GSC 3152 1202, a massive eccentric eclipsing binary with a fast apsidal motion.

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Introduction.

The eclipsing binary **GSC 3152 1202 (*P* = 2^d.09, *V* = 12^m.7, *e* = 0.08, *b*= - 0°.27)** was discovered by Otero et al. (2006) by searching the publicly available NSVS (ROTSE) database (Wozniak et al., 2004). The light curve of the system is characterized by the shift of the secondary minimum relatively to the phase 0.5, indicating the ellipticity of the orbit (**Fig.1**). Bulut & Bulut (2015) determined photometric elements from the *B,V,R* light curves of the binary and found its physical parameters neglecting an interstellar reddening. They found very fast period of apsidal motion 36.6 ± 9.8 years, unusual for detached system with *G* spectral types of the components. We present here the main results of a new detailed photometric investigation of the binary. We found a large interstellar absorption and derived *B* spectral type of the components. New physical parameters of the binary fully explain the value of the fast apsidal motion rate, improved in our investigation.

Observations and their analysis.

In 2011-2016 we obtained *UBVRI* photometry of the object with the 0.6-m reflector (equipped by G4-9000 CCD) at the Stará Lesná Observatory (Slovakia), 1-m and 0.6-m reflectors (equipped by CCD VersArray 512UV) of the Mt Koshka and Nauchny observatories in Crimea. We used in our analysis also ROTSE observations and some published *V* light curves. The position of the variable star in a two-colour (*U-B, B-V)* diagram, presented in **Fig. 2**, indicates a strong interstellar absorption: ***E(B-V)* = 1.73, A_V = 5.4, Sp = B2 V**, so **$(U-B)_0$ = - 0.84, $(B-V)_0$ = - 0.24**. A cloud of blue points designates data from the Mermilliod photometric catalogue (Mermilliod, Mermilliod & Hauck,1997). The derived interstellar absorption is more than twice as large as the value *E(B-V)* = 0.76, found from the dust surveys (see http://argonaut.skymaps.info/querry), for the distance 930 pc of the object.

