VZ CNC : A VERY INTERESTING DSCT TYPE VARIABLE STAR

Summary: visual estimates of VZ Cnc in 1995 seem to remark the need for a shorter beat period in respect with other values given in the past. The light variation period, fixed to 0.178363704 day by GCVS 1985, could need a positive correction.

Introduction

VZ Cnc is a variable star of δ Scuti type. The last edition of GCVS 1985 gives the following explanation for these stars: "Pulsating variables of spectral types A0-F5 III-V displaying light amplitudes from 0.003 to 0.9 mag in V and periods from 0.01 to 0.2 day . The shapes of the light curves, periods, and amplitudes usually vary greatly. Radial as well as nonradial pulsations are observed. The variability of some members of this type appears sporadically and sometimes completely ceases, this being a consequence of strong amplitude modulation with the lower value of the amplitude not exceeding 0.001 mag included. Light curves are almost exact reflections of the radial-velocity curves. The maximum of the surface layer expansion does not lag behind the maximum light for more than 0.1 period . DSCT stars are representative of the galactic disk (flat component) and are phenomenologically close to the SX Phe variables". VZ Cnc shows a light variation in the range 7.18-7.91 mag in V with a spectre A7 to F2. The Rocznik catalogue provides the following equation (1) for the maximum light:

$$\text{Max hel JD (Rocznik)} = 41304.3694 + 0.178363235 * E \qquad (1a)$$

a value of M-m equal to 0.26 period, and it informs about a beat period showed by this star.
In 1976 Todoran obtained an available value of the beat period by his photoelectric measurements carried out on VZ Cnc. The results, published in the IBVS 1141, are reported below:

$$\text{Max hel JD (Todoran,1976)} = 33631.8655 + 0.17836367 * E \qquad (2a)$$

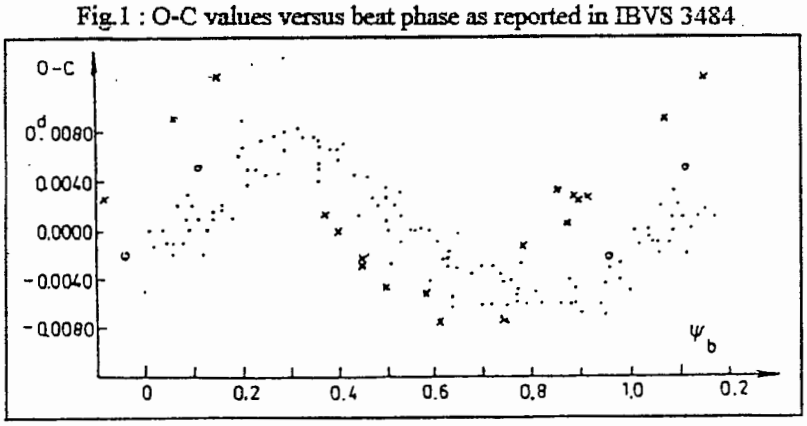
$$\text{Max hel JD } (P_{beat})\text{(Todoran,1976)} = 33631.8605 + 0.716292 * E_b \qquad (2b)$$

Successively both Cester B. et al.(1) and Quester W.(2) proved the beat period was decreased compared with that one given by Todoran. In particular, the latter observer, searching the beat period with maxima times later than JD 2440620, afforded a new one of:

$$0.716280 \leq P_b \leq 0.716288 \quad \text{day}$$

Following O-Cs versus beat phase ψ_b in respect with equation (2b) are presented, obtained by Todoran in 1976 (simple dots), Cester et al. in 1977 (blank circles) and Quester et al. in 1988-1989 (crosses):

