

Micro-Metric Measurements of 31 Aquilae

John Nanson
Star Splitter double star blog
Manzanita, Oregon

Steve McGaughey
Haleakala Amateur Astronomers, Maui Double Star Association
Maui, Hawaii

Dr. J.D. Armstrong
University of Hawaii, Institute for Astronomy
Maui, Hawaii

Abstract: This paper discusses our discovery that the 2009 and 2010 position angle measurements of 31 Aquilae (the most current available in the WDS) are notably at variance with visual observations made in the summer and fall of 2012, along with a short history of prior observations. Also discussed are our efforts to measure both the position angles and separations in the summer and fall of 2012.

In early August of 2012, I happened across an eye-catching photograph (Figure 1) of 31 Aquilae, a stunning triple star with a neglected fourth member that hasn't been measured since 1914.

After admiring the configuration of the four stars, I turned my attention to the Washington Double Star Catalog to look at the measurements (shown below in Table 1) and could see immediately that the photograph and the data didn't match up well.

As can be seen in Table 1, the position angles for both AB and AC are listed at 281 degrees. But in the photograph, it's very obvious that AB and AC are not at identical position angles. Unable to determine the date of the photograph, I decided to take a hard look at 31 Aquilae as soon as the first opportunity presented itself — and when I did, I found the current position angles of AB and AC matched up well with the photo, as shown in my Figure 2 sketch.

And that led to this project.

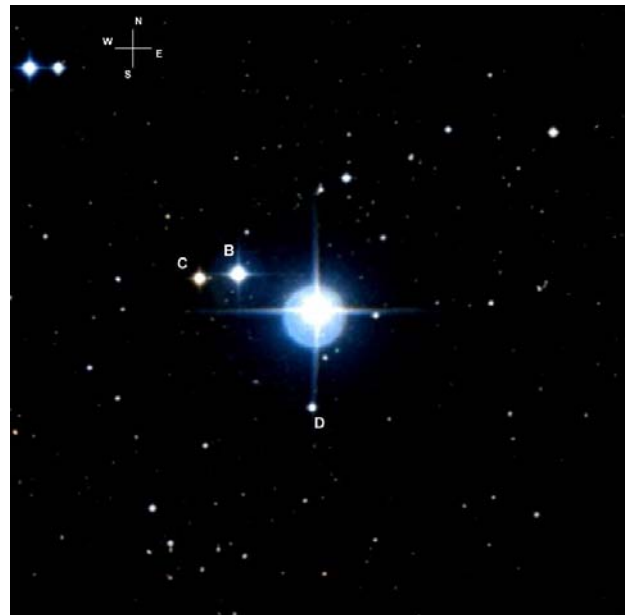


Figure 1. 31 Aquilae and its three companions. East and west reversed to match the refractor view. (Aladin photo)

Micro-Metric Measurements of 31 Aquilae

Table 1: Current WDS Measurements of 31 Aquilae

| NAME | RA DEC | MAGS | PA | SEP | DATE |
|------------|------------|----------|-----|-------|------|
| STT 588 AB | 19250+1157 | 5.2 8.7 | 281 | 105.4 | 2010 |
| STT 588 AC | 19250+1157 | 5.2 10.3 | 281 | 145.2 | 2009 |
| COM 7 AD | 19250+1157 | 5.2 10.3 | 140 | 78.8 | 1914 |
| STT 588 BC | 19250+1157 | 8.7 10.3 | 266 | 44.2 | 2010 |