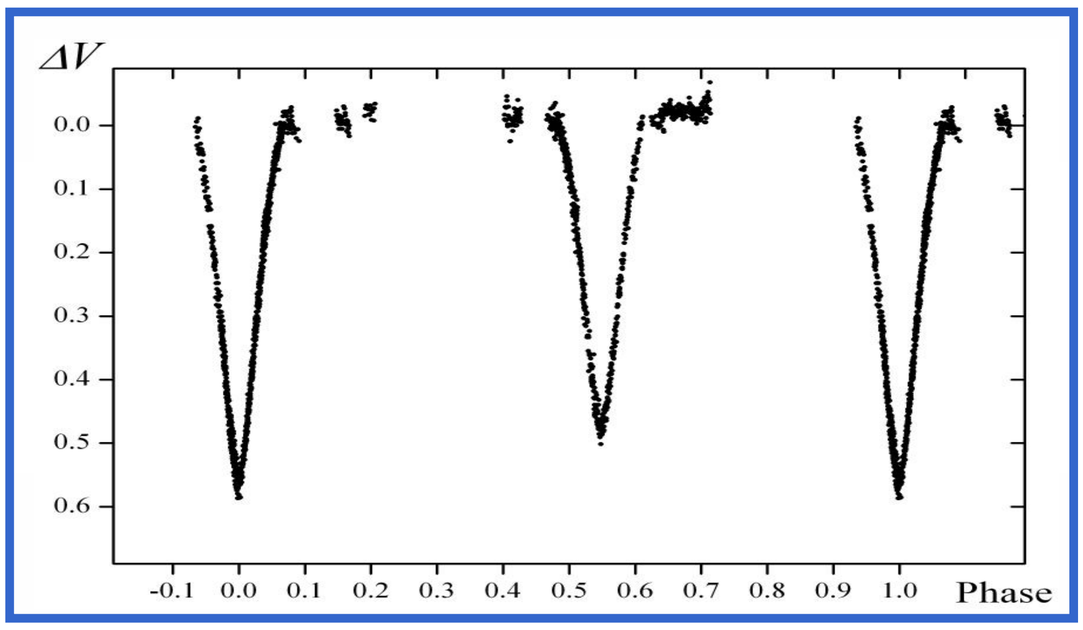

Fig. 1. All available *V*-observations, taken in 2009-2013, phased with the ephemeris (1), determined in our investigation. The phase of the secondary minimum is **ϕ = 0.5485**. This is the largest possible shift of the secondary minimum as the longitude of periastron recently passed zero at JD 2455938 (see **Fig. 4**). The small proximity effects are possible.

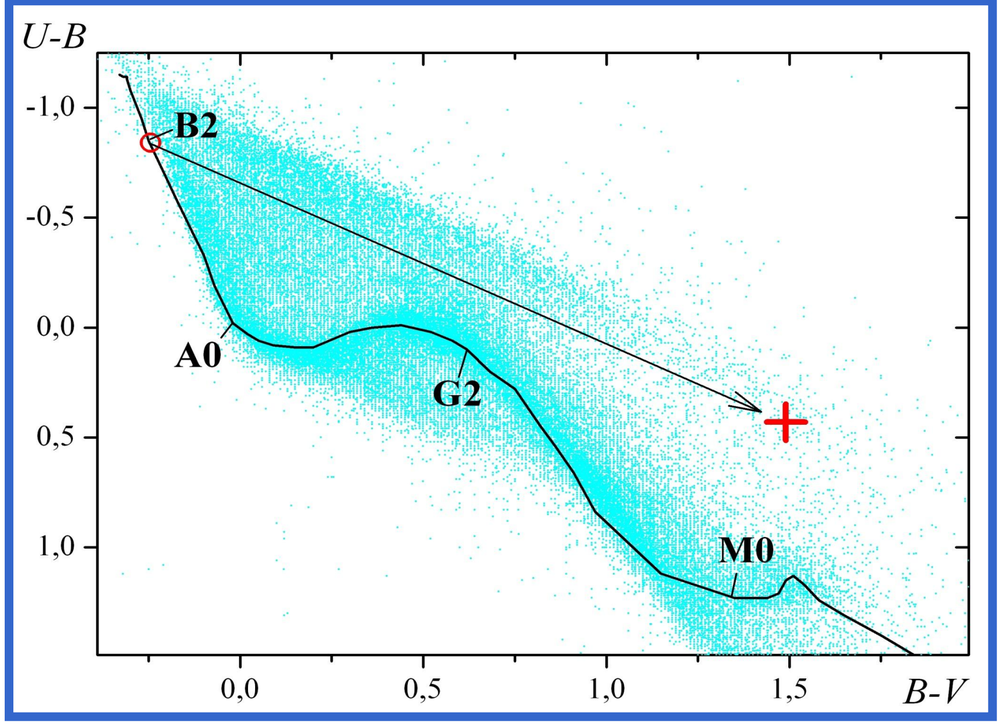

Fig. 2. A two colour (*U-B, B-V)* diagram constructed with the data from the Mermilliod photometric catalogue. Black line designates the fifth luminosity class, (see Straizys, 1992). Observed position of the variable is denoted by a red cross. The arrow indicates the vector of the interstellar absorption. Some spectral classes are also designated.

The light curve solution.

Due to that fact that the longitude of periastron passed zero in January 2012, we constructed the phased light curve (see **Fig.1**) with the same value of the period for the primary and secondary minima, using the ephemeris:

MinI HJD = 2455004.4364 + 2.093772 x *E* . **(1)**

The solution of the *V* light curve, shown in **Fig. 3**, by the modified differential corrections method (Khaliullina & Khaliullin, 1984), is presented in **Table 1**.

Absolute parameters.

From the (*U-B, B-V)* diagram (**Fig. 2**), we found the temperature of combined spectrum of the star as ***T* = 21 300 K,** using the Flower (1996) calibration. The ratio of light obtained from photometric solutions in different spectral bands allowed to get the temperatures of the components and estimate the absolute parameters of the binary from the third Kepler law in combination with a mass-luminosity relation (**Table 2**).

