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GEOS CIRCULAR ON RR LYR TYPE VARIABLES

1982 February 11

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133 TIMES OF MAXIMUM AND FIRST EPHEMERIS FOR THE RRc STAR VZ DRACONIS

ABSTRACT - 133 TIMES OF MAXIMUM AND FIRST EPHEMERIS FOR THE RRc STAR VZ DRACONIS .

VZ Draconis is an under-studied variable star, photographic range 12.0 to 12.8 (and not 11.4 to 12.2 as reported erroneously in the GCVS (69)). The reference given in the GCVS is a paper by L. MEINUNGER (1961) who classifies VZ Dra as an RR with a 0.47 day period, on the basis of photographic observations made during 6 nights.
The first visual observations made by the GEOS members in 1975 have led to establish that the period given by MEINUNGER was erroneous (A. FIGER, 1977). Some new observations, more accurate and more numerous, namely 4061 visual estimates by 18 GEOS observers in 1977-78 are discussed here.
They have allowed the determination of 133 times of maximum (listed in Tab. 2) , of standard deviation 0.012 day (that is, 17 mn). The value for the period has been derived unequivocally and a proper demonstration is given in § 3.2 . The corresponding ephemeris (error bars at 95 % level of confidence) is:

(4) Maximum = hel. J.D. 24 43 534. 7546 + 0. 321 025 0 E
± .33 ± 6 3

Finally VZ Dra is an RRc , of the SX UMa type according to the classification by LANGE (1960). The M-m value is 0.36 . The mean visual range is of the order of 0.5 magnitude. A detailed analysis of the light curve near maximum (Blazhko effect) would be desirable.

RESUME - 133 DETERMINATIONS DE MAXIMUMS ET PREMIERE EPHEMERIDE POUR L'ETOILE RRc VZ DRACONIS .

VZ Draconis est une étoile variable sous-étudiée, variant de mpg 12,0 à 12,8 (et non 11,4 à 12,2 comme reporté à tort dans le GCVS (69)). La référence bibliographique donnée dans le GCVS est un article de L. MEINUNGER (1961) qui la classe RR et annonce la période de 0,47 jour d'après 6 nuits d'observations photographiques.
Les premières observations visuelles effectuées par les membres du GEOS en 1975 ont permis d'établir que la période donnée par MEINUNGER était erronée (A. FIGER, 1977). De nouvelles observations du GEOS, plus précises et plus nombreuses: 4061 estimations visuelles de 18 observateurs en 1977-78 sont analysées ici.
Elles ont permis de déterminer 133 instants de maximums (listés au Tableau 2) d'écart-type 0,012 jour (soit 17 mn). La valeur de la période de VZ Dra a pu être obtenue sans aucune équivoque : une démonstration appropriée est donnée au § 3.2 . L'éphéméride correspondante est :

(4) Maximum = J.J. hél. 24 43 534, 7546 + 0, 321 025 0 E (bandes d'erreur au niveau de confiance de 95 %)
± 33 ± 6 3

En définitive VZ Dra est une RRc , du type SX UMa selon la classification de LANGE (1960). Le M-m vaut 0,36 . L'amplitude visuelle moyenne est de l'ordre de 0,5 magnitude. Une analyse fine de la courbe de lumière au moment du maximum (effet Blazhko) serait souhaitable.

RIASSUNTO - 133 DETERMINAZIONI DI MASSIMI E PRIMA EFFEMERIDE PER LA VARIABILE RRc VZ DRACONIS .

VZ Draconis è una variabile poco studiata, variante fra le magnitudini fotografiche 12.0 e 12.8 (e non 11.4 - 12.2 come mal riportato nel GCVS 1969). La citazione bibliografica data dal GCVS è un articolo di L. MEINUNGER (1961) che la classifica come RR e annuncia il periodo di 0.47 d sulla base di 6 notti d'osservazioni fotografiche.
Le prime osservazioni visuali effettuate dai membri del GEOS nel 1975 hanno permesso di stabilire che il periodo dato da MEINUNGER è errato (A. FIGER, 1977). Sono qui analizzate nuove osservazioni del GEOS, più precise e numerose (4061 stime visuali di 18 osservatori nel 1977-78). Esse hanno permesso di determinare 133 tempi di massimo (elencati nella tab. 2), con scarto quadratico medio 0.012 d (cioè 17 minuti). E' stato possibile ottenere il periodo di VZ Dra senz'alcuna ambiguità: nel § 3.2 è data un'apposita dimostrazione. La corrispondente effemeride è, con barre d'errore al livello di confidenza del 95 % :

(4) Max. elioc. = 24 43 534. 7546 + 0. 321 025 0 x E
± . 0033 ± . 000 006 3

In definitiva VZ Dra è una RRc, del tipo SX UMa secondo la classificazione di LANGE (1960), con M-m = 0.36 . L'ampiezza visuale media è dell'ordine di 0.5 mag . E'auspicabile un'analisi dettagliata della curva di luce intorno ai massimi (effetto Blazhko).

RESUMEN - 133 DETERMINACIONES DE MAXIMOS Y PRIMERA EFEMERIDE PARA LA ESTRELLA RRc VZ DRACONIS .

