Visual Astrometry Observations of the Binary Star Beta Lyrae

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Abstract: Students from Arroyo Grande High School and Cuesta College observed the separation and position angle of the binary star Beta Lyrae (WDS 18501+3322). The separation and position angle were found to be 46.7 arc seconds and 149.6° respectively. These values compared favorably to past observations.

Introduction

Beta Lyrae was first observed in 1777 (Mason, 2011). We determined its current separation and position angle as a part of the fall 2011 Astronomy Research Seminar at Cuesta College's South Campus in Arroyo Grande, CA. This was the fifth year this seminar was held at Arroyo Grande High School and we built on the experiences of past student projects (Alvarez et al., 2009; Marble et al., 2008). Visual observations are relatively easy to make, and thus are well suited to novice researchers. Seven student observers joined telescope owner Joseph Carro on July 2, 2011 at Santa Margarita Lake to observe β Lyrae.

Procedure

The observations were made with an 11 inch Celestron model CPC 1100 telescope of Schmidt-Cassegrain design and 2,800 mm focal length to determine the separation and position angle of Beta Lyrae. This telescope is computerized and motorized, and was fitted with a Celestron 12.5 mm Micro Guide astrometric eyepiece.

Figure 1: From left to right, Kyle Berlin, Sarah Collins, Joseph Carro, Chris Jordano, Clare Cardoza, and Tatum Waymire

For calibration, the linear scale was oriented east -west with the celestial sphere by slewing the telescope east and west and rotating the eyepiece until the primary star of Beta Lyrae did not deviate from

the linear scale. The date for the calibration was obtainted by aligning the primary star at one end of the linear scale, turning the right ascension motor off, and determining the time it took for the star to travel to the other end of the linear scale.

Thereafter, the scale constant was determined by the equation below, where Z is the scale constant in arc seconds per division, 15.0411 is the number of arc seconds per second of the Earth's rotation, t is the average drift time in seconds, d is the declination of the star, and D is the number of divisions on the linear scale (60) (Frey, 2008):

$$Z = \frac{15.0411\, t\, \cos(d)}{D}$$

Eleven position angle measurements were made by aligning both stars on the linear scale with the primary star on the 30 division, disabling the tracking feature and allowing the primary star to drift across the eyepiece. The point at which the primary star intersected the inner protractor was estimated to the nearest degree. After each measurement, the tracking feature was enabled and the process repeated.

The separation was determined by placing the primary star on the linear scale, and estimating the scale divisions between the two stars. This process was repeated a total of twelve times.

Scale Constant

Four team members conducted four drift time measurements each, resulting in a total of sixteen measurements. The scale constant was calculated by the procedures described above. The results are shown in Table 1. Included are drift time, the mean, standard deviation, and the standard error of the mean, calculated by *Microsoft Excel*. The scale constant was found to be 7.17 arc seconds per division.

Table 1: Drift Time data for the primary star

	Drift Time (secs)
Mean	31.5
St. Dev.	1.7
St. Error	1.4

Table 2: Data for Position Angle and Separation

	Separation (as)	Position Angle (deg)
Mean	46.7	149.6
St. Dev.	0.3	0.8
St. Error	0.7	3.7

Separation and Position Angle

The objective of observing the binary star Beta Lyrae was to determine the current separation and position angle between the two stars. In order to avoid bias, three team members whispered each measurement privately to the recorder so as to not influence the other team members. However, the eyepiece was not repositioned after each observation, which may have resulted in systematic error. Table 2 indicates the mean, standard deviation, and standard error of the mean for separation and position angle. The calculations were completed using *Microsoft Excel*.

Discussion and Conclusion

The data compares favorably with historical observations. The position angle was found by our observations to be 149.6°, while the mean of all past observations reported in the Washington Double Star Catalog is 148.9°. In terms of separation, we concluded it is currently 46.7 arc seconds, whereas the mean for all 102 WDS observations states it is 46.3 arc seconds (Mason, 2011). A plot of previous observations compared to our data is shown below in Figures 2 and 3.

