

How Nu Coronae Borealis Lost its Five Star Rating or One Less Star in the Northern Crown

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Abstract: This paper discusses our efforts to determine if the “D” and “E” components listed in the WDS for Nu-1 and Nu-2 Coronae Borealis were the same star.

In June of 2013, I had occasion to observe Nu-1 and Nu-2 Coronae Borealis, a beautiful pair of 5.4 and 5.6 magnitude orange-gold stars with a separation of 355 arc-seconds, located four degrees east of the Hercules Keystone. The WDS data at that time showed Nu -1 had 11.3 & 12.9 magnitude companions, while Nu-2 had a single 10.2 magnitude companion making Nu Coronae Borealis both literally and figuratively a “Five Star System”.

As I looked closely at the image in the eyepiece, four of the components (A-B-C & E) were easily spotted, but the fifth and faintest of the group, 12.90 magnitude “D”, was nowhere to be seen.

A careful examination of the position angles and separations of AD and BE (included at the bottom of the sketch in Figure 1) pointed to “D” and “E” being at either the same location or very close to it. Using the Aladin Sky Atlas I was able to not only pull up an image of the area, but also plot the WDS data for AD and BE over the top of the image (Figure 2). The resulting measures, which varied slightly from the WDS data shown at the bottom of Figure 1 confirmed my suspicion that “D” and “E” were at virtually the same location.

Since it was possible the missing 12.90 magnitude

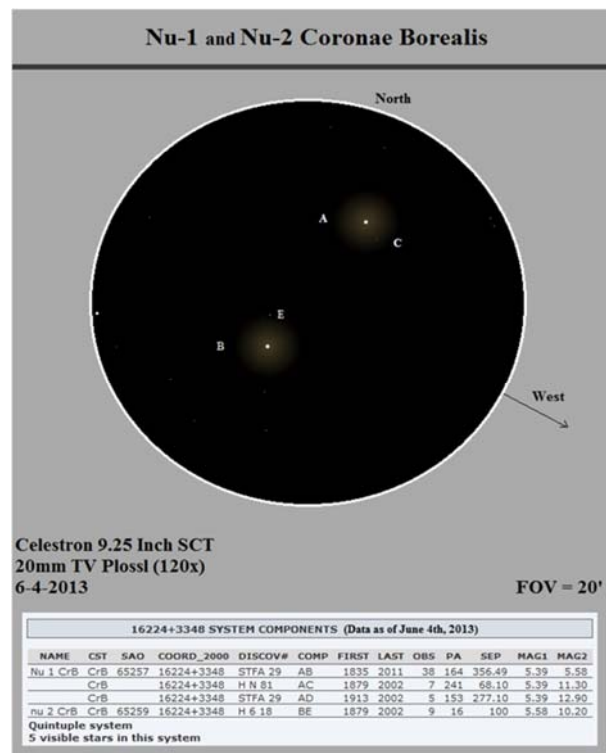


Figure 1. J Nanson's sketch of Nu CrB.

