WDS 00049+3005 STT 548AC, Ignored for 156 Years?

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Abstract: 00049+3005 STT 548AC was first interpreted as a triple system by Otto Struve in 1861, in its only historical measurement on record. Using iTelescope T11, known for its accurate astrometry, and T24, the largest iTelescope system in the northern hemisphere, we postulate that 00049+3005 STT 548 is not a gravitationally linked triple star system. In addition, we suggest that Otto Struve likely measured a high proper motion star, the A component, and mistook another for a third star in the system. In several more recent photos, it appears that the AC pairing may be categorized incorrectly and that there is actually no C component found near the A position.

Introduction

WDS 00049+3005, a star measured only once in the Washington Double Star Catalog (WDS) since its discovery in 1861, interested the researchers because it has only the single measurement. WDS 00049+3005 is cataloged as a triple system where the B component is only 0.9 arc seconds away from the A component, making the system a challenge to measure.

History of 00049+3005 STT 548AC

The only historical measurement for 00049+3005 AC determined theta at 64 degrees and rho at 28.6 arc seconds. The primary star in the system is magnitude 8.22 with a spectral type of F7V, meaning it is a yellow -white star on the Main Sequence (Struve 1861).

The original observer of 00049+3005 was Otto Wilhelm von Struve, the second director of the Pulkovo observatory in St. Petersburg, Russia (Abalakin 2009). He was a very prestigious astronomer and won the Gold Medal of the Royal Astronomical Society.

There is only one measurement of 00049+3005 (Mason and Hartkopf, 2015) which used Struve's fifteen-inch refractor and a micrometer. Another "measurement" is outlined in the historical data in 2014. The annotation on this date was not a measurement of the star but was a reference to a paper explaining how to access and use the Washington Double Star Catalog. No data for theta and rho was imputed. This means 00049+3005 was truly not measured in the WDS in 156 years, Table 1.

Materials and Methods

The star system has an RA of 00 04 51.96, and DEC of +30 05 09.4. The declination places the system above the celestial equator; thus it was most practical to acquire images from the iTelescope network using telescope eleven (T11), Figure 1, in Mayhill, New Mexico, and telescope twenty-four (T24), Figure 2, in Auberry, California. T11, equipped with an FLI Proline PL11002M CCD camera, has a resolution of 0.81 arc seconds/pixel. The reason T11 was used for research was based on the location, separation, and magnitude of 00049+3005 which is 8.22 on the A component and an unknown magnitude on the C component which may be much dimmer. Images were later gathered from T24 for similar reasons. T24, equipped with an FLI PL09000 camera, and a resolution of 0.62 arc seconds/pixel made it a candidate to photograph 00049+3005. Fourteen images were captured from the iTelescope network (telescopes used are indicated after the filters in parentheses), Table 2. Additionally, three more images we gathered from the 2MASS infrared sky survey with H, J and K band filters.

Table 1. *Historical data reference.*

Epoch	**Theta**	**Rho**
1861.9	64	28.6
2014	No Data	No Data

WDS 00049+3005 STT 548AC, Ignored for 156 years?

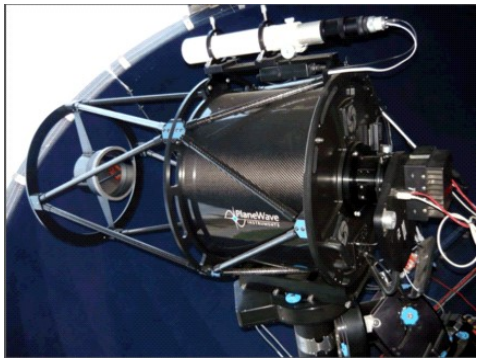

Figure 1. Telescope 11 - New Mexico.

Images were calibrated for the World Coordinate System (WCS) using Maxim DL. This establishes which way is north through identification of the target star using "PinPoint Astrometry" and comparison of the images to those in sky surveys matching the coordinates in our image. Images were then imported into Mira Pro x64 to be measured.

Data and Results

The AB components are separated by less than an arcsecond. Therefore, the pair was not resolvable for measure. The C component of 00049+3005 was not found in or near the same location as the 1861 entry in the WDS image. Measurements were conducted of nearby stars and it was found that the separation was much wider than the cataloged separation for 00049+3005. Additionally, images from the 2MASS (1997) sky survey presented some candidate stars but did not yield a star that could be identified as the C component. Therefore, new data for 00049+3005 was not possible.

Analysis and Discussion

In the images acquired, none of the surrounding stars proved to be candidates for the C component. In the images acquired from the 2MASS survey, Figure 3, there were two close stars that were not present in the iTelescope images. Each candidate was measured yet the results were inconsistent with what would be expected as the C star.

