Improved elements of the eclipsing binary WISE J205119.0+343149 Cyg

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Abstract: *WISE J205119.0+343149 Cyg was discovered by WISE-Project* [1] *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 object is also listed in the ASAS-SN and Atlas variable catalogs, but with a period that does not match our observations exactly.*

Introduction

WISE J205119.0+343149 Cyg was discovered as a photometric variable by the WISE-Project and classified as eclipsing binary. The amplitude is given as 0.3 mag. The VSX specifies a brightness of 12.67 mag for the WISE passband 3.368 µm. The variable is listed in the ATLAS [2] and ASAS-SN-Variable Star Database [3].

During these studies, we furthermore discovered several period solutions for this star in an extensive datasheet prepared by the ATLAS project [2]. Only one of these periods (ATLAS) is similar to ours. We have at our disposal 25 time series with approx. 4400 images that were taken between 2010 and 2020. The observation time per night was between 2 and 7 hours.

Since the minima derived from our data cannot be represented by the ASAS-SN, WISE and ATLAS periods, we have used our data to present an improved period solution.

Periods known so far:

Simbad	no information
ASAS-SN	0.4202373 d
ATLAS	0.4202450 d
VSX [4]	0.4202395 d (WISE)
ZTF [5]	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 [6] and self-written programs by Franz Agerer and Lienhard Pagel [7] 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 = (raw instrumental) magnitude

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

All coordinates are taken from the Gaia DR2 catalogue [8].

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).

WISE J205119.0+343149 Cyg
Cross-ID's
= UCAC3 250-234225
= Gaia DR2 1869260068924940672
= ATOID J312.8291+34.5305
= ASASSN-V J205118.99+343149.0

Right ascension: 20h51m18.9963s at epoch and equinox J2000
Declination: +34° 31' 50.026"   at epoch and equinox J2000
Barycentric right ascension (ICRS) at Epoch=2015.5: 312.829159832° +/- 0.01 mas
Barycentric declination (ICRS) at Epoch=2015.5:   +34.530527981° +/- 0.01 mas

Gaia DR2 Catalog:
14.2500 mag G-band mean magnitude
14.5930 mag Integrated BP mean magnitude
13.7218 mag Integrated RP mean magnitude
 0.8712 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.

Our ephemeris represents a significant improvement over the ASAS-SN period and all ATLAS periods, since our minima are not represented with all periods known so far.

The amplitude for Min I is given as 0.36 mag, 14.16-14.52 mag and for Min II as 0.30 mag, 14.16-16.46 mag.

WISE J205119.0+343149 Cyg (improved elements)

Amplitude: Min I: 0.36 mag (instr.)   Min II: 0.30 mag (instr.)
Type: EW type eclipsing binary