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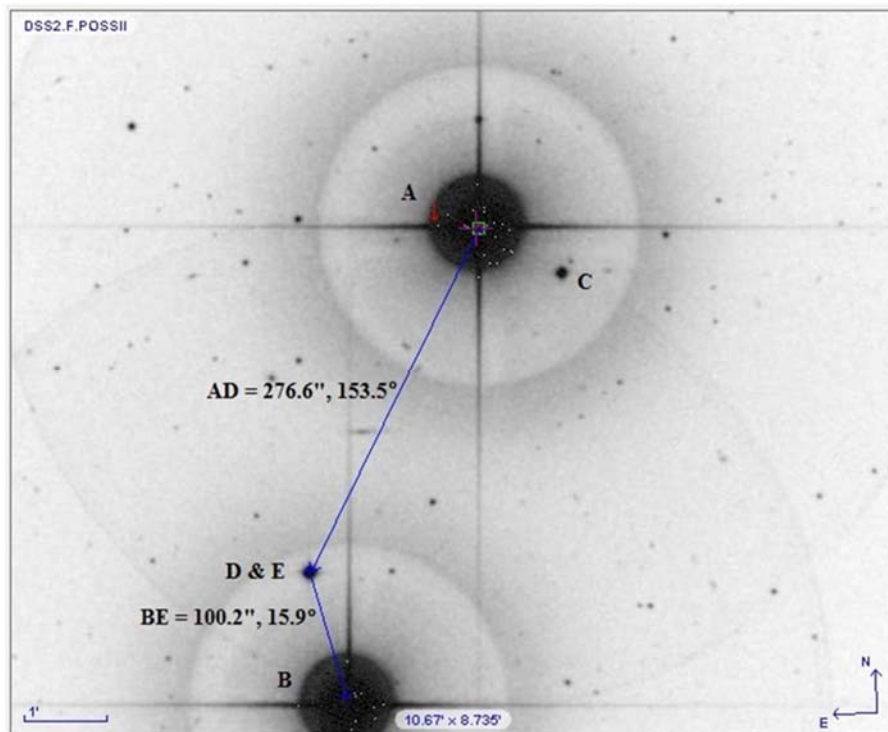


Figure 2. Vizier Plot

“D” component was hiding in the tenth magnitude glare of “E”, I enlarged that image (see Figure 3) and found what appeared to be a candidate for “D”, although it was so faint as to be unlikely and so indistinct it was far from conclusive

I posted my findings on my blog and there things stood until I received an email in August (2013) from Steve Smith, who had read my findings and wanted to assist in trying to locate “D”. He included a photo he had recently taken of the area with a four inch refractor which also showed a possible candidate for “D” (see Figure 4), but this one was located on the opposite side of “E”. While this candidate was widely separated from “E” and was relatively bright on the frame, we were unable to find any matching star on any of the sky survey photos and Steve has been unable to re-capture it in any of his subsequent photos (see Figure 5). We have since written this candidate off as most likely due to sensor noise or “hot pixels.”

With repeated observations over the ensuing weeks, all of our efforts to locate “D” either visually or photographically were going nowhere, leaving us at an impasse. While we couldn’t definitively eliminate the possibility of there actually being a “D” component, it nevertheless was possible our equipment was insufficient for detecting and/or resolving the potentially dim

