Another Kind of Data Mining - Looking for Anomalies

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Abstract: Comparing the data of different star catalogs with the WDS catalog data is a highly suitable method to find WDS entries that need to be further checked. This approach is similar to the WDS Neglected Doubles lists but it also adds the magnitude discrepancies between the WDS and the other catalogs.

Report

It should be noted that the WDS is a compilation of previously published lists, quite often with estimated visual magnitudes. Errors in these older lists are carried over into the WDS, if not meanwhile corrected by recent precise measurements. This explains why less often observed WDS entries are sometimes listed with magnitudes quite different from those given in other catalogs.

A data mining study by Tom Bryant (2017, previous article) using software written by himself for comparison of the data of different star catalogs with the content of the WDS catalog (see his website http://mainsequence.org/html/wds/magnitudeStudy/MagnitudeAnomalies.html) selected objects with an assumed magnitude discrepancy larger than 1 mag. That this approach delivered a list of several thousand entries with suspect data is not very surprising. The study also lists ~60 stars not found in other catalogs. This study alone does not help much to make the WDS catalog a better one - but it can be used for selecting objects in need of measurement similar to the WDS Neglected Doubles lists but with additional data about the magnitude discrepancies.

This report takes a randomly selected sample of objects from Bryant's list that were close to the meridian at the date of this research with separation and magnitudes suitable for resolution with remote telescopes iT18 and iT27 (see specifications in the acknowledgements).

The current (beginning of 2016) WDS catalog data for these objects is listed in Table 1.

The measurement results are given in Table 2. The Notes column provides additional information, especially the comparison of the measurement results with the current WDS catalog data. Abbreviations in the

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Table 1: WDS catalog values per beginning of 2016 for the selected objects intended for measurement

WDS ID	Name		RA	Dec	Sep	Mv A	Mv B	PA	Con
10191+3620	ES 2566	AB	10:19:12.20	+36:19:49.9	4.1	11.00	11.10	218	LMi
10457+3209	MLB 845	AB	10:45:40.24	+32:09:46.6	3.4	10.50	11.00	359	LMi
10566+2714	SLE 887	AB	10:56:37.94	+27:13:42.7	15.2	11.20	12.40	342	LMi
10513-5431	BRT2055	AB	10:51:21.30	-54:29:24.7	3.3	10.63	10.60	153	Vel
10346-5607	BRT2564	AB	10:34:41.66	-56:05:54.7	3.5	11.70	12.30	236	Vel
10158-5225	CPO 286	AB	10:15:48.78	-52:24:48.2	7.3	10.50	12.00	318	Vel
10560-4445	DON1092	AB	10:56:02.09	-44:45:16.6	3.5	11.00	12.80	82	Vel
10570-5545	BRT2572	AB	10:57:02.44	-55:44:55.0	4.3	10.50	11.00	259	Vel
08416-4615	DON1074	AB	08:41:33.28	-46:15:47.8	3.3	11.00	13.00	332	Vel

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Table 2: Photometry and astrometry results for the selected objects

		RA	Dec	dRA	dDec	Sep	Err Sep	PA	Err PA	Mag	Err Mag	SNR	dVmag	Date	N	Notes
ES 2566	A	10 19 12.182	36 19 49.49	0.16	0.12	4.006	0.200	219.304	2.858	13.151	0.083	15.95	0.05	2016.20	2	iT18 stack 2x3s. SNR A and B <20. Measurement confirms WDS Sep and PA but both listed WDS Mags are far too bright
	B	10 19 11.972	36 19 46.39							13.115	0.085	15.40				
MLB 845	A	10 45 40.193	32 09 44.85	0.17	0.24	3.522	0.294	358.14	4.774	13.332	0.135	13.28	0.11	2016.20	2	iT18 stack 2x3s. SNR A <20 and B <10. Measurement confirms WDS Sep and PA but both listed WDS Mags are far too bright
	B	10 45 40.184	32 09 48.37							14.578	0.231	4.86				
SLE 887	A	10 56 37.946	27 13 43.26	0.20	0.18	14.553	0.269	340.401	1.059	12.750	0.123	19.14	0.11	2016.20	2	iT18 stack 2x3s. SNR A <20 and B <10. Measurement confirms WDS Sep and PA but both listed WDS Mags are far too bright
	B	10 56 37.580	27 13 56.97							14.042	0.159	8.95				
BRT2055	A	10 51 21.297	-54 29 24.81	0.11	0.11	3.061	0.156	156.162	2.909	12.664	0.083	53.04	0.08	2016.26	2	iT27 stack 2x3s. WDS Sep and PA slightly different but within or at least near the calculated error range. Both WDS Mags far too bright
	B	10 51 21.439	-54 29 27.61							13.395	0.088	28.52				
BRT2564	A	10 34 41.629	-56 06 54.81	0.12	0.12	3.718	0.170	235.419	2.614	12.021	0.102	58.55	0.10	2016.26	2	iT27 stack 2x3s. WDS Sep and PA within the calculated error range. Both WDS Mags ~0.3 too bright
	B	10 34 41.263	-56 06 56.92							12.592	0.103	46.26				
CPO 286	A	10 15 48.752	-52 24 47.87	0.11	0.11	7.444	0.156	318.323	1.197	12.092	0.091	70.40	0.09	2016.26	2	iT27 stack 2x3s. WDS Sep and PA within the calculated error range. Both WDS Mags far too bright
	B	10 15 48.211	-52 24 42.31							13.073	0.093	42.63				
DON1092	A	10 56 02.083	-44 45 16.62	0.10	0.10	3.465	0.141	81.870	2.337	12.781	0.073	56.92	0.07	2016.26	2	iT27 stack 2x3s. WDS Sep and PA very close to the measurement results. Both WDS Mags far too bright
	B	10 56 02.405	-44 45 16.13							13.570	0.075	38.41				
BRT2572	A	10 57 02.446	-55 44 54.89	0.08	0.08	4.394	0.113	260.304	1.475	11.498	0.081	71.11	0.08	2016.26	2	iT27 stack 2x3s. WDS Sep and PA very close to the measurement results. Both WDS Mags far too bright
	B	10 57 01.933	-55 44 55.63							12.246	0.084	42.18				
DON1074	A	08 41 33.293	-46 15 47.69	0.09	0.10	3.656	0.135	331.727	2.107	11.708	0.081	73.07	0.08	2016.27	2	iT27 stack 2x3s. WDS Sep somewhat outside error range but PA very close to the measurement result. Both WDS Mags a bit too bright but delta is less than 1 mag
	B	08 41 33.126	-46 15 44.47							13.494	0.094	21.74				