VZ Draconis es una estrella variable subestudiada, que varía entre la magnitud 12,0 y la 12,8 fotográficas (y no entre la 11,4 y la 12,2 como consta erróneamente en el GCVS(69)). La referencia bibliográfica dada en el GCVS es un trabajo de L. MEINUNGER (1961) que la clasifica como RR y anuncia el periodo de 0,47 días, basándose en seis noches de observaciones fotográficas.
Las primeras observaciones visuales efectuadas por miembros del GEOS en 1975 permitieron establecer que el periodo dado por MEINUNGER era erróneo (A. FIGER, 1977). Nuevas observaciones del GEOS, más precisas y numerosas, son las que aquí se analizan. Se trata de 4061 estimaciones visuales de 18 observadores, hechas en 1977-78.
Estas han permitido determinar 133 instantes de máximo (ver Tabla 2), de desviación-tipo 0,012 días (que equivale a 17 minutos). El valor del periodo de VZ Dra ha podido obtenerse sin ningún equívoco, como se demuestra adecuadamente en § 3.2 . La efeméride correspondiente, con bandas de error para un nivel de confianza del 95 % , es :

(4) Máximo : D.J. Heliocéntrico 24 43 534, 7546 + 0, 321 025 0 E
± 33 ± 6 3

En conclusión, VZ Dra es una RRc, del tipo SX UMa según la clasificación de LANGE (1960). El M-m es de 0,36 . La amplitud visual media es del orden de 0,5 magnitudes. Un análisis fino de la curva de luz en el máximo sería deseable, al objeto de determinar el efecto Blazhko.

1. INTRODUCTION

VZ Draconis, with coordinates 1950.0 : α 16h20m24s , δ +58 33' , is classified in the General Catalogue of Variable Stars (B.V. KUKARKIN et al.,1969), as an RR star with a 0.47 day period. No ephemeris is given. The reference is a paper (L. MEINUNGER , 1961) mainly based on the photographic light curves obtained during 6 nights in 1961. On these curves the range of variation is mpg 12.0 - 12.8 instead of mpg 11.4 - 12.2 as accepted in the GCVS. The height of the maxima seems to vary between mpg 12.0 - 12.4 on a time-scale of several days. The star has an A-spectrum (W. GÖTZ and W. WENZEL , 1961).

In 1975 we added this understudied star to the GEOS observing programme, taking the opportunity of our summer camp of VARS 1975 (in the southern French Alps). In spite of the poor quality of the observations at VARS due to an error by most of the observers when choosing the comparison stars, the RR Lyrae type could be confirmed and the 0.47 day period of L. MEINUNGER turned out to be erroneous : the true period being in fact shorter (A. FIGER , 1977). Further observations were required in order to derive an accurate first ephemeris.

In this paper such observations are analysed. They were made by the GEOS observers in 1977 and 1978.

2. OBSERVATIONS

The observations available are visual estimates using the two comparison stars . A and B (see Figure 1).

The accurate visual magnitudes for A and B are not known. Our estimations are : A = 11.3 and B = 12.7 . It must be noted that an error on these values does not affect the shape of the light curves or the times of extrema, but only the range of variation and the magnitude of the star which will have to be considered in this study as indicative values.

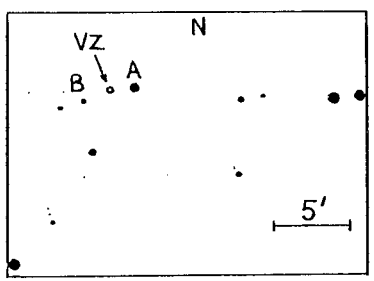

Figure 1 . VZ Dra and its comparison stars .

More than 4000 visual estimates were performed by 18 observers in 1977 and 1978 (see Table 1). Most of the observations were made during the GEOS summer camps at ST ROME (August 1977) and CHAMALOC (July-August 78) in southern France. We used there several telescopes, the 256 mm (f/D = 5.6 , built by J. LECACHEUX) being reserved to VZ Draconis only. The star was kept in the field of this instrument during almost the whole night, typically from 20 - 21 h U.T. to 2 - 3 h U.T. . All the observers estimated the magnitude of the star in turn, a whole cycle including 10 to 12 observers and taking about 8 to 15 minutes. As the observers were busy estimating other stars with binoculars and the other telescopes, they could not remember their successive estimates of VZ Dra, and thus were better protected against the risks of bias.

The magnifications used with the 256 mm reflector were 115 and 180 , corresponding to fields of 28' and 18', which are very convenient for the estimation of VZ Dra. The only problem was the large brightness difference between A and B : the magnitude level of the maximum brightness, near the middle of interval AB is difficult to estimate accurately. As a consequence, comparing maximum brightness determined on different nights, so as to investigate the Blazhko effect, is very questionable. But the magnitude of the minimum is better estimated, as the brightness of VZ Dra at minimum is very close to that of B .

