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PHOTOMETRIC ANALYSIS OF RR LYRAE STARS II. T SEXTANTIS

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RESUMEN

Se ha hecho un estudio exhaustivo de todos los datos observacionales de T Sextantis. El análisis de períodos de los datos de esta estrella, muestra que es multiperiódica con tres frecuencias de pulsación. Las frecuencias derivadas (3.080537, 8.167766 y 13.333605 c/d) con sus correspondientes amplitudes (0.235, 0.028 and 0.015 mag) ajustan muy exactamente datos observacionales que cubren 6.9 años, explicando además la variación observada de noche a noche de la amplitud de sus curvas de luz. Este análisis muestra también la existencia de variación de su período principal.

ABSTRACT

An exhaustive study of all available observational data of T Sex has been made. A period analysis of photometric data of this star shows that it is multiperiodic with three frequencies of pulsation. The frequencies derived (3.080537, 8.167766 and 13.333605 c/d) with their corresponding amplitudes (0.235, 0.028 and 0.015 mag) fit observational data very closely covering a time span of 6.9 years explaining the variation in amplitude of its light curves from night to night. This analysis also supports a variation in its principal period.

Key words: **STARS-PULSATION – STARS-RR LYRAE – STARS-VARIABLE**

I. INTRODUCTION

In a previous paper, Peniche *et al.* (1989) have suggested that the amplitude changes of ST CVn, an RR Lyrae star of Bailey class c, might be described by the simultaneous excitation of several similar frequencies that correctly explain what could have otherwise been interpreted as a Blazhko effect (Blazhko 1925, 1926). In an attempt to increase the sample, a search of the literature for observed stars with similar features was made and it was found that visual observations collected of T Sex since 1925 (Pridhodko 1947) indicate the existence of small changes in both its amplitude and minimum depth; its membership to Bailey class c was established conclusively by Tifft and Smith (1958, hereafter TS). It is a well-known fact that variables of this kind form a discrete group in the field and in globular clusters, displaying relatively sinusoidal light curves with amplitudes of less than 0.5 mag and with periods of about 0.3 days; they are found in great number as first overtone pulsators.

It has been stated by Hawley *et al.* (1986) that a study of field RR Lyrae stars may throw light on some interesting astrophysical problems since they are primary indicators of distance. They can be also used to probe the kinematics of the galactic halo, giving insight into the dynamics and evolution of the Galaxy; their observational properties also offer constraints on pulsational theories and stellar evolution models. The specific problem of determining their absolute magnitudes is of great importance since they can be used as standard candles. Moreover, they all seem to be within the limits of a narrow range of absolute magnitudes and they are fairly luminous, numerous and widely distributed throughout the Galaxy.

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II. PREVIOUS OBSERVATIONS OF T SEXTANTIS

a) *Photometric*

This star, according to Pridhodko (1947), was observed visually by V.P. Tsesevich, D.Y. Martinov and A.V. Soloviev between 1925 and 1944 (see Table 1) and from the analysis of their data, Pridhodko (1947) found variations in its period.

TABLE 1

TIMES OF MAXIMA OF T SEXTANTIS[a]

Observer	HJD of Max.	E	O–C
Tsesevich 1925-26	2424561.426	- 8923	-0.027
Martinov	25520.201	- 5970	+0.004
Tsesevich 1930	26195.480	- 3890	-0.026
Tsesevich 1932	26779.589	- 2091	+0.006
Martinov	27101.317	- 1100	-0.012
Tsesevich 1933	27410.428	- 148	+0.016
Tsesevich 1934	27481.512	+ 71	-0.002
Martinov	27540.276	+ 252	-0.003
Soloviev	27835.738	+ 1162	+0.011
Martinov	27898.384	+ 1355	-0.004
Martinov	28257.148	+ 2460	+0.002
Soloviev	28279.535	+ 2529	-0.013
Tsesevich 1944	2431188.517	+11489	-0.053

a. From Pridhodko 1947, p. 172.

Photographic and photovisual observations of T Sex were carried out from 1957 to 1962 by Radziszewski (1965) who derived five slightly different elements, one for each season, (see Table 2) making a systematic increase in the period of this star apparent. However, from the time span of his observations for each season and his reported time resolution for each point observed, the precision he could have attained is only of 10^{-5} days instead of the 10^{-8} days precision he reported. This fact makes the systematic increase in the period he reported less reliable.

The most extensive study of T Sex is that of TS, who observed the star for nine nights covering a time span of 1205 days. Unfortunately, only one fourth of these nights is long enough to cover more than half the cycle; three of them utilized V and P-V photometry, one, V photometry and the rest, U,B,V photometry. Using their data and previous observations they obtained the new elements M_{max} = HJD 2427458.463 + 0.32468767 E and remarked that different cycles of light variation cannot be exactly superimposed. They reported that a determination of absolute magnitude by the Wesselink technique was not possible for T Sex because, depending on the light cycle considered, points of equal $B-V$ have (in their corresponding phases) small and inconsistent magnitude differences.

