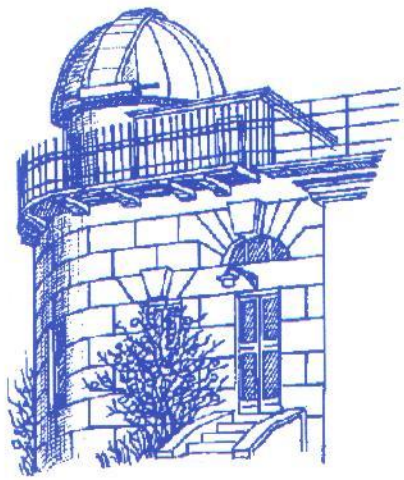
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FOREWORD

Has passed 125 years, as in Odessa on August 3, 1871 of old style a special commission of Novorossijsk (at present Odessa) University has opened the Astronomical Observatory. Its creation was headed by the head of the Astronomy chair L.F.Berkevich. The Observatory was under construction for money, allocated by state and urban authorities. The General city Council, worrying about development of education, science and culture, has considered for debt to co-citizens to present to the Observatory a a place and buildings on it, as well as to allocate for the construction of the observatory significant money resources.

To the present time the Astronomical observatory has become the largest University Observatory of the Ukraine. It, except the main base in the park named after T.G.Shevchenko, has two sub–urban stations in a villages of Kryzhanovka and Mayaki and three mountain stations in Armenia, Turkmenia and Northern Caucasus. In the observatory, which has a Status of the scientific research institute, work about 150 persons. Its scientific researches have all attributes of scientific discoveries, and it has given to the Observatory a wide popularity in the scientific world. Contribution to a world science by the astronomers of Odessa was awarded by the assignment of a name "Odessa" to one of the recently discovered asteroids (No. 2606).

The anniversary our observatory is celebrated by the International Jubilleum Scientific Conference "Contemporary problems of Astronomy", which was held on September 2–6, 1996. The scientists from Ukraine, Russia, Moldova, Estonia, Bulgaria, Poland, Slovakia, Czechia, Yugoslavia, France, Germany, Switzerland, USA and other countries have presented 32 plenary and 180 oral and poster reports. The participants of the conference worked in 12 sections on different astronomical topics. In the morning the sessions were plenary and contained the reviews by the leading astronomers of the world.

The plenary meeting devoted to the anniversary was held on September 2 in the Large Physical Auditory of the Odessa State University. Besides the official reports, a talk was presented, during which the Certificates were awarded with the assignment of names of the Odessa scientists to recently discovered small planets. In this connection it is pleasantly to note, that in the asteroid belt of the Solar system, seven small planets are moving, which are named after Odessa scientists. The message on new assignments is made by the representative of the International Committee on the naming of the newly discovered celestial bodies, the representative of the Crimean Astrophysical Observatory, N.S.Chernykh.

The present volume 9 of the "Odessa Astronomical Publications" contains 101 scientific articles, prepared by 176 authors on materials of their scientific talks and posters presented to our Jubillee conference. Unfortunately not all contributions presented at the conference, were given to us for publication in this volume. However, many of them are published in other periodic astronomical editions and have become a property of a scientific public. Thus, it is possible to believe, that the main aims of our conference - the help in discussion of recent scientific results and their publication are executed.

V.G. Karetnikov

OUTBURST CYCLE LENGTH VARIATIONS IN THE DWARF NOVA EM CYGNI

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ABSTRACT. The cycle length of the dwarf nova EM Cyg undergoes season–to–season changes which may be interpreted by changes of the accretion rate caused by a solar–type activity of the secondary star. The mean brightness of EM Cyg varies with a cycle of $\approx 3000^{\rm d}$ and is highly correlated with an amplitude of the sine–like variations. Unexpectedly no correlation was found between the seasonal values of the cycle length and the mean value or amplitude.

Key words: Stars: Cataclysmic: Dwarf Novae: EM Cyg

Introduction.

Disks accreting matter from the secondary filling its Roche lobe are dynamically unstable (Meyer and Meyer–Hofmeister 1984, Lin et al. 1985). The outburst occur regularly after the quiescent stage. Although the time intervals "P" between subsequent outbursts vary by few dozens percent, the mean value of the cycle length was believed to be a relatively constant characteristic of the dwarf novae. Search for possible correlations between the outburst characteristics was done by Szkody and Mattei (1984), Gicger (1987) and some other authors. The most famous of such correlations is the "amplitude–cycle" relation (Kukarkin and Parenago 1934), which was recently revised by Richter and Brauer (1989).

Decades of photographic and visual monitoring of dwarf novae allows to study long–term changes. Kurochkin (1981), Mattei et al. (1986), Cook (1987), Shakun (1987ab, 1988, 1989), Shakun and Timko (1994) reported on cycle length variability of V 1504 Cyg, SS Aur, U Gem, AR And, UU Aql, RU Peg and VZ Aqr. Vogt (1982) described quasi–periodic behaviour of the supermaxima in SU UMa – type stars. Bianchini (1987, 1990) explained the few year scale variations of CV's by a solar–type activity of the secondary. Similar slow variations of the X–ray sources were reviewed by Priedhorsky and Holt (1987). Andronov and Shakun (1990) have shown that the mean cycle length changes abruptly at least in 4 stars, thus one may say about the "switchings" between two separate values, rather than about quasi–sinusoidal variations. Chinarova (1995) reported on relatively smooth cycle length variations in X Leo, AB Dra, IR Gem, AY Lyr and LL Lyr with characteristic times ranging from $1500^{\rm d}$ to $8000^{\rm d}$. This phenomenon may be important for understanding the existing theoretical models of the outbursts as the limit cycles of the accretion disk structure variations.

Periodogram Analysis of EM Cygni.

The most intensely studied object of our sample is EM Cyg. For the analysis we have used 4506 observations from the AFOEV database (Schweitzer, 1996). To make the data obtained by different observers compatible, we have studied the "mag–mag" diagrams and derived coefficients for reduction of the magnitudes to the "standard" AFOEV visual system (a). The numbers of "sure" observations are n=3109(a), 697(h), 205(e), 16(p).

The following method was used. At first, the light curve was approximated by the method of "running parabolae" (Andronov 1990) with a filter half–width $\Delta t = 7^{\rm d}$ by using the "main set" of observations, and a "smoothed" values m_C were computed at times t of the minor set of observations m obtained by a fixed author.

There values were used to constrain a "$m - m_C$" diagram, as well as those obtained by smoothing the minor set at times of the major. After rejection of few uncertain observations we have found that the rest n_1 points are highly correlated. We used a linear combination

$$\tilde{m} = \bar{m}_C + \frac{\sigma_C}{\sigma}(m - \bar{m}), \qquad (1)$$

where $\bar{m}$ and σ^2 are the sample mean and variance of the initial data m and the index "C" corresponds to the smoothed values of the signat at same times. Such reduction (1) saves the sample mean and variance of $\tilde{m}$ equal to that of smoothed values m_C at the same times. After such a reduction, we added the minor observations to the majority, and applied consequently the same procedure to the observations marked as "h", "e, "p". For "e" and "p the coefficients "σ_C/σ" deviate from unity more than for "h".

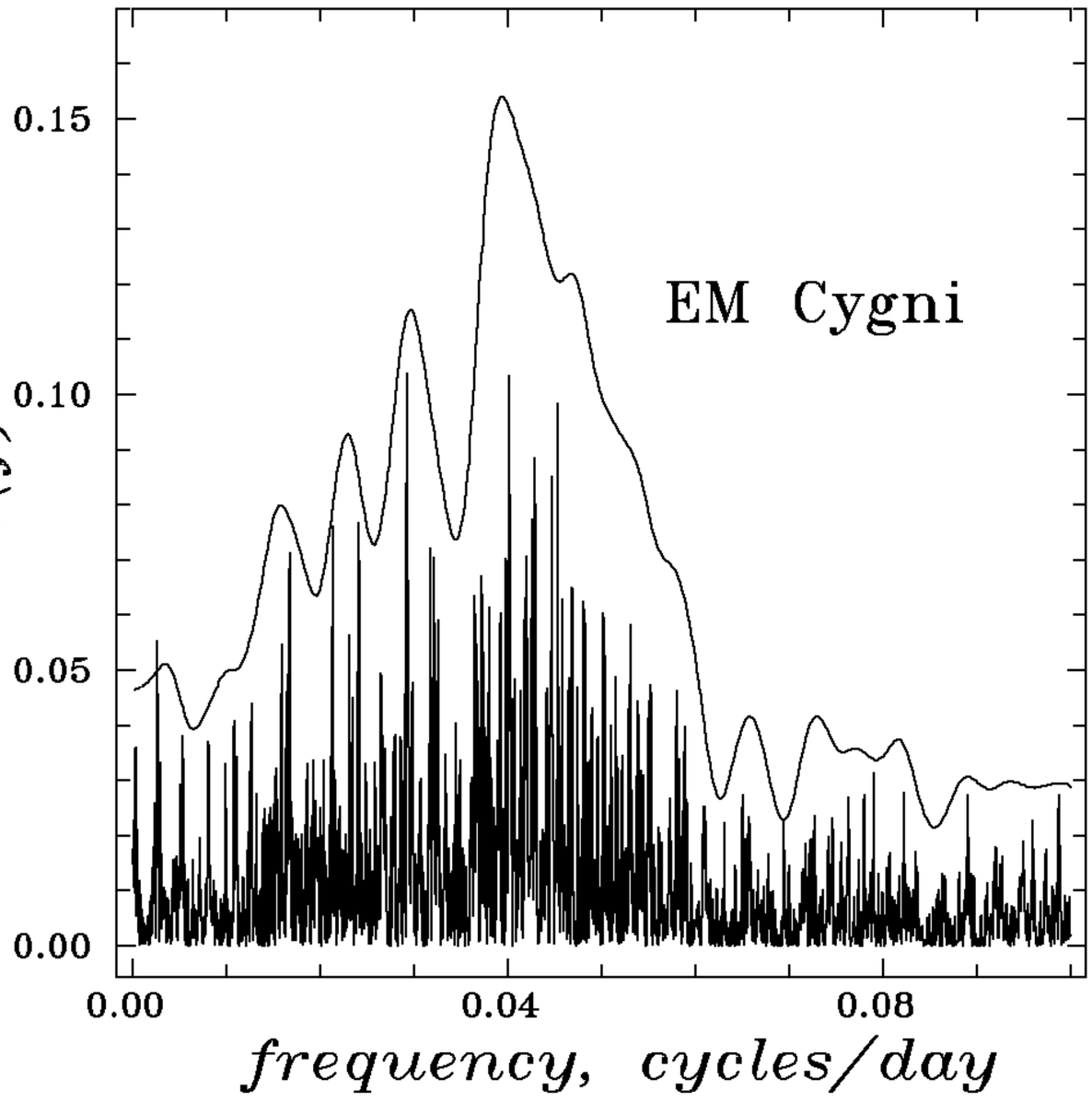


Figure 1: Periodograms $S(f)$ for the whole set of observations of EM Cyg (bottom) and a weighted mean periodogram for seasonal periodograms (up). Vertical axis is marked every 0.05. Vertical lines indicate frequences corresponding to maxima. one may note the periodogram values for the whole set.

The whole set of observations reduced to one scale ($n = 4027$, $\langle m \rangle = 13\overset{\text{m}}{.}15$, $\sigma_O = 0\overset{\text{m}}{.}532$) was studied by using the periodogram analysis with a least squares fit

$$m(t) = a + b \sin 2\pi ft + c \cos 2\pi ft \qquad (2)$$

and a test function $S(f) = \sigma_C^2/\sigma_O^2$, where "O" and "C" correspond to r.m.s. deviations of the original and smoothed with a fit (1) values from their sample means. The expectation for the white noise is $\bar{S} = 2/(n-1) = 0.0005$. The computer code FOUR–0 (Andronov, 1994) was used.

Although the presence of any coherent periodicities in the luminosity changes of a dwarf nova is doubtful, we made an analysis of the whole data set ($n = 4027$, JD 2440739–9166) in a frequency range $0 < f \leq 0.1$ cycles/day ($P \geq 10^{\text{d}}$). The periodogram is shown at Fig.2. The characteristics of few highest peaks are listed in Table 1.