LIST OF THE OBSERVERS			YEAR 1977		YEAR 1978		TOTAL
Name	Origin	Initials	ST ROME camp	Other	CHAMALOC camp	Other	1977-78
A. FIGER	F_ Paris	FGR	268	129	323	124	844
Ph. RALINCOURT	F_ Nantes	RAL	168		241		409
R. ROLLAND	F_ Rennes	ROL	213	104			317
C. ROMOLI	I_ Altopascio	RML	173		108		281
M. PENNA	I_ Asti	MPN	118		159		277
P. GUIRAUDOU	F_ Montgeron	GUI	130		115		245
S. WABNITZ	I_ Roma	WAB			239		239
JL. DUQUESNE	F_ Ramonville	DUQ			225		225
JF. LE BORGNE	F_ Brest	FLB	105		108		213
P. ALBERT	F_ Angers	ALB			204		204
E. PORETTI	I_ Arconate	POI			202		202
A. ROYER	F_ Epinac	ROY	64		97		161
M. JORDY	F_ Toulouse	JOR			107		107
B. BOUZIN	F_ Toulouse	BOU	104				104
A. GRYCAN	F_ Toulouse	GRY	45		47		92
R. BONINSEGNA	B_ Dourbes	BNN	89				89
G. TROISPOUX	F_ Orléans	TRP			43		43
A. MAROT	F_ Quimper	MAR	9				9
18 Observers			1486	233	2218	124	4061

Table 1 . Number of visual estimates performed in 1977 and 1978 .

3. DISCUSSION

3.1 List of the observed maxima

All the available estimates have been plotted in individual light curves specific for each observer. These light curves are quite representative of the variation of an RR Lyrae type star, with a fast increase in brightness of several tenths of magnitude in nearly 2 hours, a slower decrease during about 5 hours, and the maxima better defined than the minima.

Figure 2 shows several light curves of VZ Dra, obtained by some of the most active observers. According to a few observers the star remains quite brighter than B at minimum brightness. Such systematic deviations between visual observers are well-known (see for example : A. FIGER , 1975).

The times of all the observed maxima are listed in the Table 2. They were derived from the individual light curves by one or more GEOS members, using manual smoothing. When several members made the determination, the mean value was taken (in that case we often used tenths of minute in Table 2).
There are 133 observed maxima : 84 at CHAMALOC (by 14 observers), 30 at ST ROME (7 observers) , 12 at PARIS (FGR) , 7 at RENNES (ROL).

This material is rather heterogeneous. In fact some determinations, based on a few dispersed points seem quite imprecise and might have been rejected. We thought however that eliminating

