

Photometry and Measurement of Faint and Wide Doubles in Eridanus

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Abstract: Images of several double stars in Eridanus published on the “Double Star Imaging Project” Yahoo Group page suggest magnitude issues compared with the corresponding WDS catalog data per 2014.12. Taking additional images with V-filter enabled photometry for these pairs with confirming results.

Introduction

Evaluating “Double Star Imaging Project” images made in Eridanus, we found several double star systems displaying, primarily, stellar magnitudes that were noticeably different from what one would expect based on the data listed in the WDS catalog. First conclusions were the following:

- HJ342 AC – WDS 04233-0500. Listed magnitudes of 7.76 & 12. Image by Stephen McGaughey & John Pye shows “C” to be much fainter than +12 magnitude. UCAC4 lists +13.279 mag model fit for C, no Vmag.
- HJ 2187 AB – WDS 03233-1121. Listed magnitudes of 7.7 & 10.4. Image by Chris Thuemen suggests quite strongly that the secondary is considerably dimmer than the listed magnitude. UCAC4 lists +12.216 Vmag for B and +8.842 Vmag for A, indicating that “A” is also fainter than the WDS data.
- JC 1 AF – WDS 03195-2145. Listed magnitudes of 3.91 & 12.33. Image by Chris Thuemen suggests that “F” is brighter than the listed magnitude. UCAC4 lists “F” with +11.809 Vmag.
- ARA 1976 AB – WDS 03351-2309. Listed magnitudes of 9.33 & 10.6. Image by Chris Thuemen

suggests the secondary is noticeably dimmer. UCAC4 lists “B” with a +11.310 mag model fit, no Vmag and “A” with +9.534 Vmag, suggesting that “A” might be a tad fainter than the value listed in the WDS.

- BU 401 AC – WDS 03503-0131. Listed magnitudes of 9.33 & 10.6. Image by Chris Thuemen strongly suggests that “C” is a good deal dimmer than the WDS data. UCAC4 lists C with +12.838 Vmag.
- HJ 668 AB,C – WDS 03509-0010. Listed magnitudes of 8.49 & 10.9. Image by Chris Thuemen tells a very different story from the WDS data and UCAC4 lists “C” with 12.290 mag model fit, no Vmag.
- Struve 463 AB – WDS 03516+0020. Listed magnitudes of 9.3 & 12.1. Image by Chris Thuemen suggests the companion to be much brighter than the WDS records. UCAC4 lists “B” with +11.188 mag model fit, no Vmag.

Links to the images referred to above can be found in Table 4 at the end of this article. A summary of WDS 2014.12 data is given in Table 1.

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Table 1: WDS 2014.12 values for the object

Name	WDS ID	RA	Dec	Sep	PA	M1	M2
HJ 342 AC	WDS04233-0500	04:23:15.010	-05:00:20.301	23.0	80	7.76	12.0
HJ 2187 AB	WDS03233-1121	03:23:16.060	-11:20:49.499	62.9	241	7.70	10.4
JC 1 AF	WDS03195-2145	03:19:30.970	-21:45:28.297	163.5	236	3.91	12.3
ARA1976 AB	WDS03351-2309	03:35:03.350	-23:09:17.302	7.8	297	9.33	10.6
BU 401 AC	WDS03503-0131	03:50:16.100	-01:31:21.500	42.4	288	6.54	11.2
HJ 668 AB,C	WDS03509-0010	03:50:52.240	-00:09:54.200	21.7	299	8.49	10.9
HJ 3644 AB,C	WDS04215-2544	04:21:31.290	-25:43:42.402	40.7	1	6.15	12.0
STF 463 AB	WDS03516+0020	03:51:34.520	+00:20:07.400	10.0	188	9.30	12.1

Further Research

To investigate further our initial findings, we concluded that the best approach would be to obtain new images suitable for photometry. These images were taken with an online 510mm f/6.8 CDK telescope having a resolution of 1.1 seconds per pixel and equipped with a V-filter, located in Siding Spring, Australia. Photometry was completed on several additional UCAC4 listed stars within the field of the double star system for the purpose of comparing and checking the new magnitude values against those listed in the UCAC4 catalog. In addition, and by using the formula provided by R. Buchheim (2008), new separation and position angles were calculated for all systems based on the UCAC4 values which are assumed to be the

most precise available coordinates. The new values are included in Table 2 below.

