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Period and Variability Analysis of Fr307 Gem = GSC 01337-01148 (Change of period)

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Abstract: *The variability of Fr307 Gem = GSC 01337-01148 was independently discovered in 2014 by Peter Frank and in 2019 by Manuel J. Mendez and was classified as an eclipsing binary. The variable star has been listed in several databases for some years, with varying periods and classifications. Our database contains 13 minima, and the O-C diagram indicates a period change around JD 2458000. The refined period presented in this study pertains to the post-period change timeframe. The authors provide phased light curves, primary and secondary minima, and O-C diagrams to support their findings.*

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
102 mm 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 [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. 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 coordinates are computed from the positions and the proper motions.

Fr307 Gem = GSC 01337-01148

Cross-IDs
= ASASSN-V J063612.63+193154.8
= USNO-B1.0 1095-0117880
= Gaia DR3 3371872278839523584
= USNO-A2.0 1050-03920085
= ATO J099.0525+19.5318
= 2MASS J06361260+1931546
= WISE J063612.60+193154.6
= ZTF J063612.60+193154.8

Gaia DR3 catalogue:
Right ascension: 06h36m12.6019s at Epoch J2000
Declination: +19° 31' 54.689" at Epoch J2000
12.4644 mag G-band mean magnitude (350-1000 nm)
12.6408 mag Integrated BP mean magnitude (330-680 nm)
12.1406 mag Integrated RP mean magnitude (640-1000 nm)
0.5002 mag BP-RP

Periods known so far:

VSX [4]	0.8485110 d	ZTF g-band [7]	0.8484932 d
ASAS-SN [5]	0.8485215 d	ZTF r-band [7]	0.8485668 d
ATLAS [6]	0.8485010 d	Simbad [8]	0.8485080 d

Results

The variability of Fr307 Gem = GSC 01337-01148 was independently discovered in 2014 by Peter Frank and in 2019 by Manuel J. Mendez and was classified as an eclipsing binary. In the VSX database, the variable is registered as GSC 01337-01148 with the name and period recorded by one of the discoverer, Manuel J. Mendez. The database also includes a combined phased light curve (Figure 7) of Fr307 Gem = GSC 01337-01148, utilizing the period (0.8485110 d) from the VSX database along with data from the APASS and the ASAS-SN project. In the Simbad database, the variable is registered as ZTF J063612.60+193154.8. Each of the ASAS-SN, ZTF, Gaia, and ATLAS projects processed their own data on the variable a few years ago.

This variable star is also cataloged under multiple identifiers (see above under Cross ID's).

As part of the ASAS-SN, ZTF, Gaia, and ATLAS projects, these institutions processed their own observational data on the variable star in recent years. The WISE database does not provide a period or classification for this variable. However, the ATLAS, ASAS-SN, ZTF, and VSX databases report different period values for it. These variations are also reflected in the Simbad database, where the type is sometimes classified as EB (Beta Lyrae-type eclipsing binary) and other times as EA (Algol-type eclipsing binary). The phased light curve generated with our data shows the shape of an EA star.

See above under Periods known so far the period values derived from different surveys.

To verify and refine the elements, we analyzed 3150 archival images taken between 2014 and 2025, identifying 13 minima. A period change was detected around JD 2458000. The period presented in this study applies to the epoch following this change. The period derived from Gaia data closely matches our findings, as the Gaia data were also obtained after the period change.

These minima (Table 1) were used to determine the period published here. The presented elements were calculated using the method of least squares, considering all our minima from JD 2458077 to JD 2460700 (see Table below) and assuming that the true phase of Min. II is exactly at 0.5. Our analysis (Figure 5) indicates a variability range between 12.47 and 12.67 mag, with an amplitude of 0.20 mag for Min. I and 0.18 mag for Min. II (V filter).

Additionally, alternative periods (e.g., 1.06676 d, 0.71117 d, 0.53338d) were suggested in previous analyses. While these values could suggest a double or half-period scenario, they do not precisely match the expected factors of the actual period. Instead, they are most likely alias periods, arising due to data processing artifacts or observational window effects.

Our ephemeris represents an improvement over the VSX, ASAS-SN, ZTF, and ATLAS periods. The refined period allows for more precise observations of this variable star in the coming years. However, given the likelihood of future period changes, continued monitoring of the variable star is recommended.

