# The period of Fr233 Vul

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**Abstract:**  *Fr233 Vul was discovered by Peter Frank and classified as EW type eclipsing binary in 2009. Our observations between 2009 and 2021 show an inconstant period.*

## Observations

102mm f/5.0 TeleVue Refractor - f = 510 mm - SIGMA 1603 CCD-Camera - -I-U-filter - t = 90 sec.
Peter Frank, Velden, Germany
400 mm ASA Astrograph f/3.7 - f = 1471 mm, FLI Proline 16803 CCD-Camera - V-filter - t = 120 sec.
Wolfgang Moschner, Astrocamp/Nerpio, Spain

## Data analysis

Muniwin [1] and self-written programs by Franz Agerer and Lienhard Pagel [2] were used for the analysis of the frames, after bias, dark and flatfield correction of the exposures. The weighted average of 5 comparison stars was used.

**Explanations:**
HJD  =  heliocentric UTC timings (JD) of the observed minima

All coordinates are taken from the Gaia DR3 catalogue [3]. The coordinates (epoch J2000) are computed by VizieR, and are not part of the original data from Gaia (note that the computed coordinates are computed from the positions and the proper motions).

G-band mean magnitude                    = 350-1000 nm
Integrated BP mean magnitude             = 330- 680 nm
Integrated RP mean magnitude             = 640-1000 nm

# Fr233 Vul

Cross-ID's
**= UCAC3 230-246702**                        **= Gaia EDR3 1831602379784409728**
**= ATOID J307.8698+24.5357**                 **= ZTF J203128.75+243208.9**

Gaia EDR3 Catalog:
Right ascension: 20h31m28.7666s at Epoch=J2000
Declination: +30° 59' 13.848"          at Epoch=J2000
15.910480 mag  G-band mean magnitude
16.268885 mag  Integrated BP mean magnitude
15.331986 mag  Integrated RP mean magnitude
 0.936898  mag   BP-RP

**Periods known so far:**

| | |
|---|---|
| VSX (AAVSO) [4] | 0.4371630 d |
| ASAS-SN [5] | no information |
| ATLAS [6] | 0.4371670 d |
| ZTF g-Band [7] | 0.4371676 d |

## Results

Our observations over the entire period between 2009 and 2021 show an inconstant period. Our linear elements are to be used for the years 2009 to 2021. Whether these elements are valid also for the future can only be clarified by further observations. A physical interpretation of the phenomenon cannot be made here. The periods listed above are almost identical to our period. But only our time series obtained over the last 12 years has revealed that the period is not constant. Data from this star have also recently been processed by the ATLAS project [6] and the ZTF project [7].

## Fr233 Vul    linear elements

These linear elements are to be used for the years 2009 to 2021.

$$\text{Min.} = \text{HJD } 2458699.53250 + 0.4371666*E$$
$$\pm 0.00106 \quad \pm 0.0000003$$

| Observer | HJD-Date Minimum | Type | Epoch | O-C (d) |
|---|---|---|---|---|
| P.Frank | 2455039,5827 | I | -8372 | 0,0090 |
| P.Frank | 2455041,5506 | II | -8367,5 | 0,0096 |
| P.Frank | 2455063,4098 | II | -8317,5 | 0,0105 |
| P.Frank | 2455393,4648 | II | -7562,5 | 0,0047 |
| P.Frank | 2455473,4646 | II | -7379,5 | 0,0030 |
| P.Frank | 2455830,4038 | I | -6563 | -0,0043 |
| P.Frank | 2456521,5627 | I | -4982 | -0,0058 |
| P.Frank | 2457627,3721 | II | -2452,5 | -0,0093 |
| P.Frank | 2457627,5914 | I | -2452 | -0,0086 |
| W. Moschner | 2458313,5100 | I | -883 | -0,0044 |
| P.Frank | 2458318,5389 | II | -871,5 | -0,0029 |
| W. Moschner | 2458337,5539 | I | -828 | -0,0047 |
| W. Moschner | 2458698,6553 | I | -2 | -0,0029 |
| W. Moschner | 2458699,5289 | I | 0 | -0,0037 |
| W. Moschner | 2458713,5171 | I | 32 | -0,0047 |
| W. Moschner | 2458718,5446 | II | 43,5 | -0,0046 |
| W. Moschner | 2458751,3340 | II | 118,5 | -0,0028 |
| W. Moschner | 2459021,5049 | II | 736,5 | -0,0008 |
| W. Moschner | 2459056,4799 | II | 816,5 | 0,0009 |
| W. Moschner | 2459068,5009 | I | 844 | -0,0002 |
| W. Moschner | 2459074,4032 | II | 857,5 | 0,0004 |
| W. Moschner | 2459074,6205 | I | 858 | -0,0010 |
| W. Moschner | 2459089,4864 | I | 892 | 0,0013 |
| W. Moschner | 2459405,5602 | I | 1615 | 0,0037 |
| W. Moschner | 2459408,6199 | I | 1622 | 0,0031 |
| W. Moschner | 2459434,4133 | I | 1681 | 0,0037 |
| W. Moschner | 2459434,6350 | II | 1681,5 | 0,0068 |
| W. Moschner | 2459472,4490 | I | 1768 | 0,0059 |