Additional Results for JC1

It would also have been of interest to check the magnitude of JC1 B because the +9.5 value given in the WDS catalog suggests, due to single digit precision, no precise measurement. Unfortunately, the glare of the primary did not allow the resolution of the "B" companion. The radius of the star disk of the primary was, in spite of exposures of less than 1 second, larger than the A to B separation. On the very positive side of this effort was the serendipitous discovery that the "D" component of JC1 was in actual fact made up of two very similarly bright (dim) stellar components.

Table 2: Photometry and measurement results based on iTelescope images used with AAVSO VPhot

Name	WDS ID	RA	Dec	Sep	PA	M1	M2	Date	N	Notes
HJ 342 AC	04233-0500	04:23:15.032	-05:00:20.520	23.09	79.40	-	13.467	2015.120	4	1+2
HJ 2187 AB	03233-1121	03:23:16.127	-11:20:49.417	62.74	240.96	7.622	12.204	2015.120	5	1
JC 1 AF	03195-2145	03:19:31.001	-21:45:28.297	163.13	235.98	-	11.890	2015.125	5	1+2
ARA1976 AB	03351-2309	03:35:03.369	-23:09:17.350	7.52	294.31	9.285	11.421	2015.114	5	1
BU 401 AC	03503-0131	03:50:16.162	-01:31:21.252	45.86	284.92	-	12.904	2015.114	5	1+2+3
HJ 668 AB,C	03509-0010	03:50:52.246	-00:09:54.288	21.63	298.17	-	12.506	2015.123	4	1+2
HJ 3644 AB,C	04215-2544	04:21:31.319	-25:43:42.491	41.08	0.55	-	12.793	2015.123	5	1+2
STF 463 AB	03516+0020	03:51:34.506	+00:20:06.576	10.12	188.61	-	11.429	2015.120	5	1+2

1. Images for photometry taken with 1s exposure time with telescope iT31 CDK 510mm f/6.8 with 1.1 arcsec resolution per pixel and V-filter. Uploaded to AAVSO VPhot, plate solved and up to 5 images stacked. Separation and PA were calculated with the formula provided by R. Buchheim (2008) based on the UCAC4 values for RA and Dec.
2. No photometry done for M1 as WDS catalog value did not seem questionable.
3. Astrometry based on this image confirms, within the error range for a resolution of 1.1"/pixel, the new UCAC4 coordinates for "C" and therefore the new calculated Separation and PA. The WDS catalog data is quite different.

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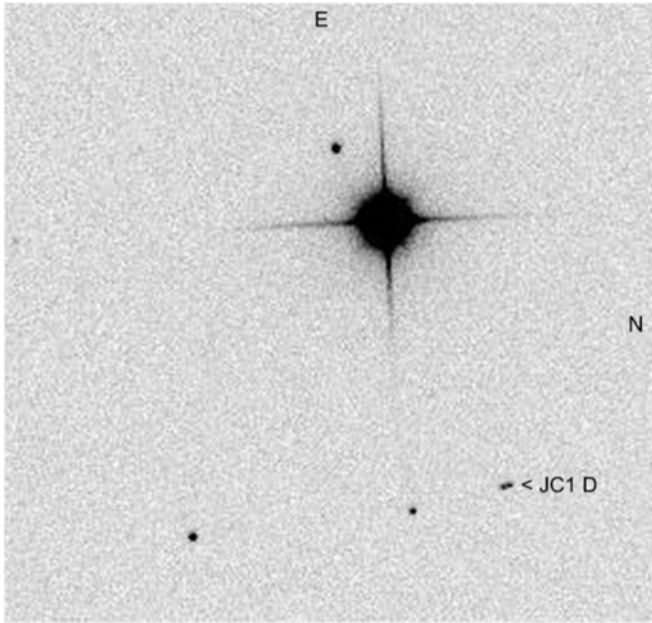