Min I =   HJD (UTC) 2458696.4050 + 0.4202421*E
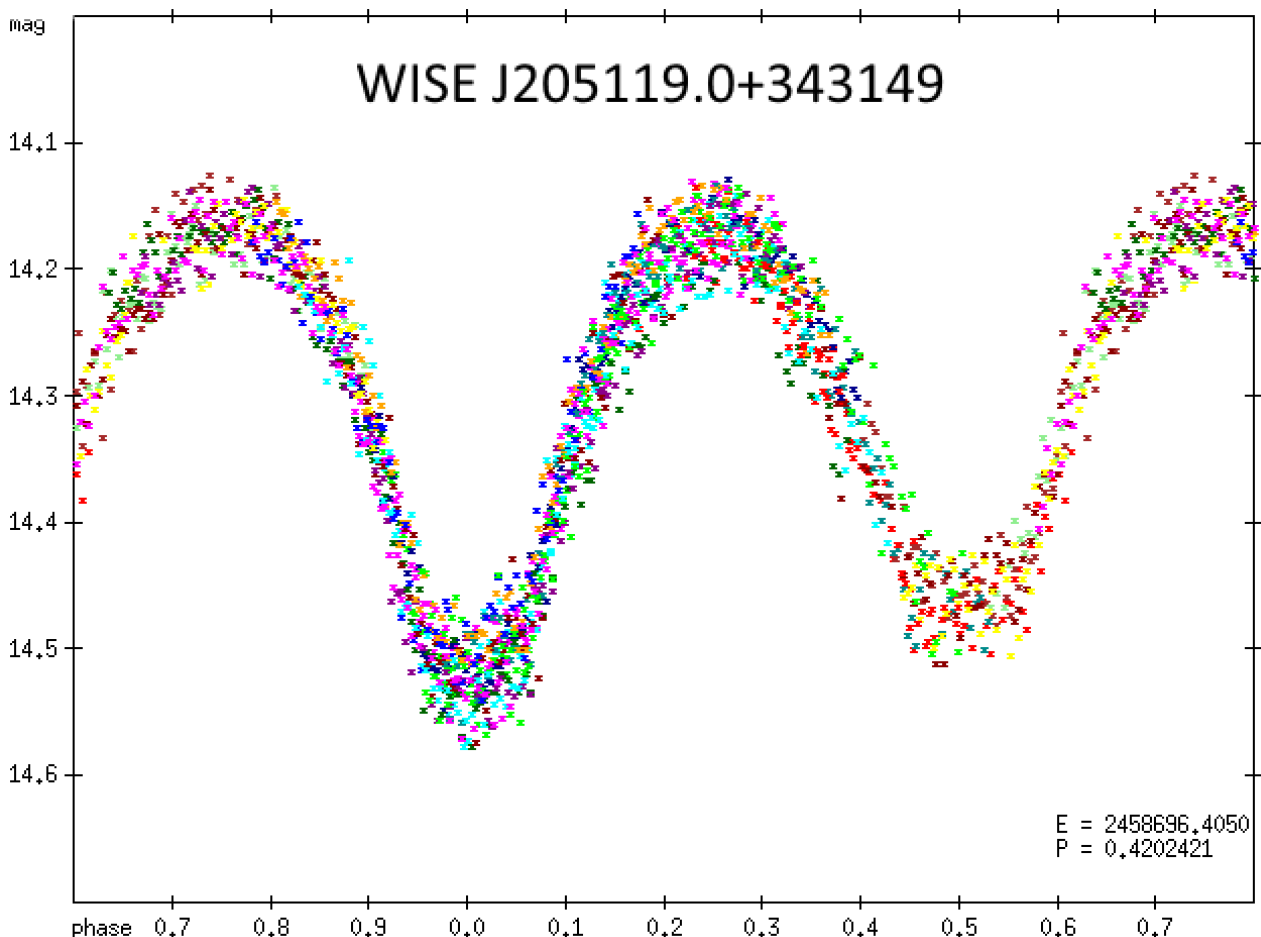   ±0.0004 ±0.0000001

Figure 1: Phased light curve of WISE J205119.0+343149 Cyg using the ephemeris given by the authors. The vertical axis shows raw instrumental magnitudes. Different colors denote different observing nights. Only the data points from the better nights were used to display the light curve. A SIGMA 1603 CCD-Camera + IR & UV cut off filter (2010-2020) was used.

Observer	HJD-Date Minimum	Type	Epoch	O-C (d)
P. Frank	2454684,5631	II	-9546,5	-0,0007
P. Frank	2455480,2962	I	-7653	0,0040
P. Frank	2456159,4007	I	-6037	-0,0027
P. Frank	2456650,2456	I	-4869	-0,0006
P. Frank	2456654,2413	II	-4859,5	0,0028
P. Frank	2456937,2718	I	-4186	0,0003
P. Frank	2457287,3330	I	-3353	-0,0003
P. Frank	2457297,4216	I	-3329	0,0025
P. Frank	2457307,2985	II	-3305,5	0,0038
P. Frank	2457307,5037	I	-3305	-0,0012
P. Frank	2457658,4037	I	-2470	-0,0033
P. Frank	2457722,2840	I	-2318	0,0002
P. Frank	2457727,3217	I	-2306	-0,0050
