



Astrometric Measurements of WDS 01332+6041 STF 131

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Abstract

The Los Cumbres Observatory Network was used to obtain astrometric measurements of the quintuple star system WDS 01332+6041 (STF 131). Through astrometric measurement software AstroImageJ 3.3.1 (AIJ), a mean separation for STF 131 AB, $13.9'' \pm 0.004''$ and a mean position angle for STF 131 AB, $143.29^\circ \pm 0.06^\circ$ was measured. Using identical method process for all sub-systems, another astrometric measurement was made for STF 131 AC, a mean separation of $28.2'' \pm 0.01''$ and mean position angle of $145.54^\circ \pm 0.04^\circ$. Astrometric measurements were made for FLE 2 AD, a mean separation of $46.4'' \pm 0.01''$ and mean position angle of $120.9^\circ \pm 0.02^\circ$. FLE 2 AE was measured to have a mean separation of $82.2'' \pm 0.01''$ and mean position angle of $135.85^\circ \pm 0.01^\circ$. Astrometric measurements were made for STF 131 BC, a mean separation of $1.98'' \pm 0.01''$ and a mean position angle of $147.78^\circ \pm 0.06^\circ$. The relative proper motion of STF 131 shows that the system is most likely not showcasing a linear path or an approximately circular orbit. Parallax measurements of the secondary stars will aid in determining whether the quintuple system is a physical or a visual pair. The proper motion of STF 131 indicates the system is astronomically low for the chances of it being a physical pair. The new measurements do not deviate much from the historical data, suggesting that the quintuple system is a visual pair.

Context

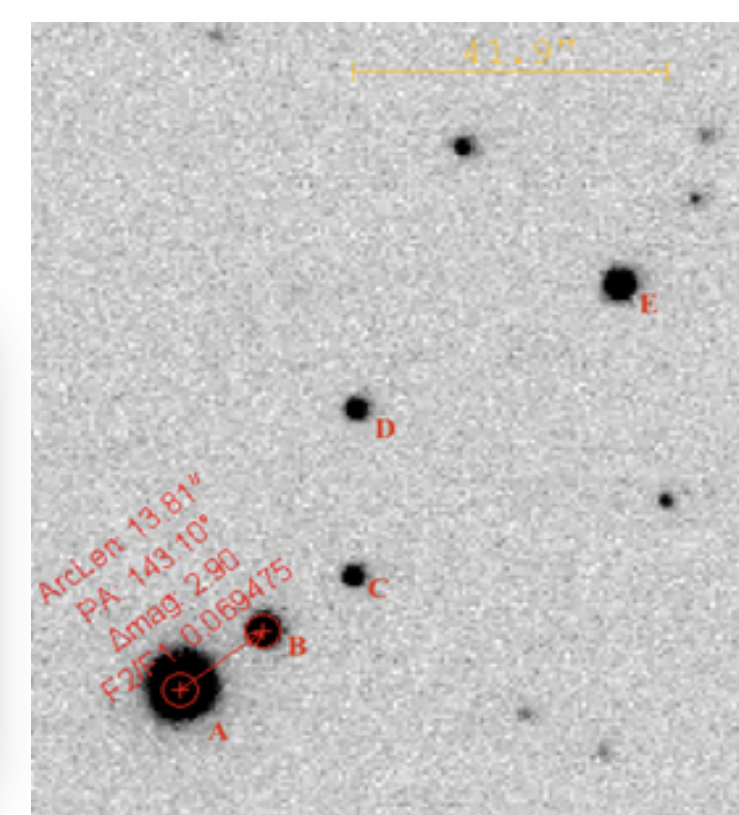
This research was part of an opportunity to add to the understanding of a known quintuple star system. We decided to observe a quintuple star system listed in the Washington Double Star Catalog (WDS) as having both known and unknown orbital solutions. The star system we selected had to be observable in the Fall, with an angular separation greater than six arc seconds, and with a listed maximum magnitude difference below 3 between each star. The primary magnitude had to be 8 or fainter. WDS 01332+6041 met these criteria. WDS 01332+6041 is a quintuple star system, including pairs STF 131 AB, STF 131 AC, FLE 2 AD, FLE 2 AE, and STF 131 BC.

STF 131 AB pair was first discovered in 1827 by German Russian astronomer Friedrich Georg Wilhelm von Struve and recorded in Stellarium Duplicium. A sky survey conducted by Richard Harshaw in 2015 titled CCD Measurements of 141 Proper Motion Stars: The Autumn 2015 Observing Program at the Brilliant Sky Observatory, Part 3, made a measurement on STF131 AB pair only, in 2015, STF 131 AB had a measured theta of 142.878 degrees, a rho of "13.920" arcseconds as a part of a sky survey of 141 systems.