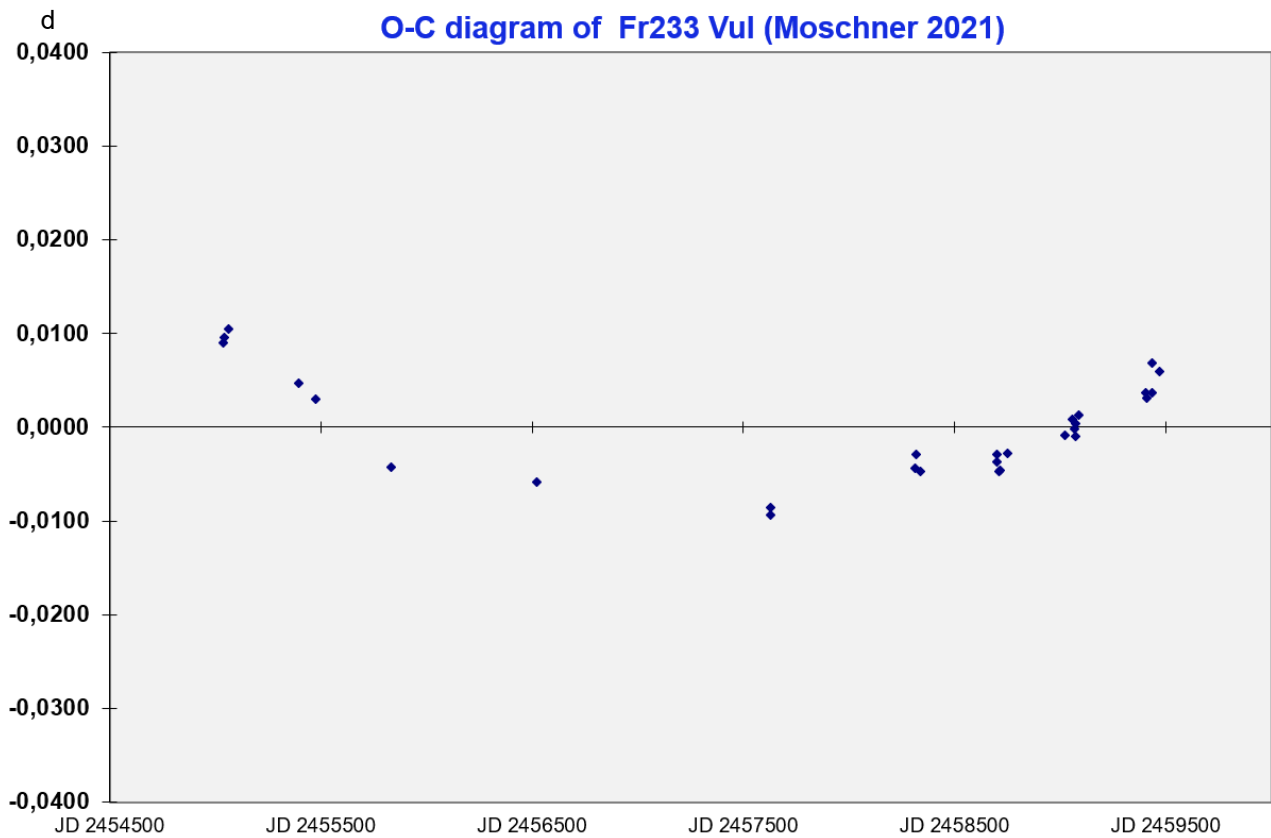Table 1: Minima from Fr233 Vul using the elements above (period 0.4371666 d).

