Astrometry of STF 1985 Shows Continued Off-Orbit Path

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Abstract: A team of high school students from Paso Robles observed the double star STF 1985 which had an orbital plot that did not fit the most recent observations. The student team's observational data point continued the off orbital plot path.

Introduction

There are two types of double stars. The first type, an optical double, are two stars that appear to be close together but in actuality are separated by vast distances (upwards of several hundred light years). From the perspective of Earth, however, they line up and appear as a double star. The second type of double stars are gravitationally bound binaries that orbit each other.

The binary we observed was STF 1985. It was discovered in 1823 by John Herschel. However, in 1831, Friedrich Georg Wilhelm von Struve made multiple observations with a larger telescope and is credited as the discoverer of the binary. It has been observed 182 times since its discovery. In the early 1990's, STF 1985 was observed by the Hipparcos space telescope and the most recent observation was in 2015. Recent observations of STF 1985 seem to be creating a path that is veering off the orbit (Figure 1) calculated by Josef Hopmann (1973).

Earlier measurements (green data points) were visual observations with micrometers and are widely scattered. The pink points are photographic measurements.

Our research question: When we add another observation, will our measurements lend support to the current published orbit or will it provide more evidence that the orbital path of STF 1985 needs revision? To answer the research question, we needed to measure the separation (in arc seconds) and position angle (in degrees) of the dimmer secondary star with respect to the brighter primary star.

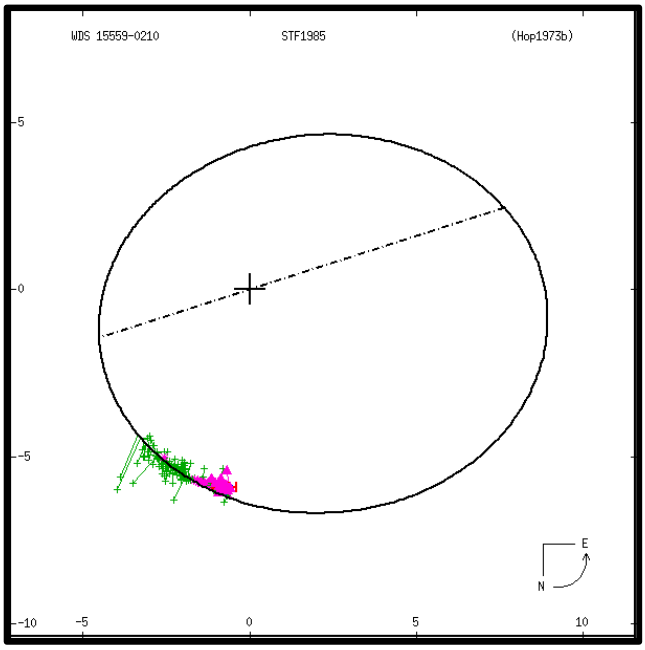

Figure 1. STF 1985 orbital plot.

Equipment and Procedures

To gather data on this binary we used the Las Cumbres Observatory (LCO) worldwide network of robotic telescopes. There are eight LCO sites that, together, host 21 telescopes. The geographic spread of the sites allow continuous observation of the night sky. All our

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observations were made with the 0.4 meter LCO telescope in Siding Spring, Australia. Although several different exposures were used, we found that 0.785 seconds gave the most consistent results and we used images with these exposures.

When we selected this close binary star for observation, we were unaware that LCO used 2x2 binning, which created some difficulties for image processing due to the low resolution. The images were analyzed using AstroImageJ (Collins, 2017).

Results

Five CCD observations were obtained on April 18th, 2018 (2018.296). We found, probably due to the small separation of the two stars and 2x2 binning, that AstroImageJ did not provide precisely the same astrometric solution for an image if a second solution was obtained. To reduce this variance, we obtained five solutions for each image and averaged them. The five solutions for our first image are provided in Table 1. The variance in the other four images were similar.

The average values of the separation and position angles for each image are provided in Table 2, along with the final average of the averages, which was a measured separation of 6.00 arcseconds and the position angle of 356.87 degrees.

Discussion

The measured values for position angle and separation are close to the expected linear trend line for past observations, see Figure 2. We did notice that the position angle of our observation was a little off the trend line. This may be due to the difficulty AstroImageJ had with the poor resolution of the binned images.

Future student teams should be careful when requesting images for binaries that are closer than 10 arcseconds. If they are, be sure to request unbinned images to increase resolution.