P. Frank	2457733,2058	I	-2292	-0,0044
W. Moschner	2457915,5949	I	-1858	-0,0003
W. Moschner	2457946,4851	II	-1784,5	0,0021
W. Moschner	2457962,4522	II	-1746,5	0,0001
W. Moschner	2457965,3935	II	-1739,5	-0,0003
W. Moschner	2457965,6040	I	-1739	0,0000
W. Moschner	2458002,3740	II	-1651,5	-0,0012
W. Moschner	2458006,5752	II	-1641,5	-0,0024
W. Moschner	2458321,5516	I	-892	0,0025
W. Moschner	2458326,5928	I	-880	0,0008
W. Moschner	2458382,4864	I	-747	0,0022
W. Moschner	2458687,5799	I	-21	0,0000
W. Moschner	2458696,4042	I	0	-0,0008
W. Moschner	2458696,6170	II	0,5	0,0019
W. Moschner	2458710,4820	II	33,5	-0,0011
W. Moschner	2458761,3314	II	154,5	-0,0010
W. Moschner	2458782,3448	II	204,5	0,0003
W. Moschner	2459051,5088	I	845	-0,0008
P. Frank	2459070,4221	I	890	0,0017
W. Moschner	2459075,4648	I	902	0,0014
W. Moschner	2459096,4758	I	952	0,0004
P. Frank	2459112,4477	I	990	0,0030
W. Moschner	2459120,4292	I	1009	0,0000
W. Moschner	2459139,3392	I	1054	-0,0010
W. Moschner	2459171,2776	I	1130	-0,0010

