Orbital Plotting of WDS 04545-0314 and WDS 04478+5318

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Abstract Students at Lincoln High School used the PlateSolve 3 program to obtain the position angle and separation of two double stars, WDS 04545-0314 and WDS 04478+5318. Both stars were observed at Kitt Peak on October 20, 2013. A java-based program developed by the team was used to plot the new data on the previously published orbital paths. It was determined that WDS 04545-0314 is maintaining the previously published orbital solution but that the orbit of WDS 04478+5318 may need to be revised.

Introduction

Students at Lincoln High School selected WDS 04545-0314 and WDS 04478+5318 for study. Speckle observations of WDS 04545-0314 showed it to follow an orbital path (Figure 1) predicted by Tokovinin et al. (2010). However, the most recent measurement indicated it may be moving off the orbital path. Similarly, recent speckle observations of WDS 04478+5318 (Prieur et al. 2009) indicated an outward expansion of the orbit (Figure 2) computed by Novakovic (2007). Our team analyzed data collected by Genet et al. (2014) from Kitt Peak National Observatory to resolve the discrepancy between observed and predicted orbital trends for both double stars.

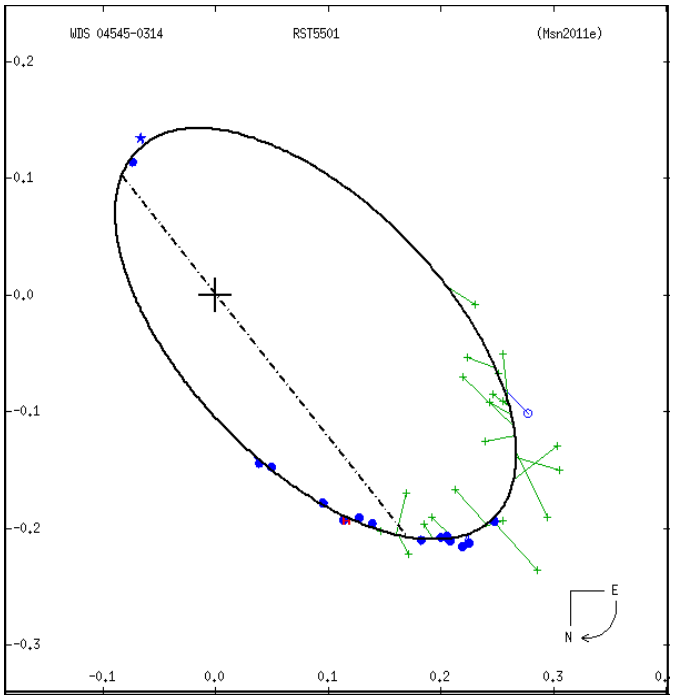

Figure 1: Published orbital solution of WDS 04545-0314.

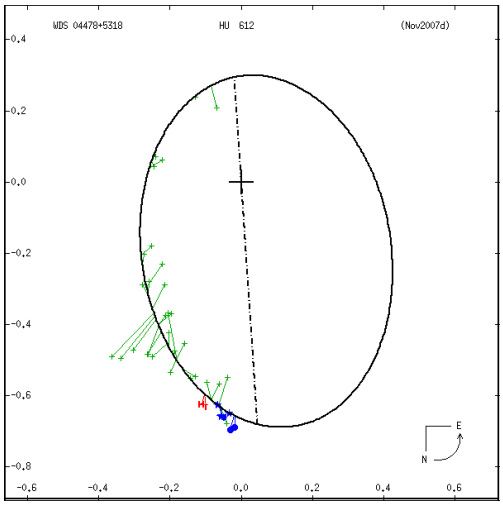

Figure 2: Published orbital solution of WDS 04478+5318.

Methods

The Kitt Peak data was analyzed using PlateSolve 3 (PS3). PS3 is a program developed for speckle interferometry (Rowe and Genet 2015). The semiautomatic reduction mode was used to reduce the data. In semiautomatic reduction mode, the program used a CSV file which contains the measurements of the double stars and reference deconvolution stars to produce an autocorrelogram for each double star, as shown in Figure 3. The image brightness was adjusted until the primary star and the secondary star were clearly distinguishable, with the primary located at the center and the companion star in two possible positions that are 180° apart. The program identifies the correct position of the secondary star based on the last observed catalog values contained in the CSV file (Genet et al. 2014). The program indicated the correct position of the secondary star. The calibration data, including the camera angle and the pixel scale in pixels/arc second, was loaded and the position angle (in degrees) and separation (in arc seconds) for both double stars was estimated.

