The period of V2991 Cyg = Fr237 Cyg

Moschner, Wolfgang - Lennestadt, Germany
email: wolfgang.moschner@gmx.de

Frank, Peter - Velden, Germany
email: frank.velden@t-online.de

Bernhard, Klaus - Linz, Austria
email: Klaus1967Bernhard@gmx.at

Bundesdeutsche Arbeitsgemeinschaft für Veränderliche Sterne e.V.

September 2023

Abstract: *V2991 Cyg = Fr237 Cyg was discovered by Peter Frank in 2012 and classified as an eclipsing binary. The authors present phased light curves from ASAS-SN [1] and ZTF [2], a list of primary and secondary minima, O-C diagrams and an improved period solution of the star.*

Observations

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
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 [3] and self-written programs by Franz Agerer and Lienhard Pagel [4] 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 EDR3 catalogue [5]. The coordinates (epoch J2000) are computed by VizieR, and are not part of the original data from the Gaia EDR3 catalogue (note that the computed coordinates are computed from the positions and the proper motions).

V2991 Cyg = Fr237 Cyg

Cross-IDs
= ASASSN-V J203004.49+503624.9   **= GSC 3581-00508**
= ATO J307.5186+50.6070   **= WISE J203004.4+503625**
= Gaia EDR3 2180260918563778432   **= ZTF J203004.47+503625.4**
= 2MASS J20300448+5036253

Gaia EDR3 catalogue:
Right ascension: 20h30m04.4913s at Epoch J2000
Declination: +50° 36' 25.515"   at Epoch J2000
13.5071 mag G-band mean magnitude (350-1000 nm)
13.7439 mag Integrated BP mean magnitude (330-680 nm)
13.1155 mag Integrated RP mean magnitude (640-1000 nm)
0.6284 mag BP-RP

Periods known so far:

Popov et. al. (VSX) [6]	1.04597 d
ASAS-SN [1]	1.0459678 d
ATLAS [7]	1.045965 d
WISE [8]	1.0459504 d
ZTF [2]	1.0458988 d

Results

After the discovery of the variable by Peter Frank in 2012, we systematically observed V2991 Cyg = Fr237 Cyg for a few years to check its period. The ASAS-SN database, the ATLAS database, the WISE database, the ZTF database and the VSX database also list the variable with different periods. The period registered in the VSX database is from Popov et. al. [6]. A possible O'Connell effect is reported there. There is no entry in the SIMBAD Astronomical database [9] yet. The presented elements were calculated by the method of least squares, taking into account all minima (see table below) and assuming that the true phase of Min. II is exactly 0.5. Our ephemeris represents an improvement over the VSX, ASAS-SN, WISE, ZTF and ATLAS periods. From the ASAS-SN data (Figure 1) we derive a variability approx. between 13.58 and 13.95 mag, with an amplitude for Min I of 0.37 mag and for Min II of 0.14 mag (uncalibrated V). Our observations do not show evidence for a period change during 2012 – 2023.

V2991 Cyg improved elements

Type = EA

Min. I = HJD 2458714.4526 + 1.0459745*E

±0.0006   ±0.0000005

Observer	HJD-Date Minimum	Type	Epoch	O-C (d)	Source
Popov et. al.	2456140.3110	I	-2461	0.0016	VSX
P. Frank	2456219.2808	II	-2385.5	0.0004	
P. Frank	2456520.5266	II	-2097.5	0.0055	
P. Frank	2456963.4877	I	-1674	-0.0036	
P. Frank	2457257.4110	I	-1393	0.0009	
P. Frank	2457261.5953	I	-1389	0.0013	
W. Moschner	2458040.3185	II	-644.5	-0.0035	
W. Moschner	2458051.3040	I	-634	-0.0008	
W. Moschner	2458054.4425	I	-631	-0.0002	
P. Frank	2458353.5918	I	-345	0.0004	
W. Moschner	2458694.5795	I	-19	0.0004	
W. Moschner	2458714.4533	I	0	0.0007	
W. Moschner	2458724.3856	II	9.5	-0.0038	
W. Moschner	2458760.4755	I	44	0.0000	
W. Moschner	2459055.4406	I	326	0.0000	
W. Moschner	2459077.4057	I	347	0.0003	
W. Moschner	2459508.3469	I	759	-0.0001	
W. Moschner	2460181.4318	II	1402.5	-0.0003	

