 2, 2006
12. Daley J., "Double Star Measures for the year 2006", *The Journal of Double Star Observations* vol 3 no 2, 2007
13. Dommanget J., Nys O., Catalogue des composantes d'étoiles doubles et multiples 2002
14. Frey T., "Visual Double Star Measurement with an Alt-azimuth Telescope", *Journal of Double Star Observations*, vol 4 no 2 Spring 2008
15. Hog E., Baessgen G., Bastian U., Egret D., Fabricius C., Grossmann V., Halbwachs J., Makarov V., Perryman M., Schwekendiek P., Wagner K., Wicenec A., 1997, *The Tycho Catalogue*, 2011 from its website www.rssd.esa.int
16. Heijen M., Star Observer website (www.starobserver.eu) 2008
17. Hoffleit D., Warren W., 1991, *The Bright Star Catalogue*, 5th Revised Edition, Yale University
18. Johnson J., Genet R., "Measurements of the Double Star STF 2079", *Journal of Double Star Observations*, vol 3 no 4 Fall 2007
19. MacEvoy B., William Herschel's Double Star Catalogs Restored, 2011
20. Mamajek E., [Kenworthy M.](#), [Hinz P.](#), [Meyer M.](#), "Discovery of a Faint Companion to Alcor Using MMT Imaging", *Science Daily*, 2009
21. Martín E., "CCD Double Star Measurements", *Journal of Double Star Observations*, vol. 5 no. 1 Winter 2009
22. Mason B., Wycoff G., Hartkopf W., Douglass G., Worley C., 2011, *Washington Double Star Catalog*
23. Muller R., Cerosimo J., Miranda V., Martinez C., Cotto D., Rosado-de Jesus I., Centeno D., Rivera L., "Observation Report 2005", *Journal of Double Star Observations*, vol. 3 no. 2 Spring 2007
24. Muenzler K., 2003, Eagle Creek Observatory (www.eaglecreekobservatory.org)
25. Myers J., Sande C., Miller A., Warren W., Tracewell D., 2002, *Sky 2000 Master Star Catalog*, Goddard Space Flight Center, Flight Dynamics Division.
26. Olcott W., "In Star Land with a 3 inch Telescope", G. P. Putnam and Sons Publisher, 1909
27. Perez J., Belt of Venus website (www.perezmedia.net) 2005
28. Perryman M., Lindegren L., Kovalevsky J., Hog E., Bastian U., Bernacca P.L., Creze M., Donati F., Grenon M., Grewing M., van Leeuwen F., van der Marel H., Mignard F., Murray C., Le Poole R., Schrijver H., Turon C., Arenou F., Froeschle M., Petersen C., 1997, *The Hipparcos Catalogue*, 2011 from its website www.rssd.esa.int
29. SAO Staff, (1996) *Smithsonian Astrophysical Observatory Star Catalog*.
30. Schlimmer J., "Double Star Measurements Using a Webcam", *Journal of Double Star Observations*, vol 3 no 3, 2007
31. Schlimmer J., "About Relative Proper Motion of 61 Cygni", *Journal of Double Star Observations*, vol 5 no 2, 2009
32. Schlimmer J., "Double Star Measurements Using a Webcam: Annual Report of 2008", *Journal of Double Star Observations*, vol 5 no 2, Spring 2009
33. Schlimmer J., "Double Star Measurements Using a Webcam: Annual Report of 2009", *Journal of Double Star Observations*, vol 6 no 3, July 2010

Astrometric Measurements of Seven Double Stars, September 2011 Report

34. Schupmann L., "Ludwig Schupmann Observatory Measures of Large Δm Pairs – Part Three", *The Journal of Double Star Observations*, vol 5 no 3 Summer 2009
35. Worley C.E., Douglass G.G 1996, *The Washington Visual Double Star Catalog*
36. Worley C., Douglass G., 2006 *The Washington Double Star Catalog*
37. Daley J., Schupmann L., "Double Star Measures for the Year 2006", *Journal of Double Star Observations*, vol 3 no 2, 2009
38. Hirschfield A., "Parallax: the Race to Measure the Cosmos", MacMillan Press 2001
39. Pannekoek A., "A History of Astronomy", Courier Dover Publications, 1989