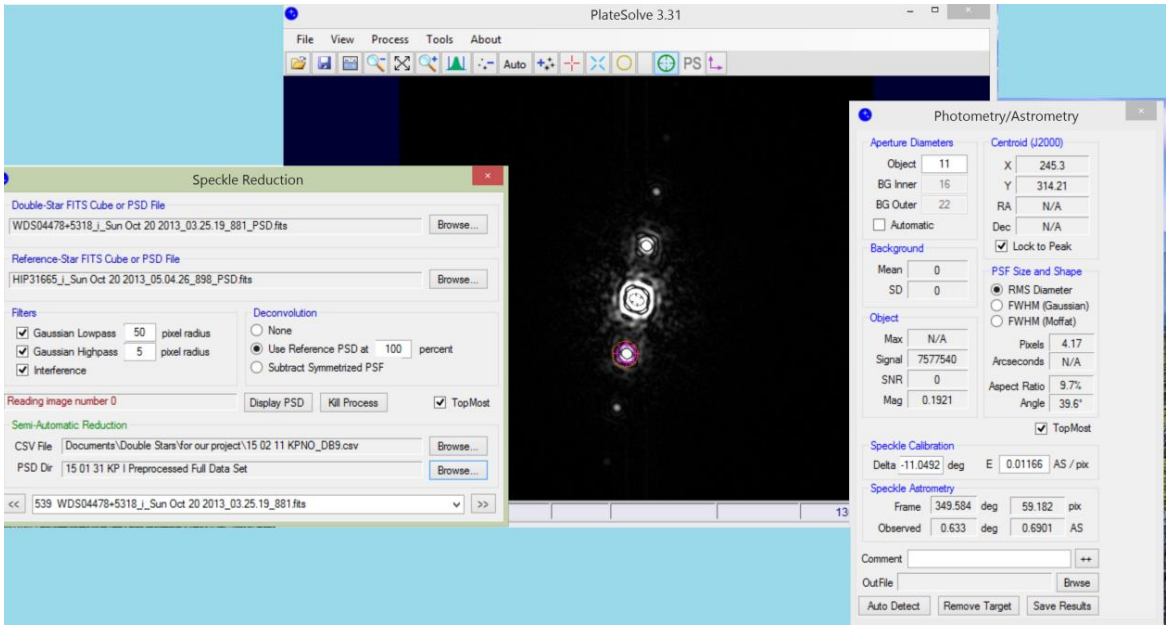

Figure 3: The user interface for PlateSolve 3. Speckle reduction (left), autocorrelogram (center), and photometry/astrometry (right).

A Java orbital plotting program developed and tested by Smith et al. (2015) was used to calculate the x- and y- coordinates in pixels of the secondary star on the existing orbital solution in ImageJ. The observed positions were then compared to predicted positions provided by Brian Mason at the U.S. Naval Observatory.

Results

The results of the team's measurements are shown in Table 1 including the position angle, separation, and location on the orbital diagram. Figures 4 and 5 show the new orbital plots of WDS 04545-0314 and WDS 04478+5318, respectively.

WDS Identifier	Position Angle (°)	Separation (″)	x-coordinate	y-coordinate
WDS 04545-0314	188.459	0.1434	21.5 pixels left from center	144.7 pixels down
WDS 04478+5318	0.637	0.6897	3.34 pixels left from center	300.0 pixels down

Table 1: Observational results for WDS 04545-0314 and WDS 04478+5318.