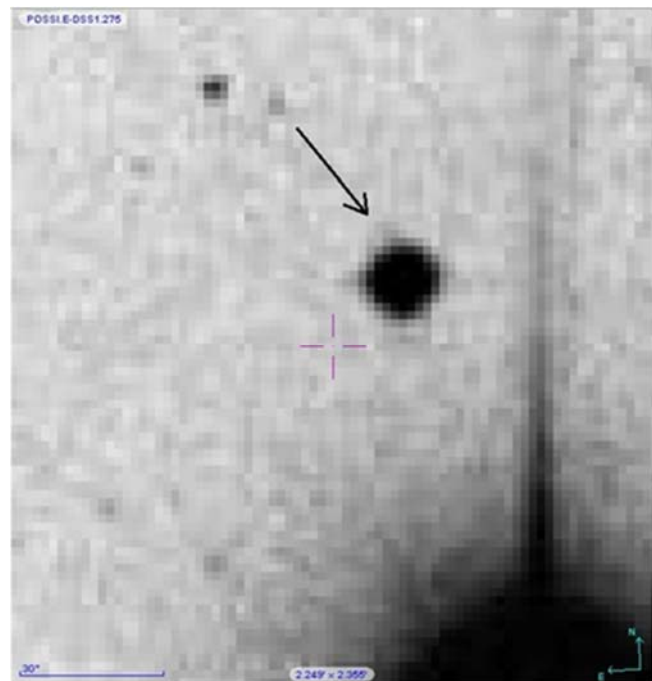


Figure 3. Vizier Image

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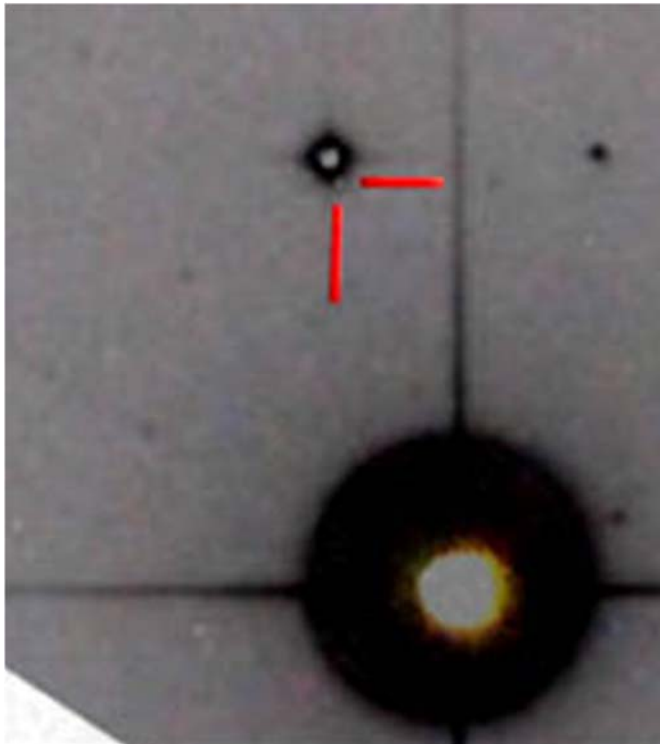
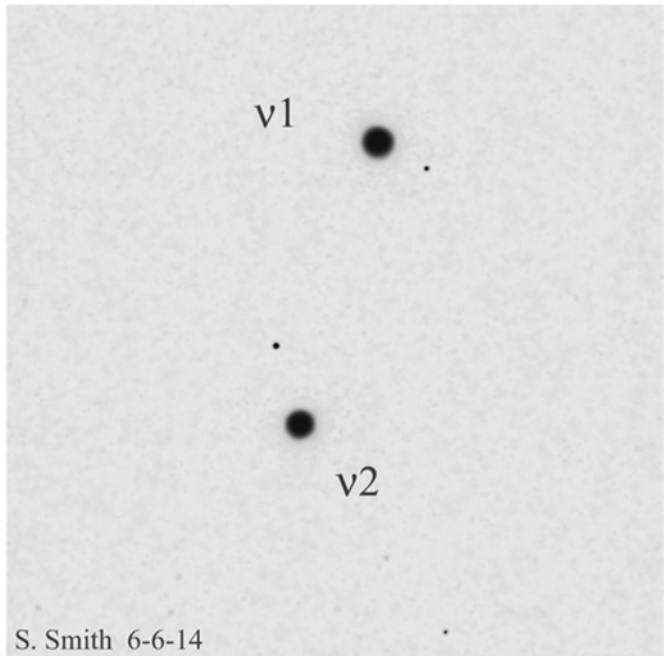


Figure 4. S. Smith August 2013 Photo of Nu 2 over-laid on top of DSS Survey photo in attempt to identify Possible “D” Component Candidates



S. Smith 6-6-14

Figure 5. Recent photo of the Nu CrB area.

and tightly spaced component.

In June of 2013 I had sent a request to Brian Mason at the USNO for the detailed text file which lists all of the Nu CrB measures, from its discovery to the present day. Since the WDS data (both online and in the text file) didn't provide any separation and PA values specifically for the DE pair, Steve decided to put together an AutoCAD plot using the 2013 data to establish their separation and PA in order to determine whether or not they were beyond the visual and imaging capabilities of our equipment.

That plot (see Figure 6) showed the separation to be an exceedingly tight 0.32 arc-second, which would definitely place it well beyond the reach of our current equipment. A second plot (not shown) which used data from 1913 showed a separation of 1.13 arc-seconds between “D” and “E”. But the plots also began to set in our minds the possibility that the data as presented was in error, as well as the distinct possibility that D & E were in fact the same star.