TABLE 2

RADZISZEWSKI'S OBSERVATIONS OF T SEXTANTIS[a]

Year	Months	Num. pg	of Observ. pv	Elements[b] Applied
1957	I-IV	11	10	0.32468767
1959	II-V	40	30	0.32469948
1960	II-IV	33	22	0.32470026
1961	IV	8	4	0.32470325
1962	I-IV	13	4	0.32470533

a. Reproduced from Table 1 of Radziszewski 1965.
b. J.D. 2435861.400 + E × P.

Preston and Paczynski (1964) reported four short nights of U,B,V photometry restricted mostly to the phase interval between minimum and maximum light since the transient phenomena they were studying occurs during rising light. An average value for V of 10.08 mag is estimated with an amplitude of 0.45 mag and a color difference of 0.122 mag. From their V and $(B-V)$ curves they found a marked hump characteristic of most RRc Lyrae stars. The elements used from the Rocznik Astronomiczny No. 34 of the Cracow Observatory were

$$T_{max} = \text{HJD } 2434795.409+0.3246978 \text{ E}.$$

Fitch, Wisniewski and Johnson (1966) also published four additional short nights with U,B,V photometry, reporting the estimated values of V, $B-V$, $U-B$ at maximum and minimum light together with the Preston ΔS index, period, observed rising time and the mean values for V, $B-V$ and $U-B$.

Epstein and Epstein (1973) made a (u,v,b,y) photometric study of 21 short period variable stars

TABLE 3

PHOTOELECTRIC OBSERVATIONS OF T SEXTANTIS

Epoch 2400000+	Observ. Time (day)	Photom.	Source[a]
34311	0.046	V, P-V	1
34350	0.135	V, P-V	1
34363	0.129	V, P-V	1
34508	0.065	V	1
35191	0.245	V, B-V, U-B	1
35513	0.184	V, B-V, U-B	1
35514	0.266	V, B-V, U-B	1
35516	0.259	V, B-V, U-B	1
38017	0.030	V, B-V, U-B	2
38018	0.084	V, B-V, U-B	2
38035	0.184	V, B-V, U-B	2
38038	0.092	V, B-V, U-B	2
38460	0.050	U, B, V	3
38466	0.029	U, B, V	3
38483	0.071	U, B, V	3
38849	0.141	U, B, V	3
40678	0.090	V, (b-y), m, c	4
40680	0.100	V, (b-y), m, c	4
41013	0.020	V, (b-y), m, c	4

a. Source: 1) Tifft and Smith 1958; 2) Preston and Paczynski 1964; 3) Fitch *et al.* 1966; 4) Epstein and Epstein 1973.

one of which was T Sex, which was observed around maximum light (phases ranging from 0.918 to 0.243) during three very short observing nights; however, in their Table V, they report several physical parameters at minimum light.

A summary of the published photometric data is shown in Table 3 of the present paper.

b) *Spectroscopy of T Sex*

Besides their photoelectric observations of T Sex, TS have also reported spectroscopic observations used for radial velocity determinations and spectral classification. In the estimations of radial velocity, they considered the broad hydrogen lines and the Ca II K line with dispersions of 81 A/mm and 93 A/mm accounting for 75 percent of the determinations. This yielded a velocity amplitude of 28 km/s, comparatively smaller than the amplitudes in velocity of other RR Lyrae stars, a fact which is in agreement with the small amplitude in light variation of this star. They determined the spectral type of T Sex considering the K line and other metallic lines (when discernible) and obtained the spectral type A2-A3 at maximum light and A3-A4 at minimum light. When using the hydrogen lines, an A9 spectral type was obtained at maximum light while a F4 type was assigned at minimum light. Both the K line and the hydrogen lines suggested a luminosity class III.

The spectroscopic observations of this star reported by Preston and Paczynski (1964) with a resolution of 16.2 A/mm show no hydrogen emission lines, unlike the RRab Lyrae stars that they also reported. The temperature estimated from the relation $\theta = 5040/T_e$ varied from 6811 K to 7522 K. The radial velocities exhibit systematic deviations in phase that were attributed in part to errors in the location of the starting positions of the trails. The estimated values for the radial velocities given by these authors ranged from +33.5 km s^{-1} to +2.7 km s^{-1} as determined from the metallic lines and varied from +37 km s^{-1} to 0 km s^{-1} when the hydrogen lines were utilized.

III. PERIOD ANALYSIS

The idea of undertaking an exhaustive analysis of all the available data related to this interesting star was supported by the fact that the periods are the only accurate quantitites that can be used in testing theories of stellar structures and evolution when supplemented by a wealth of data that can be obtained from radial velocity and light curves.

The procedure followed to analyze the periodic content of T Sex has been extensively used by the authors (see for example, Peniche *et al.* 1989). As a first step, a standard Fast Fourier Transform method (Deeming 1975) is applied to a sample of the data in order to obtain a first estimate of the primary frequency.