Table 1: Minima WISE J205119.0+343149 Cyg, 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.
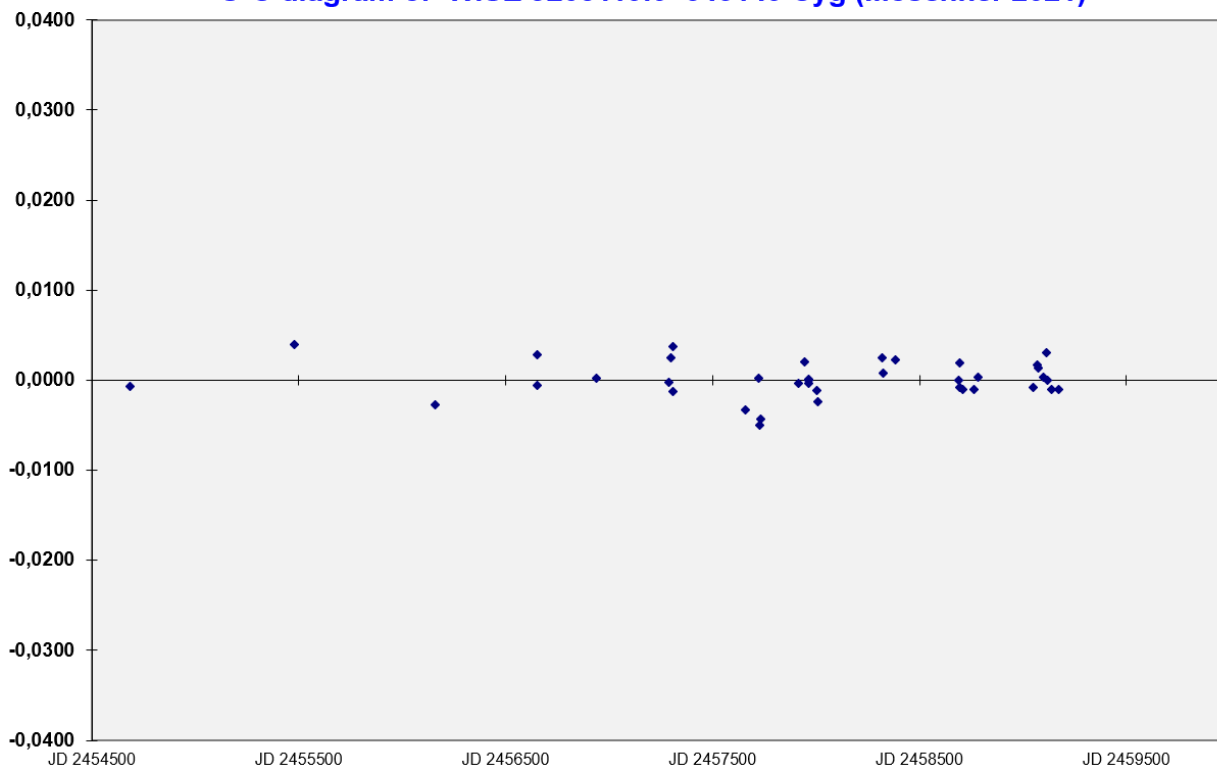
Figure 2: O-C-diagram for WISE J205119.0+343149 Cyg using the ephemeris given by the authors.
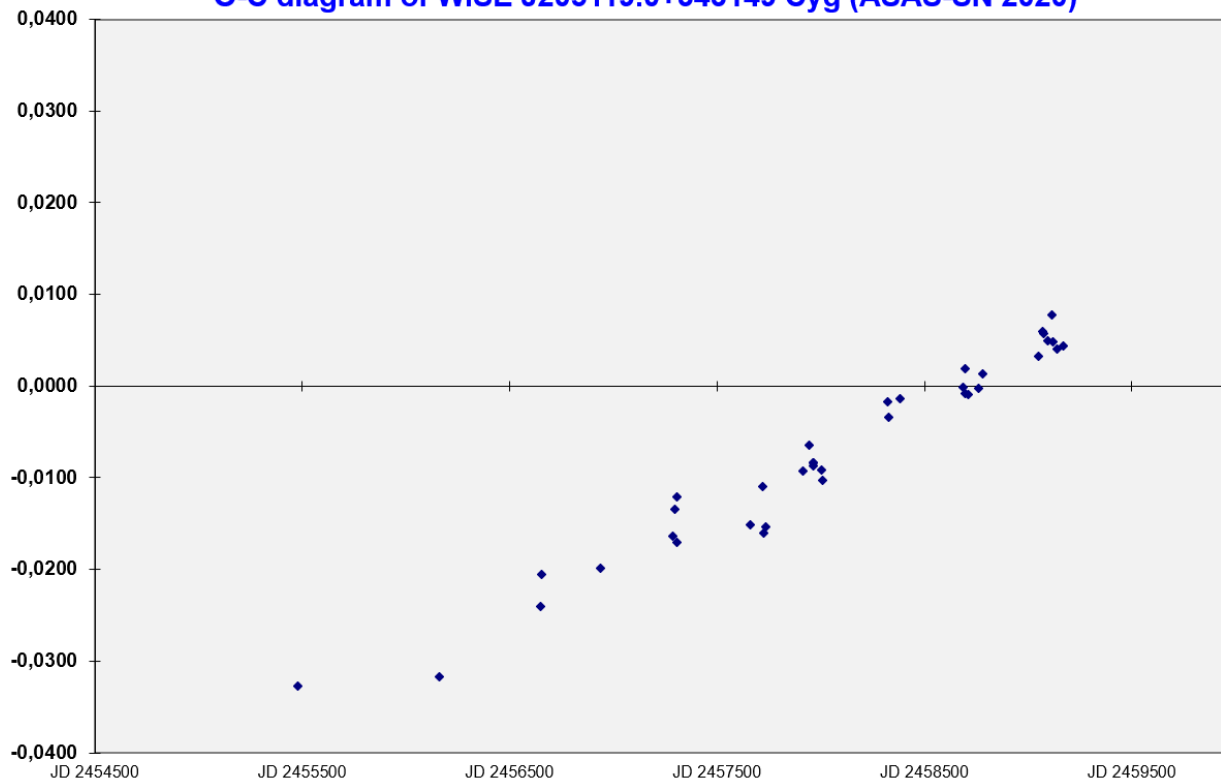

