

CCD Measurements of WDS 13510+6819 STTA127

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Abstract: WDS 13510+6819, a three-star star system, discoverer code STTA 127, is imaged using CCD cameras for astrometric measurements in comparison to historic data contained in the Washington Double Star Catalog. The historical data outlines measurements between the A-B and the B-C components and the 2016 measurements support the trend outlined in the WDS

Introduction

STTA 127 (WDS 13510+6819), Figure 1, is a triple star system in the constellation Draco. The last reported observations were 2015 for the AB component and 2010 for the BC component. Charged Coupled Device (CCD) imagery was used to add 2016 separation angle (Theta) and angular separation (Rho) of this Triple Star system. Referencing the Washington Double Star catalog (WDS), the criteria for selection was: stellar separations of 4 arc seconds or more, visual magnitude of 12 or brighter, and difference in WDS reported magnitude less than 3.

A group of remotely operated telescopes, the iTelescope network, was used to acquire the CCD images for these Theta and Rho measurements. These telescopes provide a large enough aperture to acquire high quality images of the fainter stars around STTA127. Table 1 identifies the two different telescopes used.

Imaging occurred on two different nights: T7 on March 30, 2016 and T11 on April 16, 2016, see Table 2. A variety of filters were chosen to enable satisfactory imagery for measurements on the faint C component

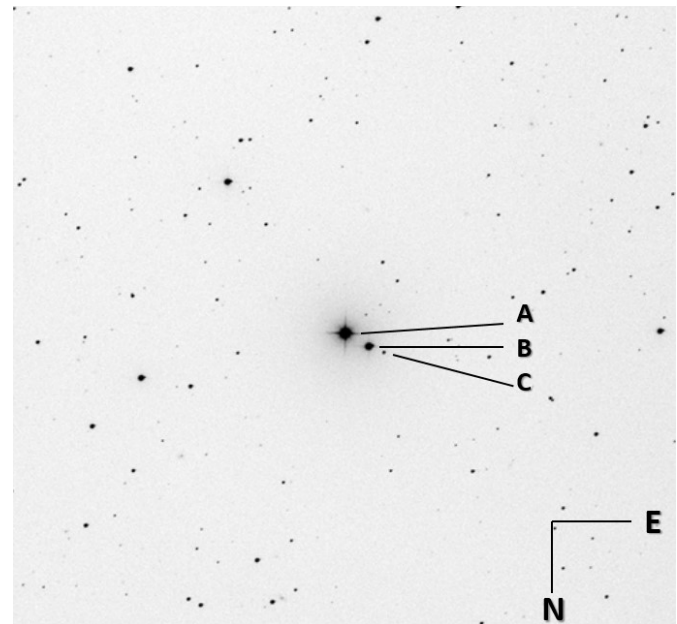


Figure 1. STTA127 with stars labeled

Table 1. Telescope Comparison

Name	Location	Telescope	CCD Camera	Focal Length	Resolution	Field of View
T7	Nerpio, Spain	CDK 17"	SBIG STL11000M	f/6.8	0.63"/pixel	28x42 arcminutes
T11	New Mexico	CDK 20"	FLI Proline PL11002M	f/4.5	0.81"/pixel	36.2x54.3 arcminutes

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Table 2. Telescope Image Summary

Name	Epoch	Number of Images	Filters	Exposure Length
T7	2016.2445	4	Luminance	180-seconds
	2016.2445	2	Luminance	120-seconds
	2016.2445	2	Hydrogen Alpha (Ha)	120-seconds
T11	2016.2910	2	Green	180-seconds
	2016.2910	2	Red	180-seconds
	2016.2910	2	Luminance	180-seconds

while ensuring there were not any oversaturation/ blooming issues on the brighter stars of A and B.

Methods and Procedures

The historical observation data for STTA127 were requested and acquired from the United States Naval Observatory. CCD images were scheduled through the iTelescope's online interface and calibrated (Darks, Flats, Bias) by iTelescope prior to downloading. MaximDL and Pinpoint Astrometry were used to set the World Coordinate System (WCS) into the images FITS headers through star matching against the Fourth U.S. Naval Observatory CCD Astrograph Catalogue (UCAC4). This process was successful for the images acquired through the T11 telescope but failed to provide a solution for images acquired with T7. A WCS plate solution for the T7 images was successful when processed through Astrometry.net's website interface (<http://www.astrometry.net>).

