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IMPROVEMENT OF THE PERIOD FOR THE RR LYR STAR TZ AURIGAE.

Abstract:

From the times of maximum light published by Tsesevich, and those obtained visually by members of the GEOS and the BAV, an ephemeris can be computed :

$$\text{Max (J.D.Hel)} = \underset{\pm\ 18}{2\ 419\ 902.4287} + \underset{\pm\ 77}{0.391\ 674\ 800}\ *E$$

This confirms that the period of TZ Aur has not significantly changed over an interval of more than 70.000 cycles.

Résumé:

A l'aide des instants de maximums publiés par Tsesevich et des maximums observés visuellement par des membres du GEOS et du BAV, une nouvelle éphéméride a pu être calculée :

$$\text{Max (J.D.Hel)} = \underset{\pm\ 18}{2\ 419\ 902.4287} + \underset{\pm\ 77}{0.391\ 674\ 800}\ *E$$

Ceci confirme que la période de TZ Aur n'a pas significativement changé sur plus de 70.000 cycles.

Resumen:

Con la ayuda de los instantes de los maximos publicados por Tsesevich y de los maximos observados visualmente por los miembros des GEOS y del BAV, se ha podido calcular una nueva efeméride :

$$\text{Max (J.D.Hel)} = \underset{\pm\ 18}{2\ 419\ 902.4287} + \underset{\pm\ 77}{0.391\ 674\ 800}\ *E$$

Esto confirma que el periodo de TZ Aur no ha variado significativamente tras mas de 70.000 ciclos.

Riassunto:

Utilizzando gli istanti di massimo pubblicati da Tsesevich e massimi osservati visualmente da membri GEOS e della BAV, è stato possibile calcolare una nuova effemeride :

$$\text{Max (J.D.Hel)} = \underset{\pm\ 18}{2\ 419\ 902.4287} + \underset{\pm\ 77}{0.391\ 674\ 800}\ *E$$

Questa conferma che il periodo di TZ Aur non ha subito variazioni significative in oltre 70.000 cicli.

1. INTRODUCTION

TZ Aurigae (α_{2000} = 17h11mn37s ; δ_{2000} = +40° 47'.2) was discovered by L.P. Tserasskaya. The 4th edition of the G.C.V.S. (Kholopov and al.,1985) gives the following elements :

it is an RRab-star, with variations between 11.08 and 12.45 in V-light, with a spectral type A9-F6; the M-m is 0.14 P.

The ephemeris for TZ Aur is :

Max (J.D. Hel) = 2 419 902.4324 + 0.391 674 615 *E (1)

The finding chart for TZ Aur is shown on fig. 1, with the comparison stars selected for visual observations (Batyrev, 1951).
The magnitudes for the comparison stars are unknown.

Tsesevich (1966) gave a list of times of maxima observed visually; from these maxima, he calculated the ephemeris quoted above. All the elements given in the GCVS come from the paper of Tsesevich and from his visual observations.
Besides, he noticed that the period of TZ Aurigae has remained constant since its discovery, and for an interval covering 46 000 cycles. The same remark was made (Tsesevich,1972) in a paper on period variations in RR Lyrae stars.

Preston (1959) gave a determination of the spectral type of TZ Aur, with some radial velocity measurements.

2. IMPROVEMENT OF THE PERIOD

From the 20 times of maxima given by Tsesevich (one can notice here that one of the maxima assigned to Batyrev does not exist in the reference quoted), the current ephemeris (1) can be calculated with its error bars.

Max (J.D. hel) = 2 419 902.4329 + 0.391 674 60 *E (1')
± 24 ± 18

(95% confidence interval for error bars)

The 20 minima published by Tsesevich are listed in table 1 with the O-C's according to ephemeris (1').

On the whole, both ephemerides (1) and (1') are similar. Still, this allows us to seek for a possible improvement of the period, using all the maxima available, the error being on the 7th decimal place.