Figure 3: O-C-diagram for WISE J205119.0+343149 Cyg using the period from ASAS-SN.
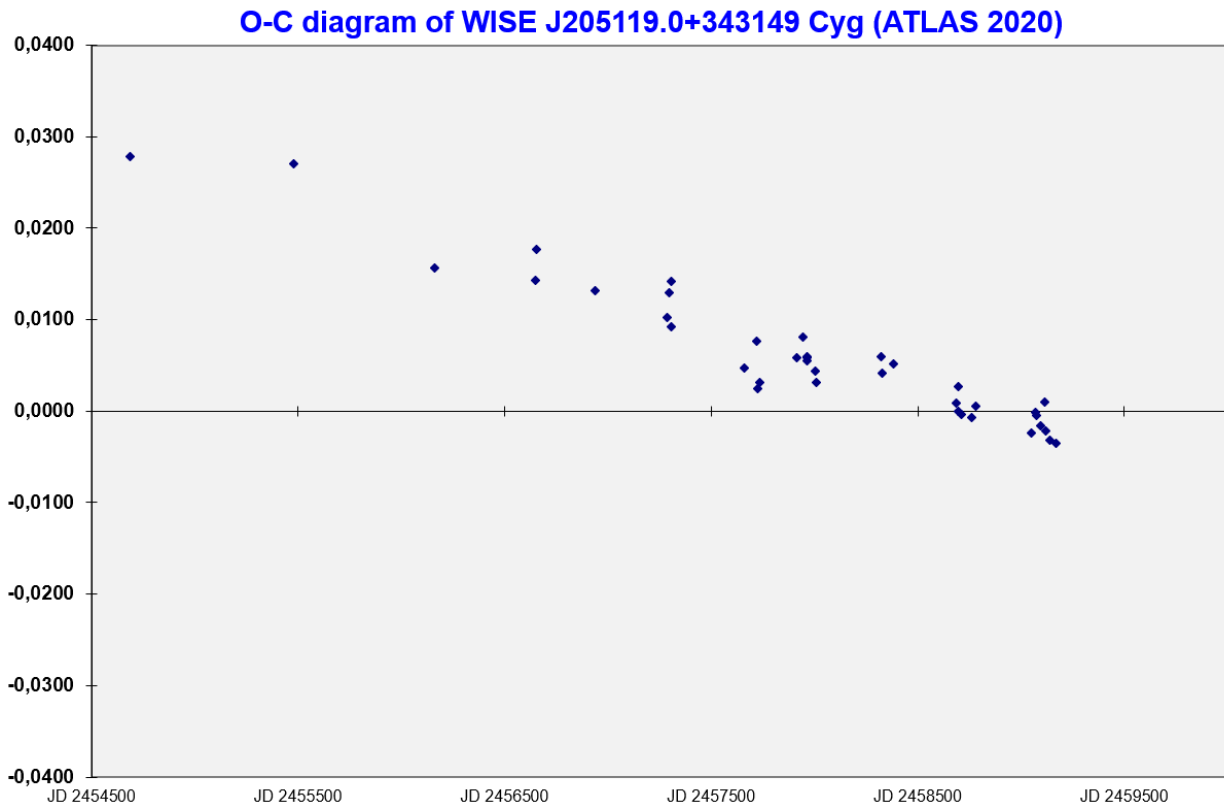
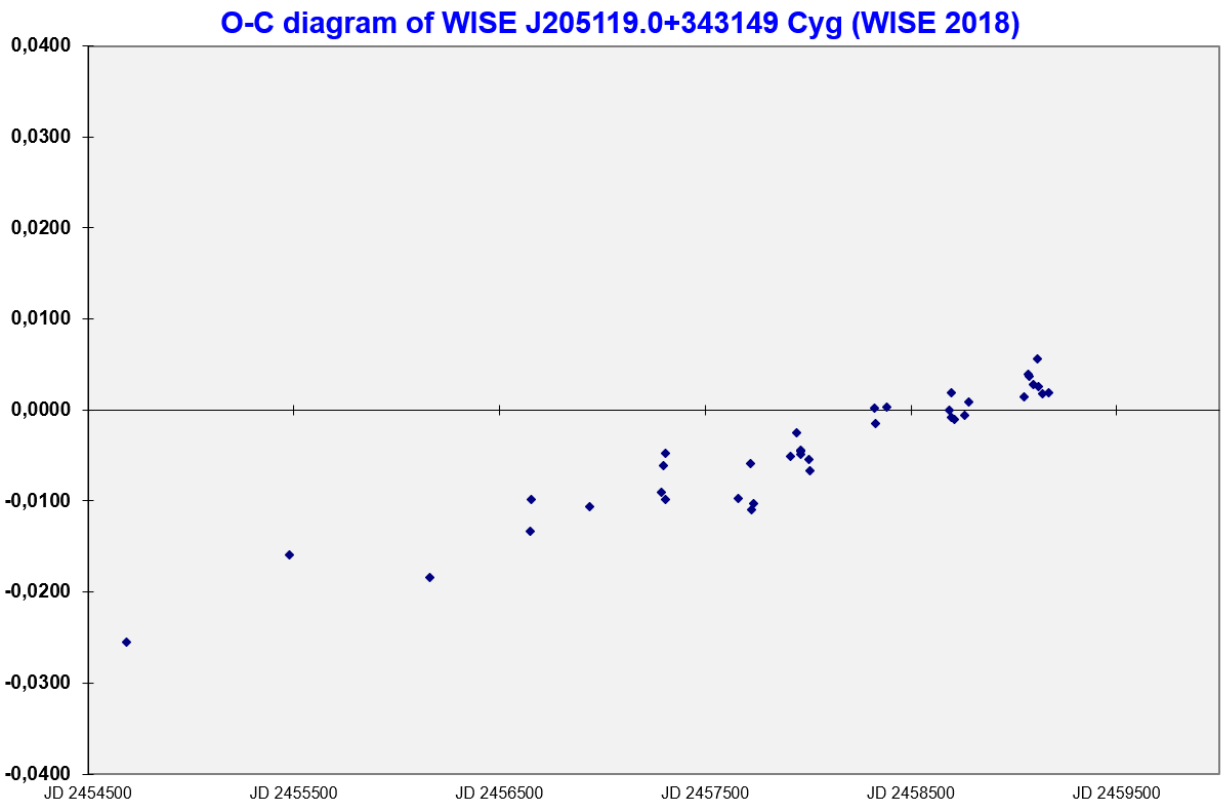Figure 4: O-C-diagram for WISE J205119.0+343149 Cyg using the period from ATLAS.