We have also subdivided the observations into 24 "seasons" and computed the similiar periodograms for them. The "weighted mean" periodogram with the weights $\rho_j = n_j \sigma_{Oj}^2$ for j^{th} season

$$S(f) = \frac{\sum\limits_{j=1}^{n_s} \rho_j \ S_j(f)}{\sum\limits_{j=1}^{n_s} \rho_j} \qquad (3)$$

is shown at Fig.2, and the most prominent peaks are listed in Table 2. One may note that, despite obvious

Table 1. Characteristics of the high peaks at the periodogram for all observations of EM Cyg (in the descending order of height).

f	P	$S(f)$	r	$S/\bar{S}$	L_p
0.0293	34.174±0.009	0.0259	0.12	52	20
0.0401	24.913±0.004	0.0259	0.12	52	20
0.0454	22.041±0.003	0.0251	0.12	51	20
0.0429	23.308±0.004	0.0222	0.11	45	17
0.0447	22.363±0.003	0.0214	0.11	43	16
0.0409	24.821±0.005	0.0207	0.11	42	15
0.0426	23.478±0.006	0.0194	0.10	39	14
0.0241	41.437±0.012	0.0194	0.10	39	14
0.0218	46.780±0.015	0.0191	0.10	38	14
0.0317	31.501±0.008	0.0181	0.10	36	13
0.0398	25.095±0.005	0.0179	0.10	36	13
0.0168	59.672±0.027	0.0178	0.10	36	13
0.0420	23.806±0.006	0.0178	0.10	36	13
0.0322	31.092±0.008	0.0176	0.10	35	13

Table 2. Characteristics of the mean weighted periodograms of EM Cyg.
R.m.s. value of r for pure white noise is $r_{WN} = 0\overset{\text{m}}{.}169$.

f	P	$S(f)$	r	σ_{O-C}
0.0230	43.6±0.4	0.093	0.226	0.500
0.0297	33.7±0.2	0.115	0.252	0.494
0.0394	25.4±0.2	0.154	0.291	0.483
0.0467	21.4±0.1	0.122	0.259	0.492

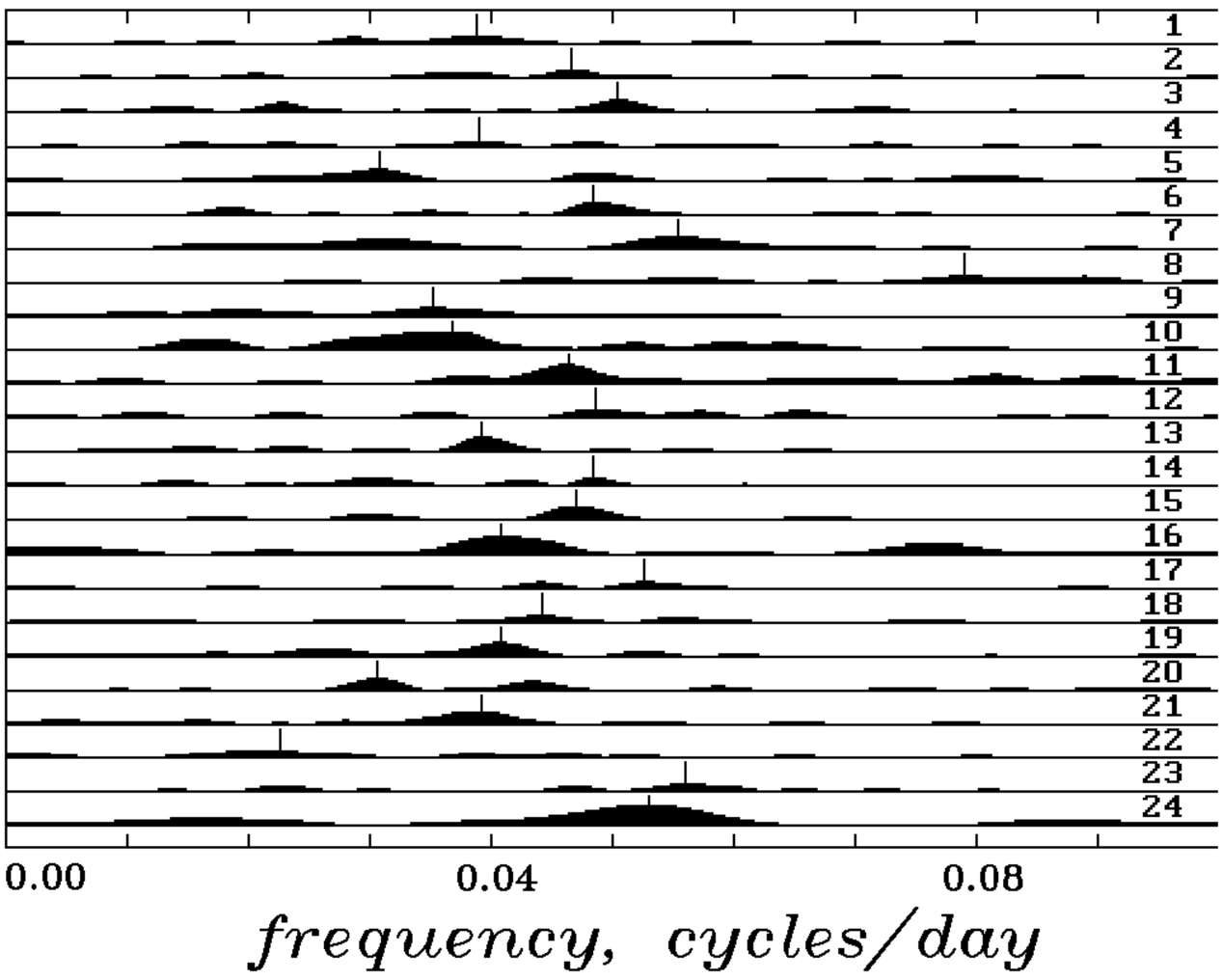


Figure 2: Periodograms $S(f)$ for the individual seasons. Shift step is equal to 1 (dimensionless units). Vertical lines indicate frequences corresponding to maxima at a given seasonal periodogram.

difference of the shape of the periodogram, two peaks of similiar height appear at $P = 25^{\rm d}$ and $34^{\rm d}$. Details of application of the weighted mean periodogram to another cataclysmic variable TT Ari are published by Tremko et al. (1996).

One may note significant variations of the "mean" cycle length from season to season. As in other dwarf novae, they may be explained by variations of the accretion rate (Andronov and Shakun 1990) due to solar–type activity of the secondary (Bianchini 1988) filling its Roche lobe. Detailed study of the correlations between outburst characteristics will be published elsewhere.

Dependence on time of the best fit period P, semi–amplitude r and mean brightness a is shown at Fig 3. One may see variations of all these parameters. Variations of a seem to be more regular, than of other parameters, and have a time scale $\Pi \approx 3000^{\rm d}$. This value is close to that observed in other cataclysmic variables (e.g. Bianchini 1988, 1990, Andronov and Shakun 1990). However, this object shows more sharp variations of r and P.

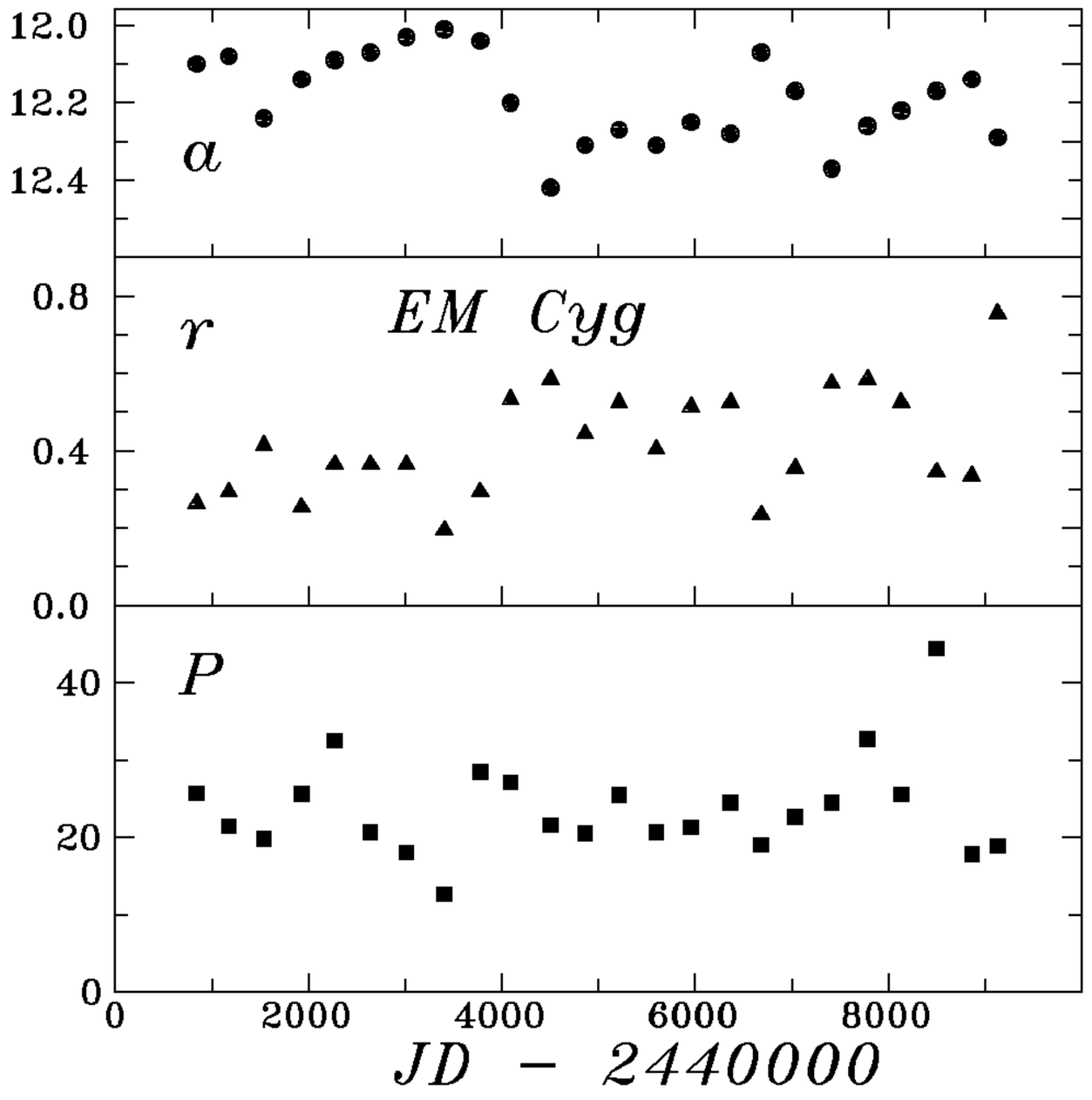


Figure 3. Variations of the cycle length (P), semi–amplitude (r) and mean level (a) for seasonal sine–like fits.

Correlations between the outburst characteristics.

To study possible correlations between the characteristics, we have analysed the seasonal best fit parameters. Contrary to previous studies (e.g. Szkody and Mattei 1984, Gicger 1987), we use the "effective" seasonal characteristics instead of the shapes of the individual outbursts. For the analysis, we have chosen the following parameters: $\langle t \rangle$ – mean time of the observations within one season (thus possible correlations may reflect apparent trends); P – "best fit" period; $f = 1/P$ – corresponding frequency; $S(f)$ – height of the maximal peak (i.e. ratio "signal"/"signal+noise"); r and a – semi–amplitude and mean level in the fit (1); σ_O, σ_{O-C} – r.m.s. deviations of the observations from the mean and sine curve, respectively. Also we used the brightness at "mean maximum" $(a - r)$ and "mean minimum" $(a + r)$.

The table of the seasonal characteristics was published by Chinarova and Andronov (1995). In the present work we have recomputed the periodograms avoiding one misprint found in the AFOEV database. Depite the qualitative the results have not been changed, the quantitative characteristics are slightly different. The corrected values of the parameters for the season JD 2447302–7540 are: the sample mean time $\langle t \rangle = 2447411$, the number of data $n = 248$, the test–function $S(f) = 0.405$, the "false alarm probability" $Pr = 10^{-26.2}$, the semi–amplitude $r = 0\overset{\rm m}{.}58 \pm 0\overset{\rm m}{.}05$, the cycle length $P = 24\overset{\rm d}{.}52 \pm 0\overset{\rm d}{.}14$, the mean $a = 13\overset{\rm m}{.}37 \pm 0\overset{\rm m}{.}03$, the r.m.s. deviations $\sigma_O = 0\overset{\rm m}{.}61$, $\sigma_{O-C} = 0\overset{\rm m}{.}47$.