This frequency is then refined by means of the Multiple Frequency Fitting method (MFF) which consists of a least squares fitting to periodic functions of the data. Then, this frequency is subtracted from the original data, and the Fast Fourier Transform method is applied to the residuals in order to obtain a second frequency which is refined by means of the MFF method using both frequencies simultaneously. The procedure is repeated if there are more frequencies. Each of them can be swept independently and simultaneously to obtain the best set of frequencies, amplitudes and phases. The goodness of fit is established by four statistical indicators: 1) the mean square error, 2) the multiple correlation coefficient R^2 which gives the fraction of the variation of the independent variable explained by the model, 3) the F test, a percentage of the variation not explained by the model and 4) the Durbin-Watson statistics which is a numerical indicator of the harmonic content of the residuals.

In the present case, to simplify the window function and hence to facilitate the analysis of the periodograms, a group of relatively close nights was formed and analyzed. The data obtained by TS for the almost consecutive nights HJD 2435513, 14, 16 (which were also among the longest of all the available data) were considered.

A periodogram analysis (Figure 1a) and then the use of the MFF method gave a refined frequency of 3.083 c/d with an amplitude of 0.226 mag and a correlation coefficient of 0.975. When this frequency was prewhitened, two peaks with about the same power were found at 7.2 and 8.2 c/d (Figure 1b). The MFF method gave better statistical parameters for the latter.

With the idea of a possibly changing period in mind, the whole set of data was divided in three subsets and then analyzed independently. The accuracy that can be obtained in the determination of each frequency is calculated from the equation $T = T_0 + E\,P$ where E is the number of cycles in the time span of the observations, P is the period in days and T_0 an initial reference time. From this equation the accuracy δP can be estimated as $\delta P = \delta(T - T_0)/E$ or equivalently $\delta P = (2)^{1/2} T/E$, where δT is the accuracy in time of the determination of each observed point, typically of 0.0035 d. Accordingly, one could write $\delta P = 0.0049/E$ and consequently, the relation that determines the accuracy in the frequency is $\delta\nu = 0.0049 / (E\, P^2)$.

The first subset considered, covering a time span of 2.45 years, consisted of data from TS for the nights (HJD 2430000+) 4311, 4350, 4363, 4508, 5191, 5195. The refined frequency and the uncertainty provided by the time span of the observations was 3.07989 ± 0.00002 c/d with an amplitude of 0.227 mag and a correlation coefficient of 0.960.

The second subset, consisting of data for the nights (HJD 2430000+) 5513, 5514, 5516 from TS and (HJD 2430000+) 8017, 8018, 8035, 8038 from Preston and Paczynski (1965) was analyzed in the same way and the refined frequency 3.080537 ± 0.000006 c/d was obtained with an amplitude of 0.233 mag and a correlation coefficient of 0.973. Since this subset was the longest of those considered, with a time span of 6.9 years, it was used to improve the second frequency found to 8.167766 c/d with an amplitude of 0.028 mag. The fit to the data in this subset when both frequencies were considered, increased the correlation coefficient to 0.987. These two frequencies were prewhitened and a periodogram of the residuals showed two other peaks of equivalent power at 12.3 and 13.3 c/d (Figure 1c). The MFF method gave better statistical parameters for the last frequency which was then refined to 13.333605 c/d with an amplitude of 0.015 mag. The fit to the data with the three frequencies increased the correlation coefficient to 0.992. Prewhitening of the previously determined frequencies yielded a power spectrum at the noise level (Figure 1d). With these three frequencies a prediction function was built and applied to the data for nights HJD 2435513, 14 and 16. Figure 2 shows the observations and the predictions. The variation in amplitude of the observations is clearly described by the simultaneous existence of the three frequencies.

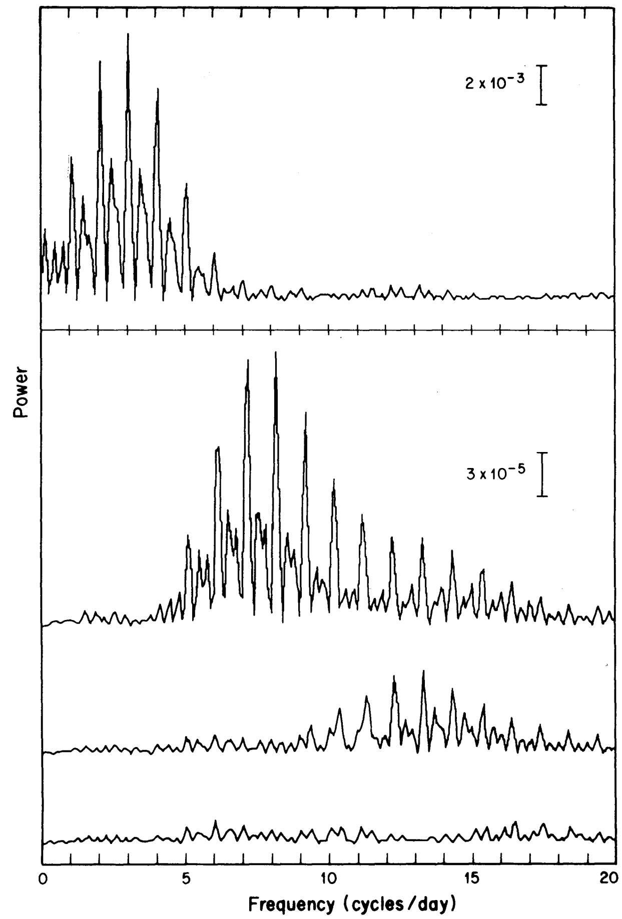

Fig. 1. Periodograms of observed data of T Sextantis constituted by the nights HJD 2435513, 14, 16 from TS. The upper periodogram was obtained from the observed data, while the other periodograms were obtained from prewhitening the frequencies 3.083 c/d; 3.083 and 8.168 c/d; 3.083, 8.168, and 13.334 c/d respectively. The lower periodogram shows the noise level.