Apsidal motion.

The eclipse time variation diagram (ETV), constructed using published and our own data taken in 2009 – 2017 (**Fig.4**), allowed to determine the rate of periastron motion:

***dω/dt* = 9.1(1)°/year or *U* = 39.5(6) years.**

The theoretical value of the rate of periastron motion is:

***dω/dt* = 8.9(1)°/year or *U* = 40.3 (5) years.**

Table 1. The results of the *V* light curve solution.

Parameter	value
r_1	0.236(2)
r_2	0.189(3)
i	85.96(2)
e	0.083(1)
L_1=1-L_2	0.63(1)
u_1	0.35
u_2	0.38
σ_{o-c}	0^m.0139

Table 2. Absolute parameters of the components.

	Primary	Secondary
M [M☼]	7.5(5)	6.3(5)
R [R☼]	3.98(4)	3.57(5)
log *g*	4.11(4)	4.14(4)
T [K]	21 600 (500)	19 300(400)
M_{bol}	-4.03(7)	-3.31(9)
distance [pc]	930(40)	

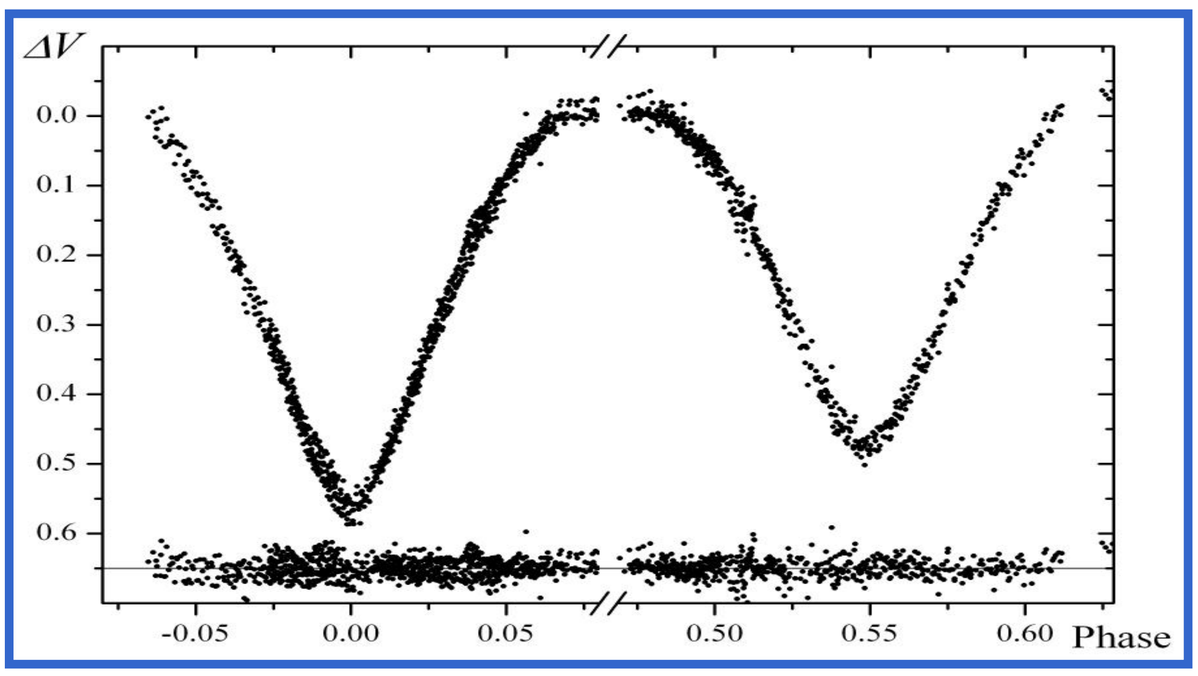

Fig. 3. The photometric *V* light curve of GSC 3152 1202 (except observations obtained in 2014-17) during eclipses and the *O - C* residuals between the observed points and the best fit solution in **Table 1**. The scatter of points in primary minimum may indicate a small physical variability of the secondary component.