Fr307 Gem = GSC 01337-01148 - improved elements

Type = EA

Min. I = HJD 2460264.6755 + 0.84850893*E

±0.0028 ±0.00000104

Observer	HJD Minimum	Type	Epoch	O-C (d)
P. Frank	2456712.3691	II	-4186.5	-0.0238
P. Frank	2456714.4996	I	-4184	-0.0145
P. Frank	2456746.3170	II	-4146.5	-0.0162
W. Moschner	2457471.3776	I	-3292	-0.0065
W. Moschner	2458077.6440	II	-2577.5	0.0002
W. Moschner	2458105.6434	II	-2544.5	-0.0011
W. Moschner	2458521.4143	II	-2054.5	0.0004
W. Moschner	2458865.4849	I	-1649	0.0006
W. Moschner	2459172.6442	I	-1287	-0.0003
W. Moschner	2459263.4355	I	-1180	0.0005
W. Moschner	2459955.3946	II	-364.5	0.0006
W. Moschner	2460264.6753	I	0	-0.0002
W. Moschner	2460700.3836	II	513.5	-0.0012

Table 1: Minima of Fr307 Gem = GSC 01337-01148 using the elements from the authors. The O-C of the secondary minima were calculated assuming that the true phase is exactly at 0.5.

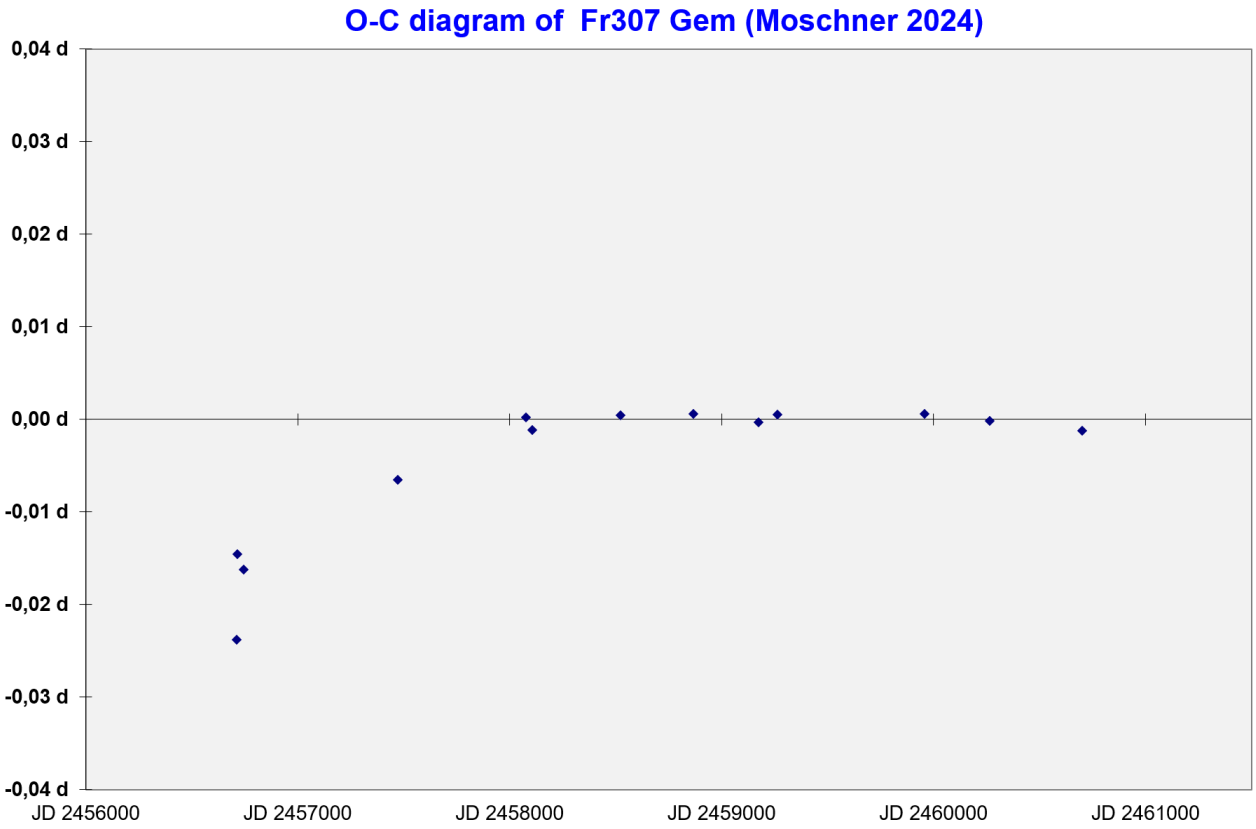

Figure 1: O-C-diagram of Fr307 Gem = GSC 01337-01148 using the ephemeris given by the authors.