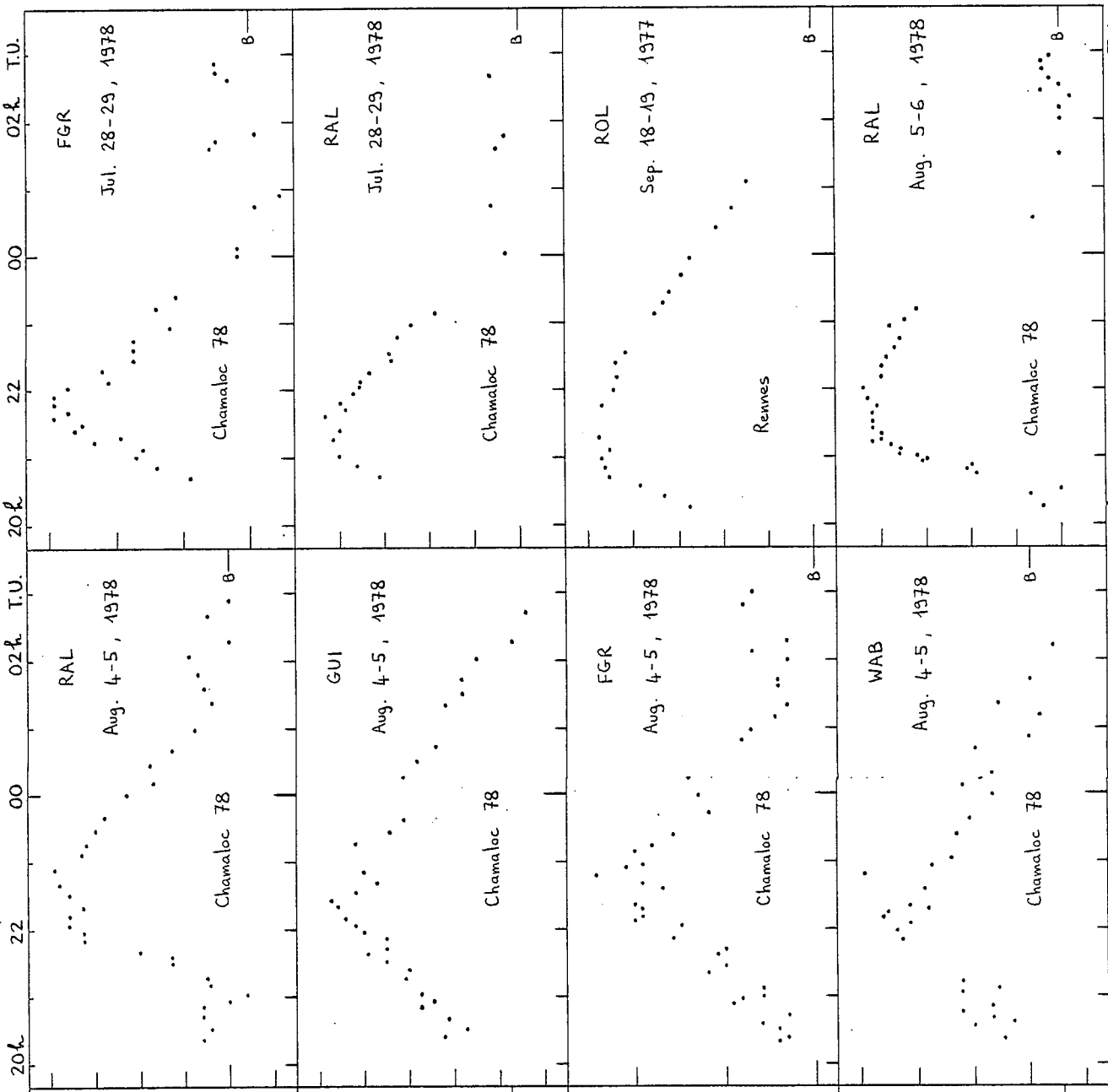

Figure 2. Some visual light curves of VZ Dra. The scale of ordinates is in tenths of the range AB ; the brightness of comparison star B is shown, whenever possible, at the right of the curves.

GEOCENTRIC TIME OF MAXIMUM U.T.	OBSERVER Initials	OBSERVER Site	HELIOCENTRIC TIME OF MAXIMUM Hel. Corr. $\times 10^{-4}$ day	HELIOCENTRIC TIME OF MAXIMUM J.J. 24 43 000 +
1977				
03 AUG 00h08	FGR	Paris	− 4	358 . 5052
05 AUG 21h32	GUI	S^t Rome	− 5	361 . 3967
21h37	BNN	"	"	. 4002
21h42	FGR	"	"	. 4037
21h43	RAL	"	"	. 4044
21h58	RML	"	"	. 4148
09 AUG 02h10,5	GUI	"	− 5	364 . 5901
02h14.5	RML	"	"	. 5929
02h19	BNN	"	"	. 5960
02h21	ROL	"	"	. 5974
02h24	FLB	"	"	. 5995
02h24.5	FGR	"	"	. 5998
02h40	RAL	"	"	. 6106
10 AUG 01h32	FGR	"	− 5	365 . 5634
11 AUG 00h23	FLB	"	− 6	366 . 5154
00h30	FGR	"	"	. 5202
00h35	GUI	"	"	. 5237
01h19	RAL	"	"	. 5543
01h23	ROL	"	"	. 5570
11 AUG 23h47	FGR	"	− 6	367 . 4904
13 AUG 21h41	GUI	"	− 6	369 . 4029
21h43	FLB	"	"	. 4043
21h47	FGR	"	"	. 4070
22h08.5	BNN	"	"	. 4220
22h10	RML	"	"	. 4230
22h23.5	ROL	"	"	. 4324
22h28	RAL	"	"	. 4355
14 AUG 21h18.5	BNN	"	− 7	370 . 3871
21h20	FGR	"	"	. 3882
21h24	FLB	"	"	. 3910
21h42	ROL	"	"	. 4035
01 SEP 20h38	FGR	Paris	− 10	388 . 3587
09 SEP 21h33	FGR	"	− 11	396 . 3968
10 SEP 20h53	FGR	"	− 11	397 . 3690
11 SEP 20h06	FGR	"	− 11	398 . 3364
12 SEP 03h12	ROL	Rennes	− 11	. 6322
17 SEP 22h21	ROL	"	− 12	404 . 4301
18 SEP 21h13	FGR	Paris	− 12	405 . 3828
21h26.5	ROL	Rennes	"	. 3922
27 SEP 21h26	FGR	Paris	− 13	414 . 3918
12 OCT 23h16	ROL	Rennes	− 13	429 . 4681
13 OCT 22h08	ROL	"	− 13	430 . 4209
15 OCT 20h08	ROL	"	− 13	432 . 3376
16 OCT 19h20	ROL	"	− 13	433 . 3043
1978				
12 JUN 00h20	FGR	Paris	+ 7	671 . 5146
30 JUN 22h58.5	FGR	"	+ 3	690 . 4576
16 JUL 00h52	FGR	"	0	705 . 5361
27 JUL 21h59.0	WAB	Chamaloc	− 3	717 . 4157
22h12.2	RAL	"	"	. 4248
22h24	JOR	"	"	. 4330
22h24.2	FGR	"	"	. 4332
22h51.8	DUQ	"	"	. 4523
28 JUL 21h12.0	WAB	"	− 3	718 . 3830
21h18.0	DUQ	"	"	. 3872
21h20.4	ALB	"	"	. 3889
21h21.4	RAL	"	"	. 3896
21h26	ROY	"	"	. 3928
21h29.5	POI	"	"	. 3952
21h30.5	TRP	"	"	. 3959
21h35	JOR	"	"	. 3990
21h37.0	MPN	"	"	. 4004
21h43.4	FGR	"	"	. 4048
21h45.0	FLB	"	"	. 4060
02 AUG 00h21.3	FLB	"	− 4	722 . 5144
00h53	ALB	"	"	. 5364