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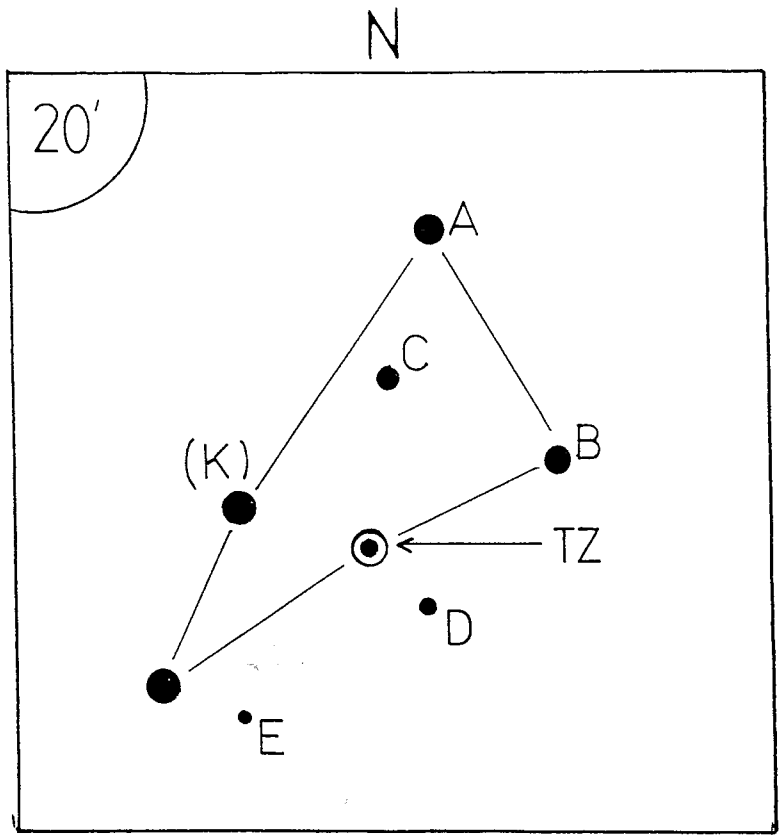

Figure 1 : Comparison stars for TZ Aurigae.

J.D. Hel. (2400000+)	E	O-C(1')	Observer
19902.4340	.0	.001	Bolt./Graff
20070.4580	429.0	-.003	Blazhko
26065.4350	15735.0	.002	Tsesevich
26067.3950	15740.0	.004	Tsesevich
26071.3070	15750.0	-.001	Tsesevich
27343.4650	18998.0	-.002	Lange
27790.7560	20140.0	-.003	Lange
28476.5800	21891.0	-.002	Gur'ev
33389.3480	34434.0	-.008	Batyrev
33402.2910	34467.0	.009	Batyrev
33598.5240	34968.0	.013	Batyrev
33635.3240	35062.0	-.004	Batyrev
33675.2840	35164.0	.005	Batyrev
33733.2480	35312.0	.001	Batyrev
33747.3440	35348.0	-.003	Batyrev
34007.4150	36012.0	-.004	Batyrev
35188.3190	39027.0	.001	Alaniya
37946.4890	46069.0	-.001	Lange
37959.4135	46102.0	-.002	Lange
37968.4202	46125.0	-.004	Lange

Table 1 : (O-C)'s according to ephemeris (1').

The B.A.V. (Hübscher and al., 1989) published 2 times of photographic maxima observed by Möschner.

15 maxima were observed visually by two members of the GEOS (BTL = Boistel G., VRR = Verrot J.P.), using Argelander's method .

Therefore, 37 times of maxima are available which allows an improvement of the period.
Ephemeris (2) below is calculated with these 37 maxima.

$$\text{Max (J.D. hel)} = \underset{\pm\ 18}{2\ 419\ 902.4287} + \underset{\pm\ 77}{0.391\ 674\ 800} * E \qquad (2)$$

(95% confidence interval for error bars)

Table 2 gives the list of the 37 maxima with the O-C's calculated from ephemeris (2).

The O-C's diagram is shown in figure 2. All the O-C's are within a $0^d.02$ band, i.e. about 28 minutes.

The mean O-C is : $\overline{O - C} = 0^d.00003$
the standard deviation : $\sigma = 0^d.005$

These values clearly indicate that the O-C's vary within a very short range, and for this reason, one can say that the period has not significantly changed since the discovery of TZ Aur.

Figure 3 shows the visual light curve obtained from 313 visual estimates performed by the author, between 1988 and 1990.

The shape of that curve is regular and the observations show a very little discrepancy.

The M-m is about equal to 0.14 P, and is in good agreement with the visual observations of Tsesevich.

3. CONCLUSION

Thus, it appears that the period of TZ Aurigae is exceptionally stable, and over more than 70 000 cycles, no significant variation could be observed.