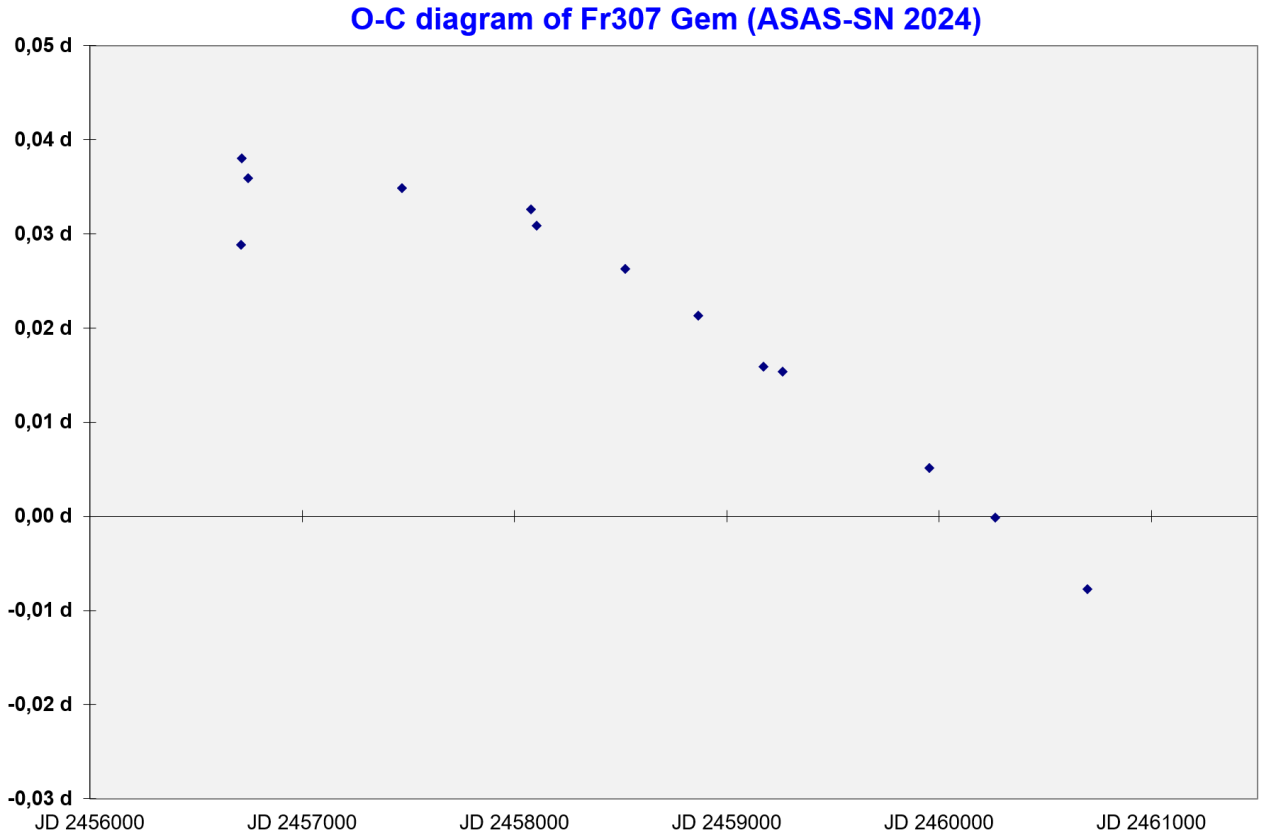

Figure 2: O-C-diagram of Fr307 Gem = GSC 01337-01148 using the period from the ASAS-SN Project (0.8485215 d).

