Change of period and improved elements of the eclipsing binary Fr234 Vul = UCAC3 230-248078

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Abstract: *Fr234 Vul = UCAC3 230-248078 was discovered by Peter Frank in the year 2009 and classified as EW eclipsing binary. The authors present a phased light curve, a list of primary and secondary minima, O-C diagrams and an improved period solution of the star. The star is listed as variable in the ATLAS data bases.*

Introduction

Fr234 Vul = UCAC3 230-248078 was discovered as a photometric variable by Peter Frank in the year 2009 and classified as eclipsing binary. From our measurements (Fig. 1) we derive a variability between 15.7 and 16.2 mag, with an amplitude of 0.5 mag (uncalibrated V)The variable is also listed in the ATLAS data bases [1].

During these studies, we furthermore discovered several period solutions for this star in an extensive datasheet prepared by the ATLAS project. Only one of these periods that we found by ATLAS is similar to ours. We have at our disposal 32 time series with approx. 4600 images that were taken between 2009 and 2020. The observation time per night was between 2 and 8 hours.

Since the minima derived from our data cannot be represented by the ATLAS period, we have used our data to present an improved period solution.

Periods known so far:

Simbad [2]	no information
ASAS-SN [3]	no information
ATLAS	0.412681 d
VSX [4]	no information

Observations

400mm ASA Astrograph f/3.7
f = 1471 mm
FLI Proline 16803 CCD-Camera
V-filter, t = 120 sec.
Wolfgang Moschner, Astrocamp/Nerpio,
Spain

102mm f/5.0 TeleVue Refractor
f = 509 mm
SIGMA 1603 CCD-Camera, Kodak
KAF1603ME, IR & UV cut-off filter
t = 90 sec.
Peter Frank, Velden, Germany

Data analysis

Muniwin [5] and self-written programs by Franz Agerer and Lienhard Pagel [6] were used for the analysis of the frames, after bias, dark and flatfield correction of the exposures. The weighted average of five comparison stars was used.

Explanations:

HJD = heliocentric UTC timings (JD) of the observed minima
mag = magnitude
The magnitudes of the comparison stars were taken from the UCAC3 catalogue (f.mag - UCAC fit model magnitude 579-642nm). Since our measurements were made with the V-filter, the mentioned magnitudes of the variable can also be described as uncalibrated V.

All coordinates are taken from the Gaia EDR3 catalogue [7].

The coordinates (epoch J2000) are calculated by VizieR, and are not part of the original data from Gaia (note that the calculated coordinates are calculated from the positions and the proper motions).

Fr234 Vul = UCAC3 230-248078
Cross-ID's
= UCAC3230-248078
= ATOID J308.2124+24.7882
= 2MASS 20325100+2447177
= Gaia EDR3 1831519362353835264

Right ascension: 20h32m51.0010s at epoch and equinox J2000
Declination: +24° 47' 17.691"   at epoch and equinox J2000
Barycentric right ascension (ICRS) at Epoch=2016.0:   308.212469681° +/- 0.03 mas
Barycentric declination (ICRS) at Epoch=2016.0:   24.788214606° +/- 0.02 mas

Gaia EDR3 Catalog:
15.859364 mag G-band mean magnitude (350-1000 nm)
16.246600 mag Integrated BP mean magnitude (330- 680 nm)
15.284734 mag Integrated RP mean magnitude (640-1000 nm)
 0.961865 mag BP-RP color

Results

With our observations obtained with the 400 mm ASA astrograph in Nerpio we have created a phased light curve. The presented elements were calculated by the method of least squares, taking into account all our minima (see table below) and assuming that the true phase of Min II is exactly 0.5. In the O-C diagram, you can see that a change in the period occurred around 2018. To calculate the new period, the data between the years 2018 to 2022 were used. The period has decreased by approx. 0.6 sec. A physical interpretation of the phenomenon cannot be made here.

Our ephemeris represents an improvement over the ATLAS period, since our minima are not represented by the latter.

The amplitude for Min I is given as 0.5 mag, 15.7-16.2 mag and for Min II as 0.5 mag, 15.7-16.2 mag.

Fr234 Vul = UCAC3 230-248078 (improved elements)