Figure 1: O-C-diagram from Fr233 Vul using the elements above (period 0.4371666 d).
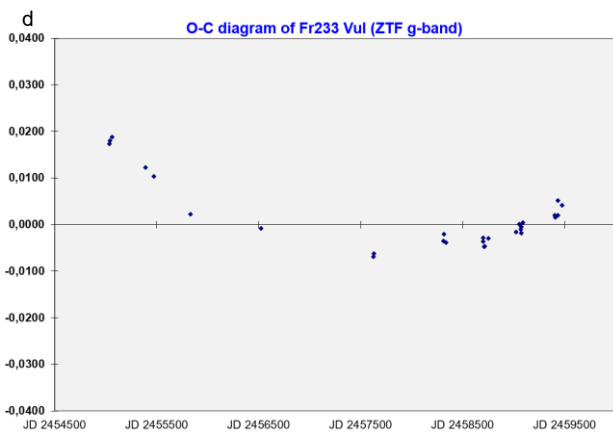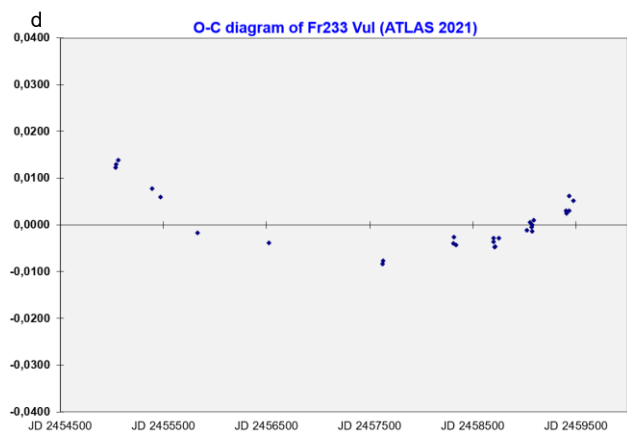


Figure 2



Figure 3

Figure 2: O-C-diagram from Fr233 Vul using the period from ZTF g-band (0.4371676 d).

Figure 3: O-C-diagram from Fr233 Vul using the period from ATLAS (0.437167 d).

References

[1] Motl, David: MuniWin
    http://c-munipack.sourceforge.net

[2] Pagel, Lienhard: Starcurve
    https://www.bav-astro.eu/index.php/weiterbildung/tutorials

[3] Gaia EDR3 (Gaia Collaboration. 2020)
    European Space Agency.
    http://vizier.u-strasbg.fr/viz-bin/VizieR?-source=I/350

[4] The International Variable Star Index
    https://www.aavso.org/vsx/index.php?view=search.top

[5] All-Sky Automated Survey for Supernovae ASAS-SN
    http://www.astronomy.ohio-state.edu/asassn/index.shtml
    Shappee et al., 2014, ApJ, 788, 48S
    https://ui.adsabs.harvard.edu/abs/2014ApJ...788...48S
    Jayasinghe et al., 2019, MNRAS, 485, 961J
    https://ui.adsabs.harvard.edu/abs/2019MNRAS.485..961J:

[6] A first catalog of variable stars measured by ATLAS (Heinze et al., 2018)
    http://vizier.u-strasbg.fr/cgi-bin/VizieR-3?-source=J/AJ/156/241/table4

[7] ZTF Zwicky TransientFacility, Systematic Exloration of the Dynamic Sky
    https://www.ztf.caltech.edu/