GEOCENTRIC TIME OF MAXIMUM U.T.	OBSERVER Initials	OBSERVER Site	HELIOCENTRIC TIME OF MAXIMUM Hel. Corr. $\times 10^{-4}$ day	HELIOCENTRIC TIME OF MAXIMUM JJ.24 43 000 +
1978 (Cont.)				
02 AUG 01h14.5	DUQ	Chamaloc	− 4	722 . 5513
01h16.2	RAL	"	"	. 5525
01h23.2	WAB	"	"	. 5574
01h28.2	GUI	"	"	. 5609
01h40.8	FGR	"	"	. 5696
02h00.5	POI	"	"	. 5833
02h11.8	MPN	"	"	. 5911
03 AUG 00h10.7	MPN	"	− 4	723 . 5070
00h17.9	RAL	"	"	. 5120
00h27.3	ALB	"	"	. 5186
00h29.6	WAB	"	"	. 5202
00h30	POI	"	"	. 5204
00h34.5	DUQ	"	"	. 5236
00h41.7	FGR	"	"	. 5286
00h49.5	FLB	"	"	. 5340
04 AUG 22h00.0	WAB	"	− 4	725 . 4163
22h09.5	FLB	"	"	. 4229
22h18.3	MPN	"	"	. 4290
22h19.0	GUI	"	"	. 4295
22h26.5	RML	"	"	. 4347
22h27.0	RAL	"	"	. 4350
22h32	ROY	"	"	. 4385
22h35.8	ALB	"	"	. 4411
22h36	TRP	"	"	. 4413
22h38.9	FGR	"	"	. 4433
22h54.3	DUQ	"	"	. 4540
22h57.5	POI	"	"	. 4562
05 AUG 21h07.6	WAB	"	− 5	726 . 3798
21h17.0	GUI	"	"	. 3863
21h25.0	FLB	"	"	. 3919
21h28	ROY	"	"	. 3939
21h30	JOR	"	"	. 3953
21h32.0	DUQ	"	"	. 3967
21h38.2	RAL	"	"	. 4010
21h38.3	MPN	"	"	. 4011
21h45	GRY	"	"	. 4058
21h47.8	ALB	"	"	. 4077
21h50.5	POI	"	"	. 4096
21h55.0	FGR	"	"	. 4127
21h57.0	RML	"	"	. 4141
10 AUG 01h18.8	GUI	"	− 5	730 . 5542
01h29.8	POI	"	"	. 5619
01h31.8	WAB	"	"	. 5633
01h36.0	MPN	"	"	. 5662
01h44.3	FGR	"	"	. 5719
01h45	ALB	"	"	. 5724
01h50.5	DUQ	"	"	. 5762
01h51.2	RAL	"	"	. 5767
11 AUG 00h16.0	RML	"	− 6	731 . 5105
00h25.3	GUI	"	"	. 5174
00h38.3	ALB	"	"	. 5260
00h51.3	POI	"	"	. 5350
00h53.8	WAB	"	"	. 5368
01h01.3	RAL	"	"	. 5420
01h12.5	FGR	"	"	. 5497
01h12.5	MPN	"	"	. 5497
12 AUG 00h04.1	WAB	"	− 6	732 . 5022
00h05	ROY	"	"	. 5029
00h07.8	DUQ	"	"	. 5048
00h15.8	POI	"	"	. 5104
00h18.8	ALB	"	"	. 5125
00h30	MPN	"	"	. 5202
12 AUG 22h47	ROY	"	− 6	733 . 4487
22h50.5	ALB	"	"	. 4511
22h59	FGR	"	"	. 4570
23h37.5	DUQ	"	"	. 4838
22 AUG 22h08	FGR	Paris	− 8	743 . 4214
07 OCT 19h50	FGR	"	− 14	789 . 3250

Table 2 . List of the 133 observed maxima .

a lot of series was too arbitrary and decided on retaining the whole.

The 133 determinations are relative to 35 different maxima of VZ Dra. Table 3 lists the 35 times of the mean maxima obtained by averaging the " n " individual timings for each observer.

The standard deviation of the 84 individual timings made at CHAMALOC is : s_1 = 0.0119 day. This value is very consistent with that obtained from the individual timings of ST ROME, equal to 0.0110 day. Using the CHAMALOC observations together with the ST ROME series, we find a standard deviation of 0.0117 day (or 16.8 mn).
The standard deviation of the CHAMALOC mean maxima, as calculated from s_1 , is : s = 0.0044 day. This value will be of use further down in this study.