All the observations were obtained visually, and one can notice the good agreement of the O-C's (2) between each other, allowing an improvement of the period of TZ Aurigae, the error being on the 8^{th} decimal place .
A more precise estimation of the period of that star gives the following value :

$$P = \underset{\pm\ 8}{0.391\ 674\ 80}\ \text{day, or}\quad 1/P = 2.5531385\ \text{day}^{-1}.$$

G.Boistel

J.D. Hel. (2400000+)	E	O-C(2)	Observer
19902.4340	.0	.005	Bolt./Graff
20070.4580	429.0	.001	Blazhko
26065.4350	15735.0	.004	Tsesevich
26067.3950	15740.0	.005	Tsesevich
26071.3070	15750.0	.001	Tsesevich
27343.4650	18998.0	-.001	Lange
27790.7560	20140.0	-.003	Lange
28476.5800	21891.0	-.001	Gur'ev
33389.3480	34434.0	-.010	Batyrev
33402.2910	34467.0	.008	Batyrev
33598.5240	34968.0	.012	Batyrev
33635.3240	35062.0	-.006	Batyrev
33675.2840	35164.0	.003	Batyrev
33733.2480	35312.0	-.001	Batyrev
33747.3440	35348.0	-.005	Batyrev
34007.4150	36012.0	-.006	Batyrev
35188.3190	39027.0	-.001	Alaniya
37946.4890	46069.0	-.005	Lange
37959.4135	46102.0	-.006	Lange
37968.4202	46125.0	-.008	Lange
47480.6370	70411.0	-.005	BTL
47508.4490	70482.0	-.002	BTL
47562.4997	70620.0	-.002	BTL
47566.4250	70630.0	.007	BTL
47568.3770	70635.0	.000	BTL
47579.3470	70663.0	.003	Möschner
47593.4440	70699.0	.000	BTL
47615.3720	70755.0	-.006	BTL
47615.3780	70755.0	.000	Möschner
47624.3860	70778.0	.000	BTL
47890.3330	71457.0	.000	VRR
47944.3790	71595.0	-.006	BTL
47946.3380	71600.0	-.005	BTL
47946.3520	71600.0	.009	VRR
47975.3290	71674.0	.002	VRR
48275.3590	72440.0	.009	VRR
48331.3680	72583.0	.009	VRR

Table 2 : (O-C)'s according to ephemeris (2).

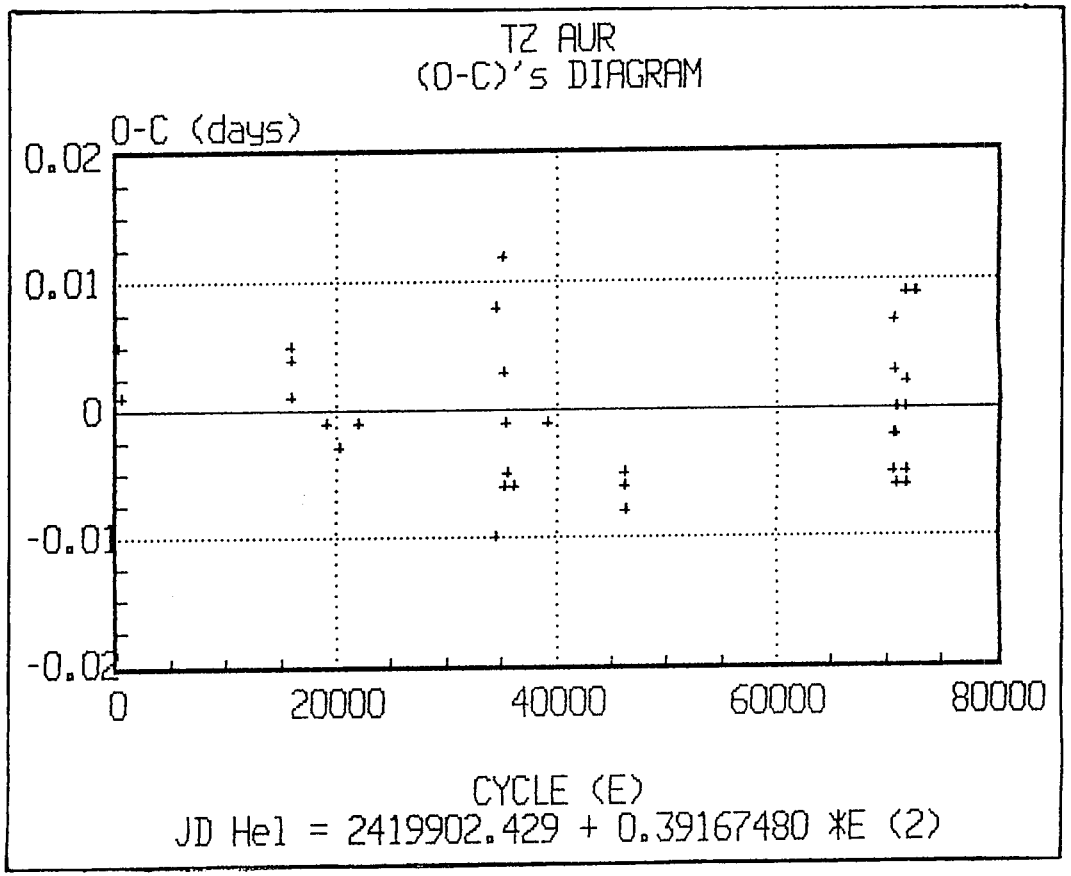

Figure 2 : (O-C)'s diagram according to ephemeris (2).