Finally, the nights (HJD 2430000+)8460, 8466, 8483, 8849 of the third subset were examined obtaining the frequency 3.08502 ± 0.00004 c/d with an amplitude of 0.220 mag and a correlation coefficient of 0.966. The results of the analysis of the three subsets of data considering the three

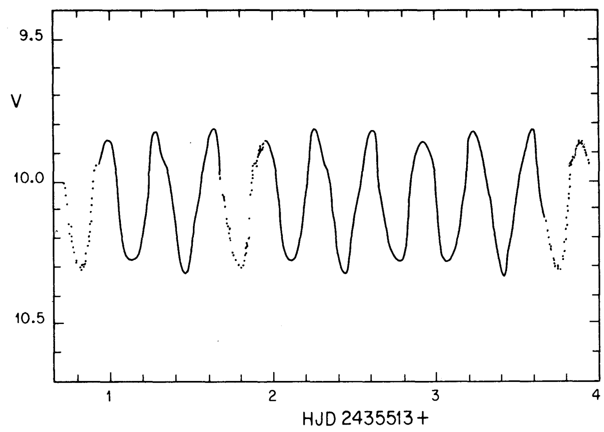

Fig. 2. Observations (dots) of T Sex from TS' data for the nights HJD 2435513, 14, 16. The continuous line represents the predicted function produced by the interaction of the three frequencies reported in this paper. Note the changes in the amplitude of the variation from cycle to cycle.

frequencies found are shown in Table 4. In all cases the correlation coefficient increased when the three frequencies were used. It is important to note that the secondary frequencies for each subset were calculated from the data of the second subset only. Since this subset was the longest in time span and produced a very stable primary frequency (Figure 3) those secondary frequencies were considered to be reliable to fit the data of the other subsets.

It seems apparent from the results presented in Table 4, that the main period has been decreasing. Since the shape of the light curves of T Sex slightly changes from cycle to cycle according to TS, some doubts arose as to whether the variable period was the result of this lack of repetition and the period-search routines or if the changes were real. To test the results, the second subset of data was put in phase using only the corresponding principal frequency found in this paper (3.080537 c/d). The fit for these data, with a time span of 6.9 yr, is excellent in phase (Figure 3). As can be seen, the photometric points fall in a band that reaches its

TABLE 4

STATISTICAL PARAMETERS FOR THE OBSERVED NIGHTS OF T SEXTANTIS WITH THE FREQUENCIES FOUND IN THIS PAPER

Set of Observ.	Frequencies (cycle/d)	R^2	F	Error ($\times 10^{-4}$)	Amplitude mag.
1	3.07989±0.00002	0.960	4177	9.4	0.227
1	3.07989±0.00002 8.16777	0.961	2107	9.4	0.227 0.005
1	3.07989±0.00002 8.16777 13.33361	0.962	1459	9.0	0.226 0.005 0.009
2	3.080537±0.000006	0.973	5313	7.2	0.233
2	3.080537±0.000006 8.167766	0.987	5757	3.4	0.235 0.028
2	3.080537±0.000006 8.167766 13.333605	0.992	5879	2.2	0.235 0.028 0.015
3	3.08502±0.00004	0.966	1016	9.6	0.220
3	3.08502±0.00004 8.16777	0.975	681	7.2	0.216 0.023
3	3.08502±0.00004 8.16777 13.33361	0.979	514	6.4	0.214 0.026 0.014

Set 1: HJD 2434311, 4350, 4363, 4508, 5191, 5195 (Tifft and Smith 1958).
Set 2: HJD 2435513, 14, 16 (Tifft and Smith 1958) and
HJD 2438017, 18, 35, 38 (Preston and Paczynski 1964).
Set 3: HJD 2438460, 8466, 8483, 8849 (Fitch *et al.* 1966).