Number n	HELIOC. TIME OF MEAN MAXIMUM J.D. 2443000 +	E	O-C	Number n	HELIOC. TIME OF MEAN MAXIMUM J.D. 2443000 +	E	O-C
1	358.5052	-549	-.0066	1	432.3376	-319	-.0100
5	361.4039	-540	+.0028	1	433.3043	-316	-.0064
7	364.5980	-530	-.0133	1	671.5146	426	+.0034
1	365.5634	-527	-.0110	1	690.4576	485	+.0059
5	366.5341	-524	-.0034	1	705.5361	532	-.0038
1	367.4904	-521	-.0101	5	717.4318	569	+.0140
7	369.4182	-515	-.0085	11	718.3948	572	+.0139
4	370.3924	-512	+.0026	9	722.5574	585	+.0032
1	388.3587	-456	-.0085	8	723.5206	588	+.0033
1	396.3968	-431	+.0040	12	725.4368	594	-.0066
1	397.3690	-428	+.0131	13	726.3997	597	-.0068
1	398.3364	-425	+.0175	8	730.5679	610	-.0119
1	398.6322	-424	-.0078	8	731.5334	613	-.0095
1	404.4301	-406	+.0117	6	732.5088	616	+.0028
2	405.3875	-403	+.0060	4	733.4602	619	-.0089
1	414.3918	-375	+.0216	1	743.4214	650	+.0006
1	429.4681	-328	+.0097	1	789.3250	793	-.0024
1	430.4209	-325	-.0005				

Table 3 . List of the mean maxima in 1977 and 1978 . n is the number of observers, E and O-C refer to ephemeris (4) (see § 3.3).

3.2 Evaluation of the period

The period is of the order of 6 ÷ 8 hours. It is in fact just a little too long to allow an accurate determination through direct observation. As a matter of fact, the longest observing-session lasted 7 hours at ST ROME and 6 h 40 m at CHAMALOC.

It is easier to get a multiple of the period : the maxima of VZ Dra occur day after day about one hour earlier. Such a daily drift is shown on Figure 3, using the 10 mean times of the observed maxima from CHAMALOC. We have plotted in ordinate the hour of the maximum occuring in the night, in relation with the date of the night of observation.

The daily drift is 0.037 ± 0.004 day so D = 0.963 day = 23.1 hours is a multiple of the period T .

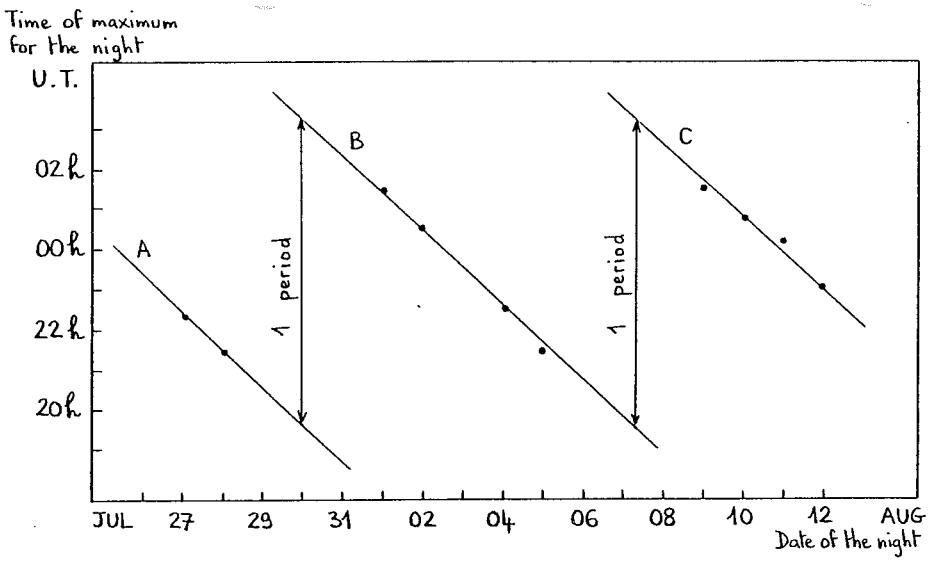

Figure 3. VZ Dra : daily drift in the occurence of the maxima. Each dot represents a mean maximum from the CHAMALOC series.

Only both sub-multiples D/3 (=7.7 hours) and D/4 (=5.8 hours) are suitable candidates for the value of the period T. Choosing between D/3 and D/4 requires an appropriate demonstration.

Let us come back to Figure 3 . The 10 dots are arranged on 3 parallel straight lines A,B,C, with a relative shift of 1 period. Assuming a value for the period, it is possible to plot all the dots on the same straight line B and to compute a linear regression using the 10 available mean maxima. For each tested value of the period T we then compute the standard deviation s' of the points. The result is shown on Figure 4 with s' as a function of T.

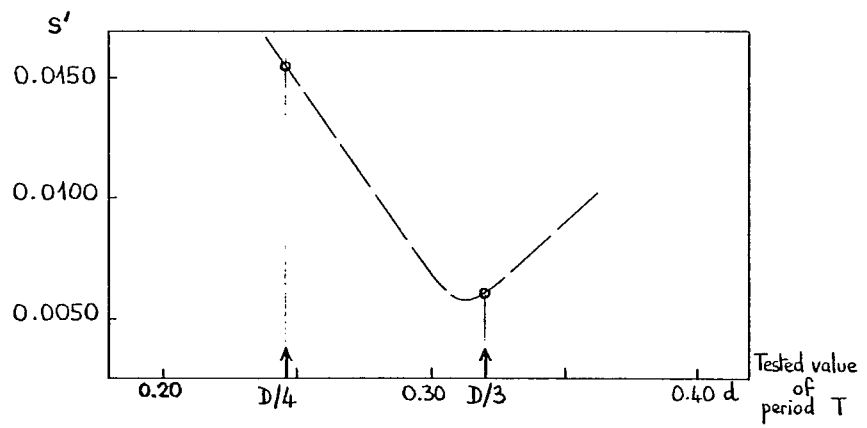

Figure 4. Discrimination of both candidates for the period of VZ Dra. The fit for 0.321 day (D/3) is extremely good.