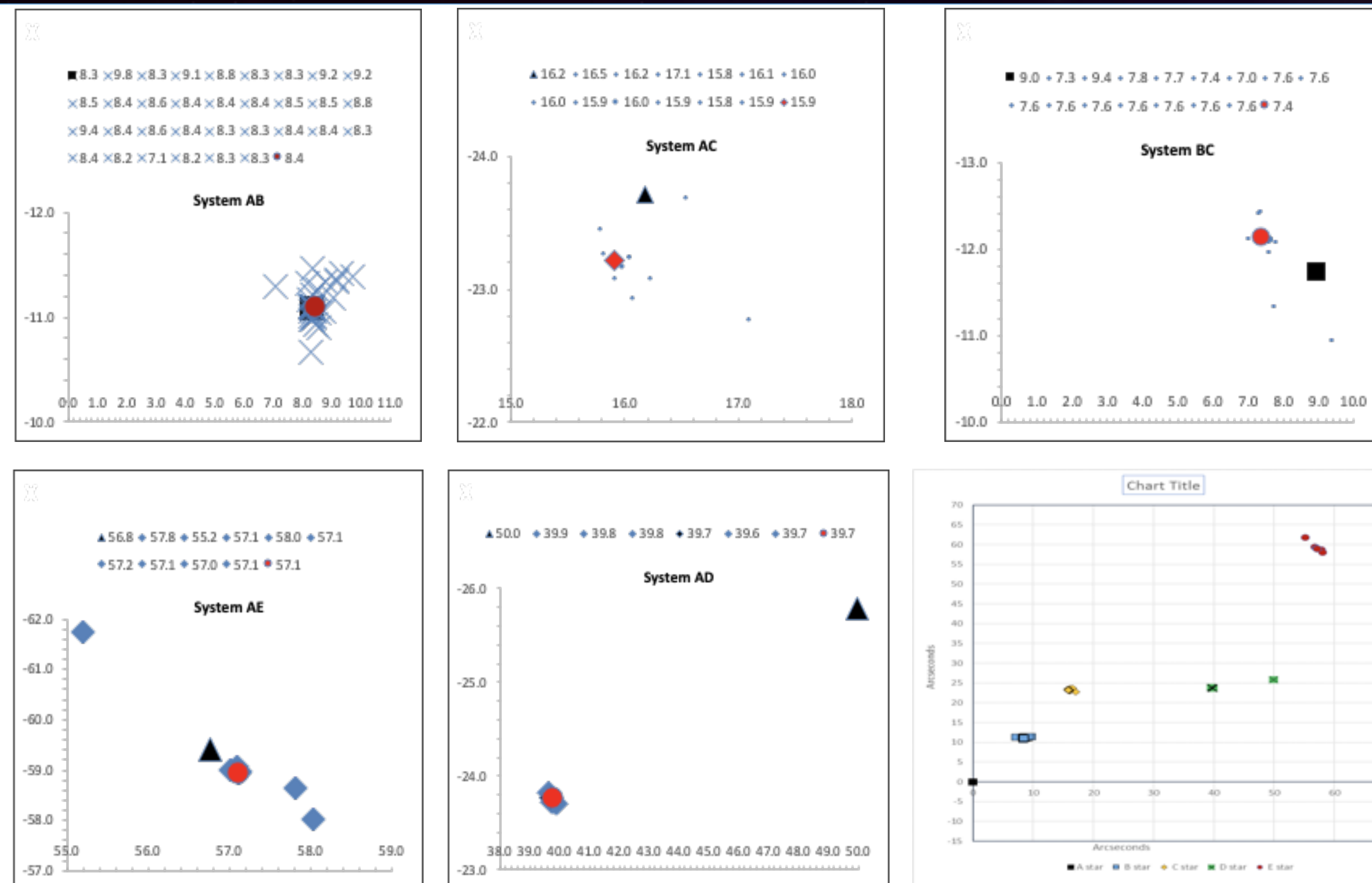
Additionally, the most recent measurements of the AC, AD, AE, and BC pairs were made in 2014 by URAT 1 during a different sky survey. Our goals with WDS 01332+6041 include the following: make 24 new observations on each pair of WDS 01332+6041 through CCD imaging, conduct new theta and rho measurements for each sub-component in this quintuple system, compare our results and conclusions to past data of WDS 01332+6041 for discussion, and implement the Monte Carlo integration method to make a suggestion on whether each component of the WDS 01332+6041 Star System is Binary or Visual.

Method

- All images for the STF131 were taken in Tenerife, Spain.
- Las Cumbres Observatory LCO system that has 0.4 meter SBIG STX-6303
- Camera with two LCO 40 cm telescopes Kb23 and Kb81
- The star system has RA of 01 33 14.01, and DEC of +60 41 11.2
- All the images were measured by using AstroImageJ 3.3.1 (AIJ).
- UP filter, RP filter, and Clear Filter. (Reference the images below).
- Rp showcases the best imagery of our system.