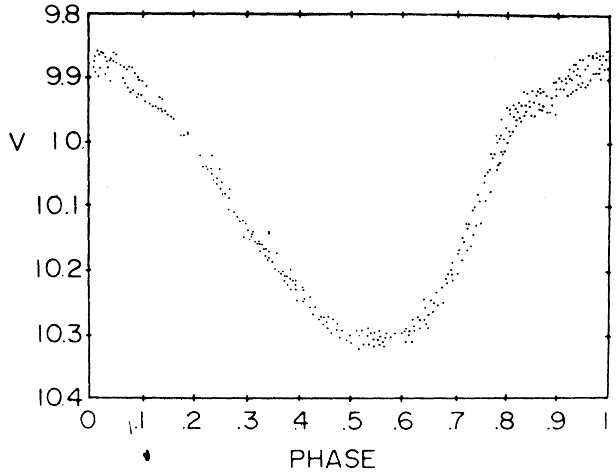

Fig. 3. Visual light curve in phase for the nights (HJD 2430000+) 5513, 5514, 5516, 8017, 8018, 8035, 8038 using the period 0.3246187d found in the present paper. These nights cover a time span of 6.9 yr.

greatest width around the maximum of the light curve. However, when the three frequencies are considered in the prediction, the fitting is almost perfect, as can be seen in Figure 4 which presents the comparison between the observations (dots) and the predictions (continuous line) obtained with the elements derived in the present analysis. With the above mentioned result shown in Figure 2, it can be concluded that the variations of amplitude are real and due to the interaction of several simultaneously excited periods of pulsation. Furthermore, one can assert that the MFF method produces reliable frequencies.

The set of frequencies with ν_1 =3.07989 c/d, ν_2 = 8.16777 c/d and ν_3 = 13.33361 c/d was used to fit the radial velocities of T Sex reported in TS since the main frequency for this set was obtained from the corresponding photometric data. The fit was rather poor (correlation coefficient of 0.667) and showed that the minimum of the radial velocity curve is shifted about 0.1 of phase with respect to the maximum in the V and $(B-V)$ curves. Similarly, the frequencies ν_1 = 3.080537c/d, ν_2 = 8.167766 c/d and ν_3 = 13.333605 c/d (corresponding to the second set of photometric observations and radial velocity determinations) excellently fit the radial velocity of T Sex reported by Preston and Paczynski (1965) with correlation coefficients of 0.958 and 0.973 when, respectively, the hydrogen lines and the metallic lines were used.

IV. DISCUSSION

The analysis of the available data of T Sex which was carried out in the present paper has reinforced the previous finding (Peniche *et al.* 1990) on the multiperiodicity of some RR Lyrae stars that substitutes the long term variation proposed by Blazkho with the simultaneous excitation of several close frequencies.

Some conclusions about the physical parameters of the atmosphere of T Sex, as well as properties such as absolute magnitude and distance, can be derived once the photometric observations have been corrected for interstellar reddening.

Since T Sex is located at relatively high latitude (b = 40.6, Kukarkin *et al.* 1970), it is not expected to be strongly reddened. In the following discussion, several methods will be described to determine such reddening.

One of the first and most extensive studies of the intrinsic *UBV* colors of the RR Lyrae stars was that carried out by Sturch (1966). Based on data gathered from than one hundred Bailey type a, b RR Lyrae stars, this study has been utilized as base for further research projects in this field.

In an extensive study of absolute magnitude and motions of RR Lyrae stars, based on statistical parallaxes of the color excess as defined by Sturch (1966), Hemenway (1975) gives a visual absorption of 0.27 mag for T Sextantis. Assuming a normal extinction law, this value translates into $E(B-V)$ = 0.09 mag.

The work of Burstein and Heiles (1978) uses galaxy counts, neutral hydrogen column densities and reddening of RR Lyrae stars and globular clusters to determine galactic reddening. However, in their compilation of RR Lyrae stars, they do not consider T Sex (l = 234, b = 40.6) or any other star in this constellation. Hence, a reddening value for T Sex has been determined interpolating the values defined for two stars they did report: RR Leo (l = 208, b = 53.1), and TV Leo (l = 263, b = 49), with reddening values, $E(B-V)$, of 0.056 and 0.083, respectively. Therefore, the interpolated value of the reddening of T Sex can be considered to be 0.07 mag, as an upper limit.

In another study, Kemper (1982) determined reddening values for RRc stars averaging Sturch's reddening values determined for RRab Lyrae in the same constellation as the RRc Lyrae stars. These values have been lowered by 0.03 by Burstein and Heiles (1978) to compensate for systematic errors in Sturch's work. Similarly, according to Strungell (1986), and Kemper (1982), the reddening values derived by Hemenway (1975), which were based on those of Sturch (1966), tend to yield larger reddening values than those obtained by Burstein and Heiles (1978).

A different approach to determine the interstellar reddening in the direction of T Sex would be by means of the law of reddening proposed by van

