Speckle Interferometric Measurements of STF 1223 and STF 1523 AB

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Abstract In this paper, we provide new speckle interferometry measurements for STF 1223 (WDS 08268+2656) and STF 1523 AB (WDS 11182+3132). STF 1223 had a measured position angle of 218.258° and a separation of 5.195″. STF 1523 AB had a measured position angle of 187.238° and a separation of 1.662″ which fell right on the orbit predicted by the 6th Orbit Catalog ephemeris.

Introduction

In the Spring 2015 semester, Cuesta College in San Luis Obispo, CA offered a distance learning course in astronomical research taught by Dr. Russ Genet. Harshaw was a teaching assistant for that course and Dolbear was a student. Harshaw and Dolbear, shown in Figure 1, live in the Phoenix, AZ area.

Figure 1: Authors Harshaw (left) and Dolbear (right) on an observing run in the Sonoran Desert.

Measurements of two double star systems, STF 1223 and STF 1523 AB, were made using speckle interferometry performed with a Skyris 618 camera attached to a Celestron C-11 (11-inch SCT telescope) as described by Harshaw (2015).

The two double stars have been historically well documented with many observations in the past two hundred or so years. However, with the introduction of speckle interferometry, amateurs have been able to add highly accurate data, thus expediting the process of identifying binary systems and solving their orbits. These two pairs were selected from the Washington Double Star Catalog (WDS) based on two criteria: their secondaries must be brighter than 7th magnitude (in order for the camera to accurately capture their positions in less than 40 milliseconds), and their separations must be greater than 1.2", which is the lower limit of the instrument's capability.

The magnitudes of STF 1223 are 6.16 for the primary and 6.21 for the secondary. Their most recent separation at the time of observation was 4.61″. The magnitudes of STF 1523 are 4.33 for the primary and 4.8 the secondary. Their most recent separation at the time of observation was 1.52″.

Equipment and Software Used

The hardware used for the measurements consisted of a Celestron C-11 SCT mounted on a CI-700 mount on a permanent base at Brilliant Sky Observatory in Cave Creek, AZ (just north of Phoenix). A Celestron Skyris 618-C camera (run in black and white mode) fed digitally into the observatory's computer (Harshaw 2015).

Figure 2: Typical speckle frame from a series of 1,000 frames shot at high integration rates (<=40 ms).

The Software required for our measurements included FireCapture (produced by Thorsten Edelman) for camera control, REDUC (produced by Florent Losse) for date reduction, and PlateSolve 3 (produced by David Rowe) for speckle analysis. REDUC was used primarily to compile our individual FITS images into FITS cubes that PlateSolve 3 can process. It was also used to determine the camera angle using the drift routine and to subtract dark frames. By use of a Fourier transform algorithm, PlateSolve 3 reduces the data from FITS cubes (consisting of 1,000 FITS images) and derives a solution for both theta (θ) and rho (ρ).

Methodology

Harshaw acquired the target stars for Dolbear. Once each star was centered on the camera's chip, Harshaw turned operations over to Dolbear, who adjusted the camera settings and obtained the necessary image files to do speckle reduction. Dolbear then took his image files with him for analysis at a later time.

The stars were imaged at f/50 using a 5x PowerMate in the optical train of the f/10 C-11. One thousand images were obtained at integration times of less than 40 ms and then combined into a FITS cube using REDUC. Ten cubes were generated for the pair STF 1223 and five cubes for the pair STF 1523 AB. After the image files were obtained, a nearby star of equal or brighter magnitude was chosen as a deconvolution star and was recorded in the same manner. The final step in the observation process was to acquire a star for drift analysis. The drift analysis determined the camera angle using REDUC.

Once all the observations were complete, the processed FITS cubes were loaded into PlateSolve 3 for pre-processing and analysis. PlateSolve 3 produced an autocorellogram from the power spectrum. The camera angle and pixel scale (determined earlier by Harshaw 2015) were then fed into the speckle reduction function built into PlateSolve 3, which in turn produced the theta (θ) and rho (ρ) values from the stars′ autocorellogram. Then all of the output values were averaged and their standard deviations and standard errors of the mean were calculated. The autocorellogram produces two centroids for the companion star. We were able to obtain two sets of measurements per FITS cube, thus providing twenty measurements for STF 1223 and ten for STF 1523 AB.