Fig.1 : O-C values versus beat phase as reported in IBVS 3484



It is evident the beat period has a value shorter than 0.716292 day.
At last, the GCVS 1985 reports the following equation (3a) for VZ Cnc, with another light variation period:

$$\text{Max hel JD (GCVS 85)} = 39897.4246 + 0.178363704 * E \qquad (3a)$$

Results and discussion

I saw there were many things to verify for VZ Cnc, so I made about 300 visual estimates from February to May 1995 using GEOS finding chart C22. By SOP program[2] I collected 13 heliocentric times of light maximum. Successively, I received other 18 times of maximum by M.Martignoni (which have been submitted to the BAV Mitt.). All these times are reported in the next table, together with O-Cs calculated in respect with previous ephemeris (1a), (2a) and (3a). Besides, the value of the beat phase according to ephemeris (2b) and the sigle of the observer (DDL=D.Dalmazio, MRT=M.Martignoni) are reported:

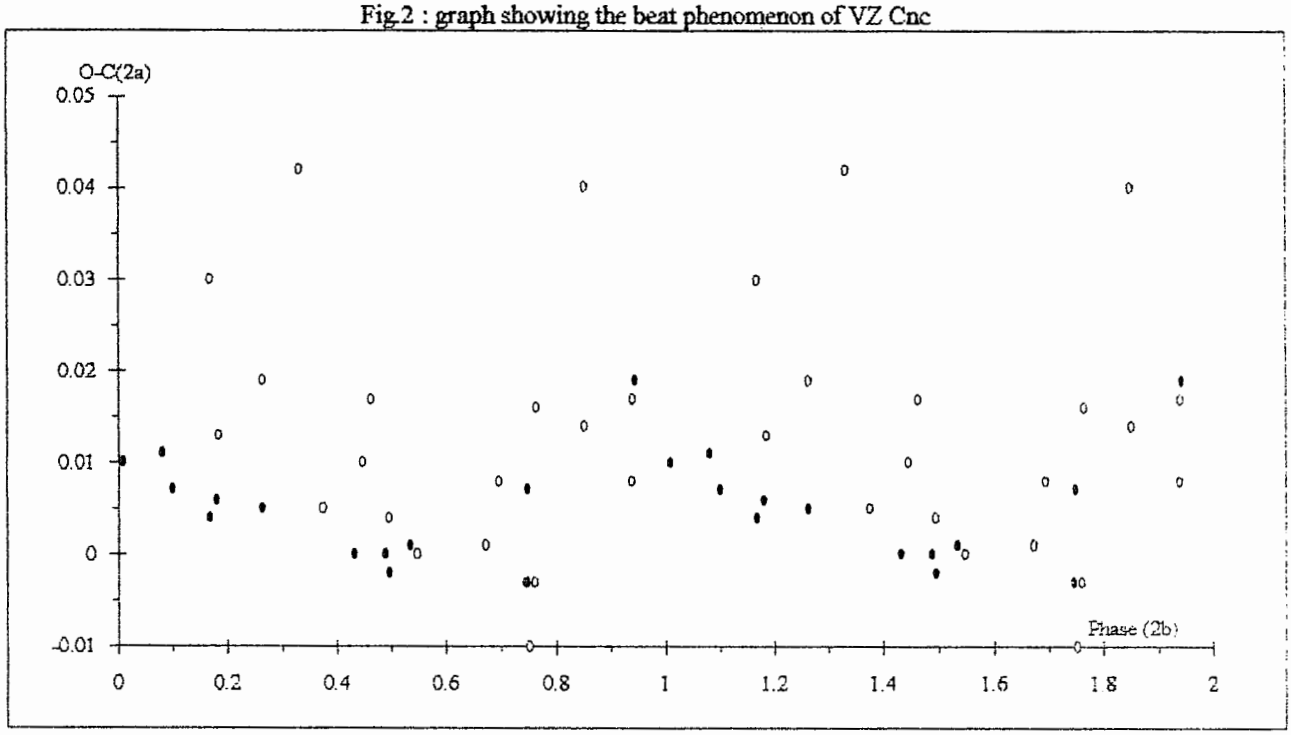
Tab.1 : heliocentric times of maximum of VZ Cnc