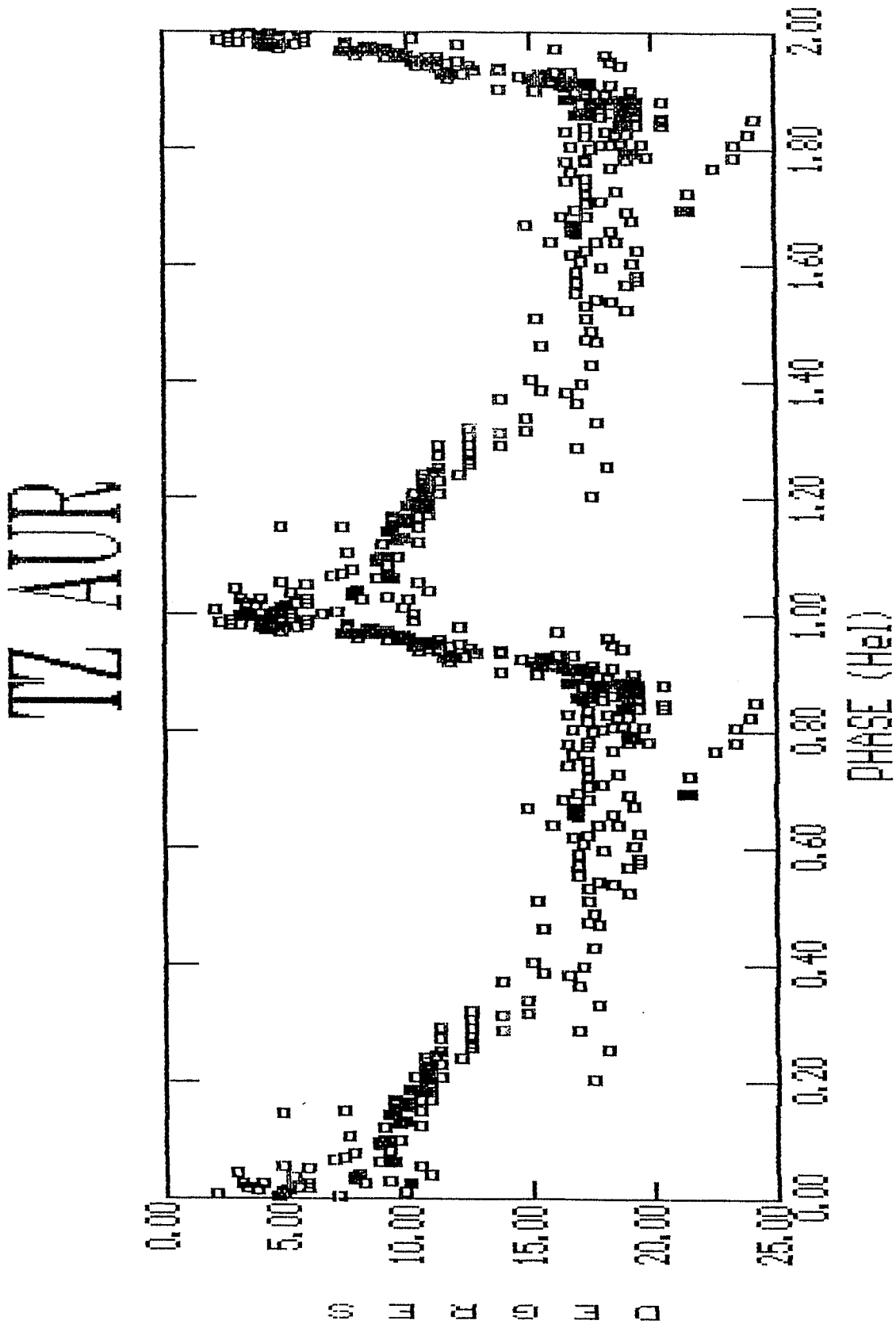

Figure 3 : Visual light-curve obtained by G.Boistel between 1988 and 1990.
Phases according to ephemeris (2).

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