Amplitude: Min I: 0.5 mag   Min II: 0.5 mag
Type: EW type eclipsing binary

Min I =   HJD (UTC) 2459405.5005 + 0.4126725*E
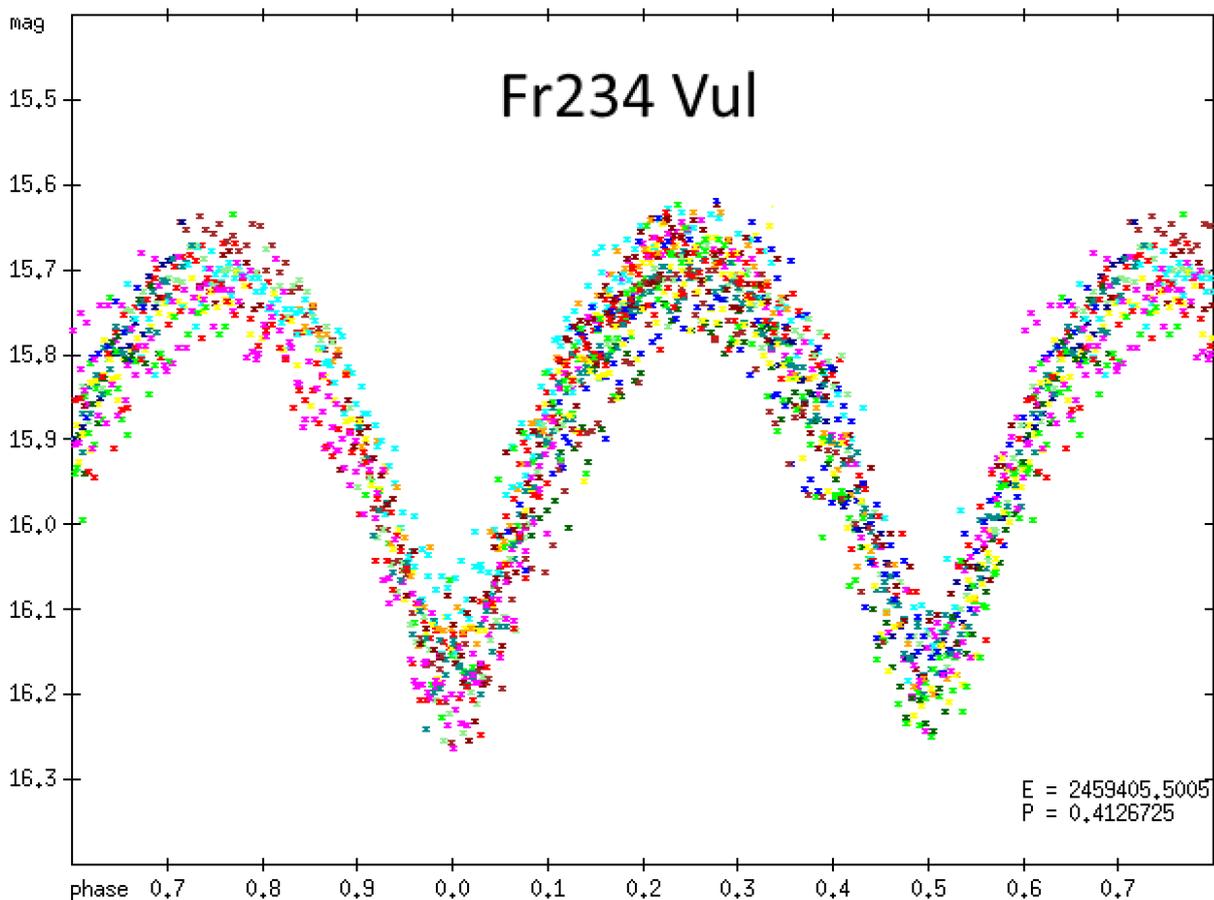   ±0.0012   ±0.0000003

Figure 1: Phased light curve of Fr234 Vul = UCAC3 230-248078 using the ephemeris given by the authors. The vertical axis shows uncalibrated V magnitudes. Different colors denote different observing nights. Only the data points from the better nights were used to display the light curve. A FLI Proline 16803 camera + V-filter (2019-2022) was used.

Observer	HJD-Date Minimum	Type	Epoch	O-C (d)
P. Frank	2455041.4416	I	-10575	-0.0472
P. Frank	2455063.5219	II	-10521.5	-0.0449
P. Frank	2455393.4395	I	-9722	-0.0590
P. Frank	2455473.2962	II	-9528.5	-0.0544
P. Frank	2455478.4587	I	-9516	-0.0502
P. Frank	2455830.4656	I	-8663	-0.0530
P. Frank	2456521.5060	II	-6988.5	-0.0328
P. Frank	2457627.4856	II	-4308.5	-0.0155
W. Moschner	2458313.5686	I	-2646	-0.0005
P. Frank	2458318.5148	I	-2634	-0.0063
W. Moschner	2458698.5912	I	-1713	-0.0013
W. Moschner	2458699.4170	I	-1711	-0.0009
W. Moschner	2458699.6240	II	-1710.5	-0.0002
W. Moschner	2458713.4470	I	-1677	-0.0017
W. Moschner	2458718.3976	I	-1665	-0.0032
W. Moschner	2458718.6028	II	-1664.5	-0.0043
W. Moschner	2458751.4140	I	-1585	-0.0006
W. Moschner	2459021.5103	II	-930.5	0.0015
W. Moschner	2459023.5719	II	-925.5	-0.0002
W. Moschner	2459056.3806	I	-846	0.0010
W. Moschner	2459056.5860	II	-845.5	0.0001
W. Moschner	2459068.5545	II	-816.5	0.0011
W. Moschner	2459074.5371	I	-802	0.0000
W. Moschner	2459089.3925	I	-766	-0.0009
W. Moschner	2459089.6028	II	-765.5	0.0031
W. Moschner	2459092.4899	II	-758.5	0.0015
W. Moschner	2459129.4230	I	-669	0.0004
W. Moschner	2459136.4388	I	-652	0.0008
W. Moschner	2459405.5023	I	0	0.0018
W. Moschner	2459408.5928	II	7.5	-0.0027
W. Moschner	2459472.3505	I	162	-0.0030
P. Frank	2459498.3525	I	225	0.0007
W. Moschner	2459760.6031	II	860.5	-0.0021
W. Moschner	2459797.5408	I	950	0.0014
W. Moschner	2459823.5373	I	1013	-0.0005