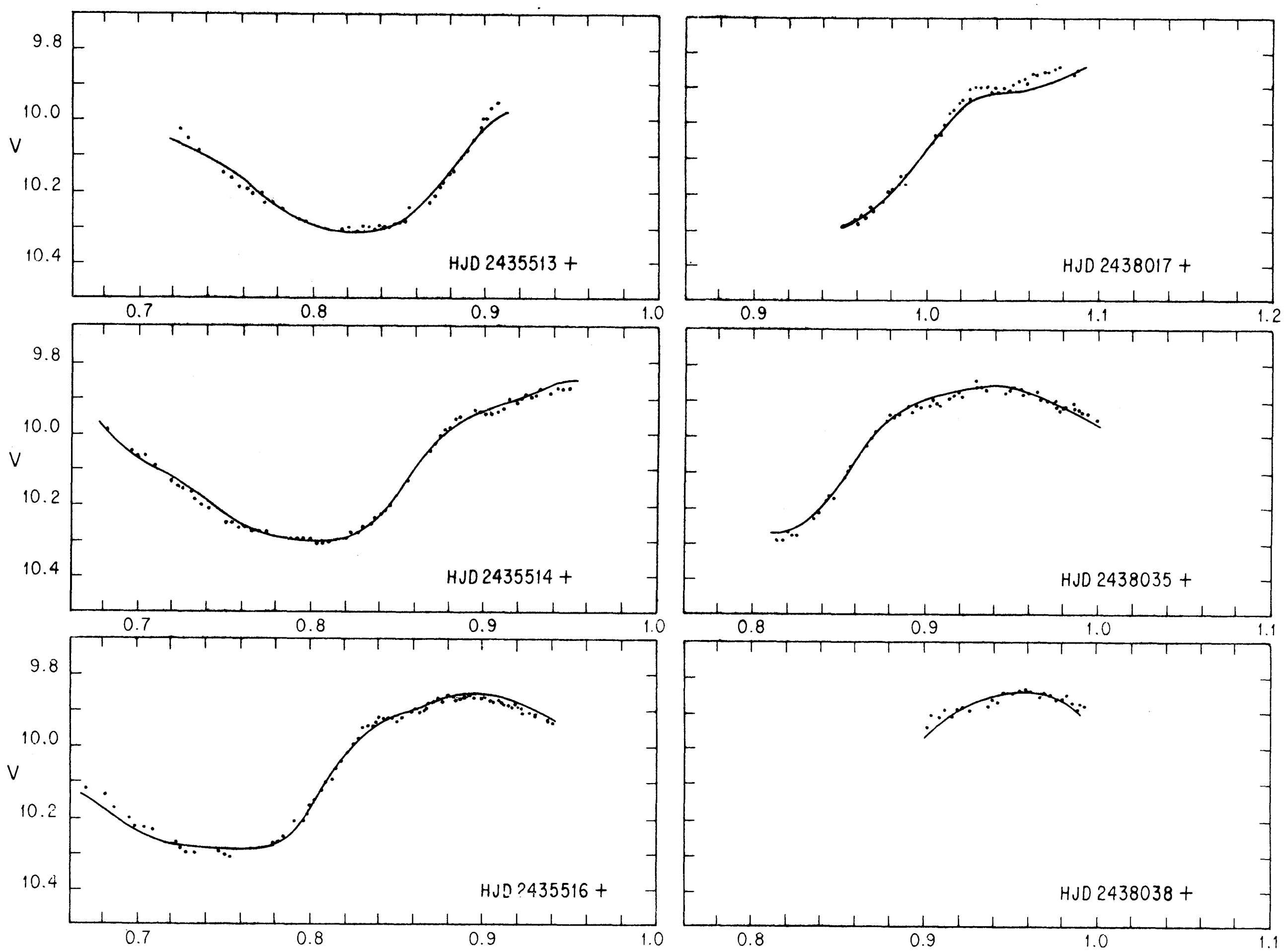

Fig. 4. a), b), c) are observations of T Sex by Tifft and Smith (1958), while d), e), f) are data collected by Preston and Paczynski (1964). Continuous lines represent the predictions with the frequencies derived in the present paper for these nights.

Herk (1965), which although questionably valid, could give a coarse guess value.

The desired reddening determination would be reached if the value $M_V = 1.06 \pm 0.38$ (Barnes and Hawley 1986) for RRc Lyrae stars is adopted. This value is in agreement with the result of a more recent study by Cohen and Gordon (1987) on metal poor RR Lyrae stars in the globular cluster M5 which yield, using a variation of the Baade-Wesselink method, a mean absolute magnitude of M_V equal to 1.05 ± 0.15 mag. The mean visual magnitude m = 10.08 mag from the nights HJD 2435191, 95 is used with an iterative procedure using the relations $\log d = (m - M - A_v + 5)/5$; $A_v = 3\,E(B-V)$ and the empirical formula

$$E(B-V) = [0.0463 \operatorname{cosec}(b)] \times \times [1 - \exp\{-0.01\, d \sin(b)\}] ,$$

(van Herk 1965), where b = 40.6° (Kukarkin *et al.* 1970) is the galactic latitude of T Sex. The value $A_v = 0$ was used as a first guess and the values $E(B-V) = 0.07$ and d = 578.5 pc were obtained after three iterations. The estimated error was $\Delta E(B-V) = 0.002$.

Taking all the above works into account, a value of 0.07 mag for the reddening of T Sex will be adopted in this work.

