Student Measurements of STFA 14 AC at Vanguard Preparatory School

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Abstract Eighth grade students at Vanguard Preparatory School measured the double star STFA 14 AC using a Bader Planetarium Micro Guide eyepiece. Navi (Gamma Cassiopeiae) was used as the calibration star. The calculated means of multiple observations of STFA 14 AC resulted in a separation of 53.3" and a position angle of 2.0°. These measurements were compared to the most recent values in the Washington Double Star Catalog.

Introduction

Nine eighth grade students observed the double star Mintaka at Vanguard Preparatory. Their team was one of two in the Vanguard Preparatory Double Star Workshop 2015. The observations were made at 34° 32' 43.90" N latitude, 117° 10' 7.12" W longitude. At 9:00 p.m. on March 20, 2015, the students measured the separation and position angle of the double star STFA 14 AC. They then reported their results to the astronomical community. The team members are shown in Figure 1.

Figure 1: The authors from left to right in the back row: Timothy Gosney, Jacob Rajacich, Lizbeth Diaz, Stephen Johnson, Scotty Sharpe, and Sean Gillette. The authors from left to right in the front row: Nathaniel Roehl, Alex Archuleta, Nikita Mohan, Kahaloha Whitt, and Kyle Gillespie.

STFA 14 AC is a multiple star system located on the western end of Orion's belt. Its mythological heritage originated from the name منطقة *manṭaqa*, which means "the belt" in Arabic. STFA 14 AC is the right-most of the belt's three iconic stars. Its right ascension is 05h 32m 00.4s with a declination of -00° 17m 56.74s. The primary star's apparent magnitude is 2.2 and its secondary is 6.8. According to Underhill et al. (1979), the primary star's temperature is 31,802 K. STFA 14 AC was last measured in 2013 (WDS).

Procedures

The telescope used was a Celestron C8 Schmidt Cassegrain telescope with a German equatorial mount. The drive of the telescope was a Celestron Advanced VX. The aperture was 203.2 mm and the focal length was 2032 mm. A Bader Planetarium Micro Guide eyepiece was used which has similar markings to a Celestron Micro Guide eyepiece. Figure 2 shows the team gathered to make observations.

The drift method was used to determine the scale constant and a stopwatch that read to the nearest 0.01 seconds was used for timing. The star, Navi (Gamma Cassiopeiae), was positioned on the linear scale of the Bader Planetarium eyepiece, and the eyepiece was rotated so the star would drift along the linear scale when the drive was disengaged. The time it took, in seconds, for the primary star to move across the linear scale's sixty division marks was determined by the stopwatch. The mean, standard deviation, and standard error of the mean were calculated. The scale constant was determined by using the following equation

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

where Z is the scale constant in arc seconds per division, 15.0411 is the Earth's rotational rate in arc seconds per second, t is the average drift time in seconds, cos(d) is the cosine of declination of the calibration star in degrees (60.72°), and D is the number of division marks on the linear scale (60).

The separation of the primary and secondary stars was determined by the linear scale; it was estimated to the nearest whole division. The stars were repositioned at different points after each student observation to avoid bias. After ten successful trials, the average, standard deviation, and standard error of the mean were calculated and multiplied by the scale constant so that the separation in arc seconds could be determined.

The position angle was determined by again aligning both stars on the linear scale with the primary star on the 30th division which marks the precise center of the eyepiece. The clock-drive was then turned off, allowing both stars to drift to the inner protractor ring of the Bader Planetarium Micro Guide eyepiece. When the primary star reached the inner protractor, the clock drive was turned back on and the primary star's position was recorded to the nearest degree. The eyepiece was rotated one hundred and eighty degrees between each observation to reduce bias. A 270° correction was applied to all position angle estimates as required with the Bader Plantation Micro Guide eyepiece, and a 180° correction was applied to half of the observations to account for the rotation after each observation. The average position angle, standard deviation, and standard error of mean were calculated after ten trials with outliers being removed.

Figure 2: The team gathers to make observations of the double star STFA 14 AC.

Results and Analysis

The weather on the night of March 20, 2015 was warm, the cloud cover was minimal which allowed easy observation. Ten measurements were made on the separation, the outliers being dropped. These measurements gave an average separation of 5.4 divisions. Ten measurements were also made on the position angle, with the highest and lowest outliers also being dropped. These careful observations resulted in an average position angle of 272°,

The Washington Double Star Catalog recorded the separation of 51.5 and a position angle of 1. These measurements yielded a separation of 53.2″ (the average separation is in units of arc seconds because the scale constant was multiplied to the average separation determined in division marks). The position angle was determined to be 2°, which was taken by adjusting the average position angle by subtracting 270°. Table 1 shows the results compared to past observations.

Parameters	# Obs	Mean	SD	SEM	WDS	Difference
Scale Constant arc sec / division	10	9.9	2.5	0.8	NA	NA
Separation (arc sec)	10	53.3	.71	0.22	51.5	1.77
Position Angle (degrees)	10	2.00	4.43	1.4	1	1

Table 1: The results are shown in Table 1, where WDS is the most recent observation reported in the Washington Double Star Catalog.

Conclusion

Our results produced a small difference from the previous observation in 2013. The measured separation differs from the WDS value by 2.5 standard deviations, well within the error expected for the students' level of experience. The position angle differed by less than one standard deviation.

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