MAX HJD	O-C(1a)	O-C(2a)	O-C(3a)	ψ_b(2b)	OBSERVER
49394.414	0.023	0.016	0.014	0.765	MRT
49395.487	0.026	0.019	0.017	0.263	MRT
49415.475	0.037	0.030	0.028	0.168	MRT
49429.357	0.007	0.000	-0.002	0.548	MRT
49719.394	0.026	0.017	0.015	0.463	MRT
49722.410	0.009	0.001	-0.001	0.673	MRT
49723.492	0.021	0.013	0.011	0.184	MRT
49745.458	0.049	0.040	0.038	0.850	MRT
49747.381	0.010	0.001	-0.001	0.535	DDL
49749.384	0.051	0.042	0.040	0.331	MRT
49750.402	-0.002	-0.010	-0.012	0.752	MRT
49750.409	0.005	-0.003	-0.005	0.762	DDL
49755.413	0.015	0.007	0.005	0.748	DDL
49765.403	0.017	0.008	0.006	0.695	MRT
49768.444	0.026	0.017	0.015	0.940	MRT
49768.446	0.028	0.019	0.017	0.943	DDL
49769.323	0.013	0.004	0.002	0.168	DDL
49777.350	0.013	0.005	0.003	0.374	MRT
49783.423	0.022	0.014	0.012	0.852	MRT
49786.452	0.019	0.011	0.009	0.081	DDL
49797.327	0.014	0.005	0.003	0.263	DDL
49798.389	0.006	-0.003	-0.005	0.746	MRT
49799.294	0.019	0.010	0.008	0.009	DDL
49800.354	0.009	0.000	-0.002	0.489	DDL
49800.358	0.013	0.004	0.002	0.495	MRT
49810.342	0.008	0.000	-0.002	0.433	DDL
49810.352	0.018	0.010	0.008	0.447	MRT
49811.420	0.016	0.008	0.006	0.938	MRT
49812.310	0.014	0.006	0.004	0.181	DDL
49827.294	0.016	0.007	0.005	0.100	DDL
49843.337	0.006	-0.002	-0.004	0.497	DDL

Mean value	0.017	0.009	0.007

In the following graph, I report O-Cs versus beat phase ψ_b, as made by others in figure 1. Blank circles indicate Martignoni's observations while filled circles indicate Dalmazio's observations:

Fig.2 : graph showing the beat phenomenon of VZ Cnc



As we see, Martignoni's and Dalmazio's data don't seem to agree. Furthermore, filled circles better follow a sinusoidal trend of O-Cs like reported in figure 1. So I thought to discuss here only the case of the 13 maxima of mine, which could lead at clearer conclusions.
An analysis of these maxima by SOP program[2] reveals a maximum of beat phase at 0.94 ± 0.08. Since about 22570 cycles of beat period elapsed from the time in equation (2a), the beat period must be corrected and its value is:

$$P_b = 0.716258 \pm 0.000002 \text{ day}$$

This period is very different from that one found by Quester in 1989. Therefore it could seem the beat period of VZ Cnc has decreased again, but we have to keep in mind that two different methods have been used to calculate a new period. If I process, as before, Quester et al. maxima, I find a value of beat period more similar to mine:

$$P_b = 0.716260 \pm 0.000004 \text{ day}$$

Probably, nowadays, this is the best beat period for VZ Cnc. In the future we could calculate the difference between our maxima of the beat period and the next revised equation (4b), to confirm or not this conclusion:

