Eps Lyr – Visual Observation and Measurements

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Abstract: The famous double-double star object Epsilon Lyrae includes also some lesser known faint components. Visual observation results made the current WDS data on these faint components somewhat questionable. A follow up with photometry and astrometry delivered recent precise measurements confirming the need for an update.

Introduction

The "Spirit of 33" project refers to ε Lyrae for checking the seeing (http://www.carbonar.es/s33/rating-seeing.htm) at the start of an observing session and I do this quite often in late summer/early autumn when Lyra is up for me.

When I got the opportunity to use a classic 300mm Clark refractor some time ago I looked for the first time not only for the ease of splitting both doubles Eps1 Lyr and Eps2 Lyr but intentionally also for the faint stars in between these two doubles. Besides the obvious ~10 mag "triangle star" there are several fainter stars potentially also of good use for estimating the current telescope magnitude limit. But on this and especially on later occasions I had the impression that these stars might be fainter than currently listed.

The WDS catalog lists in total five different discoverer designations for the different components (STFA37, STF2382 and STF2383, SHJ277 and CHR77) of Eps Lyr and besides suspect magnitudes there seem to be also some small errors in the astrometric data as the resulting positions do not exactly match as the map of the Eps Lyr, components based on the WDS parameters shows in Figure 1. The WDS data for April 2015 is given in Table 1.

The map is based on the current WDS data and shows obviously different positions for the single components due to the inconsistent parameters given for the listed objects.

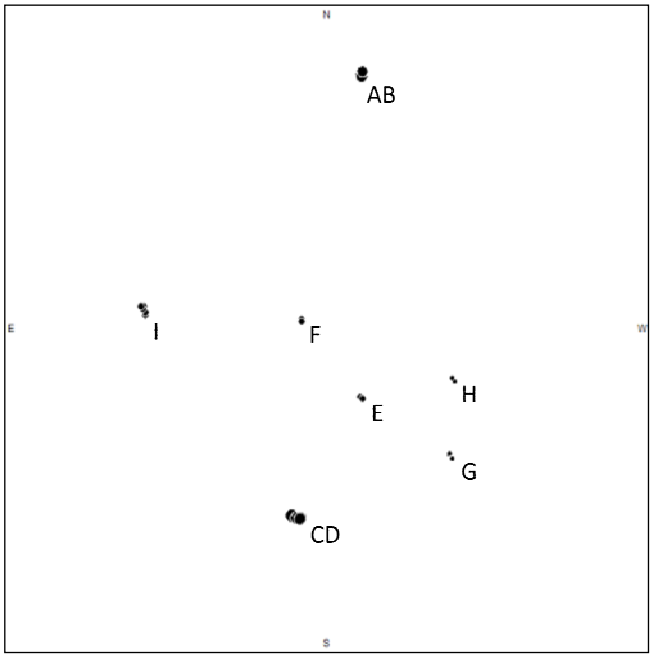

Figure 1. Map of ε Lyrae according to WDS data per April 2015.

Further Research

While separations and magnitudes for A, B, C (including Ca and Cb), and D make photometry and astrometry difficult to impossible with the usual V-filter, iTelescope imaging all of the other listed compo-

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Table 1. WDS values per April 2015 for the ε Lyrae components

Name	Comp	WDS ID	RA	Dec	Sep	M1	M2	PA
STF2382	AB	WDS18443+3940	18:44:20.339	+39:40:12.405	2.3	5.15	6.10	344
STF2383	CE	WDS18443+3940	18:44:22.777	+39:36:45.794	63.1	5.25	11.71	333
STF2383	CD	WDS18443+3940	18:44:22.777	+39:36:45.794	2.5	5.25	5.38	79
STFA 37	BI	WDS18443+3940	18:44:20.298	+39:40:14.397	149.6	6.10	10.43	137
STFA 37	AB,CD	WDS18443+3940	18:44:20.339	+39:40:12.405	207.9	4.67	4.56	171
STFA 37	BD	WDS18443+3940	18:44:20.298	+39:40:14.397	210.0	6.10	5.38	172
STFA 37	AD	WDS18443+3940	18:44:20.339	+39:40:12.405	208.6	5.15	5.38	172
STFA 37	AI	WDS18443+3940	18:44:20.339	+39:40:12.405	150.2	5.15	10.43	138
STFA 37	BC	WDS18443+3940	18:44:20.298	+39:40:14.397	210.9	6.10	5.25	172
SHJ 277	EF	WDS18443+3940	18:44:20.408	+39:37:42.799	45.4	11.71	11.20	37
SHJ 277	EG	WDS18443+3940	18:44:20.408	+39:37:42.799	49.3	11.71	13.83	237
SHJ 277	GH	WDS18443+3940	18:44:16.817	+39:37:16.501	35.1	13.83	13.22	358
SHJ 277	CD,F	WDS18443+3940	18:44:22.777	+39:36:45.794	92.2	4.56	11.20	0
SHJ 277	CD,G	WDS18443+3940	18:44:22.777	+39:36:45.794	75.6	4.56	13.83	292
SHJ 277	CD,H	WDS18443+3940	18:44:22.777	+39:36:45.794	95.8	4.56	13.22	312
CHR 77	Ca,Cb	WDS18443+3940	18:44:22.777	+39:36:45.794	0.1	5.25	30.00	225