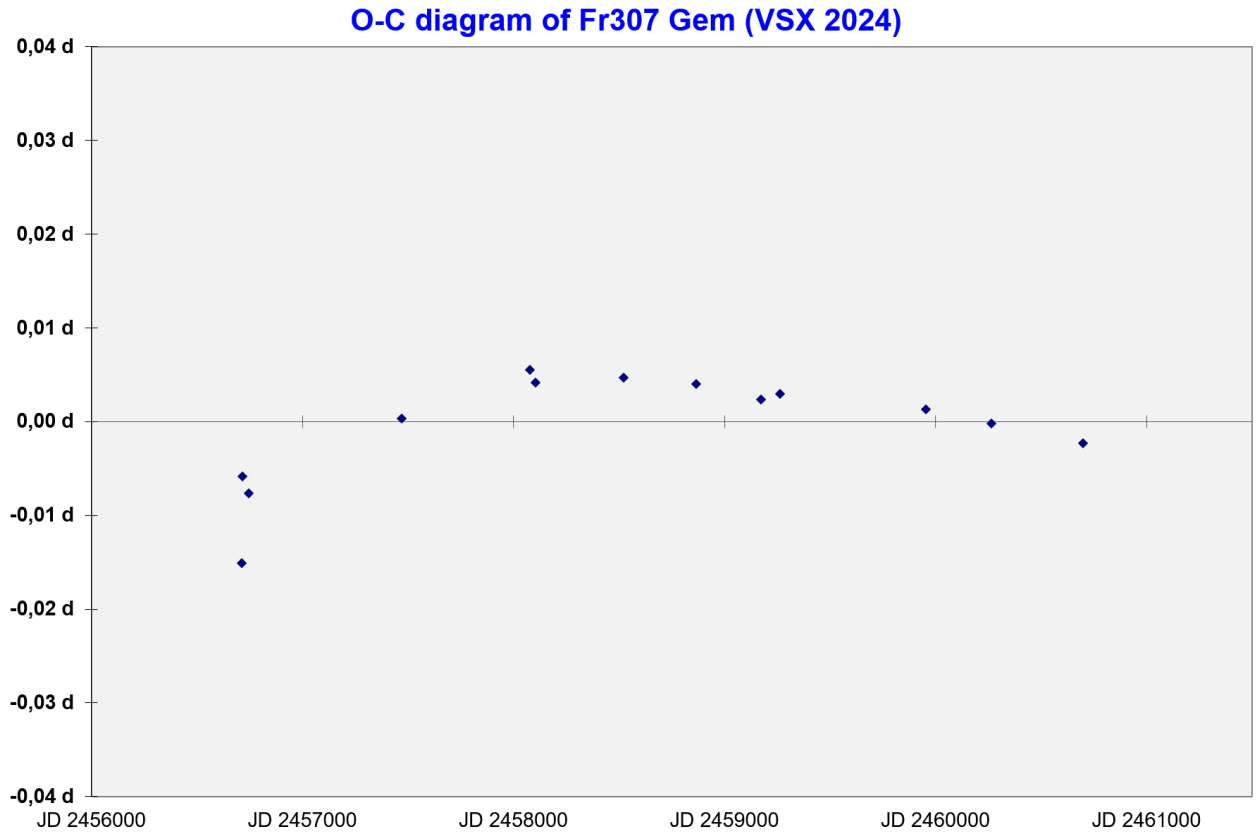

Figure 3: O-C-diagram of Fr307 Gem = GSC 01337-01148 using the period from the VSX database (0.8485110 d).