$$\text{Max hel JD } (P_{beat}) = 33631.8605 + 0.716258 * E_b \qquad (4b)$$

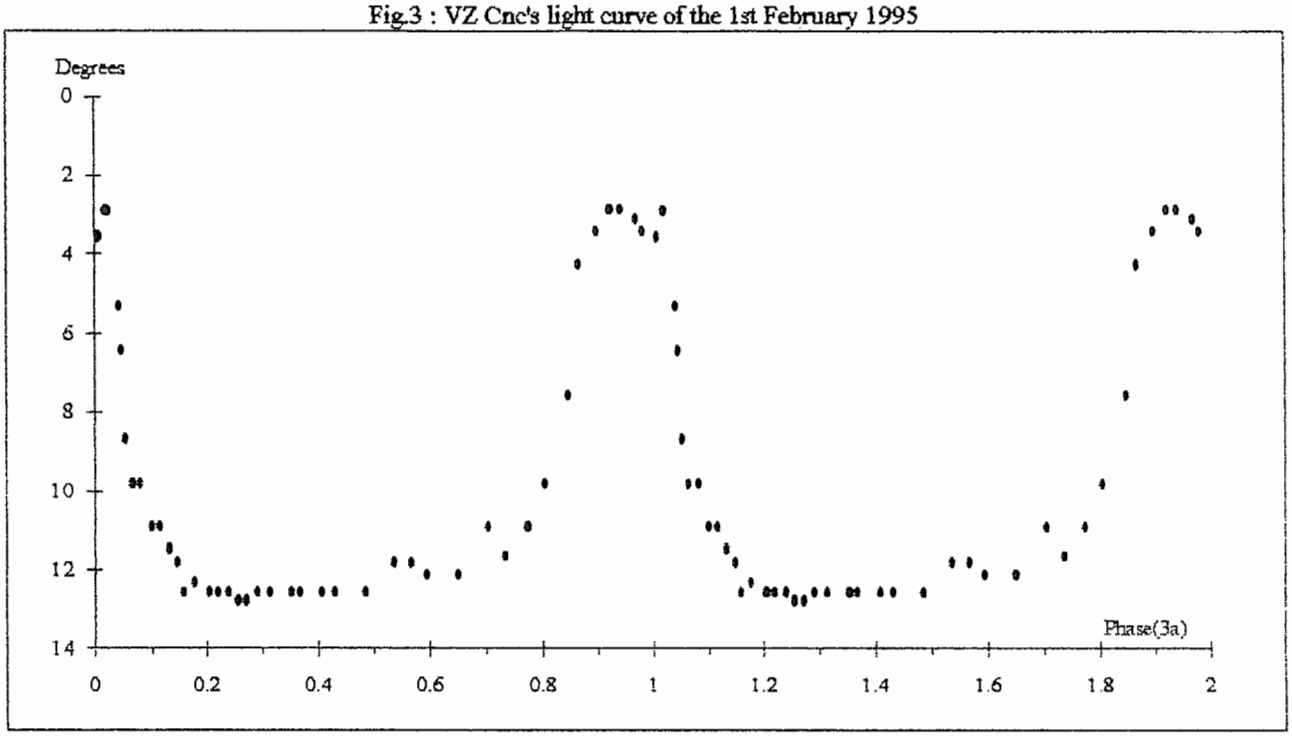
Now I will analyze the further informations taken from the figure 2. The amplitude of the beat curve is rather similar in the different works: its value is about 0.020 day but the mean value of O-C found in 1995 could indicate the need for a correction to bring at the period of equation (2a). As we see from table 1, the best ephemeris is that one of GCVS 1985, but a relevant mean O-C could indicate a

period of light variation greater than 0.178363704: it means the period of VZ Cnc has increased again. Other visual observations in the next winter-spring could clarify this hypothesis.

The light curve

Visual estimates carried out the 1st February 1995 were used to plot a light curve because they covered the whole period. The points were phased according to GCVS 1985 elements, as reported in equation (3a), and the result is depicted below:

Fig.3 : VZ Cnc's light curve of the 1st February 1995



By this graph is difficult to estimate the M-m value, which however seems to be greater than 0.26 phase, as reported in the Rocznik.

Conclusions

Visual observations of VZ Cnc in 1995 seem to remark the need for a new, shorter, beat period in respect with other values given in the past. Nevertheless a deeper analysis revealed the best beat period could be about 0.716260 day and this last one could be more stable than that we could think. Also, the light variation period seems to need a positive correction, but it will be better to collect other times of maximum to propose a new greater period. I hope all GEOS members will like to observe VZ Cnc, a star observable just by a binoculars, to follow only for 2 hours around its maximum but, however, a star to discover. If you will observe VZ Cnc, please send me your data: we could achieve a more concrete result.

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References:

(1) CESTER B. et al., *Information Bulletin on Variable Stars*, **1338** (1977)
(2) QUESTER W., *Information Bulletin on Variable Stars*, **3484** (1990)
(3) GASPANI A., *Stochastic Optimization Program*, **5** (priv. comm.)