

Photometry of Faint and Wide Doubles in Vulpecula

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Abstract: Images of several double stars in Vulpecula published on the “Double Star Imaging Project” Yahoo Group page suggest magnitude issues compared with the corresponding WDS catalog data per April 2015. Taking additional images with V-filter enabled photometry for these pairs, providing confirming results.

Introduction

This paper identifies double star systems in Vulpecula that appear to have visual magnitudes that are in conflict with the data as published in the WDS. During the course of a long term project to image double stars accessible to backyard telescopes while employing a consistent imaging regime, from one location, the sheer volume of images has allowed the authors to identify with some certainty double star systems having component magnitudes that are clearly in conflict with the published data. After visually identifying these suspect systems, the authors consult the University of Strasburg’s website, VizieR, to access the online digital sky survey catalogues to confirm the visual observations. The preliminary findings are listed below:

- J 1303 - WDS mags. 9.8, 10.3. UCAC4 fmag 12.350 and 12.578; Vmag for “A” 12.086 but no value for “B”. J 1303 actually belongs to Sagitta and somehow slipped into this list but we decided to keep it here to make use of the already existing photometry result. The image clearly shows, with the benefit of 4 additional field stars, that the WDS data is suspect (see Figure 1)
- AG 247 – WDS mags. 9.02, 12 . UCAC4 provides fmag for A & B of 8.965 and 13.121 .Vmag for A only, 9.015. During our imaging run in Vulpecula, it became apparent, given the better seeing and transparency, our imaging setup was able to record

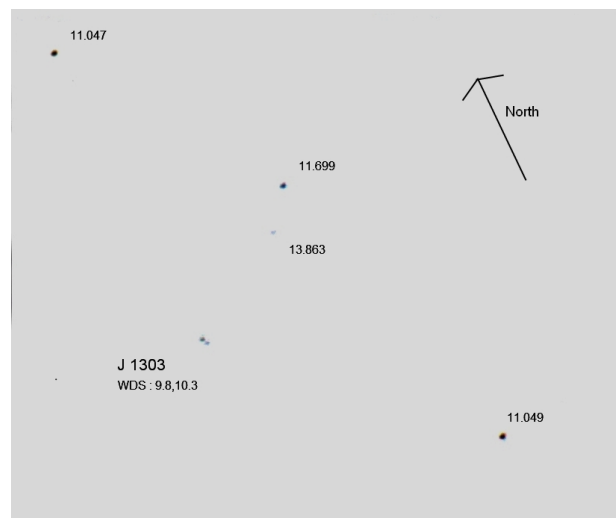


Figure 1: J 1303

deeper, at least an additional magnitude, to reach beyond 12.5. In spite of this, our image contained only the smallest hint of the companion. We estimate “B” to be approaching magnitude 13. See Figure 2.

- HJ 1504 – Chris Thuemen found what appeared to be clerical errors in the WDS data per April 2015 ...position angles or magnitudes had been interchanged...A for B and B for A, and sent Brian Ma-

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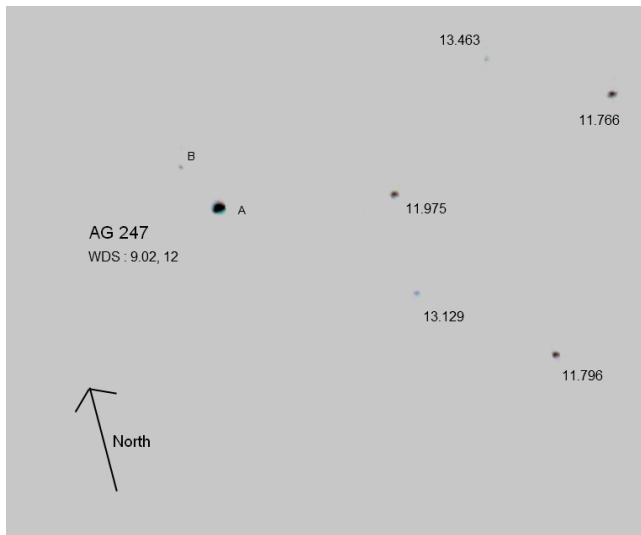


Figure 2. Image of AG 247

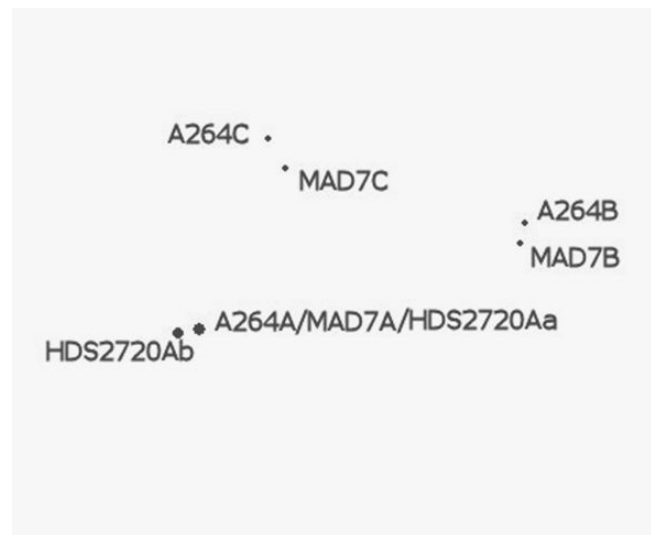


Figure 3. Star map of A 264 based on WDS coordinates.