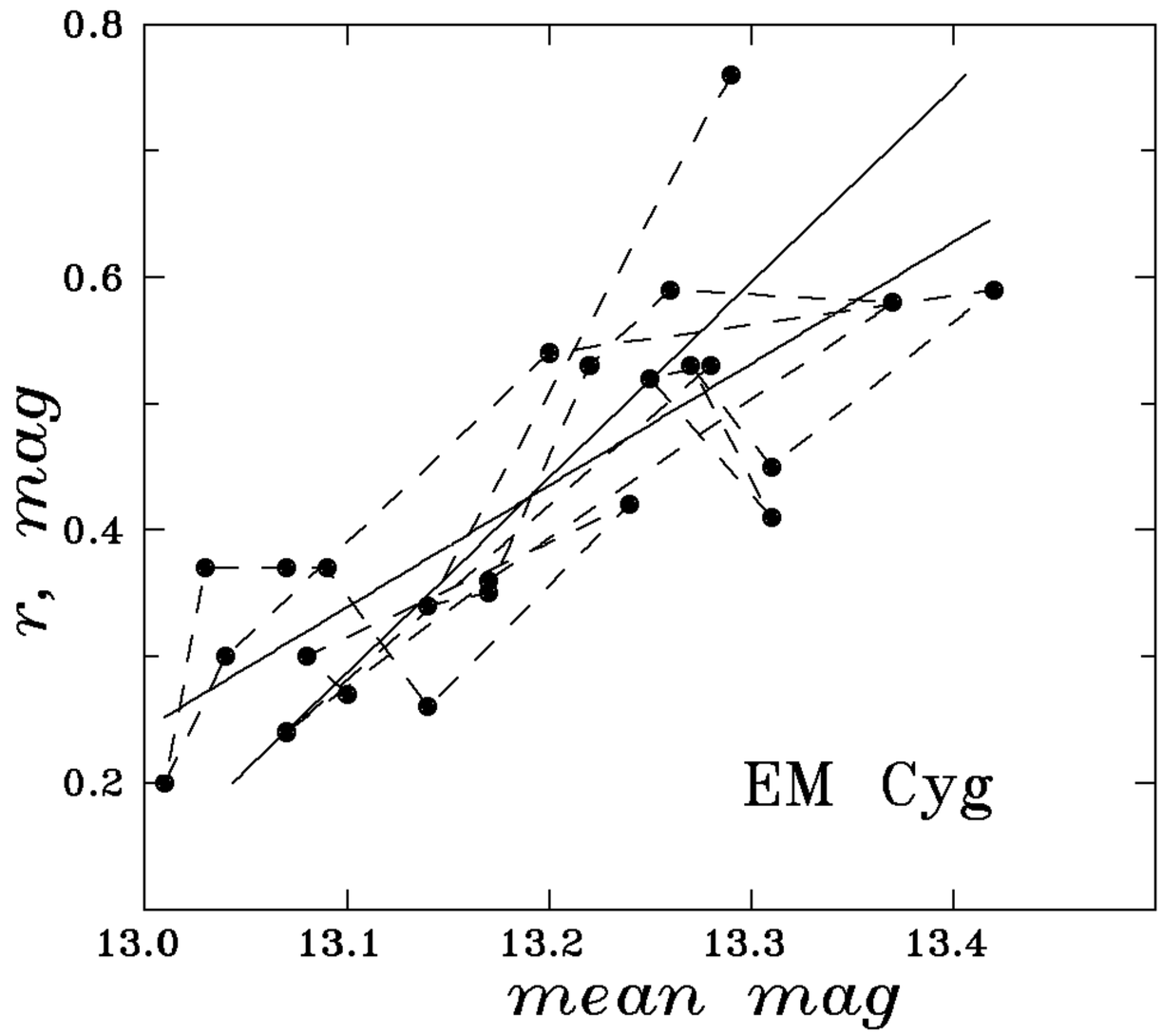


Figure 4. "Semi–amplitude – mean level" diagram for seasonal sine-like fits for EM Cygni.

Table 3. Correlation coefficients ρ for different characteristics of the seasonal sine–like fits of EM Cyg (above the diagonal) and $v = \rho/\sigma_\rho$ (below the diagonal). The $3\sigma_\rho$ level corresponds to a value $\rho = 0.538$. The values exceeding this value are marked by a bold font.

	$\langle t \rangle$	P	f	$S(f)$	r	a	σ_O	σ_{O-C}	$a+r$	$a-r$
$\langle t \rangle$	1	0.165	–0.108	0.204	0.501	0.428	**0.620**	0.468	0.495	–0.245
P	0.8	1	**–0.913**	–0.019	0.084	0.069	0.218	0.273	0.081	–0.045
f	–0.5	**–10.5**	1	–0.113	–0.223	–0.213	–0.338	–0.325	–0.231	0.078
$S(f)$	1.0	–0.1	–0.5	1	**0.869**	**0.564**	0.458	–0.128	**0.773**	**–0.662**
r	2.7	0.4	–1.1	**8.2**	1	**0.790**	**0.820**	0.309	**0.956**	**–0.574**
a	2.2	0.3	–1.0	**3.2**	**6.0**	1	**0.845**	0.493	**0.934**	0.049
σ_O	**3.7**	1.0	–1.7	2.4	**6.7**	**7.4**	1	**0.762**	**0.878**	–0.207
σ_{O-C}	2.5	1.3	–1.6	–0.6	1.5	2.7	**5.5**	1	0.415	0.155
$a+r$	2.7	0.4	–1.1	**5.7**	**15.4**	**12.3**	**8.6**	2.1	1	–0.310
$a-r$	–1.2	–0.2	0.4	**–4.1**	**–3.3**	0.2	–1.0	0.7	–1.5	1

As is well known (e.g. Korn and Korn, 1961), the ratio $v = \rho/\sigma_\rho$, where ρ is the sample correlation coefficient and $\sigma_\rho = ((1-\rho^2)/(n-2))^{1/2}$, obeys the "Student" $t-$ distribution, if the general correlation coefficient is equal to zero. As the $t-$ distribution is close to the normal one for $n \geq 20$, one may use the "3σ" criterion, corresponding to the probability of random deviations of the value larger than 3σ of 0.3 per cent. Thus the statistically significant correlations correspond to $|v| > 3$.

Results are presented in Table 3. Obviously, some of the parameters are achived to be correlating, e.g. $P-f$, $r-\sigma_O$. However, we made an analysis to search for possible new correlations. Some are "funny" – such as an increase of the "noise" characterized by σ_{O-C} with time. However, this may be attributed not to worth typical accuracy of the observations, but to increased instability of the light curve. Unfortunately, no correlation was found between the mean brightness and the outburst frequency, which could be achieved for the constant accreted mass between subsequent outbursts seen in some dwarf novae (e.g. Gicger 1987).

An interesting correlation was found between the semi–amplitude r and the mean level a. Corresponding diagram is shown in Fig. 4. Mean of the seasonal values are $\bar{a} = 13\overset{\mathrm{m}}{.}18 \pm 0\overset{\mathrm{m}}{.}02$ and $r = 0\overset{\mathrm{m}}{.}41 \pm 0\overset{\mathrm{m}}{.}02$, with a "gradient" $\sigma_r/\sigma_a = 1.06 \pm 0.16$. Thus no correlation between $a-r$ and a and an exellent correlation between $a+r$ and a. It is strange that $a-r$ and r are noticeable correlated. Another unexpected result is that the mean cycle length P is *not* correlated neither with r, nor with a. This is in a contradiction with a theoretical expectation and must be checked for other stars.

Characteristics of the individual outbursts.

For the determination of the characteristics of the individual cycles we have used the "running parabola" fit with the filter half–width $\Delta t = 10^{\mathrm{d}}$ which is optimal for variations with a cycle length $\geq 20^{\mathrm{d}}$. Alltogether 174 minima and 180 maxima have been determined. The corresponding error estimates of the brightness are $0\overset{\mathrm{m}}{.}082$ and $0\overset{\mathrm{m}}{.}079$, respectively. The range of the maxima is $11\overset{\mathrm{m}}{.}82 - 13\overset{\mathrm{m}}{.}12$, of the minima is $13\overset{\mathrm{m}}{.}07 - 14\overset{\mathrm{m}}{.}46$. The corresponding mean values $12\overset{\mathrm{m}}{.}60 \pm 0\overset{\mathrm{m}}{.}02$ and $13\overset{\mathrm{m}}{.}73 \pm 0\overset{\mathrm{m}}{.}02$, thus the mean amplitude is $1\overset{\mathrm{m}}{.}13 \pm 0\overset{\mathrm{m}}{.}03$. One may note an apparent trend of the brightness at minimum at a mean value $dm/dt = (27 \pm 7) \cdot 10^{-6}$ mag/day with no significant trend of the brightness at maximum.

The variations of the brightness at the extrema are shown in Fig.5. They were fitted with polynomials of different order. The minima show more pronounced variations with time, and the statistically significant degree of the fit is 8. Thus we have used the same order for the fits of the minima and of the extrema (both minima and maxima, what corresponds to a mean brightness level). The fits show the waves with a cycle length $\approx 3000^{\mathrm{d}}$ what justifies the result seen in the parameters of the seasonal sine fits.

Brief Notes on Other Stars.

The stars V792 Cyg, FS Aur, PU, PV, PY, QY, V336, V368, V372 Per were studied on archive plates of the Moscow and Odessa Sky Patrol Collections. For some stars the Sonneberg observations of H.Busch were added. The tables of individual observations were published by Andronov et al. (1993ab). Moments of maxima were determined and the corresponding cycle lengths were estimated. Characteristics of the outbursts are compared with that predicted by statistical relationships published in the literature. HN Cyg was erreneously classified as an UG variable in some papers, it is a long–period variable with two main oscillations. For other stars the following preliminary results were obtained (Chinarova 1995) by determination of

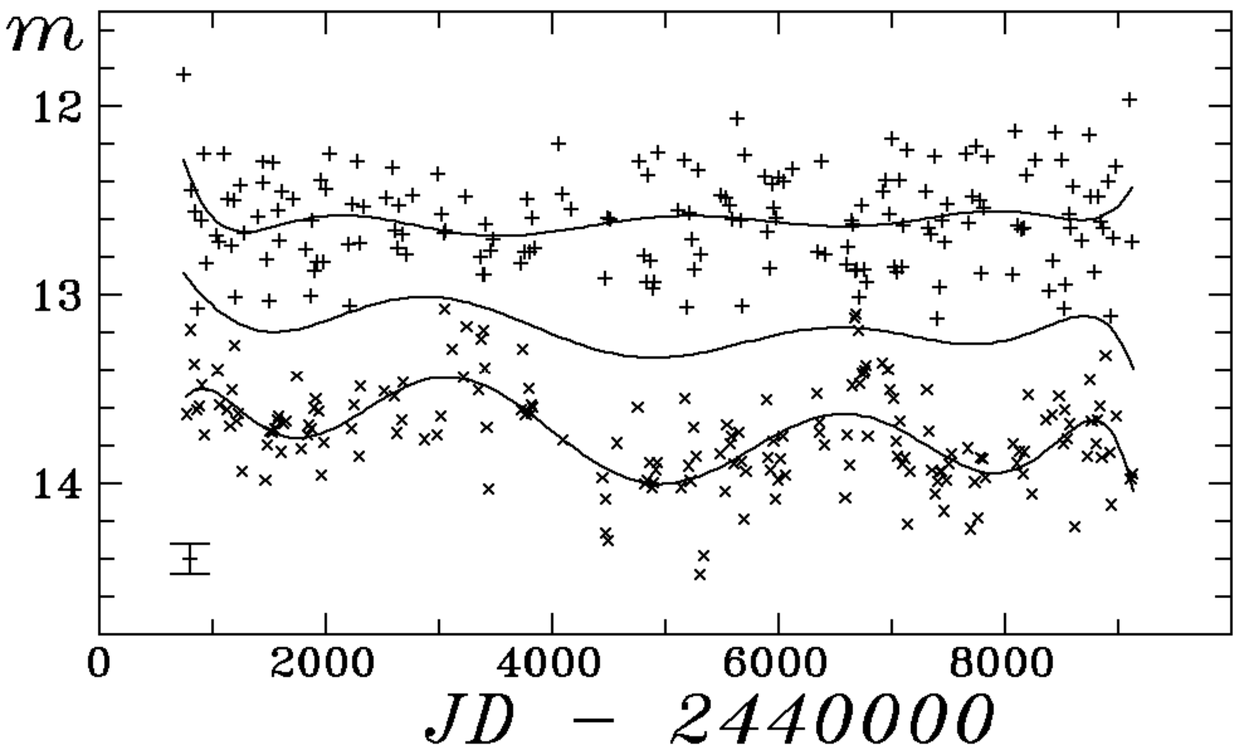


Figure 5. Dependence on time of the brightness in maxima (crosses), minima (inclined crosses) and their fits by a 8-th order polynomial separately and joinly (lines). The vertical bar shows an error estimate corresponding to a mean weight of the individual data point.

the best fit period corresponding to the moments of maxima in separate seasons (algorithm published by Andronov (1991)). However, we plan to revise these results by using more complete data from the AFOEV, VSOLJ and AAVSO data files:

X Leo: Variations of P from $11\overset{\mathrm{d}}{.}06 \pm 0\overset{\mathrm{d}}{.}03$ to $17\overset{\mathrm{d}}{.}72 \pm 0\overset{\mathrm{d}}{.}07$ with possible cycle $\Pi \approx 8000^{\mathrm{d}}$.

AB Dra: From $9\overset{\mathrm{d}}{.}74 \pm 0\overset{\mathrm{d}}{.}03$ to $14\overset{\mathrm{d}}{.}47 \pm 0\overset{\mathrm{d}}{.}04$ with $\Pi \approx 2500^{\mathrm{d}}$.

IR Gem: From $10\overset{\mathrm{d}}{.}19 \pm 0\overset{\mathrm{d}}{.}06$ to $26\overset{\mathrm{d}}{.}49 \pm 0\overset{\mathrm{d}}{.}66$ with $\Pi \approx 1500^{\mathrm{d}}$.

AY Lyr: From $19\overset{\mathrm{d}}{.}67 \pm 0\overset{\mathrm{d}}{.}19$ to $29\overset{\mathrm{d}}{.}99 \pm 0\overset{\mathrm{d}}{.}27$ with $\Pi \approx 5000^{\mathrm{d}}$.

LL Lyr: From $49^{\mathrm{d}} \pm 1^{\mathrm{d}}$ to $120^{\mathrm{d}} \pm 5^{\mathrm{d}}$.

Discussion.

The detailed study of the temporal behaviour of the individual time intervals showed apparent cyclicity with a characteristic time of some years, which may be relatively smooth and similar to the solar–like activity (Bianchini, 1990) or may be "alternating" between two distinctly different values (Andronov and Shakun 1990). This may indicate the presence of two subclasses of stars, possibly corresponding to different mechanisms (cf. Smak 1984).

Changes in the cycle occurence rate may be explained by a modulation of the accretion rate due to a long–term activity of the secondary. Another type of variability in the secondary was found by Shakhovskoy et al. (1993) who detected an UV Cet–like flare in the polar AM Her. These results argue for necessity of further study of consequences of the red star activity onto accretion flow in binary systems.