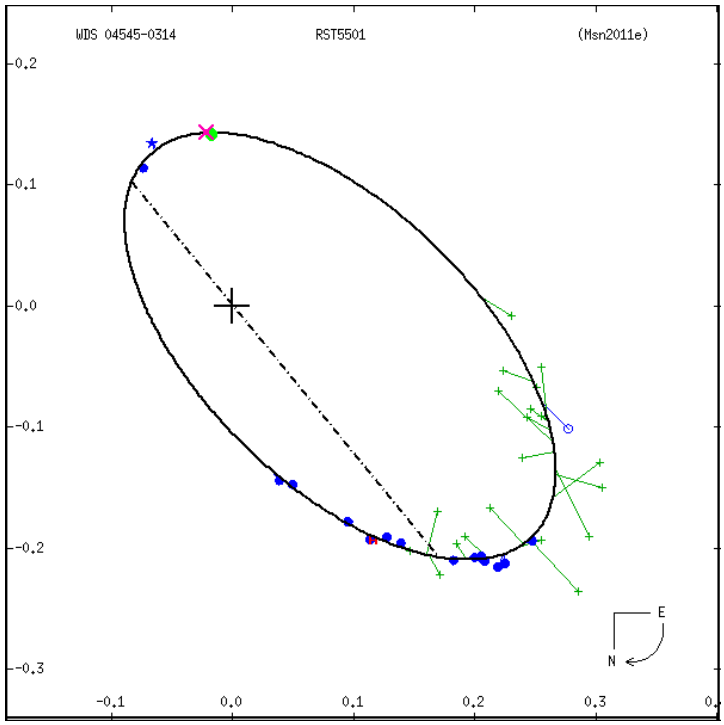

Figure 4: New orbital solution of WDS 04545-0314. The observed location is shown with an x near the top of the orbit. The nearest dot is the location predicted by the orbital solution.

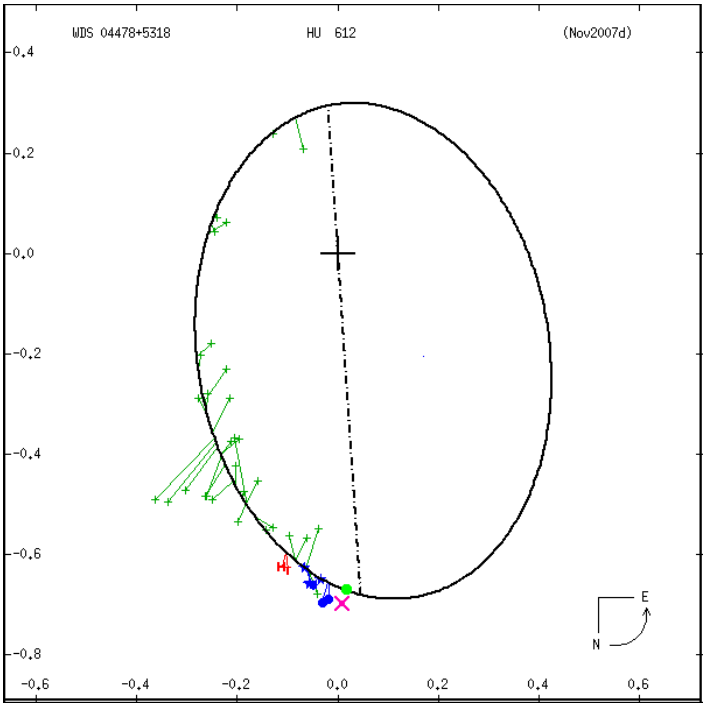

Figure 5: New orbital solution of WDS 04478+5318. The observed location is shown with an x near the bottom of the orbit. The nearest dot is the location predicted by the orbital solution.

Discussion

For WDS 04545-0314, both the predicted data and the new data confirm that the star is maintaining the previously established orbital solution. Referring back to Figure 1, the 2011 observation depicted a possible upward trend skewing away from the calculated orbit. However, our data do not support this apparent change in direction and the star appears to remain on the previously calculated orbit.

After plotting both observed and predicted data for WDS 04478+5318, the team concluded that the apparent trend noted in previous speckle observations continued. The star appears to be moving in the downward direction, hinting at a longer period than previously determined.

A source of error in the analysis arises from the fact that the measurements obtained through the Java program were rounded to the nearest hundredths value. When calculating the coordinates for both stars, the final results were rounded to whole numbers to allow proper plotting on the orbital solution since fractional pixels could not be used.

Conclusion

The purpose of this research was to confirm observed trends in the orbital path of two double stars WDS 04545–0314 and WDS 04478+5318. In order to accomplish this, we analyzed data collected at Kitt Peak in October 2013 to plot new points on previously calculated orbital solutions. PS3 was used to reduce the data to obtain the position angle and separation for each of the stars. The team then used a Java-based program to convert separation and position angle values into x- and y-coordinates which were plotted on an orbital solution using ImageJ. The new star positions were then compared with previous observations and predicted positions. We found that WDS 04545-0314 followed the last calculated orbital path, but WDS 04478+5318 appears to follow a trend of moving off the published orbital path. We believe the orbit of WDS 04478+5318 may need to be revised.

Acknowledgements

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