Figure 1. JC1 (cutting from image with luminance filter)

JC1 D is listed in the WDS catalog with a +12.48 magnitude suggesting a measurement of the combined magnitude. UCAC4 lists for JC1 D the object 342-003585 with corresponding +12.482 Vmag. Photometry with the identical setup as for Table 2 results in slightly fainter +12.605mag for D. Separate photometry for JC1 Da,Db based on another image (Figure 1) gives the values shown in Table 3.

The combined magnitude calculated with the formula according to Greaney 2012 results in +12.34 mag – this seems at odds with the above given values for the combined magnitude of JC1 D but photometry results for combined magnitude are obviously not this precise for objects with more than ~1" separation so we assume the magnitude given for JC1 D respectively UCAC4-342-003585, is wrong for this very reason.

Conclusions

First impressions were, with the exception regarding the A components of HJ 2187 and ARA 1976, completely confirmed by photometry. Photometry for JC 1 offered additional interesting results in terms of component D being itself a faint double. This example shows also that photometry for a combined magnitude of faint objects with approximately larger than 1" separation might result in questionable values.

Table 3: Measurements for JC1 Da,Db

Name	WDS ID	RA	Dec	Sep	PA	M1	M2	Date	N	Notes
JC1 Da,Db	03195-2145	03:19:22.534	-21:44:40.128	3.48	15.86	13.066	13.114	2015.123	10	1)

1) Stack of 10 images with 0.5s exposure time; same setup as for Table 2. RA and Dec coordinates taken from UCAC4-342-003585. Separation and PA estimated with the astrometry tool provided by "VPhot".

Table 4: Links to images and reports

Object	Link to image	Link to report
HJ 342 AC	www.sterngucker.eu/JDSO/Images/HJ342.jpg	www.sterngucker.eu/JDSO/Reports/HJ342.txt
HJ 2187 AB	www.sterngucker.eu/JDSO/Images/HJ2187.jpg	www.sterngucker.eu/JDSO/Reports/HJ2187.txt
JC 1 AF	www.sterngucker.eu/JDSO/Images/JC1.jpg	www.sterngucker.eu/JDSO/Reports/JC1.txt
ARA1976 AB	www.sterngucker.eu/JDSO/Images/ARA1976.jpg	www.sterngucker.eu/JDSO/Reports/ARA1976.txt
BU 401 AC	www.sterngucker.eu/JDSO/Images/BU401.jpg	www.sterngucker.eu/JDSO/Reports/BU401.txt
HJ 668 AB,C	www.sterngucker.eu/JDSO/Images/HJ668.jpg	www.sterngucker.eu/JDSO/Reports/HJ668.txt
HJ 3644 AB,C	www.sterngucker.eu/JDSO/Images/HJ3644.jpg	www.sterngucker.eu/JDSO/Reports/HJ3644.txt
STF 463 AB	www.sterngucker.eu/JDSO/Images/STF463.jpg	www.sterngucker.eu/JDSO/Reports/STF463.txt
JC 1 Da,Db	www.sterngucker.eu/JDSO/Images/JC1D.jpg	www.sterngucker.eu/JDSO/Reports/JC1D.txt

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References

- Buchheim, Robert , 2008, "CCD Double-Star Measurements at Altimira Observatory in 2007", *Journal of Double Star Observations*, **4**, 27-31.
- Greaney Michael, 2012, "Some Useful Formulae" in R.W. Argyle, *Observing and Measuring Visual Double Stars*, 2nd Ed., Chapter 25, Page 359.

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- Washington Double Star Catalog
- iTelescope
- AAVSO VPhot
- AAVSO APASS
- UCAC4 catalog via the University of Heidelberg website
- Aladin Sky Atlas CDS, SIMBAD, VizieR
- 2MASS All Sky Catalog
- AstroPlanner
- SAOImage DS9