Results

The authors present their results and a comparison to recent measurements reported in the WDS in Table 1. The measured position angle of STF 1223 is about four standard deviations higher than the most recent value in the WDS. The separation is about eight times higher than the most recently reported value. This suggests either an error in method or a real change in relative position. This position is compared to past measurements in Figure 3. The present measurements are within one standard deviation of the most recent reported position angle and separation for STF 1523 AB. This position is compared to past measurements in Figure 4.

		Last Measures		Present Measures				Residuals	
Star	Date Observed	Theta	Rho	Theta	Rho	Standard Deviation	Standard Error	Theta	Rho
STF 1223	2015.121	218 (2014)	5.1 (2014)	218.258	5.195	0.065 θ, 0.012 ρ	0.021 θ, 0.004 ρ	+0.258	+0.095
STF 1523 AB	2015.121	187 (2013)	1.6 (2013)	187.238	1.662	0.325 θ, 0.063 ρ	0.103 θ, 0.020 ρ	+0.238	+0.062

Table 1: Summary of measurements of STF 1223 and STF 1523 AB compared to recent measurements.

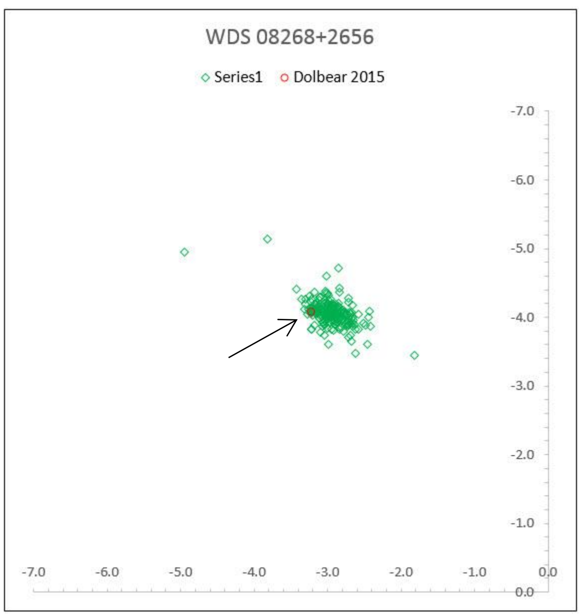

Figure 3: Plot of STF 1223 showing the present study

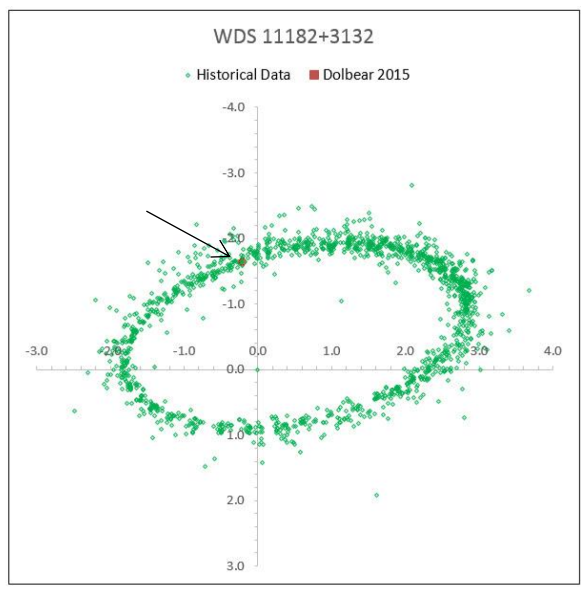

Figure 4: Plot of STF 1523 AB showing the present study.

Discussion

The measurements for STF 1223 show an uncertain pattern. It's not yet possible to say whether the pair is bound or not, though STF 1223 shows the early indications of a linear pattern in the plot. It is also possible that the pair has a very large and slow orbit. More data is needed to confirm either scenario. The measurements provided in this paper strengthen the established orbit of STF 1523 AB.

Conclusion

This paper adds two new data points to aid in solving the orbital or optical nature of the double stars STF 1223 and STF 1523 AB. These measurements show consistency on both the position angles and separations of the two pairs compared to recent measurements. This study further shows that speckle interferometry with amateur class equipment is feasible.

Acknowledgements

This research made use of the Washington Double Star Catalog maintained by the U.S. Naval Observatory. The authors thank Russ Genet, Jo Johnson, and Vera Wallen for their reviews of this manuscript.

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