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EXTREMA OF THE POLAR AM HER: RESULTS OF MULTITELESCOPE MONITORING

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ABSTRACT. The characteristics of 250 extrema of AM Her from the photographic, photoelectric and TV observations are tabulated.

Key words: Stars: Cataclysmic: Polars: AM Her

AM Her is a prototype of polars which shows significant cycle–to –cycle variations of the light curve with few year–scale variations of mean brightness and phase (e.g. Andronov 1987). To study them, the monitoring of this object was started in 1988 in Odessa. The complete table of early observations and the atlas of photovisual light curves was published by Andronov et al. (1984).

Photographic monitoring was carried out in Kishinev, some results of which were published by Smykov and Shakun (1985) and are reanalyzed in the present work. The photographic observations ($n = 1216$) were obtained at the 50-cm telescope AZT-3 by using the ORWO ZU-21 plates.

The monitoring was continued in 1986–88 in the Abastumani Astrophysical Observatory at the Schmidt camera. The photovisual negatives ($n = 341$) were obtained on the A600 film by I.L.Andronov, G.N.Kimeridze, S.V.Kolesnikov and N.V.Poplavskaya. The brightness of the comparison stars was published by Andronov and Korotin (1982).

TV observations were obtained by E.P.Pavlenko, S.V.Kolesnikov and I.G.Borodina at the MTM–500 complex of the Crimean Astrophysical Observatory (CrAO) described by Abramenko et al. (1988). At the first regime, only one filter was used all the night. At the second, two filters switched every exposure. The observations are used as the instrumental magnitude differences "var-d" ($n = 21$, 134, 216 for b, v, r).

The star was observed by N.M.Shakhovskoy at the 1.25m telescope AZT-11 of the CrAO by using the UBVRI photometer–polarimeter of the Helsinki University (Korhonen et al., 1984). The brightness of the comparison star "d" was determined by linking to the standard star BD+26°2930 (Neckel and Chini, 1980): $U = 14\overset{\mathrm{m}}{.}02$, $B = 13\overset{\mathrm{m}}{.}72$, $V = 13\overset{\mathrm{m}}{.}10$, $R = 12\overset{\mathrm{m}}{.}58$, $I = 12\overset{\mathrm{m}}{.}17$. The instrumental magnitudes were converted to the standard system. One run was obtained in V only ($n = 27$). Some results of further monitoring of AM Her were presented by Shakhovskoy et al. (1994).

For the analysis we have used the smoothing by the method of "running parabolae" introduced by Andronov (1990, 1997). The filter half–width $\Delta t = 0\overset{\mathrm{d}}{.}04$ was used which is sufficient enough to fit the two–wave light curves often observed in AM Her.

The extrema are listed in Table 1 where are marked as the "primary" and "secondary" maxima and minima. In the case of absense of the secondary minimum we have marked the single maximum as the "primary". The weighted mean phase shifts between the primary minima in a given color in respect to the minimum in V are $-0\overset{\mathrm{p}}{.}082 \pm 0\overset{\mathrm{p}}{.}016$ (U), $-0\overset{\mathrm{p}}{.}061 \pm 0\overset{\mathrm{p}}{.}020$ (B), $0\overset{\mathrm{p}}{.}008 \pm 0\overset{\mathrm{p}}{.}018$ (R), $0\overset{\mathrm{p}}{.}028 \pm 0\overset{\mathrm{p}}{.}019$ (I). The shift increases with wavelength exceeding 3σ in U, B.

In this work we present the tables of characteristics of individual extrema. These results joined with other published data will be discussed elsewhere.

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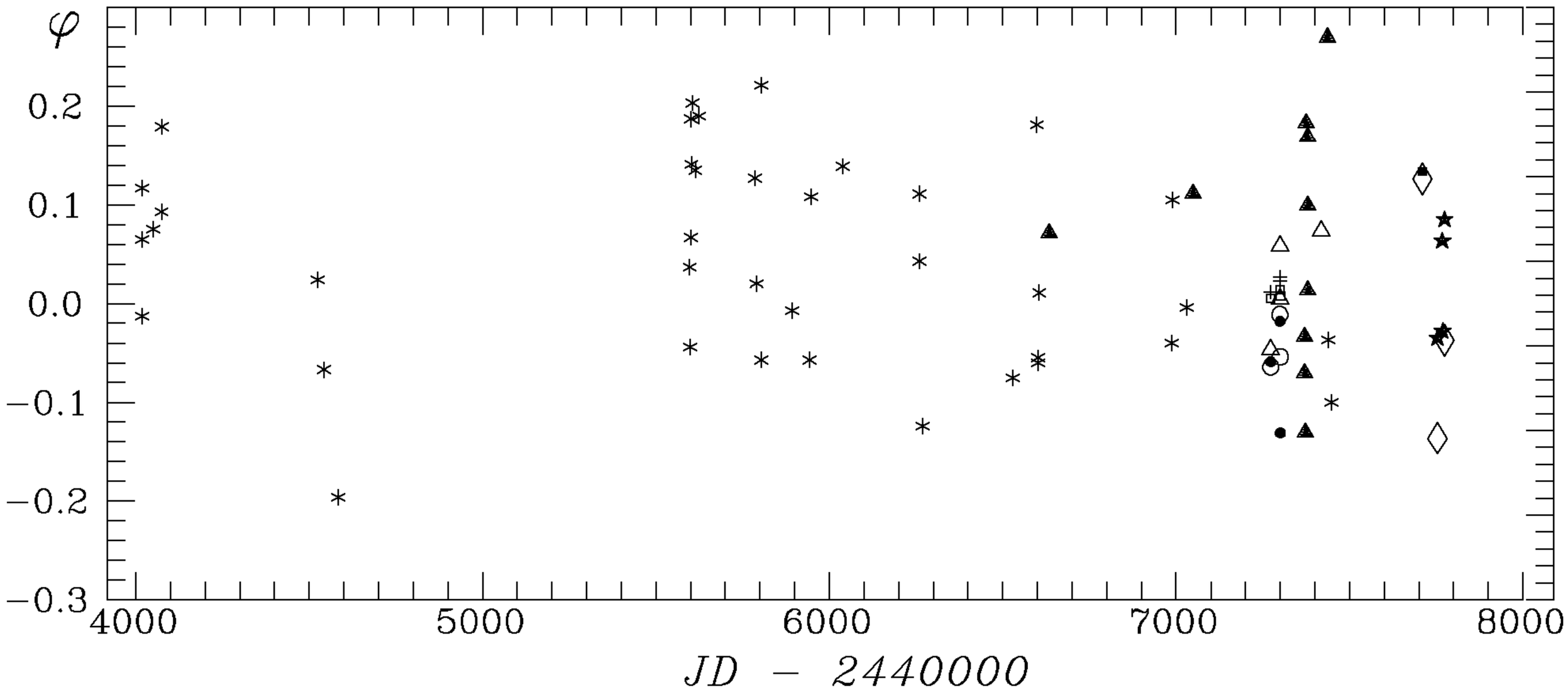


Figure 1: Dependence of the phase of the primary minimum on time for different observational sets. The labels used in the figure are listed in Table 1 in brackets. The phases are computed according to the ephemeris $Min.HJD = 2443014.713 + 0.128927 \cdot E$ (Szkody and Brownlee, 1977).

Table 1. The characteristics of extrema of AM Her: main (1) and secondary (2) minima and (3,4) maxima, i.e. the sequence is 1425...

T_e	ϕ_e	$\sigma[\phi_e]$	m_e	$\sigma[m_e]$	type	T_e	ϕ_e	$\sigma[\phi_e]$	m_e	$\sigma[m_e]$	type
Kishinev, pg (*)						4524.349	0.228	0.181	14.70	0.13	4
4017.455	-0.405	0.114	12.64	0.07	5	4542.360	-0.067	0.052	13.23	0.05	1
4017.516	0.065	0.047	13.34	0.08	1	4583.214	-0.196	0.212	13.22	0.14	1
4018.408	-0.013	0.024	13.47	0.07	1	5597.338	-0.319	0.041	13.46	0.11	5
4019.386	-0.427	0.173	12.93	0.10	2	5597.383	0.037	0.049	14.40	0.12	1
4019.417	-0.188	0.034	12.67	0.12	5	5599.363	0.394	0.053	14.38	0.16	2
4019.456	0.117	0.027	13.44	0.13	1	5599.397	-0.349	0.088	13.82	0.14	5
4019.490	0.380	0.024	12.68	0.10	4	5599.436	-0.044	0.023	14.48	0.19	1
4019.515	-0.428	0.052	12.86	0.15	2	5600.353	0.067	0.069	14.31	0.20	1
4050.393	0.075	0.149	13.38	0.15	1	5600.378	0.265	0.031	13.81	0.17	4
4074.451	-0.327	0.072	12.55	0.16	5	5600.406	0.482	0.089	14.20	0.28	2
4074.505	0.093	0.235	13.42	0.13	1	5601.338	-0.291	0.025	14.00	0.15	5
4074.533	0.311	0.050	13.19	0.04	4	5601.399	0.187	0.005	14.69	0.07	1
4075.370	-0.194	0.101	12.60	0.09	5	5602.296	0.141	0.056	14.51	0.06	1
4075.419	0.179	0.026	13.41	0.10	1	5602.326	0.372	0.034	14.14	0.09	4
4075.467	-0.445	0.023	12.64	0.06	4	5602.344	-0.489	0.029	14.25	0.10	2
4076.398	-0.223	0.044	12.56	0.07	5	5602.368	-0.298	0.064	14.11	0.11	5
4076.513	-0.333	0.066	12.46	0.03	5	5605.269	0.203	0.124	14.43	0.15	1
4078.532	0.326	0.018	12.51	0.10	4	5605.319	-0.415	0.046	13.96	0.13	4
4467.380	0.358	0.022	15.42	0.04	2	5607.412	-0.180	0.025	14.10	0.03	5
4467.403	-0.458	0.055	15.35	0.04	5	5610.354	-0.358	0.064	14.04	0.08	5
4467.475	0.096	0.200	15.24	0.04	4	5613.326	-0.304	0.024	14.66	0.12	5
4472.376	0.110	0.116	15.26	0.07	4	5613.383	0.135	0.289	14.88	0.05	1
4472.405	0.333	0.015	15.45	0.07	2	5618.336	-0.451	0.054	15.64	0.08	2
4524.283	-0.278	0.142	14.64	0.03	5	5618.340	-0.417	0.638	15.63	0.08	2
4524.322	0.024	0.167	14.92	0.09	1	5618.388	-0.042	0.055	15.40	0.13	5

Table 1 (continued).