The WDS text file not only provided the historical record of measurements for the system, but also gave us the name of William Doberck, who was credited with the first measurements of the AD pair in 1913. I located his 1913 observation in a 1913 issue of *Astron-*

omische Nachrichten (see Figure 7), but initially didn't find it to offer anything more than the WDS file that Brian Mason had provided.

As emails and conjecture continued to pass between Steve, Chris and I over the intervening days, I found myself staring at Doberck's observations again one night, trying to match them with the data in the WDS file. Once again, I wasn't having much luck until it suddenly dawned on me that Doberck had reversed the letter designations for Nu-1 and Nu-2 CrB. In other words, he had identified Nu-1 Coronae Borealis as “B” in his log, and Nu2 as “A”. Enlightened now with that critical nugget of knowledge, I was able to match Doberck's measurements in *Astronomische Nachrichten* with those in the WDS text file for Nu CrB.

The first entry in the 2013 WDS text file for AD shows this data from 1913:

```
STFA 29AD      1913 2002      5 154 153 281.7 277.1
5.39 12.9 M2IIIab
                1913.21      154.3 281.73
Dob1927 Ma 3
```

As I looked at Doberck's entries in the red box (see Figure 7), I saw those same numbers listed for the position angle (θ) and separation (ρ) of the pair Doberck

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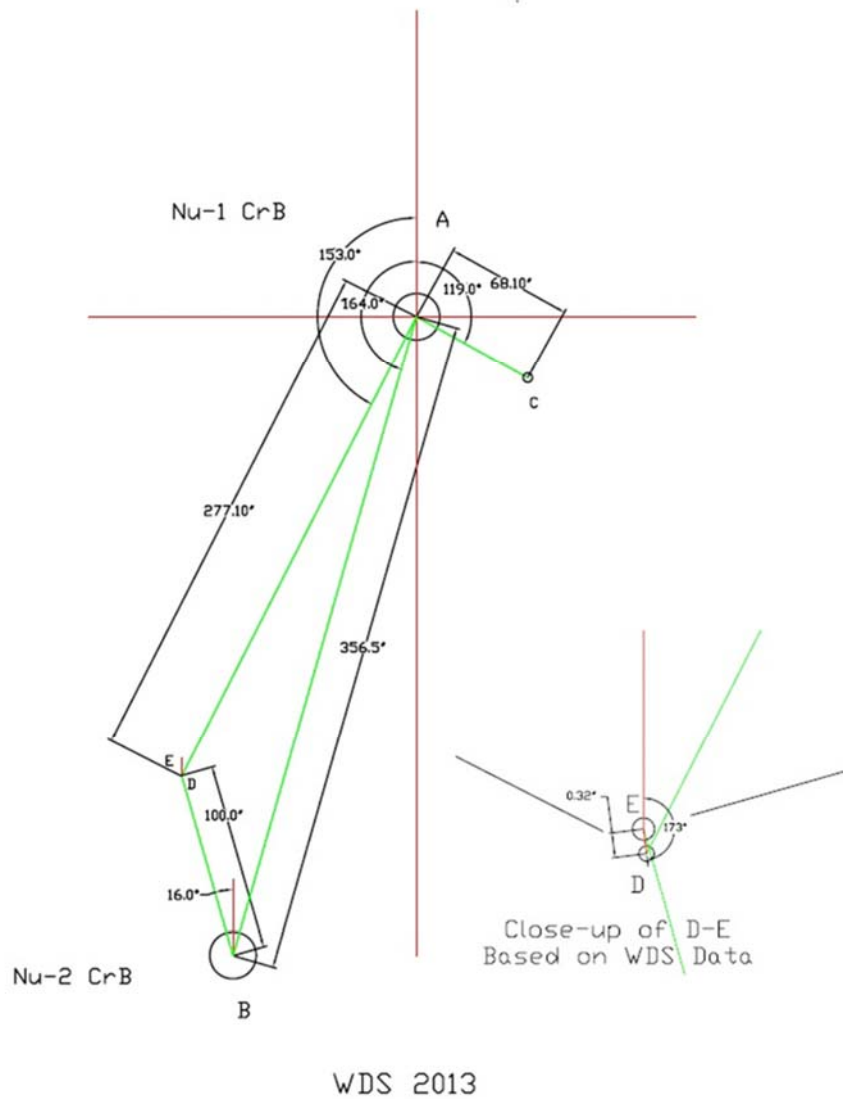