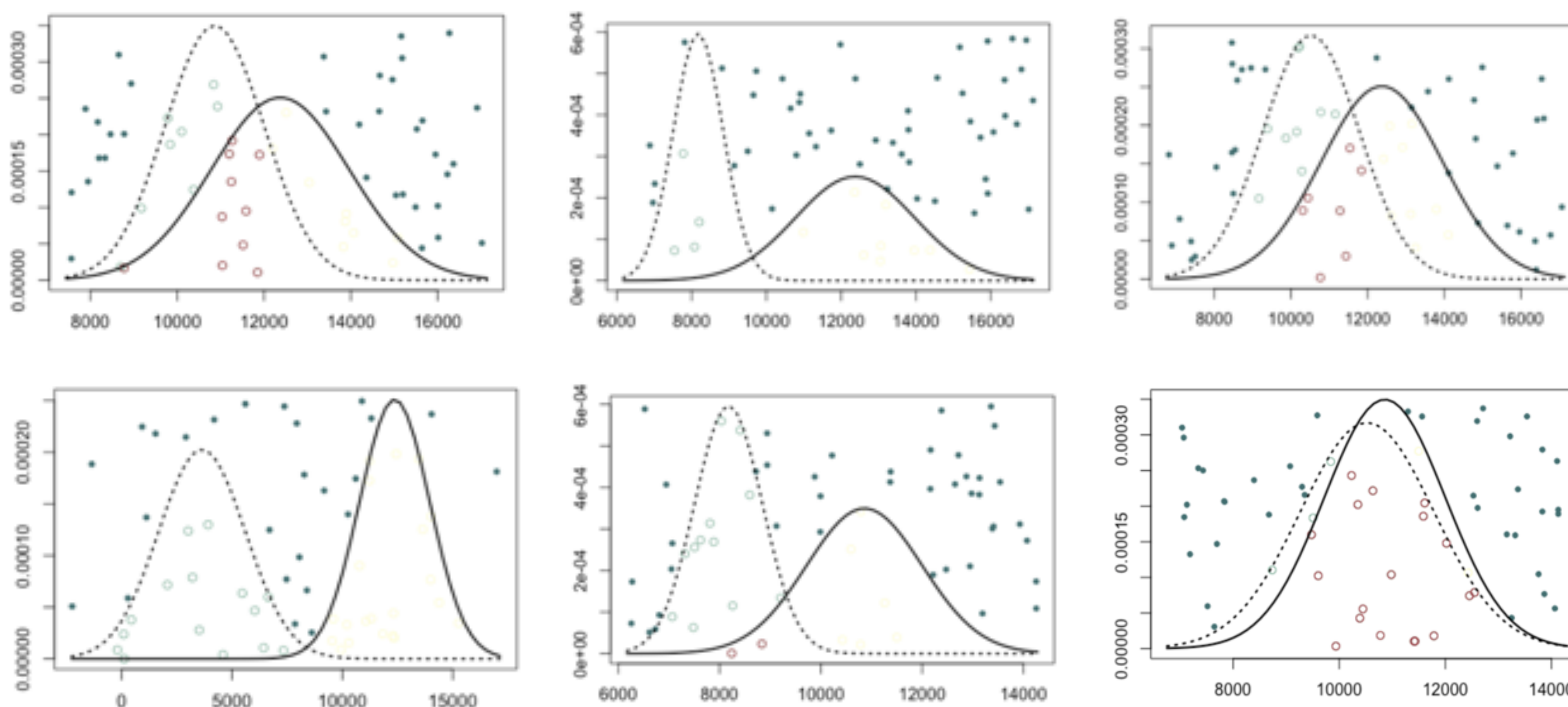


Results



- The graphs above each represent an accumulation of historical data that was recorded in the quintuple star system.
- In the following order, the first graph represents system AB, AC, AD, AE, BC, and the last graph is an accumulations of the total systems historical data including new measured data we collected.
- The historical data graphed in each system shows the movement of the star overtime. For example, in system AB, star is A is the center star in system and star B is a visual star moving nearby star A.
- The historical data starts from beginning data collected from 1827 to the current measurements our team collected in 2019. If you take a look at system AB's plot, the first data point is depicted as a black square and the last data point is depicted as a red circle.
- These measurements were graphed similarly to all other systems to showcase the stars trend in movement over time.

Results



- The graphs above represent the portability that between each star, there exists a gravitational attraction towards each other using the Monte Carlo technique.
- In the following order, the first graph is system AB, AC, AD, AE, BC, and BD.
- Each paired system in the graph, are normal distributions of the star using their mean and standard deviations.
- The Monte Carlo technique allows us to calculate the area of the overlapping distributions, giving us the probability density function (area) and absolute error that exists using the programming language R.

Implications

Combining our data from the Harshaw Probability Calculation and Monte Carlo Integration technique, and comparing our new declination and right ascension measurements to historic data for each component of our star system, we conclude that there is a low probability for our system, WDS 01332+6041 to be considered a binary system. The Monte Carlo Integration for a hypothetical BD pair hints that with additional research, there may be an unknown binary pair. Additional research of the entire system will add to our understanding of WDS 01332+6041.

Acknowledgments

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