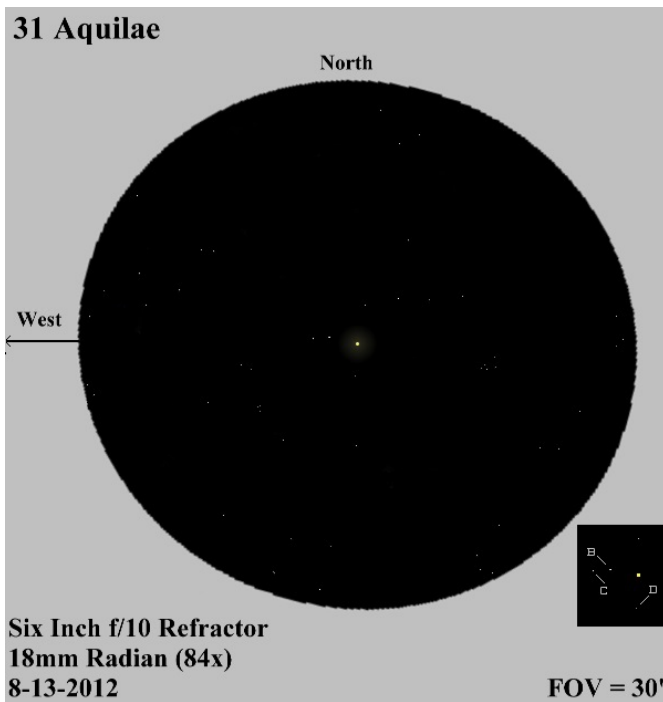


Figure 2. East and west reversed once again to match the view in the Aladin photo.

Proper Motion of 31 Aquilae

First, let's take a look at the earliest observations of 31 Aquilae.

The WDS shows the first recorded observation took place in 1852, which is credited to Otto Struve. The data from those observations is shown in Table 2, along

with the first observations of the "D" component by Comstock in 1887.

When you compare the position angles and separations of AB and AC, it's clear that considerable change has taken place in the 157 and 158 years intervening between the first and last dates of measurement. As it turns out, most of that change is attributable to the rapid movement of the primary, which is shown below (Figure 3) in Simbad's plot of 31 Aquilae.

The long red line leading up and to the left is the primary of 31 Aquilae, and the shorter line to the right of it, pointing down and to the left, is the secondary, "B".

The WDS data confirms the rapid motion of the primary, showing it at +721 in RA and +643 in Declination, and it lists the proper motion of the secondary as at +032 in RA and -087 in Declination.

Previous Configurations of 31 Aquilae

I was somewhat perplexed by the fact that none of the early very active double star observers prior to Otto Struve - especially William Herschel, John Herschel, and James South - had recorded an observation of 31 Aquilae, but I suspected the reason for that was related to the rapid proper motion of the primary.

Armed with the 1852 data from Otto Struve's observations, I plotted the position angles and separations and came up with the chart shown below in Figure 4.

If you look at it closely, it's obviously not what you would call an eye-catching configuration of stars, although it certainly was enough to prompt Otto Struve to

Table 2: WDS First Dates of Observation of 31 Aquilae

| NAME | RA DEC | MAGS | PA | SEP | DATE |
|------------|------------|----------|-----|-------|------|
| STT 588 AB | 19250+1157 | 5.2 8.7 | 4 | 142.5 | 1852 |
| STT 588 AC | 19250+1157 | 5.2 10.3 | 332 | 117.1 | 1852 |
| COM 7 AD | 19250+1157 | 5.2 10.3 | 122 | 82.2 | 1887 |
| STT 588 BC | 19250+1157 | 8.7 10.3 | 247 | 42.6 | 1852 |