Table 1: Minima of V2991 Cyg = Fr237 Cyg, O-C using the elements from the authors.
The O-C of the secondary minima were calculated assuming that the true phase is at exactly 0.5.
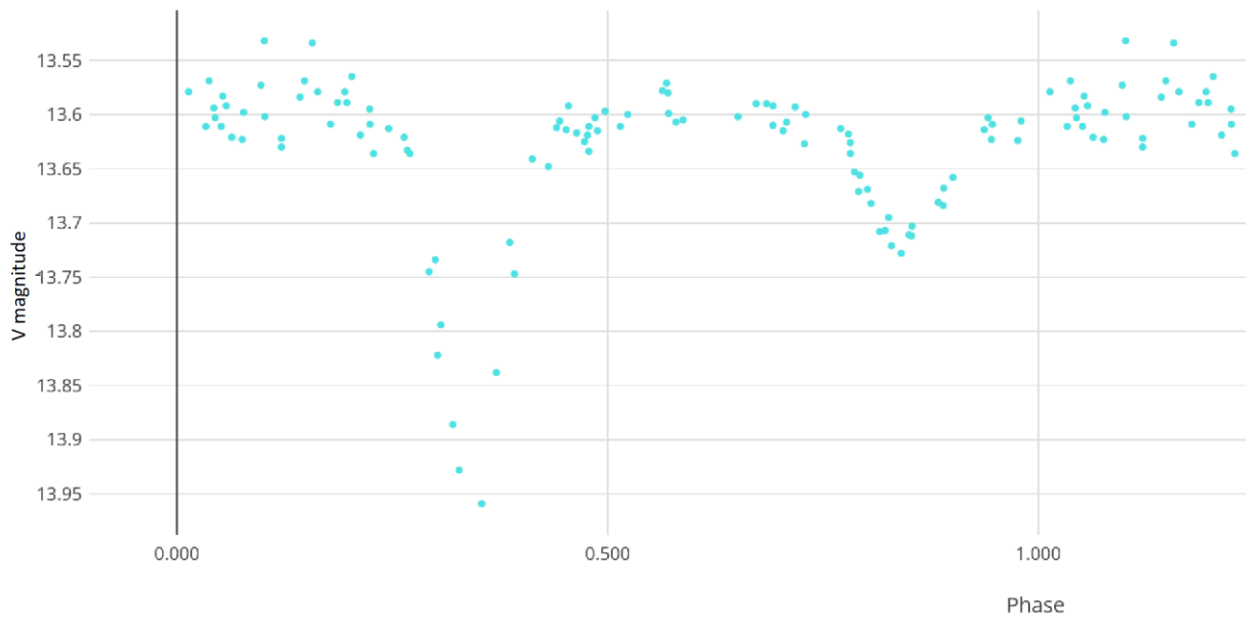
Figure 1: Phased light curve of V2991 Cyg = Fr237 Cyg using the period and data (V-Band) from ASAS-SN.
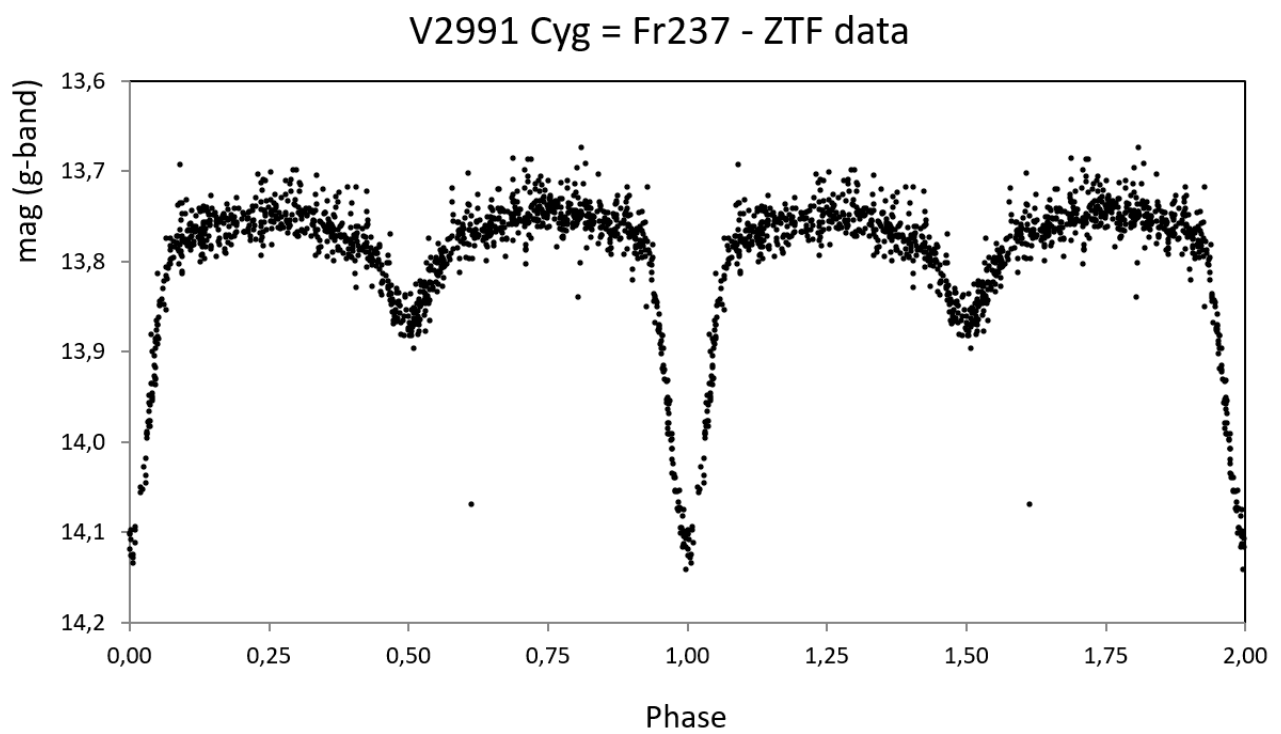This graphic is taken from the ASAS-SN website.