nents can be very well covered. We can also assume that the components A, B, C, and D are very well measured and that the given data for them can be accepted without second thoughts. As the basis for photometry and astrometry, I took 10 images with iT24 (610mm CDK with 3962mm focal length. CCD: FLI-PL09000. Resolution 0.62 arcsec/pixel. V-filter. No transformation coefficients available. The telescope is located in Auberry, California. Elevation 1405m) with 3 seconds exposure time each, plate solved and stacked them with AAVSO VPhot. This resulted in the image shown in Figure 2.

The image in Figure 2 was again plate solved with Astrometrica using UCAC4 as reference catalog (only stars from 10.5 to 14.5Vmag were used) and then photometry and astrometry was done by the comfortable point and click procedure available in Astrometrica, giving not only Vmag and RA/Dec measurements but also error estimation relevant values dVmag as average Vmag error as well as dRA/dDec as the average RA/Dec errors in arcseconds over all used reference stars plus SNR for all objects. The resulting measurement values based on these 10 observations per Bessel epoch 2015.754 with dVmag = 0.07, dRA = 0.14, and dDec = 0.12 are shown in Table 2 with direct comparison with the corresponding UCAC4 objects (with model fit fmag given if no Vmag available).

The comparison with UCAC4 shows quite similar results with the exception of the Dec coordinate for component G with a difference of about 1 arcsecond – but counter checking again with URAT1 gives here Dec with +39 37 15.168, confirming once more the validity of the measurement results. This also makes clear that it makes sense to consult URAT1 for most precise recent measurements if available for the objects in question.

Figure 2. iT24 stack 10x3s image of Eps Lyr (cut of the center)

Using the measurement results for a potential data update for the Eps Lyr WDS objects, we get the results shown in Table 3 in bold type using the formula provided by R. Buchheim (2008) for calculating Sep and PA

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Table 2: Photometry results for the selected Eps Lyr components. "Vmag" means photometry result with V-filter and "SNR" stands for Signal to Noise Ratio. The corresponding UCAC4 values are given for comparison. "fmag" stands for model fit magnitude (calculated from K- and J-band magnitudes) and is given in case of missing Vmag. Average dVmag is 0.07, average dRA is 0.14, and average dDec is 0.12

ε Lyr	RA	Dec	Vmag	SNR	UCAC4	RA	Dec	Vmag fmag
E	**18 44 20.396**	**+39 37 42.74**	**12.252**	**72.62**	649-062698	18 44 20.415	+39 37 42.785	11.965
F	**18 44 22.777**	**+39 38 19.07**	**12.728**	**55.53**	649-062707	18 44 22.791	+39 38 19.068	12.676
G	**18 44 16.796**	**+39 37 15.07**	**14.176**	**26.48**	649-062690	18 44 16.824	+39 37 16.143	13.971
H	**18 44 16.712**	**+39 37 50.89**	**13.919**	**31.72**	649-062689	18 44 16.714	+39 37 50.984	13.535
I	**18 44 29.177**	**+39 38 23.19**	**10.183**	**184.26**	649-062722	18 44 29.176	+39 38 23.133	10.121

taking the WDS RA/Dec coordinates for A, B, C, and D as given.

Summary

The photometry results listed in Tables 2 and 3 are used to create the star map of ε Lyr with the measured Vmags for the faint components – now it is clear why E and F seem through the telescope much fainter than WDS indicates and why G and H are only to be seen with larger telescopes and very good seeing conditions. At the same time we have eliminated the obvious inconsistent Sep and PA data to give a reasonable star map, Figure 3, when using the parameters for the listed WDS objects.