Each WCS calibrated image was opened with Mira Pro x64. This software, using the WCS position in Right Ascension (RA) and Declination (Dec) for the image, measures distance separation in arc seconds (Rho), and relative position angles (Theta) through the point-and-click Distance & Angle function. To ensure the most accurate measurement, Mira automatically calculates the centroid of each star when performing the requested measurements, Figure 2. This process permits accurate measurements even for the faintest stars. The red square and "+" denotes the center of the FITS image.

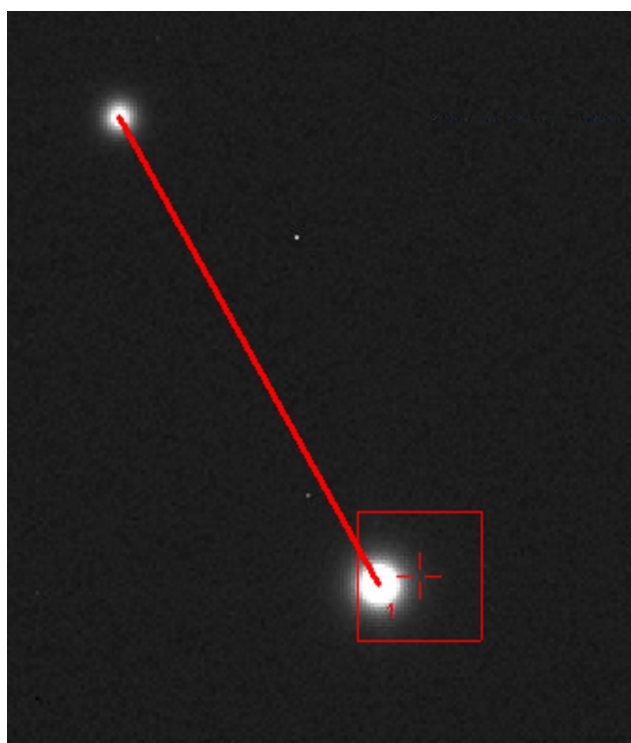


Figure 2. Example Position Angle and Separation measurement procedure with Mira Pro

The results from Mira were placed into an Excel spreadsheet to calculate the mean, standard deviation, and standard error of the mean for all components from the T7 and T11 images, Tables 3 and 4. The images

Table 3. Theta, Rho, Mean Measurement, Standard Deviation, and Standard Deviation of the Mean for Telescope T7

Telescope Used	Component	EPOCH	Measurement	Mean	Standard Deviation	Standard Deviation of the Mean
T7	AB	2016	Theta	61.6°	1.26°	0.157°
			Rho	87.2"	1.64"	0.205"
	BC	2016	Theta	70.2°	0.74°	0.093°
			Rho	54.2"	1.14"	0.142"

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Table 4. Theta, Rho, Mean Measurement, Standard Deviation, and Standard Deviation of the Mean for Telescope T11

Telescope Used	Component	EPOCH	Measurement	Mean	Standard Deviation	Standard Deviation of the Mean
T11	AB	2016	Theta	62.3°	0.27°	0.045°
			Rho	87.7"	0.98"	0.163"
	BC	2016	Theta	69.2°	0.76°	0.127°
			Rho	52.6"	0.55"	0.092"

were then compared to the measurements in the Washington Double Star catalog (WDS) to verify that the process fit the trends seen in the historical data.

Data for STTA127

The historical data, supplied by the US Naval Observatory, was compiled with the 2016 T7 and T11 measurements for the previously reported AB and BC components, Table 5. All data was plotted in Excel for a graphical depiction of the overall positioning for the previously reported AB and BC combinations, Figures 3 and 4. A trend line has been added as well.