T_e	ϕ_e	$\sigma[\phi_e]$	m_e	$\sigma[m_e]$	type	T_e	ϕ_e	$\sigma[\phi_e]$	m_e	$\sigma[m_e]$	type
Kishinev, pg (*)						Kishinev, pg (*)					
5623.351	0.449	0.151	15.71	0.07	2	6598.520	0.181	0.049	14.01	0.04	1
5624.349	0.190	0.057	15.65	0.08	1	6600.486	0.425	0.037	14.42	0.06	4
5785.500	0.127	0.038	14.76	0.07	1	6601.434	-0.218	0.029	14.38	0.10	5
5789.440	-0.313	0.031	14.55	0.01	5	6601.455	-0.055	0.066	14.54	0.10	1
5789.482	0.020	0.163	14.73	0.06	1	6602.486	-0.060	0.120	14.81	0.05	1
5792.529	-0.347	0.112	15.27	0.05	2	6605.460	0.011	0.121	14.57	0.10	1
5792.554	-0.155	0.070	15.17	0.04	5	6986.433	-0.040	0.099	14.23	0.09	1
5796.470	0.218	0.030	15.26	0.05	4	6986.464	0.202	0.008	13.99	0.03	4
5804.464	0.221	0.072	15.43	0.25	1	6988.417	0.349	0.084	13.97	0.12	4
5804.515	-0.381	0.024	15.15	0.08	5	6989.383	-0.159	0.007	14.00	0.02	5
5804.557	-0.057	0.092	15.68	0.07	1	6989.417	0.105	0.086	14.37	0.08	1
5824.502	-0.360	0.063	15.65	0.03	2	6989.442	0.296	0.040	14.09	0.15	4
5827.376	-0.062	0.325	15.50	0.14	5	6989.470	-0.482	0.114	14.28	0.20	2
5827.389	0.032	0.128	15.48	0.11	5	7025.421	0.362	0.006	13.97	0.01	2
5893.394	-0.007	0.034	14.18	0.14	1	7031.389	-0.348	0.050	13.61	0.02	5
5914.490	-0.380	0.071	14.10	0.06	5	7031.433	-0.004	0.039	14.00	0.04	1
5943.375	-0.342	0.175	13.76	0.07	5	7040.419	-0.306	0.045	13.58	0.05	5
5943.411	-0.057	0.052	13.92	0.07	1	7382.426	0.410	0.025	13.50	0.05	4
5947.300	0.108	0.029	14.32	0.14	1	7382.455	-0.364	0.150	13.77	0.10	2
5947.352	-0.495	0.029	13.87	0.07	5	7386.417	0.365	0.145	13.53	0.05	4
6005.373	-0.464	0.035	13.97	0.14	5	7387.358	-0.331	0.098	13.38	0.10	5
6039.229	0.139	0.258	14.13	0.14	1	7389.412	-0.406	0.014	13.71	0.03	2
6039.254	0.329	0.078	13.90	0.12	4	7389.455	-0.067	0.055	13.51	0.04	5
6039.284	-0.436	0.116	14.25	0.15	2	7438.323	-0.037	0.092	13.69	0.02	1
6137.520	-0.489	0.103	14.11	0.12	5	7448.332	-0.401	0.062	13.63	0.04	5
6165.433	0.017	0.010	15.34	0.02	4	7448.371	-0.100	0.029	13.92	0.08	1
6165.474	0.331	0.060	15.71	0.04	2	Abastumani, pv (▲)					
6176.441	0.397	0.111	15.79	0.14	2	6633.274	0.741	0.073	14.35	0.07	5
6176.476	-0.333	0.045	15.41	0.06	5	6633.317	0.074	0.023	14.70	0.05	1
6176.552	0.258	0.038	15.24	0.12	4	6633.356	0.380	0.043	14.27	0.14	4
6194.472	0.254	0.140	15.45	0.06	4	6633.485	0.376	0.088	14.61	0.06	2
6194.507	-0.475	0.233	15.70	0.11	2	6634.498	0.240	0.135	14.40	0.11	4
6259.424	0.043	0.031	14.69	0.05	1	7048.338	0.114	0.053	13.97	0.06	1
6260.392	-0.452	0.040	14.21	0.08	2	7049.250	0.191	0.097	13.50	0.15	4
6260.426	-0.187	0.130	14.07	0.06	5	7059.333	0.399	0.455	13.71	0.10	4
6260.464	0.111	0.055	14.43	0.05	1	7063.334	0.430	0.092	13.59	0.11	4
6262.432	0.373	0.039	14.37	0.10	4	7063.360	0.633	0.033	13.79	0.10	2
6262.453	-0.465	0.006	14.46	0.03	2	7064.243	0.481	0.025	12.96	0.24	4
6269.459	-0.124	0.033	14.63	0.10	1	7064.346	0.275	0.038	13.43	0.14	4
6288.394	-0.263	0.102	15.72	0.07	2	7078.308	0.571	0.082	13.73	0.05	5
6288.425	-0.021	0.109	15.45	0.05	5	7080.230	0.477	0.029	13.91	0.09	2
6301.475	0.202	0.079	15.49	0.06	4	7080.260	0.716	0.047	13.51	0.15	5
6305.399	-0.364	0.042	15.76	0.08	2	7348.382	0.354	0.087	12.94	0.09	4
6327.421	0.448	0.031	15.48	0.05	5	7348.402	0.514	0.038	13.00	0.07	2
6327.456	-0.283	0.193	15.67	0.07	2	7370.379	-0.031	0.111	13.63	0.11	1
6334.395	-0.459	0.054	15.78	0.06	2	7370.438	0.431	0.059	12.87	0.06	4
6528.427	-0.484	0.020	15.64	0.22	2	7370.503	-0.068	0.094	13.73	0.15	1
6528.457	-0.251	0.082	15.20	0.19	5	7373.332	-0.128	0.011	13.83	0.15	1
6528.480	-0.075	0.018	15.77	0.13	1	7373.430	0.638	0.035	12.71	0.10	5
6528.513	0.179	0.030	15.08	0.12	4	7373.501	0.185	0.009	14.33	0.20	1
6581.450	-0.221	0.100	14.45	0.04	5	7378.329	0.636	0.037	12.83	0.08	5
6598.488	-0.067	0.037	13.69	0.05	5	7378.378	0.016	0.099	13.59	0.11	1

Table 1 (continued).

T_e	ϕ_e	$\sigma[\phi_e]$	m_e	$\sigma[m_e]$	type
Abastumani, pv					(▲)
7378.461	0.657	0.100	13.09	0.12	5
7379.301	0.171	0.176	13.59	0.11	1
7379.349	0.549	0.061	12.97	0.12	5
7379.421	0.102	0.024	13.85	0.06	1
7427.450	0.633	0.057	13.78	0.07	2
7433.470	0.325	0.171	13.72	0.16	2
7436.428	0.272	0.103	13.79	0.11	1
7437.425	0.998	0.030	12.79	0.14	5
CrAO, AZT–11, U (×)					
7272.438	0.305	0.030	12.91	0.02	2
7272.467	-0.470	0.017	12.80	0.02	5
7272.520	-0.059	0.050	13.31	0.12	1
7272.546	0.149	0.007	12.65	0.06	4
7299.342	-0.018	0.014	11.96	0.04	1
7299.364	0.155	0.054	11.86	0.04	4
7299.398	0.417	0.039	12.06	0.03	2
7300.314	-0.479	0.156	12.18	0.03	2
7300.323	-0.407	0.085	12.17	0.03	5
7300.359	-0.131	0.039	12.29	0.02	1
7300.402	0.203	0.035	12.05	0.02	4
7389.348	0.099	0.014	12.00	0.02	4
7389.395	0.467	0.027	12.43	0.02	2
CrAO, AZT–11, B (◯)					
7272.432	0.261	0.028	13.93	0.02	2
7272.466	-0.471	0.058	13.83	0.02	5
7272.519	-0.064	0.039	14.01	0.03	1
7299.343	-0.011	0.023	13.23	0.04	1
7299.376	0.250	0.145	13.14	0.03	4
7299.392	0.374	0.043	13.18	0.02	2
7299.448	-0.196	0.124	12.95	0.02	5
7300.312	-0.496	0.082	13.27	0.03	2
7300.327	-0.376	0.066	13.24	0.03	4
7300.368	-0.054	0.034	13.48	0.02	1
7300.414	0.300	0.026	13.22	0.02	4
7389.349	0.107	0.030	13.27	0.02	4
7389.403	-0.476	0.052	13.52	0.02	2
7389.448	-0.126	0.078	13.33	0.02	5
CrAO, AZT–11, V (△)					
7272.456	0.451	0.050	13.48	0.04	4
7272.464	-0.491	0.084	13.48	0.04	2
7272.487	-0.314	0.036	13.41	0.05	5
7272.522	-0.044	0.027	14.03	0.04	1
7299.352	0.061	0.011	13.52	0.05	1
7299.433	-0.308	0.034	12.78	0.03	5
7300.328	-0.371	0.031	12.91	0.03	5
7300.376	0.007	0.020	13.67	0.02	1
7300.426	0.389	0.018	13.01	0.02	4
7389.424	-0.313	0.019	13.01	0.03	5
7418.301	-0.331	0.032	13.03	0.04	5
7418.353	0.076	0.245	13.48	0.04	1
CrAO, AZT–11, R (□)					
7272.454	0.436	0.033	12.73	0.03	4

T_e	ϕ_e	$\sigma[\phi_e]$	m_e	$\sigma[m_e]$	type
CrAO, AZT–11, R (□)					
7272.462	0.498	0.024	12.74	0.03	2
7272.488	-0.302	0.018	12.58	0.04	5
7272.528	0.005	0.014	13.45	0.03	1
7299.346	0.014	0.039	12.77	0.04	1
7299.437	-0.277	0.023	11.98	0.02	5
7300.308	0.476	0.038	12.29	0.03	2
7300.330	-0.349	0.018	12.12	0.03	5
7300.376	0.008	0.016	12.98	0.02	1
7300.422	0.361	0.013	12.26	0.01	4
7389.378	0.337	0.038	12.43	0.02	4
7389.398	0.486	0.039	12.47	0.03	2
7389.425	-0.306	0.019	12.33	0.03	5
CrAO, AZT–11, I (+)					
7272.456	0.449	0.065	12.00	0.02	4
7272.462	0.493	0.030	12.00	0.02	2
7272.489	-0.296	0.020	11.85	0.03	5
7272.529	0.012	0.011	12.66	0.02	1
7299.347	0.023	0.052	12.08	0.05	1
7299.384	0.312	0.032	11.70	0.03	4
7299.391	0.362	0.072	11.71	0.03	2
7299.438	-0.274	0.021	11.36	0.02	5
7300.331	-0.346	0.020	11.50	0.02	5
7300.379	0.027	0.021	12.33	0.03	1
7300.420	0.347	0.015	11.61	0.02	4
7389.375	0.309	0.016	11.73	0.02	4
7389.400	-0.500	0.023	11.83	0.02	2
7389.426	-0.297	0.022	11.70	0.03	5
CrAO, MTM–500, b (■)					
7710.351	-0.095	0.070	-0.56	0.04	5
7710.381	0.134	0.078	-0.44	0.04	1
7710.394	0.238	0.053	-0.46	0.04	4
7710.429	-0.492	0.060	-0.21	0.05	2
CrAO, MTM–500, v (◇)					
7710.379	0.126	0.004	0.35	0.06	1
7710.432	-0.469	0.094	-0.37	0.07	4
7710.463	-0.225	0.087	-0.13	0.08	2
7753.407	-0.136	0.135	0.51	0.07	1
7753.444	0.146	0.154	0.29	0.06	4
7753.471	0.357	0.095	0.36	0.05	2
7774.306	-0.037	0.032	0.36	0.04	1
7774.342	0.243	0.023	-0.08	0.04	4
7774.383	-0.438	0.051	0.27	0.03	2
CrAO, MTM–500, r (⋆)					
7753.420	-0.035	0.043	0.50	0.05	1
7753.478	0.410	0.070	0.07	0.04	4
7767.357	0.063	0.064	0.33	0.03	1
7768.447	-0.483	0.028	0.27	0.06	2
7768.474	-0.275	0.066	0.08	0.03	5
7768.506	-0.028	0.103	0.22	0.03	1
7773.420	0.085	0.103	0.39	0.03	1
7773.463	0.424	0.032	0.05	0.04	4
7773.492	-0.350	0.014	0.28	0.04	2

THE ECLIPSING BINARY SYSTEM BM ORI

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ABSTRACT. Photometric and spectroscopic features of eclipsing binary system BM Ori can be described well by a model in which the components are the primary star B3 ZAMS, the secondary F2 pre-main sequence star and a dusty envelope of large grains around the secondary. The eclipse on ingress and egress phases has been produced by a dust envelope only, but during the total phase the F2 star makes yet the partial eclipse.

Eclipsing binaries in which the major puzzle is a nature of an eclipsing body are considered. Some parameters indicate that candidates to relative objects to BM Ori can be ϵ Aur, TY CrA, θ^1 Ori A and variable stars in multiple systems.

Key words: Stars: eclipsing binaries, young stars

BM Ori is a wellknown eclipsing binary in Trapezium Ori. It is among extremaly young objects. Its age is estimated from 2x10^4 yr (Wilson 1972) to 3x10^5 yr (Vitrichenko 1996c, 1997b). Photometric and spectral features of this system allow to call it as unique object (Zakirov, Shevchenko 1982).

The major puzzle of star is a nature of eclipsing body. There are some models to explaine the secondary origin: it may be a star (Parenago 1947; Antokhina et al. 1989); a disk (or a ring) around an invisible star, which may be a black hole (Wilson 1972); semitransparent envelope around invisible star (Shevchenko, Zakirov 1977), a disk, in which a luminosity of central part corresponds to F or G star (Zakirov, Shevchenko 1982).

These models describe well enough the light curve in V band, but further observations in different spectral ranges are required to confirm or except them.

The new photometric and spectroscopic study of BM Ori were made in 1994-96. The photometric results are based on the original and earlier published UBVRI and infrared observations and present the photometric behaviour of BM Ori up to 10.7 mkm (Bondar, Vitrichenko 1995, 1996a,b,c; Vitrichenko, Larionov 1996).

In general the following features have been taken. The secondary minima did not discovered in any UBVRI band. Analysis of O-C for all data and on ingress, egress and total phases show no changing in period on observing interval covered about 70 years. This fact excepts the mass loss in the system. The depth of minimum depends on wavelenghts. Analysis of this dependence reveals a presence of non-selective absorption produced by the envelope grains. Change of the minimum form has been suspected. If it is real the dimension of eclipse body is changing on 0.03 % per year.

The light curve is unstable. There are detected flares on outside and on eclipce with duration ~ 2 hours and amplidute up to $0^m.5$ in U. The energy distribution of flare corresponds to Rayleigh-Jeans law. The probability of the flare activity is estimated ~ 15 %. The calculations shown that continuum in region 0.36–10.7 mkm can be presented as the sum of the flux from the primary star B3 ZAMS, the secondary pre-main sequence F0 star and a dust matter around it with temperature about 1100^o K.

The spectroscopic data allow to derive physical parameters of system (Vitrichenko et al. 1996).

Amplitude of radial velocity determined from hydrogen lines is less than amplitude determined from helium lines. The cause of such difference is the doublicity of star. Hydrogen lines are the superposition of lines of main and secondary stars and helium lines are formed only on the main star. The syntethic spectrum corresponds well to observing one in assuming that lines are produced by the main star B3 and the secondary F2 (Vitrichenko, Tzymbal 1996).

Basing on photometric and spectposcopic results a following model of BM Ori were considered in detail (Bondar', Vitrichenko 1997; Vitrichenko 1997b). The primary B3 ZAMS star is eclipsing by the dust envelope surrounding the secondary pre-main sequence F2 star. The ingress and egress phase are produced by the dust envelope and near to the central part of total eclipce the F2 star makes the partial eclipce yet.