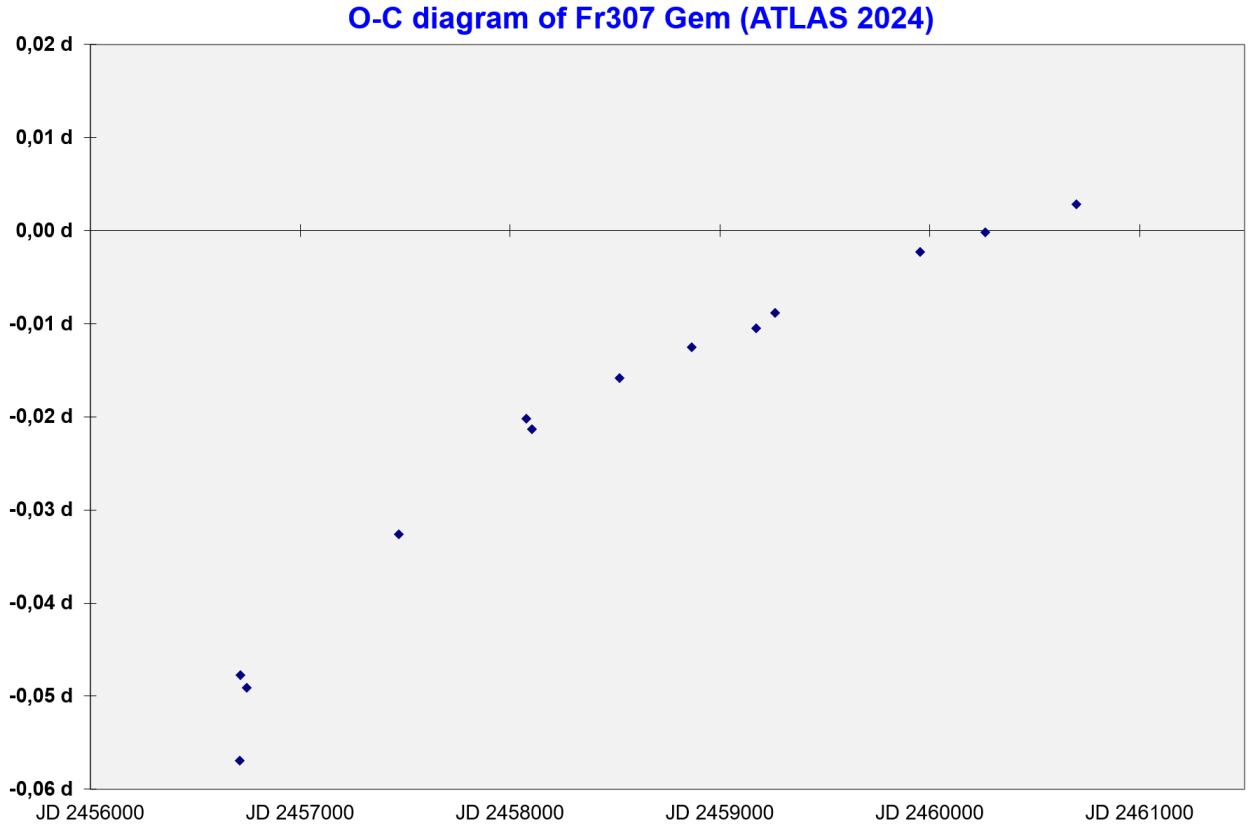

Figure 4: O-C-diagram of Fr307 Gem = GSC 01337-01148 using the period from the ATLAS project (0. 8485010 d).