Acknowledgments

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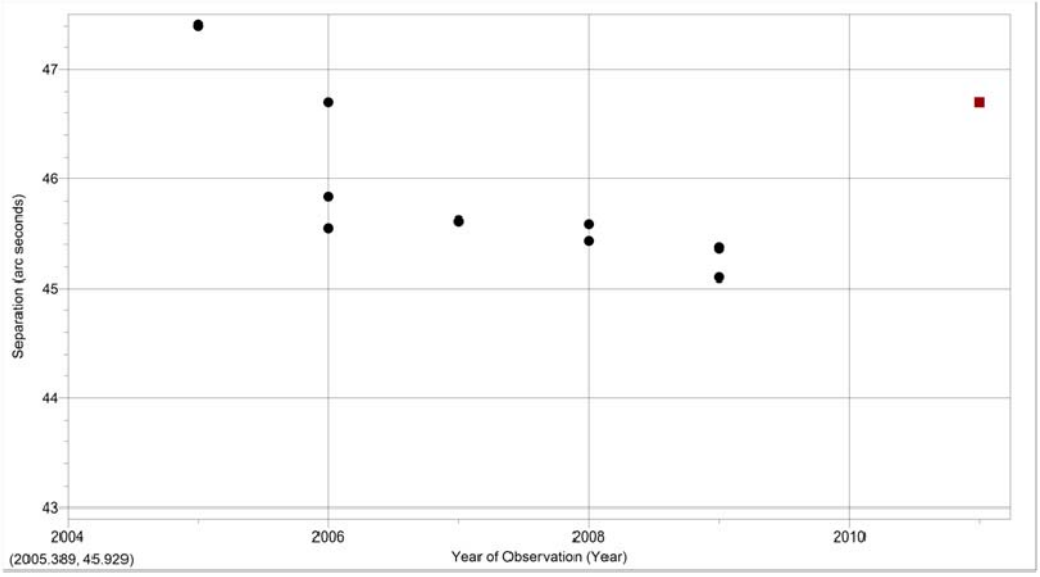

Figure 2: Our separation measurements compared to historical observations

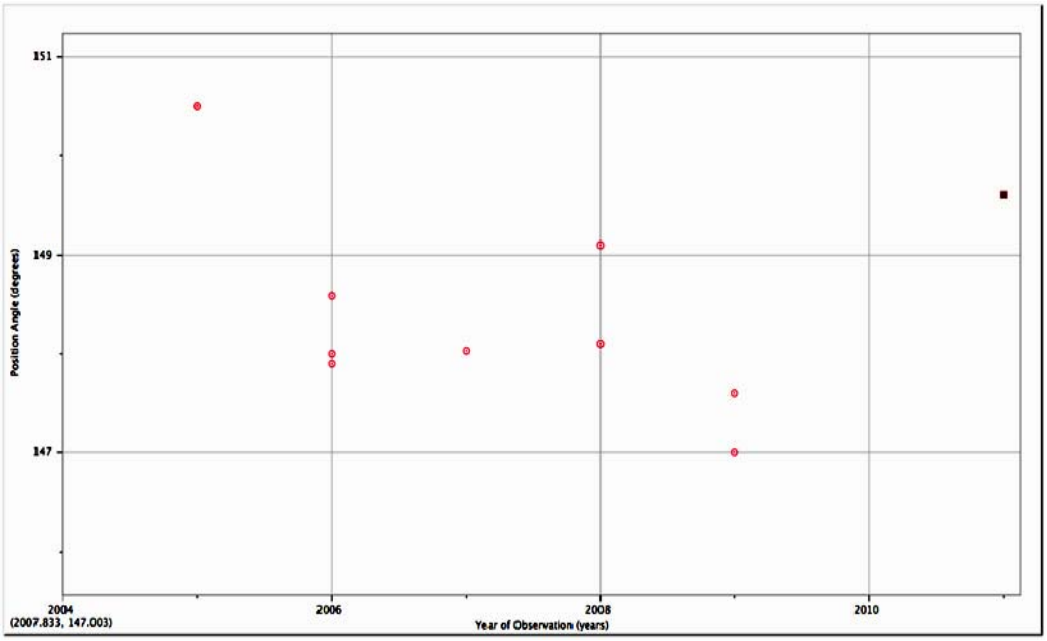

Figure 3: Our position angle measurement compared to historical observations

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