The nature of dust is discussed by Vitrichenko (1997a). The best agreement with observations are given the envelope from SiO_2 drops and grains which sizes are ~ 2 mkm. The suggestion that extensive dust envelope around the secondary may be responsible for the eclipce in BM Ori system were proposed earlier by Shevchenko, Zakirov (1977).

It is interesting to search for relative objects to BM Ori. Such question were discussed by Wilson (1972).

He considered some observational arguments indicating a similar origin of eclipsing body in ϵ Aur and BM Ori and introduced a common model for these systems in which the secondary is a black hole. Earlier such model were propesed for β Lyr, but soon he declined it. New observations of ϵ Aur in 1982-84 did not confirm this model too. A hot early B star was found in system from IUE observations (Ferluga, Hack 1985). But the idea that BM Ori and ϵ Aur would have a common mechanism of eclipce remains interesting to consideration.

Search for an analogy between these stars is based on the quantitative characteristics. Basic features of these stars are given in Table 1.

Some parameters described light curves and spectrum in eclipse are similar. It is not rule out that ϵ Aur is a young system too and the difference in evolutionary stage of these systems can be explained by the difference in masses of their components. Hack (1984) proposed too that ϵ Aur would be on a short scale of evolution.

TY CrA may be suspected as relative object to BM Ori (Vitrichenko et al. 1995). Some arguments indicate a precense of dust in the system. Radius of secondary F2 star is greater one of normal star. Infrared excess has been detected in the system radiation. As in the case of BM Ori the eclipce can be explained by a dust matter. Spectral features confirm an analogy between these stars too. There are detected in spectrum of secondary only NaD line.

According Zakirov (1979) photometric behaviour of θ^1 Ori A may be explained similar to BM Ori. New facts taken from spectrographic and photometric investigations confirm this suggestion (Bondar', Vitrichenko 1997).

The considered samples allow to assume that stars related to BM Ori are exhibited the excess of radii and infrared flux and would be detected with a high probability in the star formation regions, particular among the stars in multiple systems.

Table 1. Comparison of features of two binary systems

Features	BM Ori	ϵ Aur
Photometric properties		
The depth of eclipse in V	$0^m.7$	$0^m.8$
The flat bottom during total eclipce	+	+
Non-selective absorption by secondary	0.36-0.97	0.17-4
The secondary minima is not detected	+	+
The form of minima is changing	+	+
The duration of eclipse to duration of total eclipse (D/d)	1.93	2.16-1.65
The brigthness is irregular on outside and on eclipce	+	+
Spectral properties		
The spectrum of primary star is visible always on the all phases	+	+
The spectrum of secondary is invisible on the total phase	+	+
The flux from secondary dominates in the region	IR	UV
The dust radiation is detected	+	+
Physical parameters		
$M_1/M_\odot$	6.3	1.5–16
$M_2/M_\odot$	2.5	4-15
$R_1/R_\odot$	2.5	> 150
$R_2/R_\odot$	1.9	3-5
M_{v_1}	$-0^m.98$	$-8^m.4$
M_{v_2}	$-0^m.85$	
Spectral type	B3+F2	FOI+B3
Other characteristics		
Multiple system	8	6
The region of star formation	Trapezium Ori	Aur OB1
Distance	400 pc	580 pc
Period	$6^d.47$	27.1 yr
The estimates of age	$10^4 - 10^5$	$10^3 - 10^6$

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THE CATALOGUE OF PHOTOMETRIC, GEOMETRICAL AND ABSOLUTE ELEMENTS OF CONTACT BINARY STARS OF THE EARLY SPECTRAL TYPE

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ABSTRACT. The Catalogue of the early type contact systems is described and it's analysis is presented.

Key words: Stars: contact early binary systems (CE-systems); photometric, geometrical and absolute elements; diagrams of physical characteristics.

Catalogue

For the first time the early type contact systems were identified as an individual class in the Catalogue by Svechnikov (1969), which contains 8 systems of this type. The Catalogue by Coch et al. (1970) contains 37 systems of the early spectral type.

According to Svechnikov's classification a primary component (more massive and hotter) of a CE-system has a spectral class earlier than F0-F2 and an orbital period of more than 0,5 day. Usually the spectral class of a primary is earlier than the spectral class of a secondary. Both components fill their Roche lobes on 90-100 per cent and more. The following Catalogue by Svechnikov and Bessonova (1984) contains 38 CE-systems. Bondarenko (1986) published the Catalogue of the CE-s tars, which contained 83 systems.

Physical characteristics of the CE-stars presented in the list of catalogs abovementioned, were obtained by different authors by using different methods of calculation.

We propose the Catalogue of the CE-systems with homogeneous absolute physical characteristics, that allows to define accurately general features of this class of binary stars. The comparing of physical characteristics of the CE-systems with other classes'characteristics of binary stars can show the possible evolutionary stages of the CE-systems.

The foundation of absolute elements of the CE-systems are the spectral observations (radial velocity curves of the both components or radial velocity curve of the primary) and photometric observations (on the whole, the latest multicolour photoelectric, in a few cases photographic and visual observations). The accuracy of modern photometric observations is high, and generally they are processed with the help of reliable computer methods both classical and synthetical methods. But reliable spectral obser vations (the ray speed curves) are very scarce, especially for both components. We have prefered the spectral class of a primary (usually it is more bright), supposing, that it's spectral class was defined accurately, and photometric and geometrical elements from light curves.

Our Catalogue contains 100 CE-stars; 31 systems have the ray speed curves of the both components, 12 systems have the ray speed curve of the primary.

All stars from our Catalogue were classificated preliminarily as CE-stars by Svechnikov et al (1980). The absolute elements of other stars of the Catalogue were obtained by using a spectral type of the primary and the diagram mass ratio – observed radius of the component.

Our Catalogue consist of three parts: photometric, geometrical and absolute elements of CE-systems. All stars were divided approximately into two groups: massive ($M_1 > 3M_\odot$ for primary) and less-massive stars ($M_1 < 3M_\odot$ for primary).

Hertzsprung - Russell (H-R) diagram

On this diagram primaries and secondaries of the massive stars are locate near ZAMS, the width of ZAMS make up 3 spectral subclasses on the average. The spectral classes of primaries (O7-B3) are determined unreliablly, becose take place the lines' superposition of gas streams and shells, and it leads to deviation within the 0.5 spectral class.

The primaries of the less-massiv stars locate near ZAMS too, but secondaries have an excess of luminosity as compared with the normal stars corresponded to theese spectral classes, becquse they have more large sizes after filling Roche lobes. Several secondaries of less-massive stars deviate to the left from ZAMS, therefore, they have hagher temperature as compared with normal stars of main sequence, becquse they are the members of CE-systems, which exchanged their roles.

The mass-absolute bolometric magnitude diagram

The majority of primaries and secondaries are located more to the left from the same relation for detached binary stars of main sequence. The CE-systems have

excess of luminosity nearly the $1^m - 2^m$, because of filling of their Roche lobes. The following relations take place for primary

$$\begin{aligned} M_{1bol} = & - & 8.8126 \lg M_1 + 3.868 \\ & \pm & 0.154 \qquad \pm 0.220 \end{aligned}$$

and for secondaries is

$$\begin{aligned} M_{2bol} = & - & 7.609 \lg M_2 + 2.337 \\ & \pm & 0.137 \qquad \pm 0.238 \end{aligned}$$

Secondaries of the less-massive CE-stars have significant excess of luminocity $2^m - 4^m$.

The mass-radius diagram

This diagram shows the location of CE-systems as compared with detached binary stars. There are components of massive CE-systems not far from the same relation for detached systems. Dispersion of CE-stars shows differehent evolutionary status because of different degree of Roche lobes filling.

The stars with the $M_1 > 10 M_\odot$ have significant excess from the same relation. It is explained by very reliable spectral observations because of spectral line's superposition of both components. The primaries with $1.4 M_\odot < M_1 < 3.2 M_\odot$ correspond to $M - R$ relation for detached stars, but at the same time secondaries have significant excess of radii as compared with detached stars. It is one of the most important differences of CE-stars, especially from W UMa-type. The mass-radius relation for the primaries is

$$\begin{aligned} \lg R_1 = & & 0.620 \lg M_1 + 0.161 \\ & \pm & 0.059 \qquad \pm 0.084 \end{aligned}$$

for secondaries is

$$\begin{aligned} \lg R_2 = & & 0.581 \lg M_2 + 0.234 \\ & \pm & 0.040 \qquad \pm 0.070 \end{aligned}$$

We think, these stars experienced an exchange of roles. The excess of radii for the secondaries explains the excess of luminosity as compared with the normal stars of main sequence.

The mass - spectral class diagram

Primaries correspond to M-Sp relation for normal stars of main sequence, because we have supposed that primaries are normal stars. B1 - G0 secondaries are below, i.e. these components had a transfer of matter. The majority of G0 - K9 secondaries locates above. It is possible, these pairs of stars do not have any role exchange. Thus, such location of CE-stars on the M-Sp diagram points to different evolutionary stages of binary stars. The mass-effective temperature relations for primaries and secondaries are

$$\begin{aligned} \lg T_{1eff} = & & 0.547 \lg M_1 + 3.784 \\ & \pm & 0.040 \qquad \pm 0.060 \end{aligned}$$

$$\begin{aligned} \lg T_{2eff} = & & 0.463 \lg M_2 + 3.881 \\ & \pm & 0.038 \qquad \pm 0.066 \end{aligned}$$

The primary mass - semimajor axis

This is one of the most interesting diagram regarding evolution of binary stars. For the first time such diagram appeared in Svechnikov (1969). The region of co-ordinates

$$\begin{aligned} &\lg M_1 = 0.0; \quad \lg A = 0.9, \\ &\lg M_1 = 0.0; \quad \lg A = 0.5, \\ &\lg M_1 = 0.7; \quad \lg A = 1.0 \end{aligned}$$

was called a region of absence for unevolved close binaries stars. Later CE-stars from (Bondarenko, 1986) filled that region. And our new investigations confirm this. This region is filled as the unevolved stars as evolved components (i.e. they experienced role exchange). Rich information about CE-systems (majority of them are dull objects) allows to make the following conclusion: the CE-stars fill the "prohibited" region. The solid lines shows minimal value of orbital semimajor axis with fixed mass ratio for normal stars, which correspond M-R relation, if they fill their Roche lobes.

Conclusions

As a result of CE-systems study we can propose the following conclusions:

1) the components of CE-stars influence each other greatly and increase their evolutionary processes;

2) primaries components (more massive and hotter) satisfy general relations of physical characteristics for normal stars of main sequence;

3) majority of secondaries satisfy the same relations too. But many of secondaries have differences, which make up the CE-systems as an individual class of close binaries stars. Secondaries have an excess of luminosity and excess of radii;

4) due to the fact that mass transfer take place in close binary stars, many of them exchanged their roles and became CE-systems (the evolved CE systems). But many of them became CE-stars wthout role exchange, being the stars of main sequence;

5) both components fill their Roche lobes within 90-100% and more.

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A SPOT STRUCTURE OF ACCRETION DISK OF U GEMINORUM

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ABSTRACT. On the basis of modelling of emission lines of dwarf novae U Gem, conclusion is made, that the observed orbital phase change of model parameters of a accretion disk can not be explained in frameworks of Keplerian velocity field in a disk. The reason of such change can be spiral shock in a accretion disk.

Key words: accretion, accretion disks - methods: individual (U Gem) - spectroscopy: data analysis

Introduction

U Gem is one of the best-studied cataclysmic variables of all time. It is the prototype of the dwarf nova class of cataclysmic variables. The photometric study of U Gem by Krzeminski (1965) showed that U Gem is an eclipsing binary system with an orbital period of 4^h15^m. In an optical spectrum U Gem dominate broad double-peaked emission lines of H I, He I and Ca II, arise from the accretion disk. Spectra of U Gem show also narrow emission line components which vary sinusoidally in wavelength (called "S-wave" component), and which have previously been ascribed to emission from the gas stream or the bright spot. On basis of the most full spectral researches U Gem Smak (1976) has made a conclusion, that the S-wave component is formed in stream close to the accretion disk. However Marsh et al (1990), applying Doppler tomography method, have determined, that the S-wave component comes from mixture of disk and stream matter, each of which has passed through a shock in the bright spot region. The velocity of the emission is then an average of the disk and stream velocities.

The aim of our work is to research a spot structure of the accretion disk of U Gem on basis of phase modelling of emission lines profiles. In paper Borisov and Neustroev (1996) we have presented a technique of calculation of emission lines profiles, formed in the non-uniform accretion disk. Results of these calculations have shown, that modelling of spectra, obtained in different phases of an orbital period, allows to estimate basic parameters of a spot (such as geometric sizes and luminosity) and to investigate a structure of the accretion disk.

Observations and modelling

The spectral data of U Gem were obtained during January 21, 1994 and December 5-6, 1994 with the 1000-channel television scanner and the spectrograph SP-124 of the 6-m telescope of the SAO. In January, 21 25 spectra were obtained in wavelength range $\lambda\lambda$3600-5600 Å with dispersion 1.9 Å/channel. In December, 5-6 23 spectra were obtained in wavelength range $\lambda\lambda$4400-5300 Å with dispersion 1.1 Å/channel. The spectra were taken with typical integration times of 300 seconds. Both series of spectra cover approximately identical phase range from 0.7 to 0.3. After modelling we obtained all basic parameters of the accretion disk and bright spot.

