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The elements of Fr77 Aur = UCAC3 254-059161

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Abstract: *Fr77 Aur was discovered by Peter Frank and classified as short period eclipsing binary in 2009. 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 variability of Fr77 Aur was discovered independently by Atlas as well as Chen et al, 2020. The latter evaluated the data from the ZTF. Their period is also accessible via the VSX.*

Observations

102mm f/5.0 TeleVue Refractor - f = 510 mm - SIGMA 1603 CCD-Camera - -Ir-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

Fr77 Aur

Cross-ID's

= UCAC3 254-059161
= ATOID J084.7564+36.7227
= Gaia EDR3 189220384862898560
= ZTF J053901.53+364322.1

Gaia EDR3 Catalog:
Right ascension: 05h39m01.5336s at Epoch=J2000
Declination: +36° 43' 22.076" at Epoch=J2000
12.9486 mag G-band mean magnitude
13.3100 mag Integrated BP mean magnitude
12.4119 mag Integrated RP mean magnitude
0.8981 mag BP-RP

Periods known so far:

ZTF [4]	0.3154564 d
ASAS-SN [5]	no information
ATLAS [6]	0.315455 d

Results

After the discovery of the variable by Peter Frank in 2009, we systematically observed Fr77 a few years later to determine its period. The VSX database lists the above-mentioned ZTF period with the type EW. The Atlas database lists several periods and the following information about the type: MSINE = Stars showing modulated sinusoids. These are exactly analogous to the MPULSE stars, except that instead of a classic sawtooth pulse light curve, the fundamental waveform being modulated is a simple sinusoid. Physically, the MSINE stars may include spotted ellipsoidal variables, rotating stars with evolving spots. The data of the TESS project [7] (Figure 1b) indicate an EW star. After evaluating the data, light curves and information available to us, the type EW is probable, but not certain. With our observations we present an improved period solution.

The presented elements were calculated by the method of least squares, taking into account all our minima from JD 2454847 to JD 2459629 (see table below). Data from this star were also recently processed by the ATLAS project [6] and the ZTF project [8].

Fr77 Aur improved elements

Min. = HJD 2457761.38770 + 0.31545205*E

±0.00122 ±0.00000037

Observer	HJD-Date Minimum	Type	Epoch	O-C (d)
P. Frank	2454847.3959	II	-9237.5	-0.0035
W. Moschner	2457695.6181	II	-208.5	0.0021
W. Moschner	2457761.3853	I	0	-0.0024
W. Moschner	2457761.5460	II	0.5	0.0005
W. Moschner	2457850.3500	I	282	0.0048
W. Moschner	2458039.6126	I	882	-0.0038
W. Moschner	2458074.4703	II	992.5	-0.0035
W. Moschner	2458141.3491	II	1204.5	-0.0006
W. Moschner	2458141.5121	I	1205	0.0047
W. Moschner	2458382.6671	II	1969.5	-0.0035
W. Moschner	2458861.3709	I	3487	0.0019
W. Moschner	2459175.5565	I	4483	-0.0027
W. Moschner	2459175.7180	II	4483.5	0.0010
W. Moschner	2459262.3098	I	4758	0.0013
W. Moschner	2459262.4692	II	4758.5	0.0029
W. Moschner	2459609.3081	I	5858	0.0023
W. Moschner	2459629.3326	II	5921.5	-0.0045

Table 1: Minima Fr77 Aur, O-C using the improved elements. The O-C of the secondary minima were calculated assuming that the true phase is at exactly 0.5.

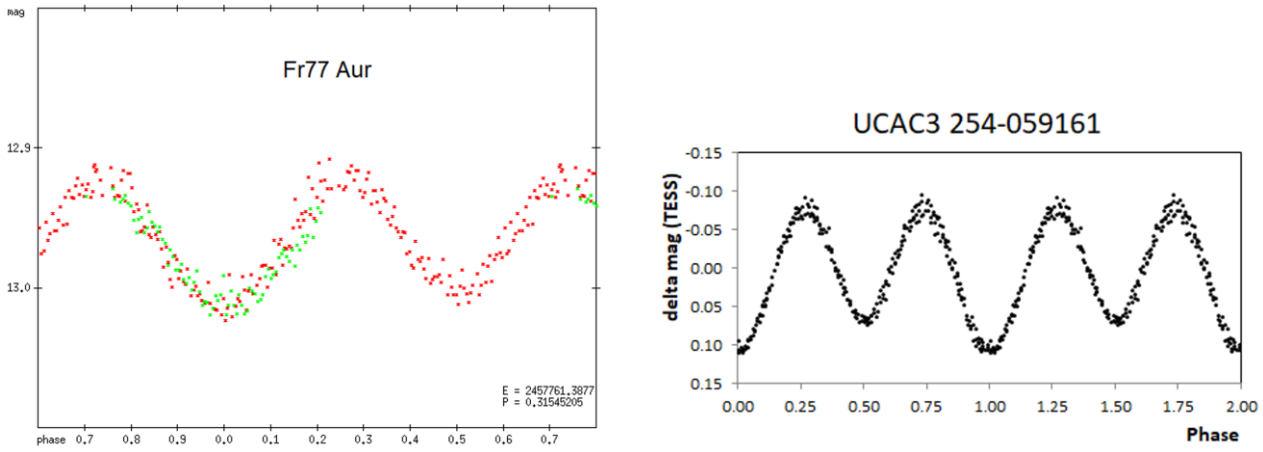

Figure 1a left: Phased light curve of Fr77 Aur = UCAC3 254-059161 using the ephemeris given by the authors. The vertical axis shows raw instrumental magnitudes. Different colors denote different observing nights. Only the data points from the better nights were used to display the light curve. A FLI Proline 16803 camera + V-filter (2020+2021) was used. Figure 1b right: Phased lightcurve (bandpass range of 600 to 1000 nm) with the data of the TESS project using the ephemeris given by the authors.