Micro-Metric Measurements of 31 Aquilae

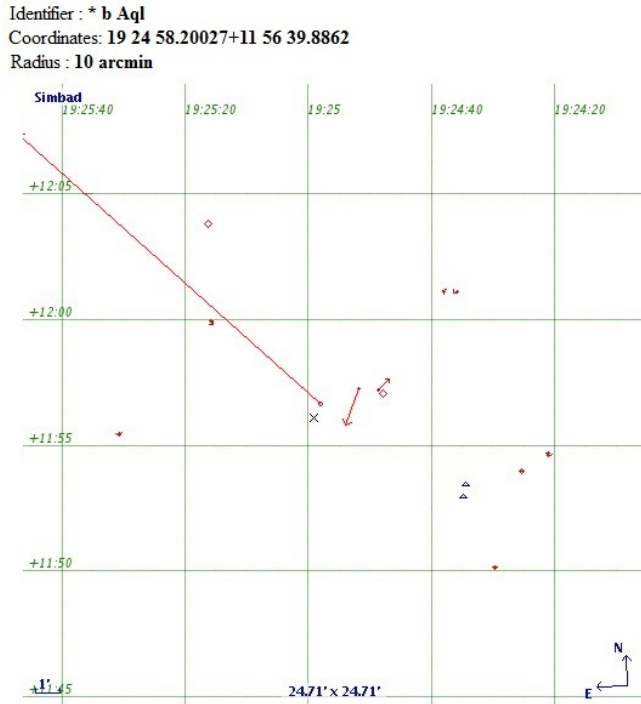


Figure 3. Plot of proper motions of 31 Aquilae "A" and "B". (From Simbad plot of "b", or 31, Aquilae).

record the first measurements of 31 Aquilae.

Using the proper motions of the primary and the secondary shown in the WDS, and leaving "C" in place since its proper motion is relatively minor compared to that of the other two stars (+003 RA, +001 Dec), I plotted the positions of "A" and "B" backward in time to 1781. On July 25th of that year, William Herschel recorded an observation of nearby 28 Aquilae, located about one degree to the northwest of 31 Aquilae. Based on my results, if he had caught 31 Aquilae at that time, he would have seen something very close to the view shown in Figure 5. (See the references for a link to a discussion of both 28 and 31 Aquilae).

The circular field represents about a six arc minute eyepiece field of view, which is roughly equivalent to what William Herschel would have seen at 460x in the 160mm reflector he was using in 1781. Once again, hardly an eye-catching sight, and chances are he might have missed "B" altogether since it was probably well outside the field of view.

Back to the Present

So that takes us back to August and September of 2012. After mulling over all of the above information,

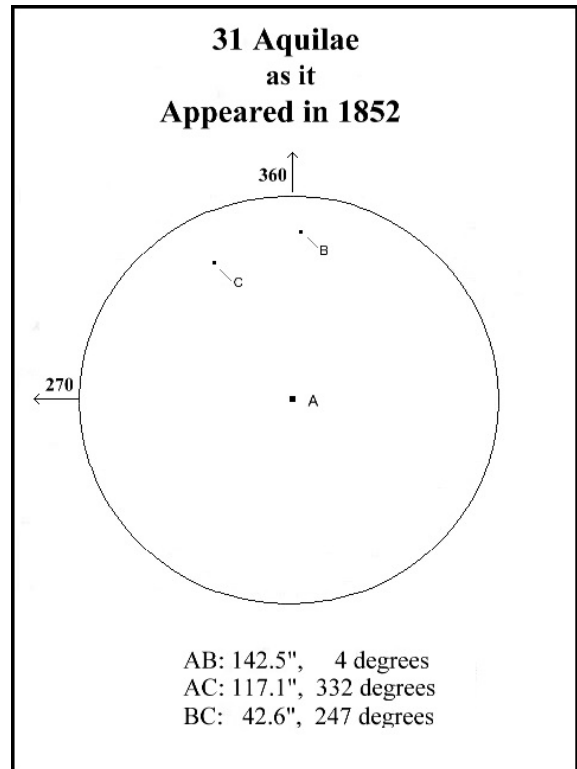


Figure 4. Plot of 31 Aquilae as it appeared to Otto Struve in 1852.