Discussion of Results for STTA127

From the graphed data for the AB and BC pairs, there appears to be a trend in the position angle and separation of this pair that are supported by the 2016 CCD images and measurements with greater movement in Rho than in Theta. Prior to 1991, most measurements were completed with a Micrometer. After 1991, most were obtained through imagery. Given this diversity in measurement styles, most are in agreement and support the linear solution of STTA127 as noted in the WDS (Mason, 2015).

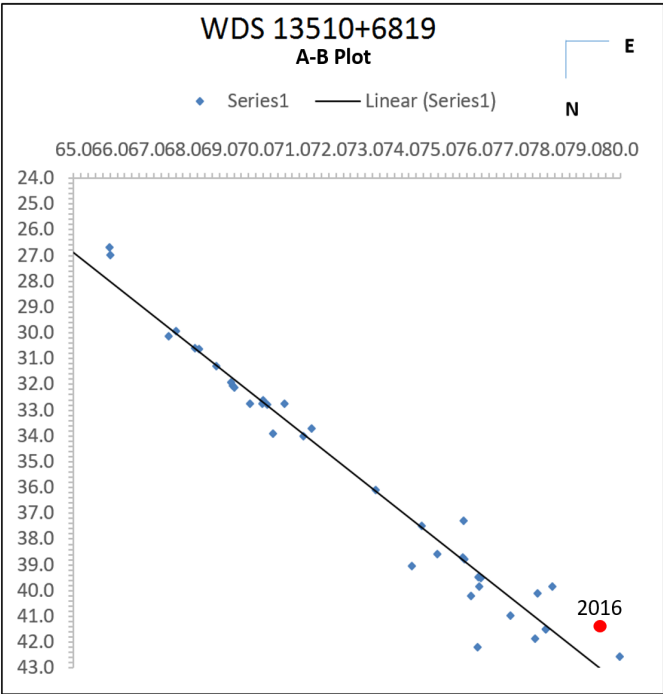


Figure 3. Graphical depiction of AB component for all historical measurements with 2016 measurement highlighted..

Table 5. Current and historical comparison for the AB and BC pairs.

Component	Number of Measurements	EPOCH	Theta	Rho
AB	35	1844 (First Recorded)	68°	71.2"
		2015 (Last Recorded)	63°	87.5"
	8	2016.2445 (T7)	61.6°	87.2"
	6	2016.2910 (T11)	62.3°	87.7"
BC	4	1912 (First Recorded)	65°	44.9"
		2003 (Last Recorded)	69°	51.9"
	8	2016.2445 (T7)	70.2°	54.2"
	6	2016.2910 (T11)	69.2°	52.6"

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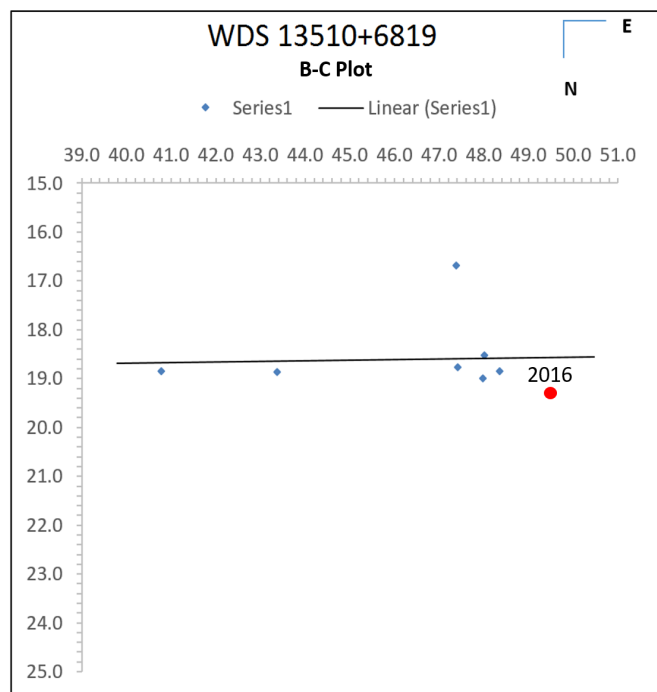


Figure 4. Graphical depiction of the BC component for all historical measurements.

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