The 0.321 day period (D/3) fits especially well. Its s' (= 0.0060 day) is very close to the minimum standard deviation. Note also the consistency between both values independently computed for the standard deviation of the CHAMALOC mean maxima, when the 0.321 day period is adopted : s' = 0.0060 day compares well with s = 0.0044 day, as computed at the end of § 3.1 . On the contrary, the 0.24 day value (D/4) gives neither a good fit on Figure 4 , nor a value for s' coherent with s : in fact s' = 0.0156 day. This value is quite large and moreover corresponds to a strongly biased distribution of the O-C's against the elapsed time.
As a consequence the sub-multiple D/4 must be rejected, and the true period is D/3 . Using all the 15 mean maxima of 1978, the following ephemeris is derived :

(1) Maximum = Hel. J.D. 24 43 724. 1591 + 0. 320 995 E
± 44 ± 57
(95 % confidence interval)

3.3 Determination of an accurate mean period

We have computed two other ephemerides, independent from the previous one.
Ephemeris (2) has been calculated from the GEOS maxima, observed in 1977 (20 mean maxima).
Ephemeris (3) is a reinterpretation of the photographic measures of L.MEINUNGER issued in 1961. Table 4 lists the observed maxima by MEINUNGER and their O-C's according to ephemeris (3). The O-C's are quite large but their standard deviation is still twice smaller than that found with the 0.47 day period announced by MEINUNGER.

(2) Maximum = Hel. J.D. 24 43 392. 5406 + 0. 321 070 E
± 47 ± 59

(3) Maximum = Hel. J.D. 24 37 558. 766 + 0. 321 11 E
± 27 ± 51

TIME OF MAXIMUM	E	O-C
Hel.J.D. 24 37 543.35	- 48	- 0.002
37 544.32	- 45	+ 0.005
37 545.30:	- 42	+ 0.021
37 558.405	- 1	- 0.039
37 575.475	+ 52	+ 0.012
37 586.385	+ 86	+ 0.004

Table 4. Observed maxima by MEINUNGER.
E and O-C refer to ephemeris (3).

The three ephemerides (1),(2) and (3) agree well together. The value for the period, found from (1) and (2) to be 0.321032 ± 0.000041 day, is accurate enough to allow us to link the observations of 1977 and those of 1978 in one manner only ; so the number of elapsed periods between the epochs used as a basis for the ephemerides (1) and (2) is : 1033 . Using this figure we have computed ephemeris (4) taking in account all the 1977 and 1978 observations :

(4) Maximum = Hel. J.D. 24 43 534. 7546 + 0. 321 025 0 E
± 33 ± 6 3

Now let us try to link the GEOS observations with those of MEINUNGER. The elapsed time Δt between the epochs of ephemerides (3) and (4) is : Δt = 5975.989 ± 0.027 . Then ,
Δt/T = 18 615.34 ± 0.38 .
Assuming the constancy of the period, one integer value of E only agrees with the computed Δt/T value. However the error bars (at 95 %) are rather large and an integer value of E = 18 616 cannot be totally excluded. That is why we did not compute a mean period for the years 1961 to 1978.

Note that the GEOS observations of 1975 agree well with ephemeris (4) but are too imprecise to be used to improve the results and to help to a better connection with the 1961 observations.
Note also that the hypothesis of a period constant within 10^{-5} or 10^{-6} day is very questionable. Other RRc stars, as RZ Cep, show larger variations in period.

3.4 Light curve of VZ Draconis

The height of the maxima is variable. This phenomenon, discovered by MEINUNGER (1961), has probably been observed by several visual observers at STROME 77 and CHAMALOC 78.

Nevertheless the results are quite imprecise due to the lack of a convenient comparison star (as already mentioned in § 2.). This is why an examination of the Blazhko effect, which would require a lengthy study, has not been attempted yet. At first glance the Blazhko period could be about one or two weeks.

VZ Dra might have a double maximum, as this feature is present on various individual light curves. A detailed analysis would be required to clear up this question. In any case, the mean curve including all the estimates of the three most productive observers in 1977 and 1978 (FGR, RAL, ROL) can just show a smoothed variation (see Figure 5). Table 5 gives the M-m value for each year and each observer. The mean value is : M-m = 0.36 .

OBSERVER	YEAR	ESTIMATES NUMBER	AMPLITUDE mag.	PHASE OF MAXIMUM	"M-m" VALUE
FIGER	1977	360	0.34	0.99	0.36
"	1978	323	0.30	0.02	0.35
RALINCOURT	1977	168	0.51	0.05	0.37
"	1978	241	0.53	0.99	0.36
ROLLAND	1977	317	0.46	0.03	0.35

Table 5 . VZ Dra : M-m values from the individual mean light curves by FGR , RAL , ROL (1409 estimates).
Phase of maximum refers to ephemeris (4).