Table 2. *Overview of images acquired in 2017 and the telescopes used.*

Exposure Time	H α Filter	Luminance Filter	Blue Filter	Red Filter
30s		3 (T24)	3 (T24)	3 (T24)
60s	2 (T11)	3 (T11)	3 (T24)	3 (T24)
120s	2 (T11)	3 (T11)	3 (T24)	3 (T24)

Figure 2. Telescope 24 - California

An option was explored that Struve measured C close to the A star in 1861 and given the high proper motion of the A star (SIMBAD Web) it had moved far enough to provide a significantly different theta and rho in 2017 than was expected. The proper motion of A is listed as +066-033 indicating an eastward movement of 66 arc seconds and southern movement of 33 arc seconds in 1,000 years. Thus, A would have moved approximately 9.9 arc seconds east in RA and 4.95 south in declination. Noting this estimated 1861 position in the 2MASS image, Figure 4, measurements were recalculated to the two candidates shown (NOTE: both candidates are assumed to have zero proper motion during the last 150 years). The measurements were not in the vicinity of the 1861 measurements. The dot in Figure 4 shows the estimated position of A in 1861 with the dashed line indicating its proper motion vector.

In order to further confirm Struve's measurement was not of a binary star, data was gathered from the Gaia DR2 survey using Aladin 10. Two data sets were collected, one of 63 stars nearest to the A component's current location (set 1), and one of 55 stars nearest to the location of the A star 156 years ago (set 2). Stars were measured based on their location relative to the A star but some further away stars with fast proper motions were added to the set, as they may have crossed paths with the A star 156 years ago. The data (RA, DEC, proper motion, and their error values) were entered into an Excel spreadsheet that calculated total

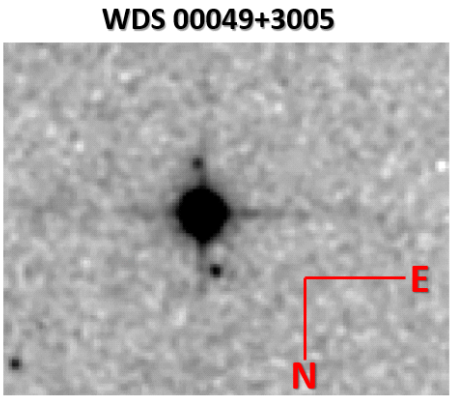

Figure 3. *00049+3005 from the 2MASS catalog (3' field of view).*

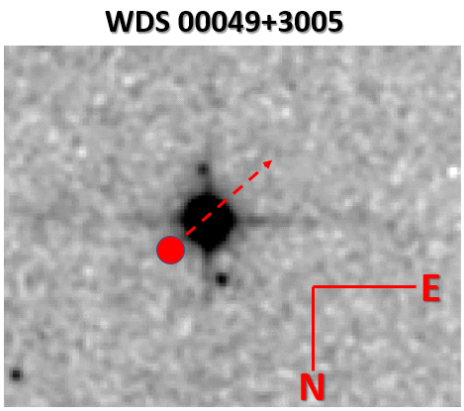

Figure 4. *00049+3005 from the 2MASS catalog (3' field of view).*

movement of the stars over 156 years, and their distances away from the A star. The proper motion of the A component was also taken into account. The data set 1 presented three stars that were 68 to 84 arcseconds away from the A component 156 years ago. The data set 2 yielded no stars that would have been close enough to the A star 156 years ago to be potential candidates.

Consideration was given to the possibility that the position and proper motion errors reported in Gaia DR2, when applied to a 156 year period, could allow old positions to vary somewhat and fall within the potential area that Struve observed. The A star has a rather high proper motion, and the other three stars in set 1 generally do not. When extrapolating the position and proper motion errors for A to 1861, we found less than one arcsecond potential position variation. The variation would be even smaller for the three candidates in set 1. Thus, none of these three, which are 68 to 84 arcseconds separated from A, could have been at the reported 28.6 arcsecond separation needed to be the C star.

We then considered the possibility that Struve had mistakenly measured a nearby double star with similar magnitudes and separations. STF 3058, which is about 15 arcminutes away, was the only comparable nearby candidate with an A star magnitude of 7.81 vs. STT 548 A's magnitude of 8.22. Its B component is a magnitude 9.21 star at a current separation of 12.6 arcseconds per the WDS. There is no reported magnitude for Struve's STT 548 C (which in itself is unusual). A similar 156-year extrapolation of the two stars' positions and proper motions established that the AB pair would have had a separation of 14 arcseconds and B would have been in the wrong quadrant in 1861. A 156-year extrapolation of STF 3058 A's neighbors found no potential C star closer than 45 arcseconds. Further Struve could not have missed the B star so a third C star is quite improbable.

We briefly considered one other possibility: that an extremely high proper motion star passed by the A star in 1861 and was not seen later when it had moved further away. We viewed the proper motion vectors from Gaia DR2 in Aladin 10 over an area of one-degree radius around the A star. Barnard's Star, which has the highest proper motion of any star, would have traversed slightly under a half of a degree over 156 years. No star with the necessary rate of motion to fulfill this scenario could be found in the one-degree radius area around STT 548 A.

Conclusion

We were unable to locate any stars matching similar criteria to 00049+3005 STT 548C that existed around the A star using 2MASS sky survey, Gaia DR2 sky survey, and current images. The data strongly suggest that it is most likely that an error occurred in the measurement process and we are unable to infer the nature of that error.

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