Table 1: Minima Fr234 Vul = UCAC3 230-248078, O-C using the ephemeris given by the authors. The O-C of the secondary minima were calculated assuming that the true phase is at exactly 0.5.

Figure 2: O-C-diagram for Fr234 Vul = UCAC3 230-248078 using the ephemeris given by the authors (period = 0.4126725 d)

Figure 3: O-C-diagram for Fr234 Vul = UCAC3 230-248078 using the period from the ATLAS project (0.412681 d).
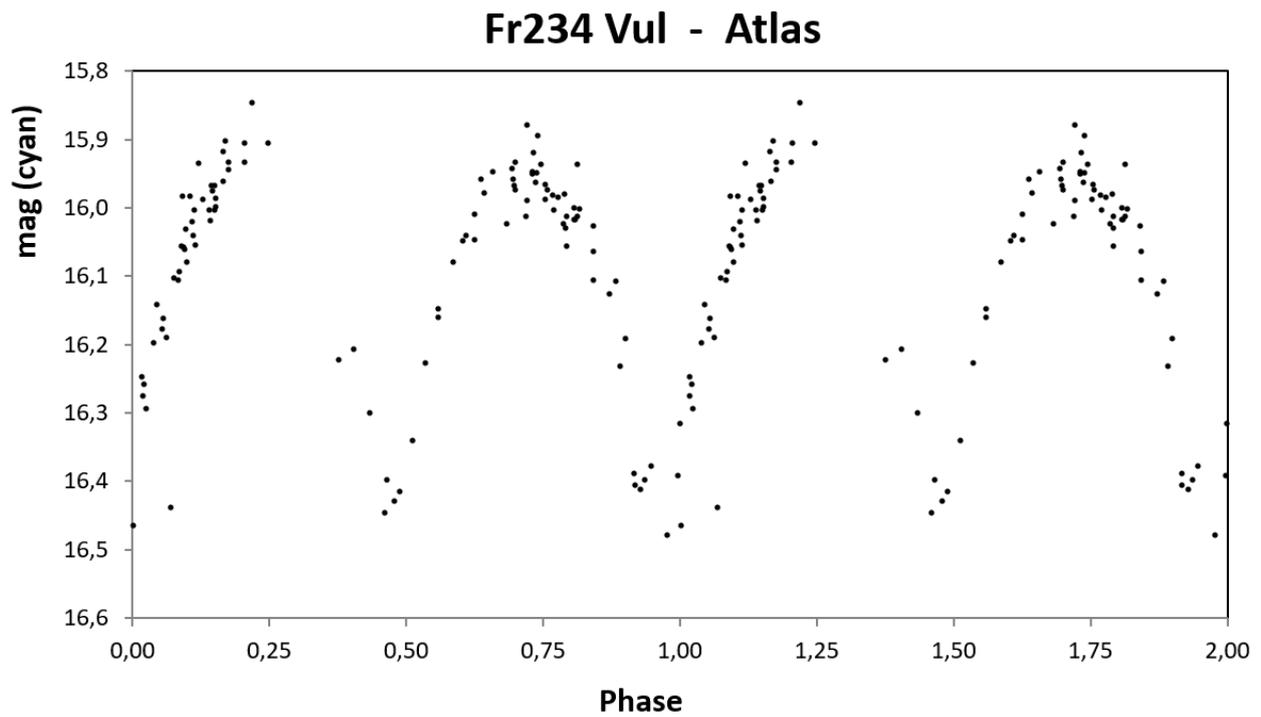
Fr234 Vul - Atlas

Figure 4: Phased light curve of Fr234 Vul = UCAC3 230-248078 using the ephemeris given by the authors (period = 0.4126725 d) and data from the ATLAS project (Cyan-Filter 420-650 nm).

For the phased light curve above, data from the period between JD 2457284 to 2457901 were used. This is before the time of the period change in which another period was still valid.
For this reason, the minimum I and the minimum II are not exactly in phase 1.00 or 0.5.

References

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https://ui.adsabs.harvard.edu/abs/2014ApJ...788...48S
Jayasinghe et al., 2019, MNRAS, 485, 961J
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http://simbad.cds.unistra.fr/simbad/sim-id?bibyear1=1850&bibyear2=%24currentYear&submit=Display&Ident=%4017527232&Name=ATO+J308.2124%2B24.7882&bibdisplay=refsum&bibyear1=1850&bibyear2=%24currentYear#lab_bib

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http://c-munipack.sourceforge.net

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