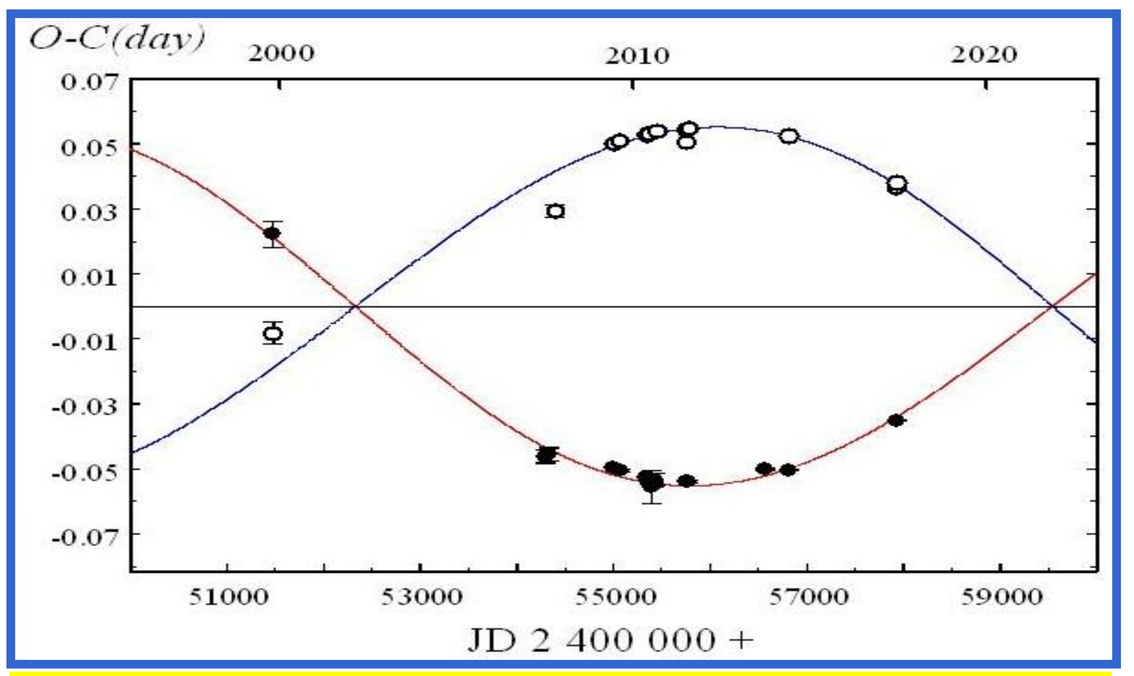

Fig. 4. The ETV diagram of GSC 3152 1202 constructed with the ephemeris **MinI HJD = 2452330.7457 + 2.093769 x *E***. The zero epoch was chosen as the closest to the longitude of periastron **$\omega = 3/2\pi$ ($\phi_{II} = 0.5$)**. **MinII HJD = MinI HJD + P/2**. Filled and empty circles represent the primary and secondary minima, respectively.

Conclusions.

Our observations of GSC 3152 1202 enabled us to construct for the first time a consistent model of the binary and to measure the fast apsidal rotation of its orbit. The binary consists of young stars of the spectral types B2 and B3. It is very interesting, that the object has very large interstellar absorption, similarly as other young stars on elliptic orbits, e.g. GG Ori, E(B-V) = 0.53 (Volkov & Khaliullin, 2002) or GSC 4292 0745, E(B-V)=1.04 (Volkov, Bagaev & Chochol, 2015). Perhaps we are witnessing dissipated circum-stellar dust shells. It seems that the GSC 3152 1202 binary is very young and should be in a stage of a fast circularization of its orbit. The object is very important to test the theory of stellar evolution and needs further photometric and spectroscopic observations.

Acknowledgements.

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