son/USNO an email to confirm this in the latter part of August 2015. This led to a change in the WDS data accordingly, including changes in the estimated magnitudes for A, B, C to 7.1, 12.4, and 11.3.

- A 264AB – WDS mags. of 8.20 and 13.00. There is conflicting data in the UCAC4 and NOMAD1 surveys. The image clearly shows something at the approximate location of the “B” component which tells us it has to be brighter than mag 13 with an estimation around 12.0. A careful review of the WDS records indicates there is a second component, the “C” from MAD 7AC that is likely contributing to the unexpected brightness at the “B” component location. A 264 is actually a multiple with six components including HDS 2720 Aa,Ab indicating A to be a close double itself. MAD 7 contains two entries in the WDS, MAD 7AC and BC. A star map (see Figure 3) based on the WDS data shows inconsistent positions for B and C. Using the WDS given positions for A and B for calculating separation and position angle with the formulae provided by Buchheim 2008 we get 3.1” and 285° PA means somewhat off from the listed values and for this reason we included MAD7 in our list. Also the coordinates for HDS2720 are somewhat questionable – if A264A is a close double then HDS2720Aa cannot have identical coordinates.
- HO 445 with WDS M1 9.8 and M2 10.9. The image is suggesting that the companion is dimmer than the WDS data. We estimate a magnitude in the order of 11.5
- DAM 373 – was added to the list because it is in the same field of view as A 264 and WDS mags

with single digit precision suggested estimation instead of measurement. The WDS data indicates a DM of 2.2 but our image is suggesting the difference to be negligible.

- STF 2523CD a.k.a. KRU 8 – WDS mags of C and D are 7.10 & 14.20. The DSS2.F.POSSII image from Aladin very nicely shows the “D” component as a real bump on the southeast quadrant of the primary “C” component. This is consistent with our new image in that the “D” component is quite obvious and clearly separated from the primary. Component “D” is brighter than the mag. 12.804 (UCAC 4 # 556-091331) south southwest of the “C” star. We found no mag value for “D” from either UCAC4 or NOMAD1 data but we estimate the “D” component magnitude at ~11.9.

A summary of the WDS April 2015 data is given in Table 1.

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 610mm f/6.5 CDK telescope having a resolution of 0.625 arcseconds per pixel and equipped with a V-filter, located in Auberry, California. Initial plate solving and stacking of 5 images each was done with AAVSO VPhot and plate solving of the stacked image was then repeated with Astrometrica with UCAC4 as reference star catalog. Photometry was completed with Astrometrica based on all plate solving using reference star Vmags. Only reference stars with magnitude between 10.5 and 14.5 were used because of the higher precision in this magnitude range, thus results for stars significantly brighter are less reliable than

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Table 1: WDS 2015 April values for the objects *Further Research*

ID	Name			RA	Dec	Sep	PA	M1	M2
WDS19157+1654	J 1303	AB	Sge	19:15:42.819	+16:54:02.601	4.7	198	9.80	10.30
WDS20089+2520	AG 247	AB	Vul	20:08:54.732	+25:20:12.403	39.0	30	9.02	12.00
WDS20225+2618	HJ 1504	AC	Vul	20:22:32.589	+26:17:53.103	52.0	228	7.16	11.20
WDS19127+2435	A 264	AB	Vul	19:12:42.437	+24:34:36.299	3.2	288	8.20	13.00
WDS19127+2435	A 264	DE	Vul	19:12:44.250	+24:34:24.798	5.0	119	15.00	15.50
WDS19127+2435	A 264	AD	Vul	19:12:42.437	+24:34:36.299	27.3	115	8.23	15.00
WDS19127+2435	MAD 7	AC	Vul	19:12:42.437	+24:34:36.299	1.9	340	8.20	12.80
WDS19127+2435	MAD 7	BC	Vul	19:12:42.218	+24:34:37.103	2.3	72	13.00	12.80
WDS19124+2435	HO 445	AB	Vul	19:12:27.022	+24:35:29.102	5.4	243	9.80	10.90
WDS19126+2433	DAM 373	AB	Vul	19:12:38.270	+24:32:37.297	8.7	123	12.00	14.20
WDS19268+2110	STF 2523 KRU 8	CD	Vul	19:26:58.870	+21:06:22.997	10.5	138	7.10	14.20