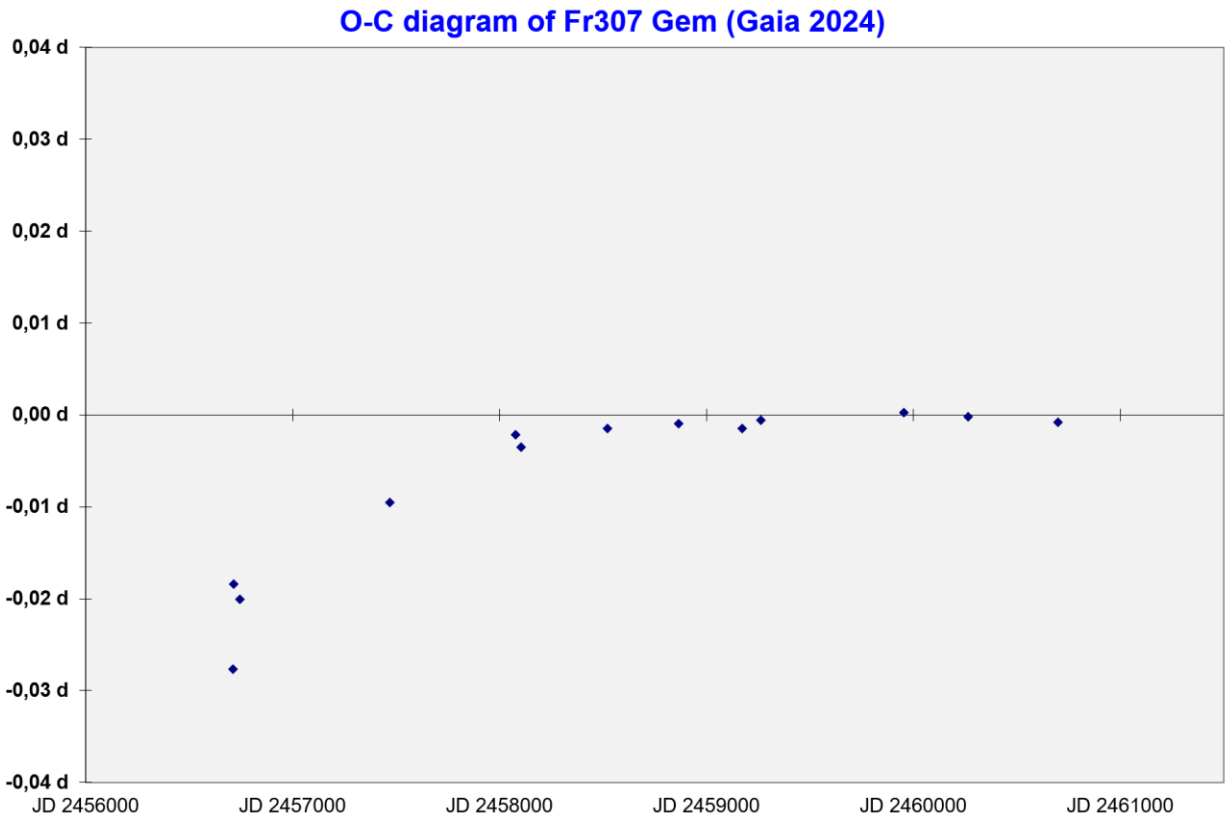

Figure 5: O-C-diagram of Fr307 Gem = GSC 01337-01148 using the period from the Gaia project (Simbad) (0.8485080 d).