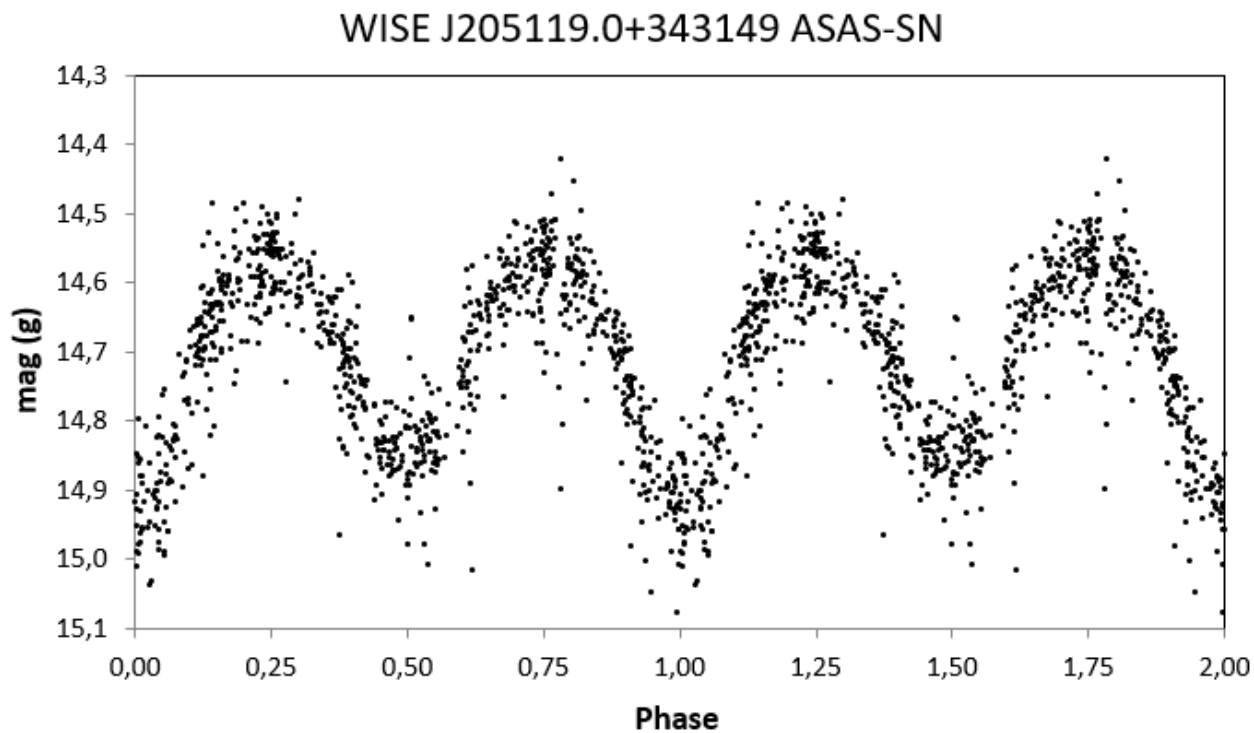Figure 5: O-C-diagram for WISE J205119.0+343149 Cyg using the period from WISE (VSX).