Figure 2: Phased light curve of V2991 Cyg = Fr237 Cyg using the improved elements and data from ZTF
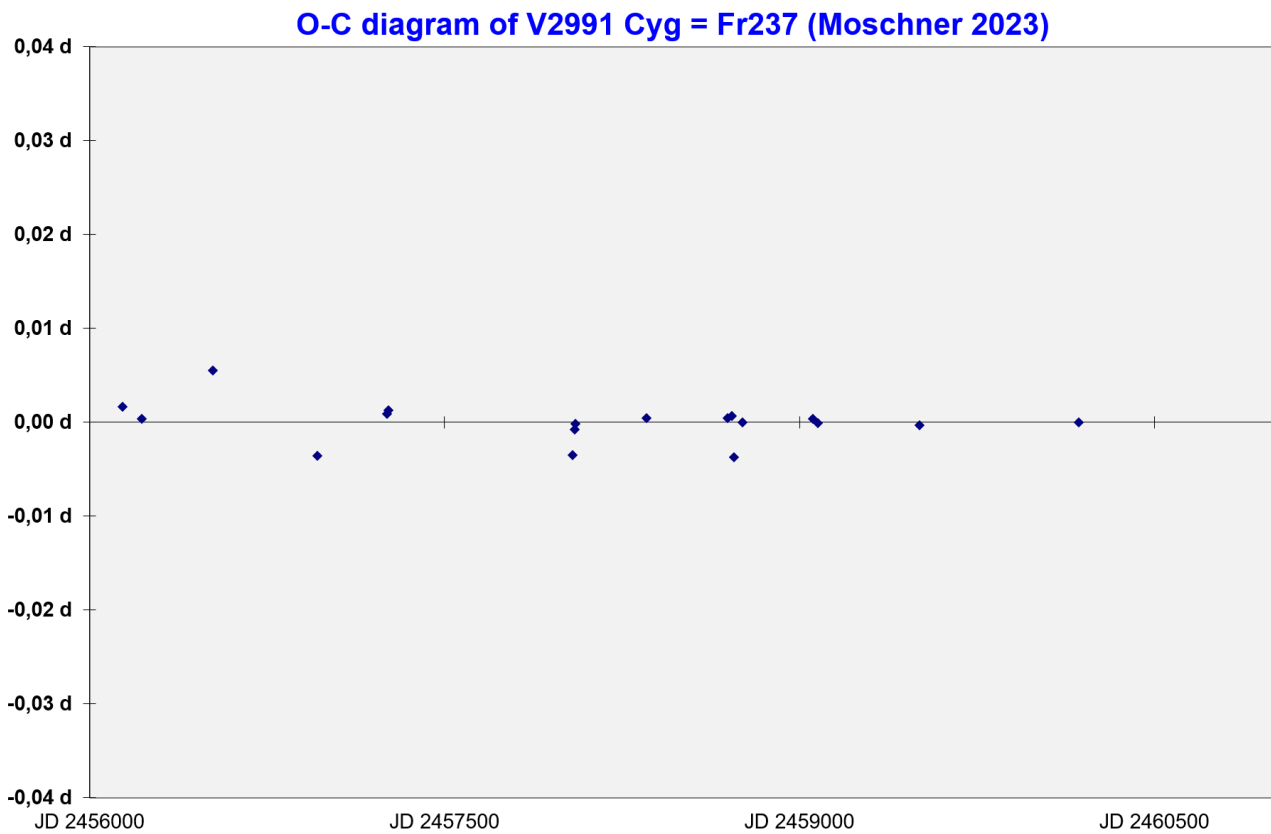(g-band 420-550 nm).