3.5 Classification

VZ Draconis is doubtless an RRc type star (log P = -0.493 , and spectrum A). Note that the only spectral determination available was made at J.D. 24 37 353. 640 (GÜTZ and WENZEL, 1961), that is near the maximum of light. The star is of SX UMa type according to the classification proposed by LANGE (1960).

The M-m , 0.36 , is also typical : for example RZ Cep (0.32), DE Lac (0.33) and DH Peg (0.38) show very similar values.

4. CONCLUSION

VZ Draconis is an RRc type star with a period of 0.321 025 day and an amplitude of about 0.5 magnitude.

Ephemeris (4) represents well the elements of the variation for 1977 and 1978. This ephemeris seems to be rather accurate, but it will be of interest to check it in the near future. To that matter, let us emphasize that :

- all the times have been determined assuming a unique smoothed maximum,
- when computing the period, the Blazhko effect has been disregarded,
- the RRc star RZ Cep, very similar to VZ Dra in period and M-m has a strongly variable period.

As a consequence GEOS intends to start further investigations regarding VZ Dra.

A. FIGER

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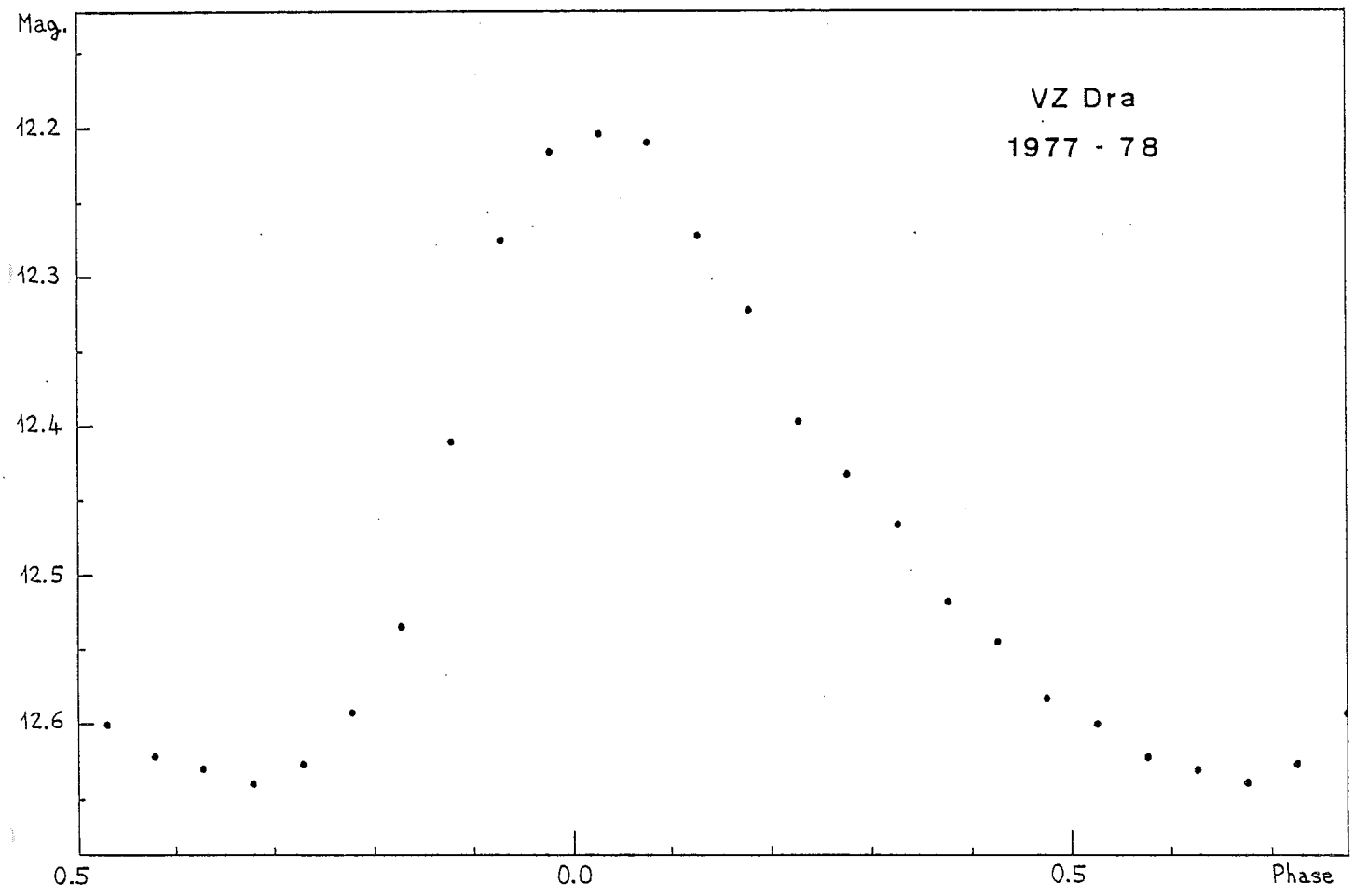

Figure 5. Mean light curve of 1409 estimates by FGR, RAL, ROL. Dots are means on fractions of 0.05 period.