Table 1: Repeated solutions of the same image (#355) using AstroImageJ

Trial #	Separation (as)	Position Angle (deg)
1	5.91	358.10
2	5.43	357.53
3	5.43	357.53
4	5.91	358.10
5	5.91	358.10
6	5.91	358.10
Average	5.75	357.91
Standard Deviation	0.25	0.29
Error	0.10	0.12

Table 2: Average separation and position angles of STF 1985 from 5 images

Image #	Separation (as)	Position Angle (deg)
355	5.75	357.91
356	5.92	357.98
357	5.85	356.11
358	6.01	356.79
359	6.22	356.60
Average	6.00	356.87
Standard Deviation	0.18	0.83
Error	0.08	0.37

The observations were plotted on the orbital plot using the procedure outlined by Robert Buchheim (2017). Unfortunately, the image we used had been

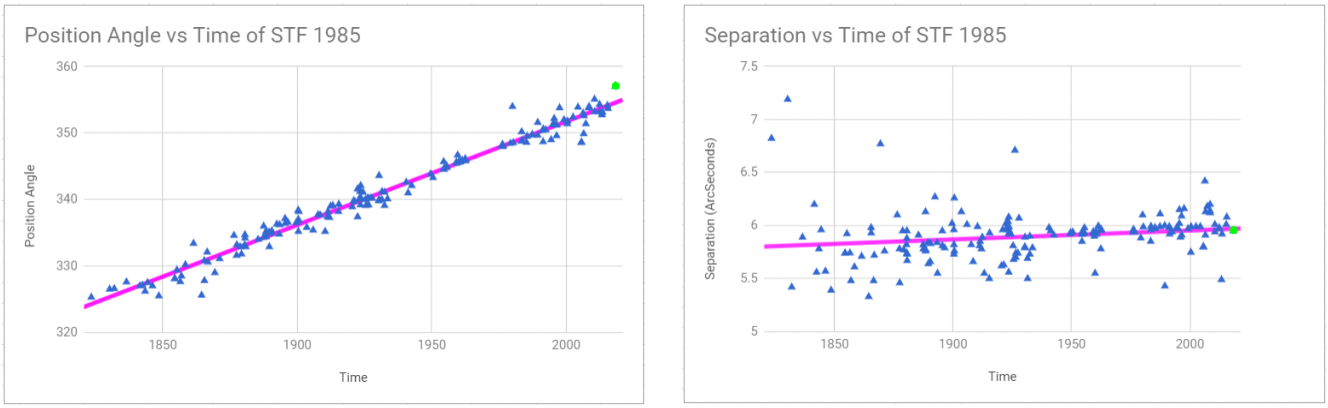

Figure 2. Position angle and separation versus time using historical data on STF1985. A linear trend line is shown for reference. The round green dot is our observation.

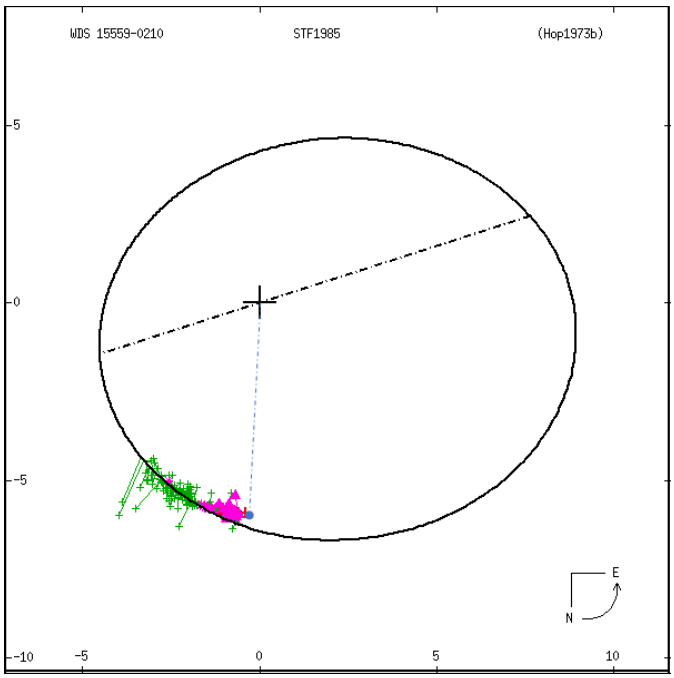

Figure 3. Correctly scaled orbital plots for STF 1985. Accidental re-sizing almost led to an inaccurate conclusion regarding our observation.

stretched horizontally by a team member when resizing for this paper. We then noticed the scale on the Y-axis was smaller than the scale on the X-axis so we returned to the original image downloaded from the WDS Catalog. Our corrected plot of our observation then aligned well with past observations, including the most recent observation in June 2017 (Musegades, 2018). The revised graph is shown in Figure 3.

Conclusion

The objective of this research was to collect observational data on a well-studied binary and measure its position angle and separation. Even with poor resolution, the image analysis software was able to give fairly consistent results and the objective was met.

Acknowledgements

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