Figure 6: Nu CrB AutoCAD Plot of June, 2013, Data

had labeled as “BC”. That pair is labeled “AD” in the WDS, which meant Doberck had measured to the companion from present-day Nu-1 CrB. Because the star he measured to is identified as “D” in the WDS, that meant Doberck’s BC is the WDS’s AD.

I went back to the WDS text file entry for BE and saw Doberck’s name was also listed for the 1913.21 measurement of that pair:

H 6	18BE	1879	2002	9	16	16	104.6
100.0	5.58	10.2	K5III				
		1913.21		16.3			103.43
Dob1927	Ma	3					

I compared the 16.3° and 103.43° listed there with

his observing log, and immediately above the red box (see Figure 7) saw those same numbers in the section of his log he had labeled as AC. Aware now that Doberck’s “A” is the WDS’s “B”, and his “C” is the WDS’s “D”, I could see the pair he labeled as “AC” was actually the stars labeled “B” and “D” in the WDS but the WDS identified that pair as BE.

The cloud of confusion surrounding Nu CrB for the past months suddenly evaporated with a burst of stellar clarity: where Doberck had measured to the same star from Nu-1 and Nu-2 (his BC and AC), the WDS listing showed two separate designations for the second star of those two pairs, AD and BE. In other words, “D” and “E” were the same star.

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		4695										266		
1900 +	Name	RA. 1915.0	Decl. 1915.0	1900 +	δ	π	ϱ	π	z	Q	Power	Means		
												1900+	δ	ϱ
7235	ξ Scorpil MC(cont.)	16 ^h 0 ^m	-11° 9'	13.48	62.2	4	7.17	4	-0.1	m	450	13.46	62.4	7.40
7549	σ Cor. bor.	16 12	+34 5	13.38	217.4	4	4.91	4	-2.2	rg	450			
	HI 3				217.8	4			-1.1	g	450			
					217.4	4	4.84	4	-0.2	vg	450	13.42	217.5	4.87
7613	ϱ Ophiuchi	16 20	-23 15	13.43	352.6	4	3.15	4	-0.3	g	250			
	H II 19				352.0	4	3.39	4	-0.1	rg	450			
					351.8	4	3.46	4	-0.2	m	450	13.45	352.1	3.33
7608	ν Cor. bor. AC	16 19	+34 0	12.45	16.30	5			-1.0	rb	150			
					16.90	4	102.35	5	-2.4	b	150			
					16.43	3	103.84	6	+0.7	rg	150			
					15.65	4	104.10	5	+0.8	m	150	13.21	16.32	103.43
					154.73	4			-1.1	b	150			
					154.52	4	281.53	7	-2.3	b	150			
					154.30	4	282.79	7	+0.5	rg	150			
					153.82	4	280.88	7	+0.9	rb	150	13.21	154.34	281.73
7649	λ Ophiuchi	16 27	+2 10	13.45	73.0	5	1.18	4	-0.3	rg	450			
	HI 83				73.2	4	1.33	4	0.0	rg	450			
					73.7	5	1.19	4	+0.2	rb	450	13.46	73.5	1.23

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from

Astronomische Nachrichten, Vol 196, pp. 265-66

Figure 7: Doberck log

We set the issue aside for a time but that pause was interrupted in June, 2014, when Steve, who had resumed his imaging activities of Nu CrB as it became visible again in the evening sky, sent me his latest picture (Figure 5) along with a note that the WDS had revised the magnitudes for D & E; they were now at an identical magnitude of 11.53. The previous data from 2013 had listed those two stars with very different magnitudes, 12.90 for "D" and 10.20 for "E, which had reinforced the impression there were five stars in the Nu CrB system. (see Table 1).