Discussion

In Fig. 1 we show the orbital phase dependence of the disk parameters. In case of driving substance in the disk on keplerian circular orbits a peak separation in emission lines mostly affects on the definition of parameter V should remain constant during an orbital period. However, it can be seen, that parameters, including V, is sinusoidally vary with a double wave for an orbital period (hypothesis about a constancy of parameters can be rejected with a confidence probability more than 99%). Moreover, explicit correlation between change of V, R and α is observed. Multiple correlation coefficient between V and parameters R and α for all lines is more than 0.72 with a confidence probability more than 96%. Such variability of parameters present in both data series and the phases of their modification are almost identical. The most interesting is the behaviour of a parameter V, as its change from a phase as a double wave for a period reveal about a deviation of a velocities field in the disk from circular keplerian. The similar effect was marked also by Marsh et al (1990). The possible reason of such parameters modification is the noncircular form of an exterior edge of the accretion disk.

A research of dynamics and stabilities of keplerian elliptic accretion disks have shown (Lyubarskij, Postnov and Prokhorov, 1994), that such disks should be stable

formations. However modelling has shown, that the peak separation in emission lines, formed in the keplerian elliptic accretion disk will remain constant during an orbital period. Therefore, at preservation of a hypothesis about keplerian velocities in the disk the phase variability of the peak separation can be explained only by a deviation area of emission lines generation from a circle in the circular disk. For the elliptic disk the area of generation should have at least an eccentricity different from the disk.

Paczynski (1977) investigated the tidal effect of the secondary star upon the disk by integrating the orbits of test particles in the restricted three-body problem to determine the departures from a Keplerian velocity field in a pressureless disk. Paczynski (1977) found an elliptical distortion of the outer disk. The peak separation in emission lines, formed in such disk, will vary as

$$V = V_0 - \Delta V \times \cos 2\varphi \qquad (1)$$

where φ is a phase of an orbital period. The dependence of parameters obtained (Fig.1), however, will not agree with (1) because of a shift of phases which is about 90°, and therefore cannot be explained by the model Paczynski. Such a modification of an peak separation in lines can be caused by spiral shock in the accretion disk, obtained in many numerical hydrodynamic calculations (for example, Sawada and Matsuda, 1992). A research of influence of spiral chock on emission lines (Chakrabarti and Wiita, 1993) has shown, that the peak separation in such lines under certain conditions should really vary with an orbital phase. Unfortunately, work Chakrabarti and Wiita (1993) is one of a few, devoted to study of observed display of a accretion disk spiral structure . The unequivocal conclusion about the real reason of a phase assotiation of an peak separation in emission lines can be made only after detailed researches.

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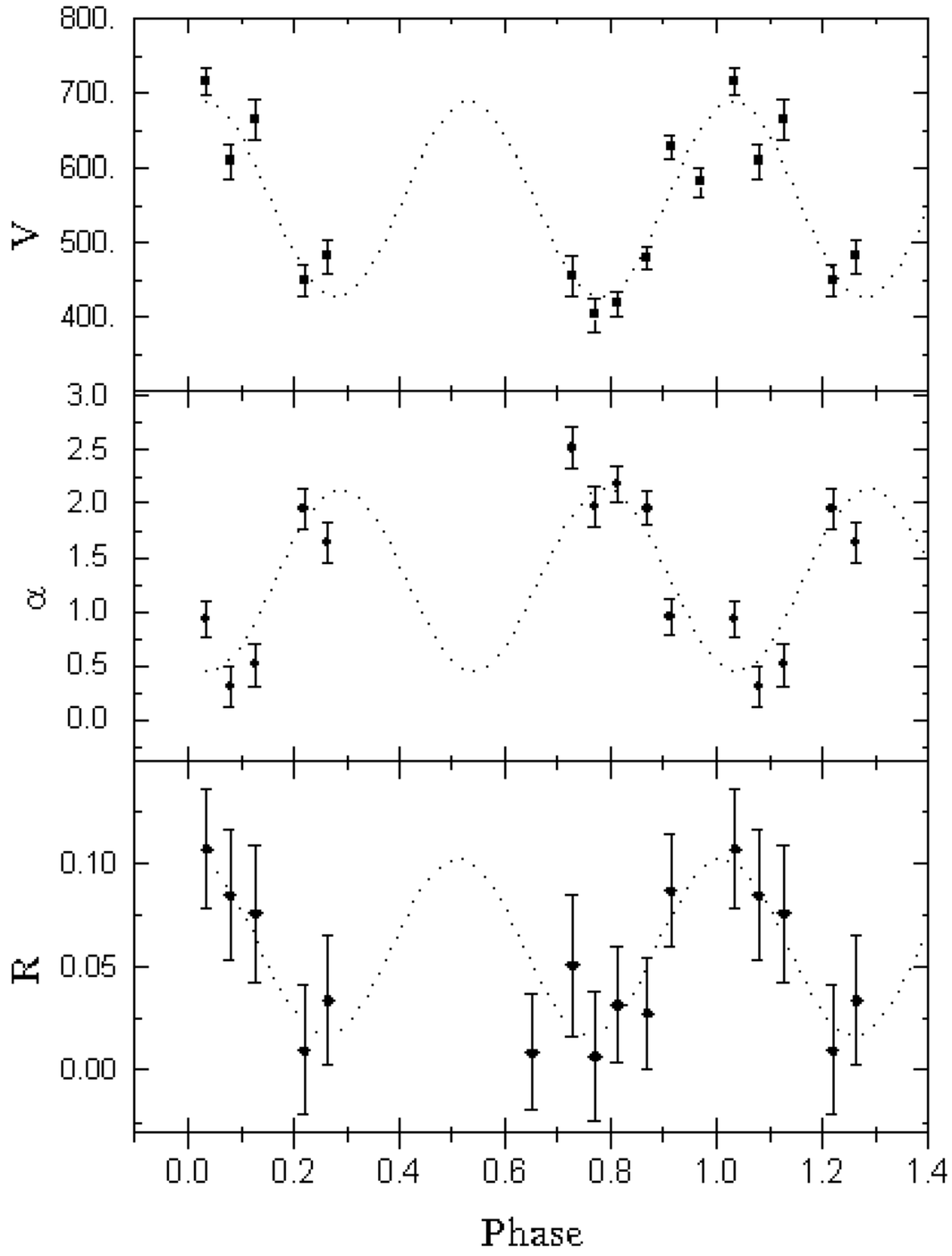


Figure 1. Variability of accretion disk model parameters with orbital phase (from modelling H_γ emission line).

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SHAPING OF NOVA SHELLS - THE CASE OF NOVA V 1974 CYGNI

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ABSTRACT. Expanding shell of Nova V 1974 Cygni consists of two major components: an outer fast low-mass envelope and an inner slow high-mass envelope. The outer envelope, detected in diffuse enhanced spectra and on radio images, is shaped and accelerated by the fast wind consisting of spherical and polar components. The inner envelope, detected in nebular spectra and on the HST images, consists of equatorial ring and polar blobs. Common envelope phase and strong magnetic field of the O-Ne-Mg white dwarf play an important role in shaping of the inner envelope. Both envelopes are prolate.

Key words: Stars: novae, circumstellar matter, Nova V 1974 Cygni

Introduction

Exact mechanism which shapes the nova shells is unclear. Spectroscopy during the early phases of the outburst and high resolution radio and HST imaging, which is able to resolve the structures in the ejecta as rings, clumps, blobs and bipolar outflows allow to study the mechanism of ejection and shaping. Components of the expanding shell appear to reflect processes which take place on the scale of binary system during the outburst. Livio (1994) discussed the importance of the common envelope phase for shaping of nova shells. The mass loss which results from orbital energy deposition occurs preferentially in the orbital plane. The coupling of the nova wind and the magnetic field could also shape the nova shell (Orio et al. 1992). According to Chevalier and Luo (1994) the magnetic field in the wind from a magnetized rotating star become increasingly toroidal with the distance from the star. Toroidal magnetic tension can constrain the flow in the equatorial region, while not interfering with the flow in polar region. Slavin et al. (1996) showed the connection between the speed class of novae and shaping. The faster novae with $t_3 < 17$ days produce inhomogenous approximately circular shells with discrete randomly distributed knots of brighter emission. The slower novae tend to produce remnants having polar blobs/equatorial ring morphologies. Slower novae spend a longer time in a common envelope, so their remnants are affected more by the orbital motion of the binary than in faster novae.

Shaping of the envelope of Nova V 1974 Cyg

a) wind

Wind was detected spectroscopically in early UV spectra as double absorptions in P Cygni profiles of Mg II lines (Shore et al., 1993). Very broad absorption centered at about 2400 km/s was caused by the spherical wind, the absorption at about 4000 km/s was caused by the polar wind. Radial velocities of the components of the wind seen in UV region correspond to the radial velocities of the broad double absorptions in the HI profiles of the Orion spectrum detected in the optical region (Chochol et al., 1993) about 50 days after the outburst.

b) outer low mass envelope

The optical diffuse enhanced spectra taken a few days after the maximum light showed double absorptions in P Cygni line profiles of HI, HeI, Ca II, Fe II and Mg II lines. Each absorption can be considered to be produced in a different region of the outer envelope approaching the observer. An increase of blue-shift of double absorptions with time suggests that the outer envelope was accelerated by the wind. Radial velocities of double absorptions caused by the wind and parts of the outer envelope approaching the observer are depicted in Fig. 1. The ratio of radial velocities of absorptions caused by the spherical and polar components of the wind is the same as for the components of the outer envelope (0.596 ± 0.007), so the spherical and polar components of the outer envelope were shaped by the spherical and polar winds, respectively. The first two radio images of the outer envelope were taken by Eyres et al. (1996) at 6cm by MERLIN on days 154 and 172. The envelope was elliptical, with major to minor axis ratio 1.37 ± 0.05.

c) inner massive envelope

Chochol et al. (1993) found in the high resolution tracings of the H_β line in the nebular stage of the nova (which started 79 days after outburst) a splitting of the emission line profile into a few components corresponding to approaching and receding parts of an expanding equatorial ring and polar blobs. The same

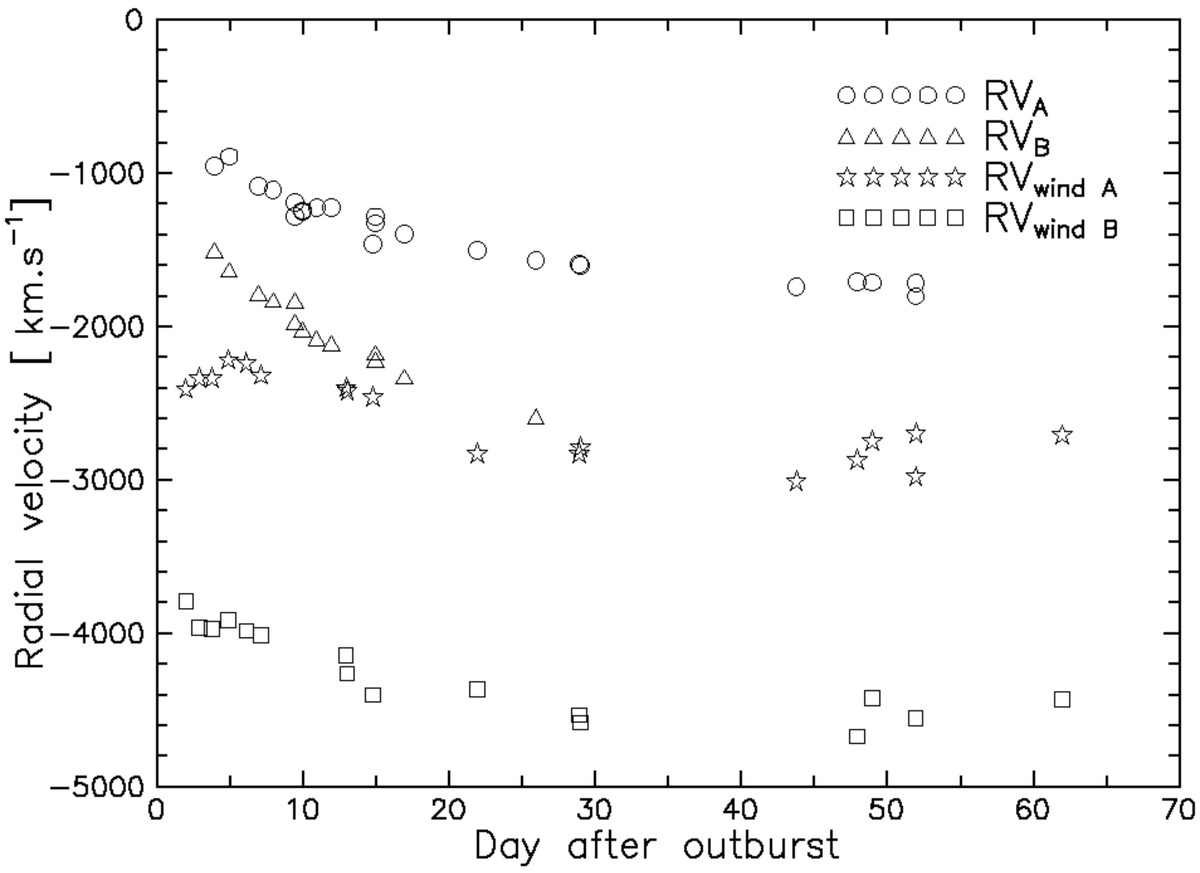


Figure 1: Radial velocities of the spherical (A) and polar (B) wind, the spherical (A) and polar (B) component of the low-mass outer envelope.