Table 2: Photometry and measurement results based on *iTelescope iT24* images used with *AAVSO VPhot*

ID	Name		M1+	Err1	M2+	Err2	Date	Notes
WDS19157+1654	J 1303	AB	12.677	0.07	13.042	0.07	2015.762	
WDS20089+2520	AG 247	AB	9.987	0.06	12.942	0.06	2015.678	1
WDS20225+2618	HJ 1504	AB	6.981	0.08	12.304	0.08	2015.678	1
WDS20225+2618	HJ 1504	AC	6.981	0.08	11.218	0.08	2015.678	1
WDS19127+2435	A 264	AB	8.189	0.13	11.941	0.13	2015.678	1
WDS19127+2435	A 264	DE	15.021	0.22	15.423	0.30	2015.678	2
WDS19127+2435	A 264	AD	8.189	0.13	15.021	0.22	2015.678	3
WDS19127+2435	MAD 7	AC	8.189	0.13	-	-	2015.678	4
WDS19127+2435	MAD 7	BC	11.941	0.13	-	-	2015.678	5
WDS19124+2435	HO 445	AB	10.191	0.16	11.614	0.16	2015.678	1
WDS19126+2433	DAM 373	AB	13.918	0.15	14.480	0.17	2015.672	2
WDS19268+2110	STF2523 KRU 8	CD	6.402	0.17	12.818	0.18	2015.678	1

Notes:

1. A too bright for reliable photometry as the used UCAC4 reference stars were in the 12mag range
2. Very low SNR
3. A too bright for reliable photometry as the used UCAC4 reference stars were in the 12mag range. WDS mag for A not consistent (8.20 vs 8.23)
4. A too bright for reliable photometry as the used UCAC4 reference stars were in the 12mag range. No resolution for C, too close to the bright A component. Position C inconsistent from A and B
5. No resolution for C, too close to the bright A component. Position for MAD 7 B not consistent with A264 B

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Table 3: Summary of results compared to WDS per April 2015. With a few exception WDS data changes are suggested

ID	Name		Notes
WDS19157+1654	J 1303	AB	The components are about 3 mag fainter than listed but delta_m remained similar to Jonckheere's estimation
WDS20089+2520	AG 247	AB	B is about 1 mag fainter than listed
WDS20225+2618	HJ 1504	AB	As already mentioned in the introduction the mag data for B was changed meanwhile to 12.4 quite close to the new measurement result of 12.304
WDS20225+2618	HJ 1504	AC	As already mentioned in the introduction the mag data for C was changed meanwhile to 11.3 quite close to the new measurement result of 11.218
WDS19127+2435	A 264	AB	B as suspected is more than 1 mag. brighter than listed. Astrometry results based on Astrometrica: 19:12:42.517/+ 24:34:36.22 for A and 19:12:42.284/+ 24:34:37.18 for B with average error 0.15/0.13 giving 3.320" +/-0.198 separation and 286.806° +/-3.421 PA rather confirm the current WDS Sep/PA data within the given error range. Latest GAIA measurements with 19:12:42.448/+ 24:34:36.318 for A and 19:12:42.231/+ 24:34:37.117 for B would give 3.066" separation and 285.123° PA
WDS19127+2435	A 264	DE	WDS mag for E 15.5 quite confirmed with 15.423
WDS19127+2435	A 264	AD	WDS mag for D 15 quite confirmed with 15.041
WDS19127+2435	MAD 7	AC	Position C could not be verified - A too bright and C too close to be separated
WDS19127+2435	MAD 7	BC	Position for B measured with RA 19:12:42.284 with an average error of 0.15 and Dec +24:34:37.18 with an average error of 0.13. With the given error range of our tools we cannot decide if the A 264 or the MAD 7 data should be corrected, it is only clear that the current data does not match. Probably it would be best to accept the latest precise measurements from GAIA
WDS19124+2435	HO 445	AB	Both components fainter than listed, especially B
WDS19126+2433	DAM 373	AB	Both components fainter than listed, especially A
WDS19268+2110	KRU 8	CD	D is about 1.5mag brighter than WDS listed

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the results for star in the indicated magnitude range. The new values are included in Table 2. M+ is new measurement, Err is the error estimation calculated as

$$Err = \sqrt{dV_{mag}^2 + (2.5 \log_{10}(1 + 1/SNR))^2}$$

where SNR = Signal to noise ratio, dVmag = average Vmag error over all used reference stars (SNR and dVmag not listed due to space restrictions). Number of observations is 5 for all objects. Date given is the Bessel epoch of the observation.

Summary

With few exceptions the photometry results confirmed the image based first impressions at least to some degree. In the Table 3 we give a summary per object.

References

Buchheim, Robert – 2008, CCD Double-Star Measurements at Altimira Observatory in 2007, Journal of Double Star Observations, Vol. 4 No. 1 Page 28

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