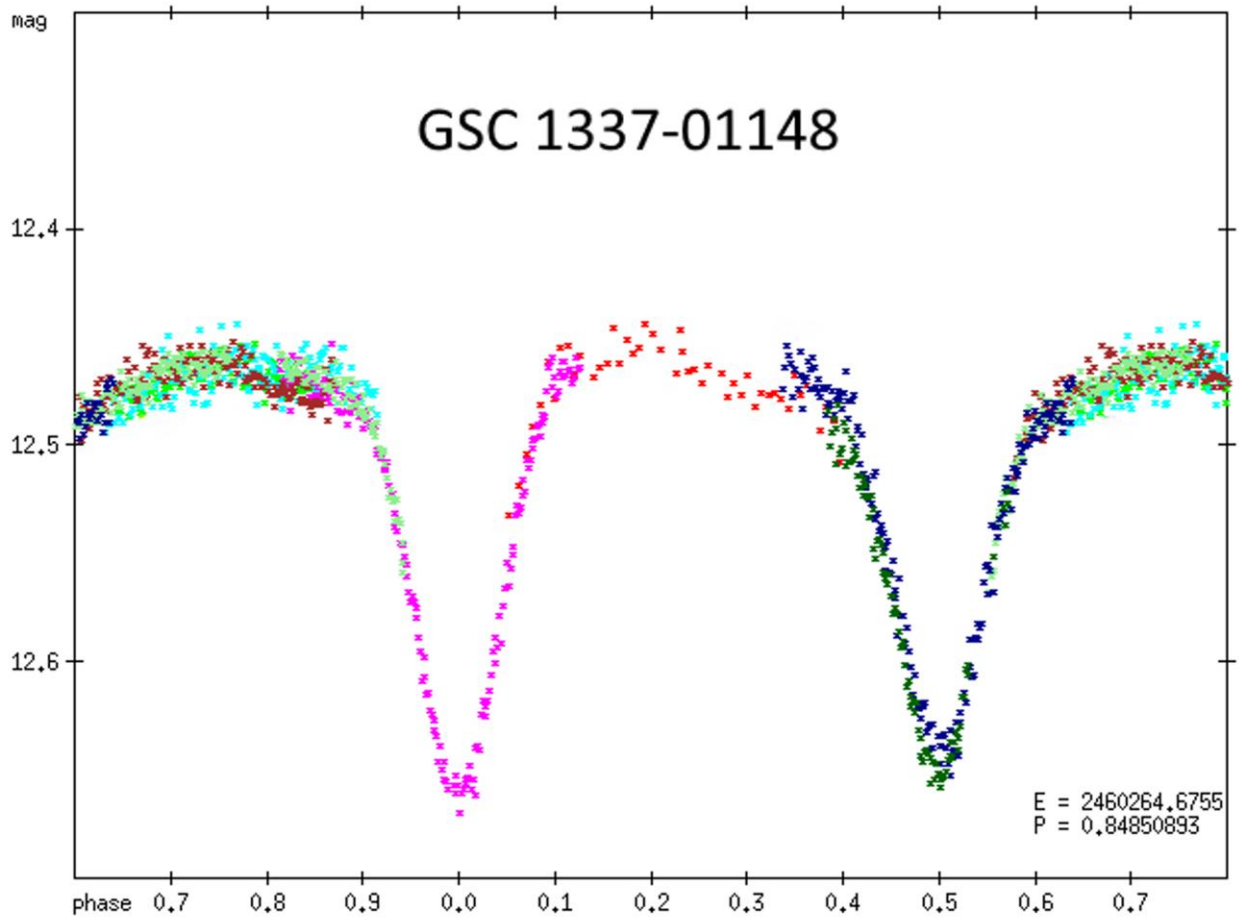

Figure 6: Phased lightcurve of Fr307 Gem = GSC 01337-01148 using the period and data (V-Band) from the authors. Different colors denote different observing nights.

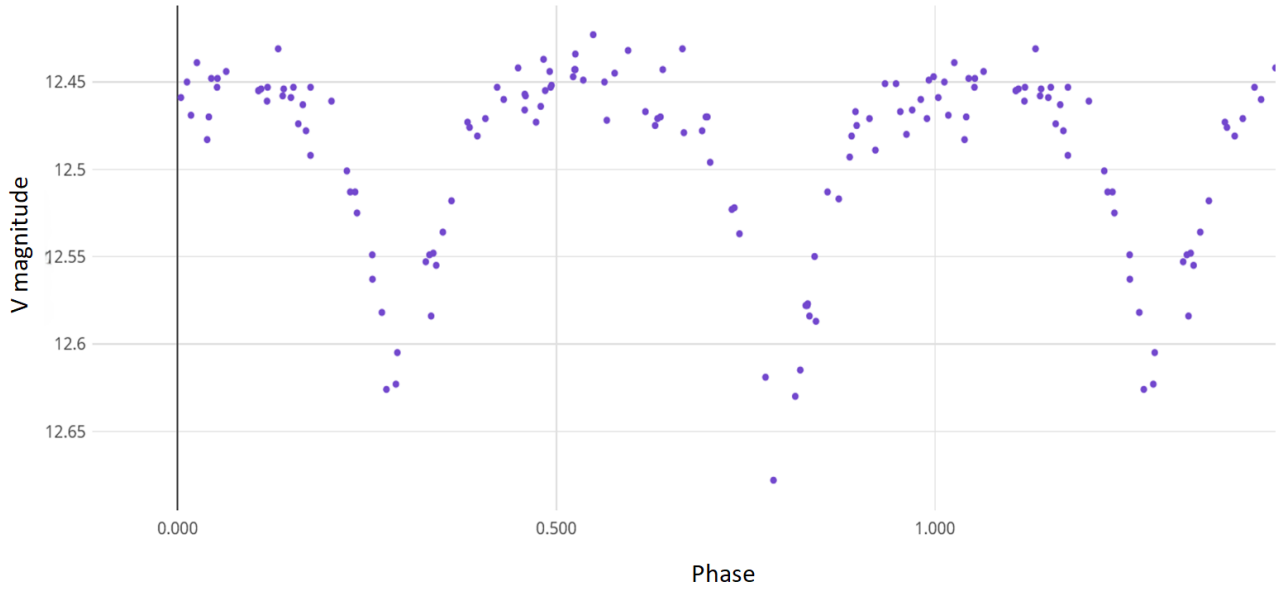

Figure 7: Phased light curve of Fr307 Gem = GSC 01337-01148 using the period and data (V-Band) from the ASAS-SN project. This graphic is taken from the ASAS-SN website.