References

Buchheim, Robert, 2008, "CCD Double-Star Measurements at Altimira Observatory in 2007", *Journal of Double Star Observations*, **4**, 27-31.

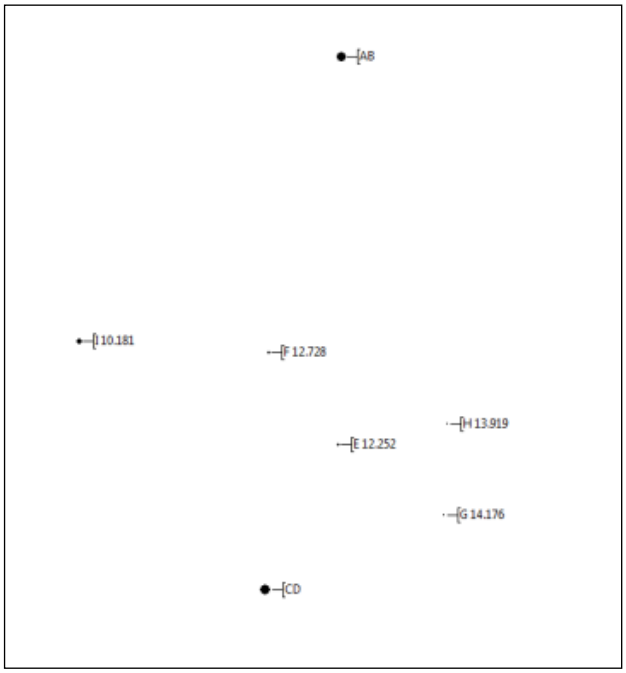

Figure 3. Map of ε Lyr with recent precise measured magnitudes.

*Table 3: Using the results from Table 2 gives suggested updates in bold type for the WDS objects in question. Sep is separation calculated as SQRT(((RA2-RA1)*cos(Dec1))^2+(Dec2-Dec1)^2) in radians. ErrSep is the error estimation for Sep calculated as SQRT(dRA^2+dDec^2). ErrM1/2 is the error estimation for Vmag results calculated as SQRT (dVmag^2+ErrSNR^2) with ErrSNR calculated as 2.5*Log10(1+1/SNR). PA is calculated as arctan((RA2-RA1)*cos (Dec1))/(Dec2-Dec1)) in radians and ErrPA is the error estimation for PA calculated as arctan(ErrSep/Sep) in degrees.*

Name	Comp	RA	Dec	Sep	ErrSep	M1	ErrM1	M2	ErrM2	PA	ErrPA
STF2382	CE	18:44:22.777	+39:36:45.794	63.244	0.184	6.10	-	**12.252**	0.072	334.212	0.167
STFA 37	BI	18:44:20.298	+39:40:14.397	**151.250**	0.184	6.10	-	**10.121**	0.070	**137.329**	0.070
STFA 37	AI	18:44:20.339	+39:40:12.405	**149.468**	0.184	5.15	-	**10.121**	0.070	**136.944**	0.071
SHJ 277	EF	**18:44:20.396**	**+39:37:42.740**	**45.569**	0.184	**12.252**	0.072	**12.728**	0.072	**37.131**	0.232
SHJ 277	EG	**18:44:20.396**	**+39:37:42.740**	**49.954**	0.184	**12.252**	0.072	**14.176**	0.081	**236.364**	0.211
SHJ 277	GH	**18:44:16.796**	**+39:37:15.070**	**35.833**	0.184	**14.176**	0.081	**13.919**	0.078	**358.448**	0.295
SHJ 277	CD,F	18:44:22.777	+39:36:45.794	**93.276**	0.184	4.56	-	**12.728**	0.072	0	0.113
SHJ 277	CD,G	18:44:22.777	+39:36:45.794	**75.059**	0.184	4.56	-	**14.176**	0.081	**292.957**	0.141
SHJ 277	CD,H	18:44:22.777	+39:36:45.794	**95.652**	0.184	4.56	-	**13.919**	0.078	**312.887**	0.110

Acknowledgements

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- Washington Double Star Catalog
- iTelescope
- AAVSO VPhot
- AAVSO APASS
- UCAC4 catalog via the University of Heidelberg website and directly from USNO DVD
- Aladin Sky Atlas v8.0
- SIMBAD, VizieR
- 2MASS All Sky Catalog
- URAT1 Survey
- AstroPlanner v2.2
- MaxIm DL6 v6.08
- Astrometrica v4.8.2.405