table headings are as follows:

- **RA, Dec:** J2000 coordinates based on 4th-order fit plate solving with URAT1 (for LMi) and UCAC4 (for Vel) reference stars in the 10.5 to 14.5Vmag range
- **dRA, dDec:** Average RA and Dec plate solving errors provided by Astrometrica software
- **Sep:** Separation in arc seconds calculated from the RA/Dec coordinates using the formula provided by R. Buchheim (2008)
- **Err Sep:** Separation error range estimation in arc seconds calculated from the average plate solving errors as $\sqrt{dRA^2 + dDec^2}$.
- **PA:** Position angle in degrees calculated from the RA/Dec coordinates using the formula provided by R. Buchheim (2008)
- **Err PA:** PA error range estimation in degrees calculated as arctan(*Err_Sep*/*Sep*) assuming the worst case that *Err_Sep* points in the right angle to the direction of the separation means perpendicular to the separation vector
- **Mag:** Visual magnitudes, as photometry result provided by the Astrometrica software
- **SNR:** Signal to noise ratio for a given star
- **dVmag:** The average Vmag error over all used URAT1/UCAC4 reference stars
- **Err Mag:** Magnitude error range estimation calculated using
- **Date:** The Bessel epoch of the observations
- **N:** The number of observations

$$dmag = \sqrt{dVmag^2 + \left[2.5\log_{10}\left(1 + \frac{1}{SNR}\right)\right]^2}$$

Summary

The measurement results of the randomly selected objects confirm Bryant's study. While the measured Sep and PA values correspond in most cases with the current WDS catalog data rather well, the measured magnitudes were in most cases more than 1 magnitude fainter than WDS listed. A quick check of other catalogs like APASS and UCAC4 show that the methods used in this study are consistent. However, these catalogs do mostly not offer sufficient data usable for correcting the WDS catalog, only in case of SLE887 APASS offers Vmags for both components with values near the measurement results.

Acknowledgements

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- Washington Double Star Catalog as data source for the selected objects
- iTelescope: Images were taken with
- iT27: 700mm CDK with 4531mm focal length. CCD: FLI PL09000. Resolution 0.53 arcsec/pixel. V-filter. Located in Siding Spring, Australia. Elevation 1122m
- iT18: 318mm CDK with 2541mm focal length. CCD: SBIG-STXL-6303E. Resolution 0.73 arcsec/pixel. V-filter. Located in Nerpio, Spain. Elevation 1650m
- AAVSO VPhot for initial plate solving and stacking
- AAVSO APASS providing Vmags
- UCAC4 catalog (online via the University of Heidelberg website and Vizier and locally from USNO DVD) for counterchecks
- UCAC4 and URAT1 catalog for high precision plate solving
- MaxIm DL6.12 for countercheck plate solving with UCAC4
- Aladin Sky Atlas v8.0 for counterchecks
- SIMBAD, VizieR for counterchecks
- 2MASS All Sky Survey Images for counterchecks
- AstroPlanner v2.2 for object selection, session planning and for catalog based counterchecks
- Astrometrica v4.9.1.420 for plate solving with UCAC4 and URAT1 astrometry and photometry measurements

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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.

Bryant, Tom, 2017, "Magnitude Anomalies in the WDS", *Journal of Double Star Observations*, **13**, 2-8.