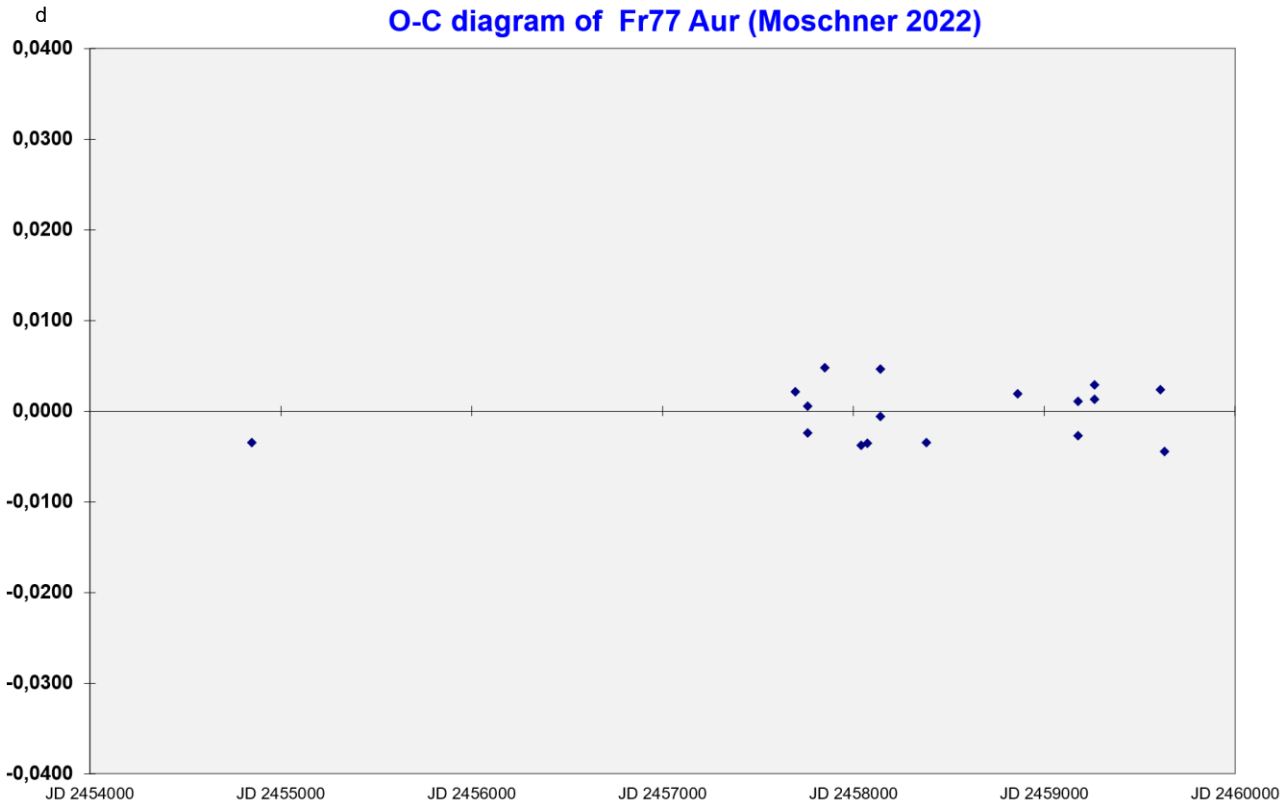

Figure 2: O-C-diagram of Fr77 Aur using the improved elements.

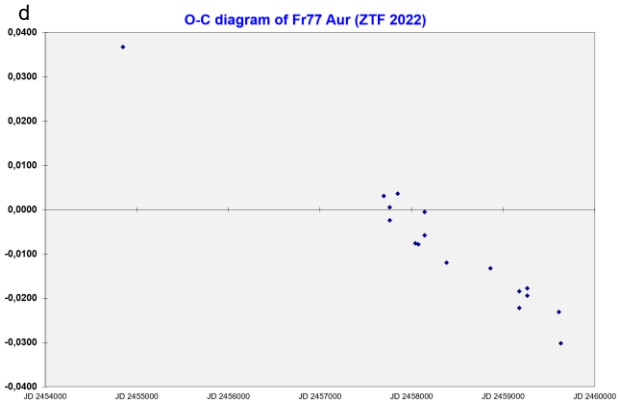

Figure 3

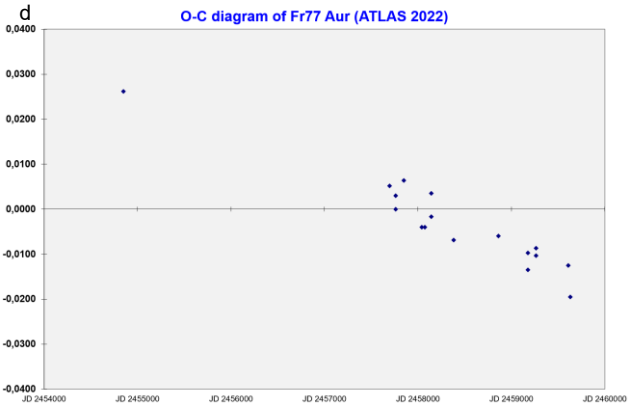

Figure 4

Figure 3: O-C-diagram of Fr77 Aur using the period from VSX and the ZTF project (0.3154564 d).

Figure 4: O-C-diagram of Fr77 Aur using the period from ATLAS project (0.315455 d).

Acknowledgements

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