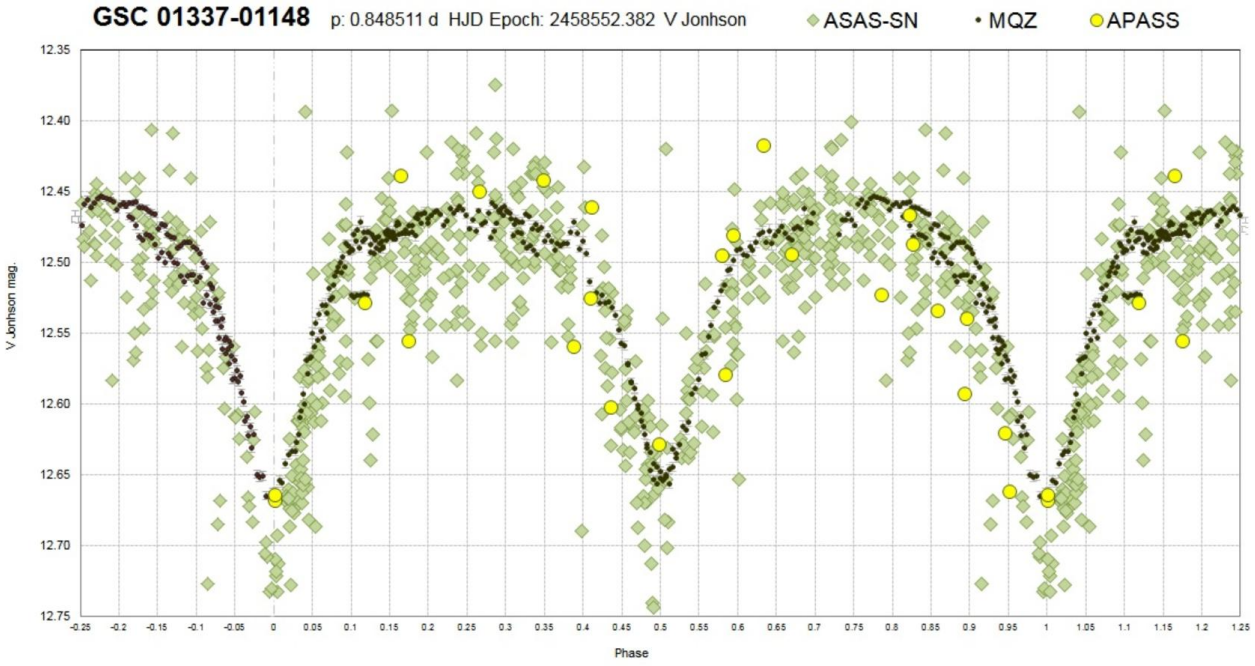

Figure 8: Combined phased light curve of Fr307 Gem = GSC 01337-01148 using the period (0.8485110 d) from the VSX database and the data from Manuel J. Mendez, the ASAS-SN project and APASS. This graphic is taken from the AAVSO website.

Acknowledgements

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Finally, we acknowledge the contribution of the ATLAS, ASAS-SN, and Gaia teams for their publicly available survey data, and the AAVSO (American Association of Variable Star Observers) for their comprehensive database of variable stars.

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Website: http://c-munipack.sourceforge.net

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

[3] Gaia DR3 (Gaia Collaboration, 2020) European Space Agency
Catalogue: http://vizier.u-strasbg.fr/viz-bin/VizieR?-source=I/355

[4] The International Variable Star Index (VSX)
Website: https://www.aavso.org/vsx/index.php?view=detail.top&oid=621259

[5] All-Sky Automated Survey for Supernovae (ASAS-SN)
Projekt-Website: http://www.astronomy.ohio-state.edu/asassn/index.shtml
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  https://ui.adsabs.harvard.edu/abs/2019MNRAS.485..961J

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Projekt-Website: https://www.ztf.caltech.edu

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[8] SIMBAD Astronomical Database
Operated by CDS, Strasbourg, France
Website: http://simbad.u-strasbg.fr/simbad/