Measurements of Beta Lyrae at the Pine Mountain Observatory Summer Workshop 2011

Joseph Carro
Cuesta College, San Luis Obispo, California

Rebecca Chamberlain
Evergreen State College

Marisa Schuler, Timothy Varney
Evergreen High School

Robert Ewing
Portland Community College

Russell Genet
Cuesta College, San Luis Obispo, California
California Polytechnic State University, San Luis Obispo, California

Abstract: As part of the Pine Mountain Observatory Summer Workshop 2011, high school and college students joined with an experienced observer to learn the use of a telescope, astrometric techniques, and measure a double star. This workshop was the first time these students operated a telescope, and, thus, constituted an educational experience for them as they used the telescope and took the measurements. The double star Beta Lyrae was measured resulting in a separation of 44.3 arc seconds and a position angle of 151.6 degrees. The Washington Double Star catalog (2009 data) lists a separation of 45.4 arc seconds and a position angle of 148 degrees

Introduction

Beta Lyrae was first determined to be a double star by John Goodricke in 1784. Beta Lyrae has catalog designations of 10 Lyrae, AAVSO 1846+33, BD+33°3223, FK5 705, HD 174638, HIP 92420, HR 7106, SAO 67451, and WDS 18501+3322. Its traditional name is Sheliak. Its precise coordinates as given by the Washington Double Star Catalog are 185004.79+332145.6.

This double star is located at the southwestern tip of the parallelogram that makes the body of the Harp, and is referred to as Sheliak, an Arabic word that means "harp". Sheliak is a spectroscopic binary whose proximity is such that the two stars constantly distort each other and constitute an eclipsing binary. Sheliak's variations are visible to the naked eye, and were discovered in 1784.

The two goals of this project were to 1) measure the position angle and separation of the aforementioned double star, and 2) learn the necessary techniques to conduct this research.

Observations

The observations were made using a Celestron model CPC 1100 telescope. This telescope is computerized and motorized and was fitted with a Celestron 12.5 mm astrometric eyepiece. The telescope is of Schmidt-Cassegrain design, with aperture of 11 inches and a focal length of 2,800 mm.

Following the procedure provided by Celestron Corporation, the Micro Guide eye piece was oriented with the celestial coordinate system using the primary star of the double star Beta Lyrae. Once the

orientation was completed, 12 drift time measurements were made, with an average value of 33.54 seconds, and a standard deviation of 0.335 seconds. That average was used to calculate the scale constant using the formula Z = 15.0411 times T average times the cosine (0.83581) of the declination angle (33.30°) divided by 60 (the number of reticle divisions) as given by Frey (2008).

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

The result was a scale constant of 7.02 arc seconds per division.

The primary star was placed on the linear scale, and 10 separation measurements were taken. The primary star was relocated and advanced on the linear scale prior to each measurement. The average value was 6.3 with a standard deviation of 0.26 and a standard error of the mean of 0.08. The average value was used to calculate the separation, which was 44.3 arc seconds.

The position angle measurements were made by aligning both stars on the linear scale with the primary star at the 30° division, disabling the tracking feature, and then allowing the stars to drift to the circular scales. The crossing of the primary star at the inner 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.

On 26 July 2011 beginning at 10:40pm PDT, position angle measurements were taken. Due to winds and fog, only seven measurements were taken with an average value of 151.6°, a standard deviation of 2.3°, and a standard error of the mean of 0.86°. Our results plus some historical measurements are given in Table 1.

Table 1: Our measurements and some past published measurements of β Lyrae.

Reference	Separation	Position Angle
	arc seconds	degrees
WDS (Mason+ 2007) 1777 data	48.9	143
SKY2000 Master Catalog (Meyers+ 1994)	45.7	149
Stargazer (richardbell.net) 1996	46	149
Double Stars (Haas 2008) 2002 data	46	150
Eagle Creek Observatory (Muenzler) 2003	46.6	149
JDSO (Muller) Spring 2007	47.4	150.5
JDSO (Muller) Winter 2007	46.4	148.8
WDS (Mason +) 2007	48	148
JDSO (Arnold) 2009	45.5	149.9
JDSO (Martín) Winter 2009	45.6	148
WDS (Mason+ 2011) 2009 data	45.4	148
Tycho Catalog 2011	45.7	148.5
Our measurements 2011	*44.3*	*151.6*

Conclusions

The position angle average and the separation of the double star Beta Lyrae were successfully measured. An understanding of the time and effort to learn the techniques to accomplish these tasks was imparted to the participants, and it is deemed that the goals of the project were met.

Acknowledgements

Heartfelt appreciation is extended to Russell Genet for his professional guidance and instruction in the completion of this project. We were appreciative of the efforts made by Thomas Frey in his management of the Workshop. Our team is grateful to the University of Oregon and the staff at the Pine Mountain Observatory for the use of their facilities, and to John Baxter for his review of this paper.

References

Arnold, D. "Divinus Lux report #16", *Journal of Double Star Observations*, vol. 5 no. 1 Winter 2009

Daley, J., 2006, "Double Star Measures for the year 2005", *The Journal of Double Star Observations*, vol 2 no 2 Spring 2006

Frey, Thomas, 2008, "Visual Double Star Measurement with an Alt-Azimuth Telescope", *Journal of Double Star Observations*, vol 4 no 2 Spring 2008

Haas, S. 2008, "Double Stars for Small Telescopes", Sky Publishing Corporation

Hoffleit, D. and Warren, W., 1991, *The Bright Star Catalogue*, 5th Revised Edition, Yale University

Martín, E, "CCD Double Star Measurements), *Journal of Double Star Observations*, vol. 5 no. 1 Winter 2009

Mason, B., Wycoff, G., Hartkopf, W., Douglass, G., Worley, C., 2010, *Washington Double Star Catalog*

Muller, R., Cerosimo, J., Miranda, V., Martinez, C. Carrion, P., Cotto, D. Rosado-de Jesus, I. Centeno, D. Rivera, L., "Observation Report 2003-2004", *Journal of Double Star Observations*, vol. 3 no. 1 Winter 2007

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

Tycho Catalogue, 2011 from its website www.rssd.esa.int