O-C diagram of V2991 Cyg = Fr237 (Moschner 2023)

Figure 3: O-C-diagram of V2991 Cyg = Fr237 Cyg using the ephemeris given by the authors.
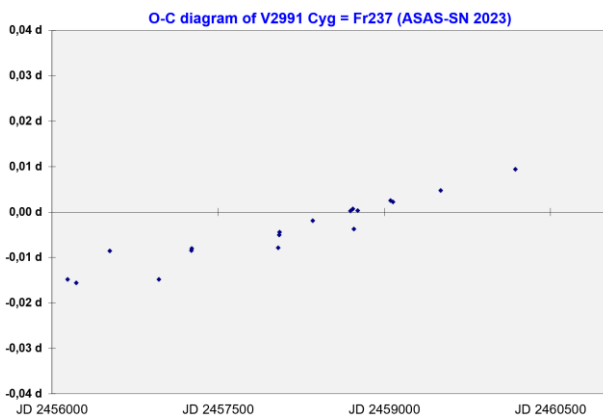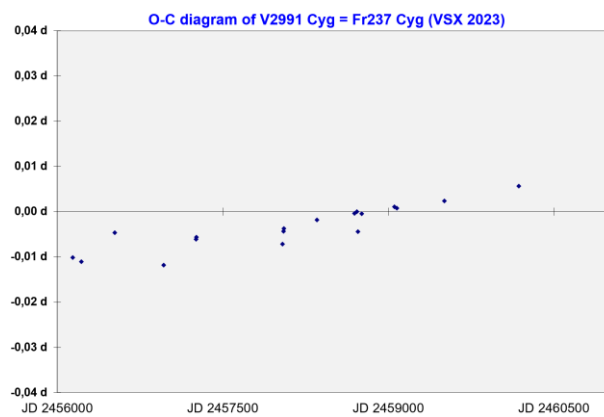The minima from Table 1 are shown in Figures 3,4 and 5.

Figure 4

Figure 5

Figure 4: O-C-diagram of V2991 Cyg = Fr237 Cyg using the period from the ASAS-SN database (1.0459678 d).
Figure 5: O-C-diagram of V2991 Cyg = Fr237 Cyg using the period from the VSX database (1.045970 d).

Acknowledgements

References

[1] 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:

[2] ZTF Zwicky TransientFacility, Systematic Exloration of the Dynamic Sky
https://www.ztf.caltech.edu/
J/ApJS/249/18/table2

Bellm, E.C., Kulkarni, S. R., Graham, M. J.et al., 2019a, PASP, 131, 018002
https://ui.adsabs.harvard.edu/abs/2019PASP..131a8002B/abstract

Bellm, E. C., Kulkarni, S. R., Barlow, T. et al. 2019b, PASP, 131, 068003
https://ui.adsabs.harvard.edu/abs/2019PASP..131f8003B/abstract

Masci, F. J.; Laher, R. R.; Rusholme, B. et al., 2019, PASP, 131, 018003
https://ui.adsabs.harvard.edu/abs/2019PASP..131a8003M/abstract

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

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

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

[6] The International Variable Star Index (VSX)
https://www.aavso.org/vsx/index.php?view=search.top
http://www.astronet.ru/db/varstars/msg/eid/PZP-15-0007

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

[8] WISE catalog of periodic variable stars (Chen et al., 2018)
J/ApJS/237/28/table2

[9] SIMBAD Astronomical Database - CDS (Strasbourg),
http://simbad.u-strasbg.fr/simbad/sim-fid