With this figure for $E(B-V)$, the unreddened values of $(B-V)$ and $(U-B)$ were estimated at maximum and minimum light from the phase of nights HJD 2435191, 95. Since the values obtained were $(B-V) = 0.179$ mag and $(B-V) = 0.301$ mag at maximum and minimum respectively from the definition $E(B-V) = (B-V) - (B-V)_0$, the estimates $(B-V)_0 = 0.109$ at maximum light and $(B-V)_0 = 0.231$ at minimum light were drawn; these, according to the calibration

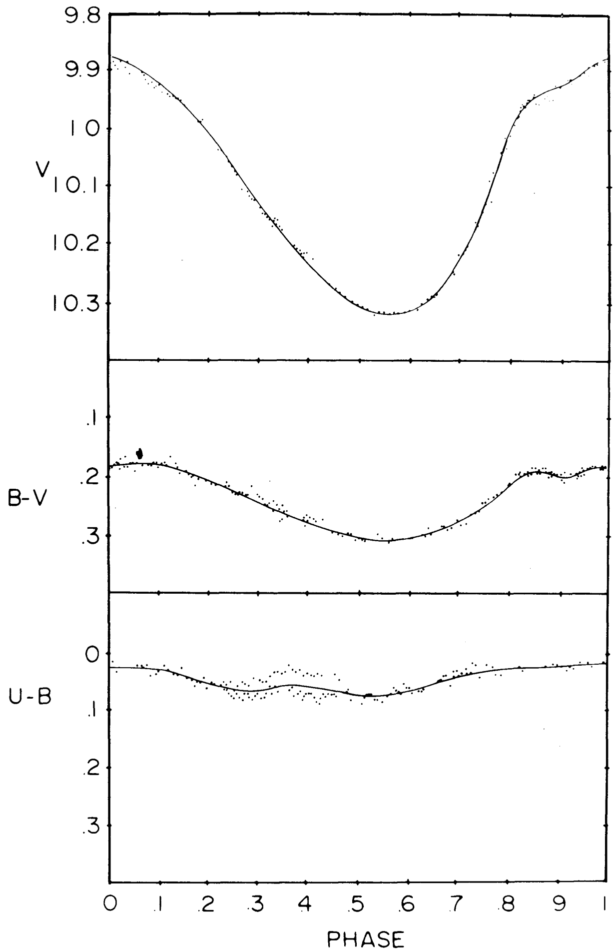

Fig. 5. *V*, *B–V*, and *U–B* curves in phase. The light curves are constituted by data from TS for the nights HJD 2435191, 95. The phase was calculated with the period 0.32469d derived in the present paper.

of Code *et al.* (1976) correspond to log T_e = 3.942 at maximum and log T_e = 3.901 at minimum. Due to uncertainties in the color index *B–V*, the uncertainty in the temperature is of about 250 K.

For the same nights, the values of $(U\text{–}B)_{max}$ = 0.073 and $(U\text{–}B)_{min}$ = 0.024 were obtained and since E(*U–B*) = 0.72 E(*B–V*) then E(*U–B*) = 0.05 and the unreddened values $(U\text{–}B)_0$ = 0.023 ± 0.07 at maximum and $(U\text{–}B)_0$ = −0.026 ± 0.07 at minimum were estimated. The high uncertainties are due to the scatter of the (*U–B*) color index shown in Figure 5.

These temperatures are too high when compared with the temperature obtained from the spectroscopy (TS) when the hydrogen lines are used (log $\langle T_e \rangle$ =3.855) although they agree with the temperature obtained from the Ca II lines (log $\langle T_e \rangle$ = 3.922). A possible explanation of this effect is the existence of an ultraviolet excess due to a lack of line blanketing since T Sex seems to be defective in metals. This behavior has been observed in subdwarfs (Wildey *et al.* 1969) where the (*B–V*) index is higher than it should be pointing to a lower temperature. In the absence of data to reliably correct the observed values of (*B–V*) for this effect, the temperature adopted was that deduced spectroscopically using the hydrogen lines.

Some conclusions about the physical parameters of the atmosphere of T Sex can be drawn from the multicolor photometry along a whole cycle (Table 5). Since none of the reported observations were long enough to cover the complete cycle, the colors *B–V* and *U–B* in phase for the nights HJD 2435191 and HJD 2435195 reported by Tifft and Smith (1958) were used after they were corrected for interstellar reddening. The smoothed *B–V* curve (Figure 5, solid line) has an amplitude of 0.301 mag at minimum light and 0.179 mag at maximum light, in coincidence with the minimum and the maximum of the visual light curve respectively. The smoothed curve for *U–B* has a magnitude difference of 0.049 between 0.073 and 0.024 mag with a larger scatter than the *B–V* observations.

In order to put *B–V* and *U–B* data from these two nights in phase, the value of 0.32469 d for the period as found in the present paper was adopted. These data were then averaged into 0.1 phase bins to form mean magnitude curves.

From the $(B\text{–}V)_0$ versus $(U\text{–}B)_0$ diagram shown in Figure 6, it can be seen that the star traces a closed path forming three loops. During that part of the cycle around maximum light, the star moves counterclockwise which is normal behavior. The separation of the two branches reflects the difference in effective gravity between the increase and decrease in brightness. When the star is around minimum light the loop is also traversed in a counterclockwise sense but the separation is small. From approximate phases 0.18 to 0.4 and 0.6 to 0.78 the star moves clockwise.