Figure 6: Phased light curve of WISE J205119.0+343149 Cyg using the new elements and data from ASAS-SN (g-Band).
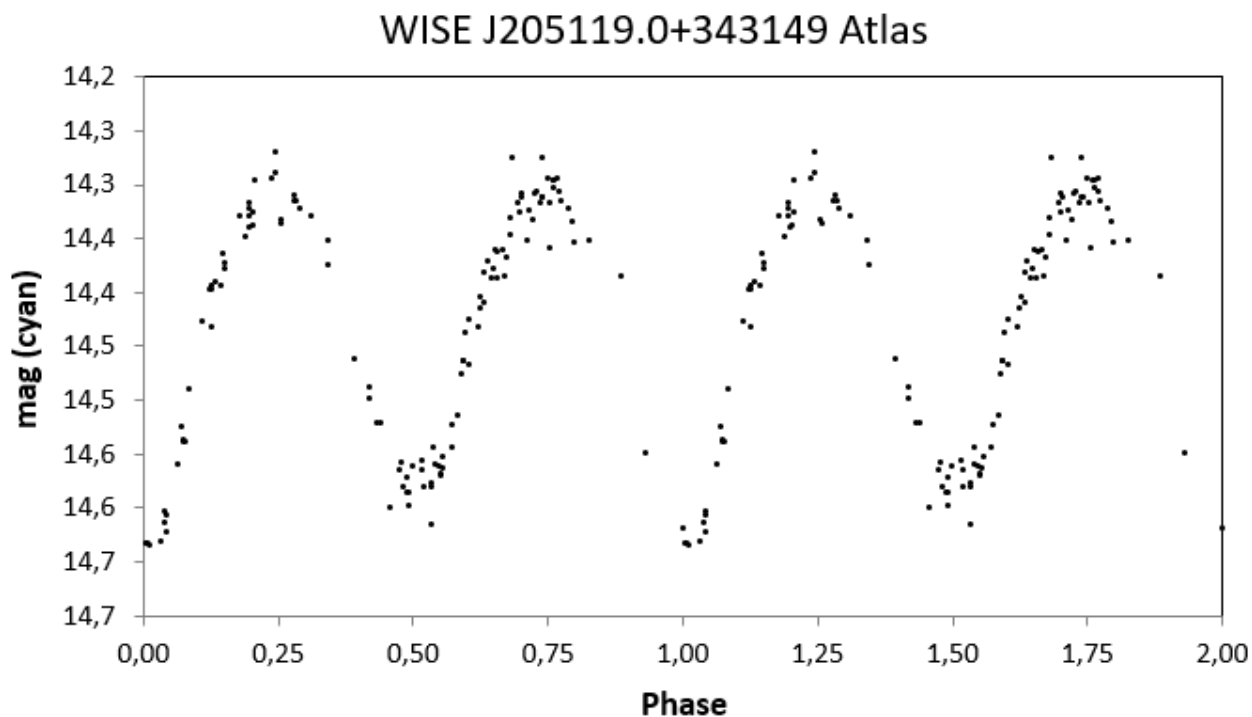

Figure 7: Phased light curve of WISE J205119.0+343149 Cyg using the new elements and data from ATLAS (Cyan-Filter 420-650 nm).

References

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    Explorer (WISE) Catalog of Periodic Variable Stars
    https://ui.adsabs.harvard.edu/abs/2018ApJS..237...28C

[2] 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

[3] 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:

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

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    https://www.ztf.caltech.edu/

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    https://www.bav-astro.eu/index.php/weiterbildung/tutorials

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    http://vizier.u-strasbg.fr/viz-bin/VizieR?-source=I/345