Although the new magnitudes for "D" and "E" indicated someone else may have concluded the two stars might be one and the same, both AD and BE were still listed as though they were separate pairs. Well aware those magnitude changes could indicate the existence of additional information Steve and I didn't have, I pulled all of our information together and sent it to Bill Hartkopf and Brian Mason at the USNO.

In less than the twenty-four hours I had a reply from Bill in which he described covering ground similar to what Steve and I had covered. At the end of his message were these welcome words:

"Bottom line - D and E are the same star. I'll change the component designation in the WDS and add a note.

Cheers,
Bill"

And shortly later the WDS listing changed BE to BD and this note was added to the WDS notes file:

16224+3348 STFA 29 A: nu 1 CrB = 20 CrB
 B: nu 2 CrB = 21 CrB
 H 6 18 BD: H VI 18. *Confusion*
in early component identification led to the BD
pair being misidentified as BE.

Both Steve and I were still wondering what had prompted the change in the magnitudes of both "D" and "E" to 11.53, so I sent another message to Bill asking whether someone else had realized the two letter designations actually referred to the same star. We learned from Bill's quick reply that he had been doing some matching of the UCAC4 Catalog against the WDS and "Since much of the matching was automated,

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the

16224+3348 SYSTEM COMPONENTS (Data as of June 4th, 2013)												
NAME	CST	SAO	COORD_2000	DISCOV#	COMP	FIRST	LAST	OBS	PA	SEP	MAG1	MAG2
Nu 1 CrB	CrB	65257	16224+3348	STFA 29	AB	1835	2011	38	164	356.49	5.39	5.58
	CrB		16224+3348	H N 81	AC	1879	2002	7	241	68.10	5.39	11.30
	CrB		16224+3348	STFA 29	AD	1913	2002	5	153	277.10	5.39	12.90
nu 2 CrB	CrB	65259	16224+3348	H 6 18	BE	1879	2002	9	16	100	5.58	10.20

16224+3348 SYSTEM COMPONENTS (Data as of June 12th, 2014)												
NAME	CST	SAO	COORD_2000	DISCOV#	COMP	FIRST	LAST	OBS	PA	SEP	MAG1	MAG2
Nu 1 CrB	CrB	65257	16224+3348	STFA 29	AB	1835	2011	38	164	354.70	5.39	5.58
	CrB		16224+3348	H N 81	AC	1879	2002	7	241	68.10	5.39	12.62
	CrB		16224+3348	STFA 29	AD	1913	2002	5	153	277.10	5.39	11.53
nu 2 CrB	CrB	65259	16224+3348	H 6 18	BE	1879	2002	9	16	100	5.58	11.53

Table 1. Comparison of Nu CrB Data, June 2013 and June 2014

program found the same astrometry and photometry for AD and AE.”

That cleared up the final bit of confusion in the database for Nu Coronae Borealis, conclusively removing one of the 5 stars that had been attributed to this system for nearly 100 years.

Acknowledgements

Many thanks to Brian Mason and especially to Bill Hartkopf, who was so quick to reply, to the many questions we directed to them. This paper couldn't have been written without the information they both so readily provided.

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- Hartkopf, William., Mason, Brian., 2013 and 2013, *Washington Double Star Catalog*, <http://ad.usno.navy.mil/wds/>
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- Nanson, John., 2013, “A Pair of Nu Ones: Nu-1 and Nu -2 in Boötes and Corona Borealis”, *Bestdoubles.wordpress.com*: <http://wp.me/pVYAT-1ss>

Web Sites

Aladin Interactive Sky Atlas: <http://aladin.u-strasbg.fr/aladin.gml>

AutoCad: <http://www.autodesk.com/>

Double Star Imaging Project: https://groups.yahoo.com/neo/groups/double_star_imaging/info

SAO/NASA Astrophysics Data System: <http://articles.adsabs.harvard.edu/>

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

Stelladoppie WDS Interface: <http://stelledoppie.goaction.it/index2.php?section=1>

Vizier: <http://vizier.u-strasbg.fr/viz-bin/VizieR>