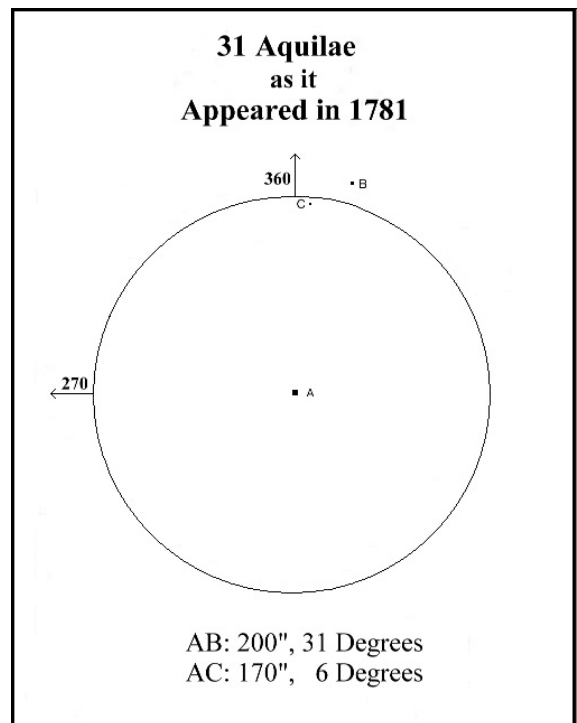


Figure 5. Plot of 31 Aquilae as it would have appeared in 1781 when Sir William Herschel was recording an observation of 28 Aquilae, one degree to the northwest.

Micro-Metric Measurements of 31 Aquilae

Table 3: My Measurements of 31 Aquilae

| NAME | RA DEC | MAGS | PA | SEP | DATE | N |
|------------|------------|----------|--------|--------|----------|---|
| STT 588 AB | 19250+1157 | 5.2 8.7 | 285.33 | 105.68 | 2012.748 | 1 |
| STT 588 AC | 19250+1157 | 5.2 10.3 | 279.30 | 145.31 | 2012.770 | 2 |
| COM 7 AD | 19250+1157 | 5.2 10.3 | 188.33 | 125.50 | 2012.773 | 3 |
| STT 588 BC | 19250+1157 | 8.7 10.3 | 268.01 | 46.24 | 2012.776 | 3 |

Notes:

1. Twenty readings using 2x Barlow (192x)
2. Twenty readings using 2.4x Barlow (230x)
3. Forty readings using 2.4x Barlow (230x)

Equipment used for all measurements: Celestron six inch f/8 refractor on a Losmandy G8 mount, Celestron 12.5mm Astrometric Eyepiece, Celestron 2x Barlow, 2.4x Dakin Barlow

I could see a real need for a tool to measure position angles and separations, and being a visual observer, my first thought was a bifilar micrometer. Unfortunately, those precision pieces of equipment are both rare and expensive, so I took a harder look at an astrometric eyepiece - a much more affordable choice, although one I had lost patience with in the past due to the difficulty of keeping the outer edges of the reticle in focus. My first choice was the Celestron eyepiece, which apparently is no longer offered in the U.S. under their name. Eventually I came across a Baader version of that eyepiece (an improvement over the original Celestron model), which I purchased and put to work immediately on 31 Aquilae.

I had become acquainted with Steve McGaughey after he had commented on a few of my columns written for the “Star Splitter” blog I co-write with Greg Stone, and thus was aware Steve had done some work with an astrometric eyepiece. Between his help and the chapter on astrometric eyepieces in Bob Argyle’s *Observing and Measuring Visual Double Stars*, the Celestron instructions, and a tutorial I found on the web site of the Italian double star publication *Il Bollettino delle Stelle Doppie*, I had enough information to get started. There were some initial frustrations with the drift method (I ended up using information from the *Stelle Doppie* tutorial to resolve that), and also with establishing a scale constant for the linear scale (I highly recommend against using the stop watch feature on a cell phone for the timings). After twenty timings of ϵ Cassiopeiae to establish a scale constant using the equipment described in the notes below for Table 3, and some practice on a few stars, I was ready for 31

Aquilae.

Micro-metric Astrometric Results

Table 3 shows the measurements I obtained in September and October of 2012.

The big question in my mind, since this was my first concerted attempt to measure both position angles and separations, was how accurate my measurements were. Steve has worked in the past with Dr. J.D. Armstrong of the Faulkes Telescope Project (FTN), so the plan was to use the Two Meter Faulkes Telescope North to image and measure 31 Aquilae.