To decide on the mode of pulsation of T Sex, the Q value is determined from the relation

$$Q = P(\rho/\rho_0)^{1/2}.$$

Considering a characteristic mass of 0.5 $M_\odot$ (Christy 1966) and a radius of 5 $R_\odot$ (Cox 1980), a value of Q = 0.0206 is obtained and, therefore, the star should be pulsating in the 1H mode.

The period rates obtained do not correspond to well-known model ratios. This is customarily interpreted as pulsation in non-radial modes.

The luminosity L is estimated from the well-known relation $L = 10^{0.4(4.79-M_V)}\ L_\odot$ where the value M_V = 1.06 ± 0.38 for RRc Lyrae stars was adopted as given in Barnes and Hawley (1986). The luminosity L = (1.19 ± 0.18) × 10^{35} erg/s

TABLE 5

PHYSICAL PARAMETERS OF T SEXTANTIS

Parameter	Value	Ref[a]
A. Observed		
V_{min}	10.308 mag	1
V_{max}	9.857 mag	1
$(B-V)_{min}$	0.301 mag	1
$(B-V)_{max}$	0.179 mag	1
$(U-B)_{min}$	0.024 mag	1
$(U-B)_{max}$	0.073 mag	1
Rad. Vel.	+38 km/s	2
Proper motion in R.A	-0.0265 "/yr	2
Proper Motion in Dec.	-0.025 "/yr	2
Pulsation freq.	3.080537 c/d	3
	8.167766 c/d	3
	13.333605 c/d	3
B. Deduced from Models		
$(B-V)_{o,min}$	0.231 mag	3
$(B-V)_{o,max}$	0.109 mag	3
$(U-B)_{o,min}$	-0.026 mag	3
$(U-B)_{o,max}$	0.023 mag	3
mv	10.080 mag	3
Mv	1.06±0.38 mag	4
L	1.19×10^{35} erg/s	5
Distance	578.5 pc	3
log $T_{e,min}$	3.833	6
log $T_{e,max}$	3.876	6
[Fe/H]	-1.18	7

a. 1) Tiff and Smith 1958; 2) Hemenway 1975; 3) This paper; 4) Barnes and Hawley 1986; 5) Lang 1978; 6) Preston and Paczynski 1964; 7) Kemper 1982.

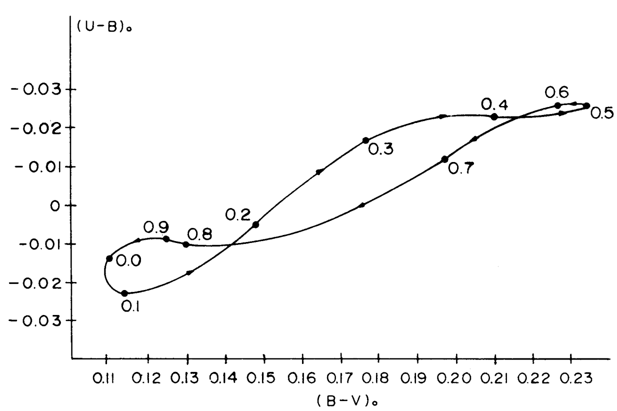

Fig. 6. $(B-V)_0$ vs. $(U-B)_0$ diagram in phase for the nights HJD 2435191, 95 using the period 0.32469d derived in the present paper.

is obtained. Regarding the metal content of this star, Butler (1975) reported that T Sex has a metal abundance of [Fe/H] = −1.23, while Kemper (1982) gives an abundance of [Fe/H] = −1.18 (a fair agreement).

The physical parameters derived for T Sex have been compared to the semiconvective models for evolution in the Horizontal Branch developed by Sweigart and Gross (1976). In these models several helium and heavy element abundances were considered with masses ranging from 0.46 $M_\odot$ to 0.90 $M_\odot$. Each sequence was evolved from the ZAHB up to the depletion to 0.05 of the helium abundance in the convective core. With the value for log T_e derived spectroscopically using the hydrogen lines and the absolute magnitude given by Barnes and Hawley (1986) it is found that the model that very closely fits the parameters of T Sex is that of (Y, Z, M) = (0.10, 0.001, 0.525), which is shown in Table 15 of Sweigart and Gross (1976) with a total mass of 0.66 $M_\odot$ and with a time elapsed from the ZAHB of 10.51×10^6 yr. The low metallic content of this model is consistent with the assumption of a defect in line blanketing used to explain the apparent high temperature of this star.

V. CONCLUSIONS

The period analysis of the photometric data for this star shows that it is multiperiodic. This fact explains the variation in amplitude of its light curves from night to night. This analysis also supports the existence of variation in its principal period as has been reported by different authors.

Since from the wealth of theoretical models dealing with pulsating stars, only a few consider stars with multiple periods and the amount of observational data is still rather poor to support any of the models, and considering the lack of studies on observational parameters complete enough to support the theoretical work on this kind of star, it is evident that additional work in this sense is necessary and hence, is strongly encouraged.

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