That particular telescope is located on the 10,000 foot summit of Mt. Haleakala, a dormant volcano on Maui, which is a site blessed with abundant clear dark skies and excellent seeing. The FTN is one of the telescopes in the Las Cumbres Observatory Global Telescope (LCOGT) network. In addition to the FTN, there is a matching 2-meter telescope, Faulkes Telescope South (FTS), which is located at Siding Springs Observatory, Australia.

(More than a dozen 1-meter telescopes and approximately two dozen 0.4-meter telescopes are being designed, built, and installed by LCOGT at diverse longitude and latitude locations around the globe to conduct research in “time-domain” astrophysics. Objects can be kept under constant surveillance around the clock as they are automatically passed from one identical telescope to another as the Earth turns. All of the telescopes in the network will be fully robotic and well instrumented including high speed, low noise EMCCD cameras that can be used for lucky imaging or speckle

Micro-Metric Measurements of 31 Aquilae

Table 4: Measurements of J.D. Armstrong

| NAME | RA DEC | MAGS | PA | SEP | DATE | N |
|------------|------------|----------|--------|--------|----------|---|
| STT 588 AB | 19250+1157 | 5.2 8.7 | 283.94 | 104.92 | 2012.844 | 1 |
| STT 588 AC | 19250+1157 | 5.2 10.3 | 278.63 | 147.65 | 2012.844 | 1 |
| COM 7 AD | 19250+1157 | 5.2 10.3 | 189.01 | 124.64 | 2012.844 | 1 |

Notes

1. Photometric observations made with the Two Meter Faulkes Telescope North.

interferometry of double stars as well as spectrographs on the 1- and 2-meter telescopes).

The measurements with the FTN were accomplished on November 3, 2012 and yielded the following data shown in Table 4.

In comparing my figures with the photometric results obtained with the Faulkes Telescope North, I was rather pleased, especially with the position angles, which showed an improvement in accuracy after my initial efforts with the AB pair. The separation of the AC pair stands out as the one figure most in need of a second look, so I have plans to measure the separation once again in the summer of 2013. In fact, considering the changes in AB and AC in the three and four years between the WDS figures and the Faulkes measurements, it could be interesting to measure them again in August of 2013 to see how much change has taken place over the course of a year. The rapid proper motion of the primary appears to make a significant difference in the visual alignment of 31 Aquilae's components in a relatively brief period of time.

References

Herschel William., 1782, "Catalogue of Double Stars." *Philosophical Transactions of the Royal Society of London*. **72**, 112-162. <http://rstl.royalsocietypublishing.org/content/72.toc>

Il Bollettine delle Stelle Doppie. <https://sites.google.com/site/ilbollettinodellestelledoppie/home>

(Tutorial for Celestron astrometric eyepiece): <https://sites.google.com/site/ilbollettinodellestelledoppie/tutorial>

Mason, Brian., 2012, *Washington Double Star Catalog*. <http://ad.usno.navy.mil/wds/>

Nanson, John., 2012, "A Radiant Study in Stellar Contrasts: 28 and 31 Aquilae", *Bestdoubles.wordpress.com*

Part 1: <http://wp.me/pVYAT-178>

Part 2: <http://wp.me/pVYAT-17j>

Observing and Measuring Visual Double Stars, Bob Argyle (editor), Springer Verlag, New York 2004.

Web Sites

Faulkes Telescope Project: <http://www.faulkes-telescope.com/>

Simbad and Aladin web site: <http://cds.u-strasbg.fr/>

Link to Aladin plot of 31 Aquilae: http://simbad.u-strasbg.fr/simbad/sim-plot?target=BLANK&ident=*+b+Aql&coo=19+24+58.20027%2B11+56+39.8862&radius.unit=arcmin&x=58&y=90&radius=10

Star Splitters: <http://bestdoubles.wordpress.com/>