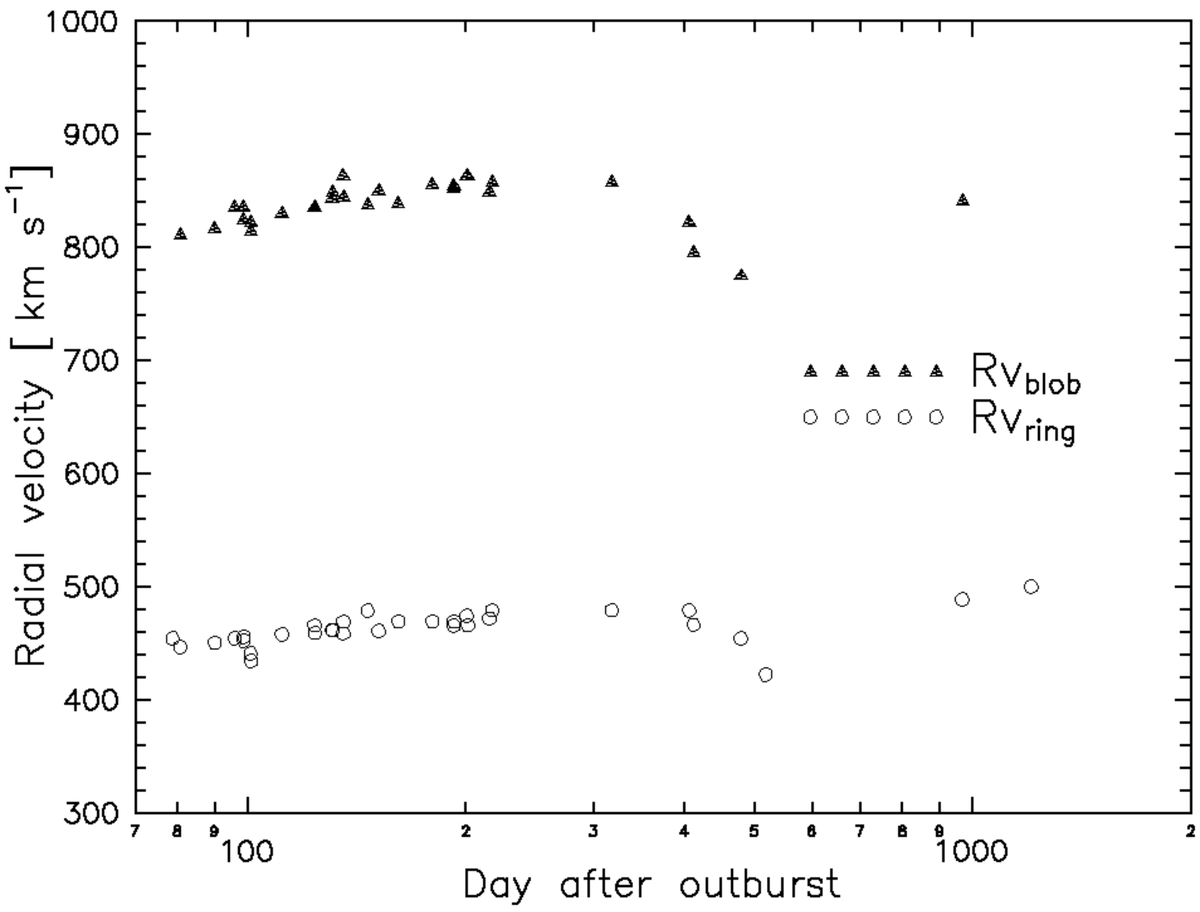


Figure 2: Mean radial velocities of ring and blobs of the inner envelope.

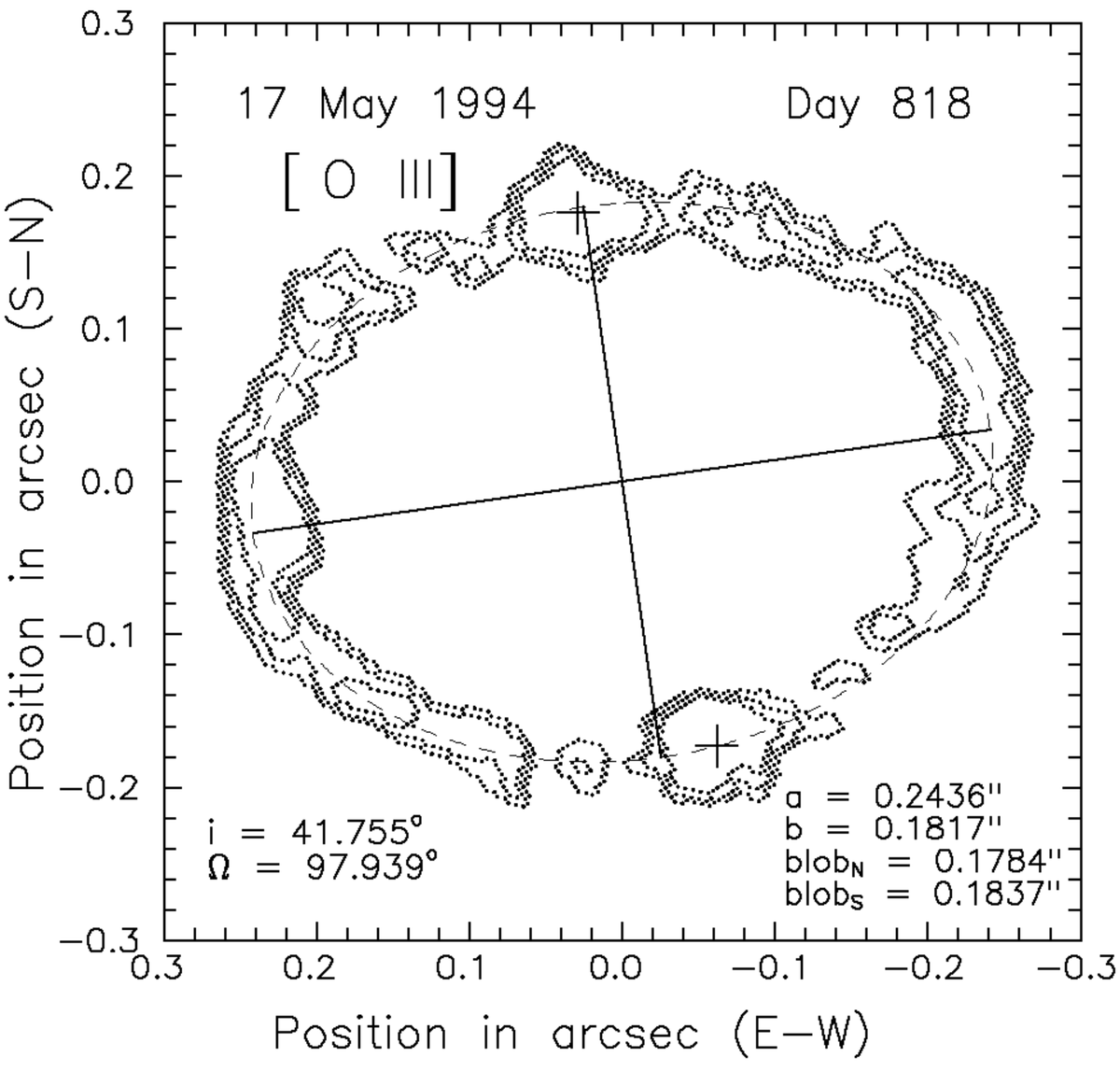


Figure 3: Ring and blobs (marked by crosses) of the inner envelope - isophotes of the HST image.

features can be seen also in [O III] lines as well as C III] and N III] lines in UV region (Chochol et al., 1996). Mean radial velocities of the ring and blobs of the inner envelope are plotted in Fig. 2. A decrease of expansion velocities of the ring and blobs after day 318 could be caused by the deceleration of the envelope due to the interaction with the preoutburst ejecta. The HST image of the expanding envelope taken 818 days after outburst clearly shows presence of the ring and two polar blobs (Fig. 3). An elliptical shape of the ring is caused by the projection of the circular ring onto a cellestial sphere. The equatorial ring formed during the common envelope phase expands in the orbital plane. Superposition of the HST images in [Ne V] and [O III] lines lead to the discovery of magnetic fountain, which originates in the polar region. Interaction of the particles flowing from the blobs in meridional arcs (flux tubes) with expanding spherical inner envelope is responsible for the origin of observed bright spots. We can conclude that the shaping of the inner envelope is largely affected by the magnetic field of the white dwarf.

d) true expansion velocities and 3D model

Radial velocities of the components of the inner and outer envelopes and their expansion rates in the plane of the sky (found from radio and the HST images) were used to determine the inclination of the polar ejecta with respect to the observer. The resulting value of i $= 38.^{\circ}7 \pm 2.^{\circ}1$ enabled us to determine the true expansion velocities of the components of the expanding envelope. Polar component of the outer envelope expands two times faster (about 3600 km/s) than the spherical component. The true velocity of the blobs of the inner envelope (about 1100 km/s) is 1.2 times larger than the velocity of the ring. Both envelopes are prolate.

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OPTICAL, UV AND X-RAY OBSERVATIONS OF THE SYMBIOTIC STAR AG DRACONIS DURING QUIESCENCE AND THE 1994/1995 OUTBURST

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ABSTRACT. Optical, UV and X-ray observations of the well known symbiotic star AG Draconis during quiescence and the active phase 1994/1995 are presented. The intensity in the UV region is well correlated with the optical activity. The observed X/ray flux dropped down by a factor of about 100 during the outburst maximum.

Key words: Symbiotic stars, X-ray sources, AG Dra

Introduction

AG Draconis is one of the most observed symbiotic stars. These stars are binary systems consisting of a cool late (M-) type primary component and a hot compact object (white dwarf, subdwarf). Because of mass loss of the primary both components are embedded in a common nebulous envelope.

AG Dra plays an outstanding role inside the group of the symbiotic stars because of its high galactic latitude ($b^{\rm II} = +41°$), its large radial velocity ($v_{rad} = -148$ km/s) and its early spectral type (K). This star is probably a metal poor symbiotic binary in the galactic halo. The historical light curve is characterized by active and quiescent phases. The active phases show outbursts of 1-2 mag in B and V followed by one or more secondary maxima. Between the active phases AG Dra is spending long periods (years to decades) at minimum light with small (0.1 mag) semiregular variations in B and V with periods of 300-400 days.

In U however regular variations with amplitudes of 1 mag and a period of 554 days are visible. This period is associated with the orbital motion of the system.

The optical spectrum of AG Dra is typical of a symbiotic star, with a probably stable cool component which dominates in the yellow region, and a largely variable nebular component with a strong blue/UV continuum and a rich emission line spectrum.

The UV continuum and line flux varies strongly with the star's activity (factor 10 in the continuum and factor 2-5 in the line flux during the 1980-83 active phase).

First X-ray observations of AG Dra during the quiescent phase with the EINSTEIN satellite revealed a soft X-ray spectrum. EXOSAT observations during the small active phase 1985/86 showed a large X-ray fading with respect to quiescence.

Recent observations

In June/July 1994 AG Dra went into a major outburst, after which it gradually declined to the quiescent level in November 1994. Like 1981/82 and 1985/86 the star underwent a secondary outburst in July 1995. In addition to the optical observations a coordinated ROSAT/IUE campaign was carried out to study the star as in the optical as in the short wavelength ranges.

IUE Observations

AG Dra was observed by IUE as a Target of Opportunity starting on June 29, 1994. The observations have continued until February 1996, covering the 1994 and 1995 outburst and the quiescent phase between them and the return to quiescence.

ROSAT Observations

AG Dra was scanned during the All-Sky-Survey over a time span of 10 days. The total observation time adds up to 2.0 ksec.

Several pointed observations with spectral resolution on AG Dra have been performed in 1992 and 1993 with the ROSAT PSPC.

When AG Dra was reported to go into outburst it has been proposed for a Target of Opportunity Ob-

servation. Because of technical problems AG Dra has been observed only since Aug. 28, 1994, about 4 weeks after the optical maximum with HRI.

The X-ray light curve of AG Dra

The X-ray intensity has been more or less constant between 1990 and May 1993 before the optical outburst. During the optical outbursts the observed X-ray flux dropped down substantially. The observed maximum amplitude of the intensity decrease is nearly a factor of 100. Between the outburst maxima the X-ray intensity nearly reached the pre–outburst level.

Results

From the optical, UV and X-ray observations the following properties of the AG Dra system were determined:

The X-ray spectrum in quiescence is very soft, with a blackbody temperature of about 175 000 K.

The quiescent bolometric luminosity suggests stable hydrogen burning in quiescence.

The monitoring at X-ray and UV wavelengths did not yield any hints for a predicted eclipse during the U-light minima. During the optical outburst in 1994 th UV continuum increased by a factor of 10, the UV line intensity by a factor of 2 and the X-ray intensity dropped by at least a factor of 100. There is no substantial time lag between the variations in the different energy bands.

There is no hint for an increase of the absorbing column during one X-ray observation with spectral resolution performed during the decline of the optical outburst in 1994. Instead, a temperature decrease is consistent with the X-ray data and also supported by the IUE spectral results.

Modeling the X-ray intensity drop by a slowly expanding white dwarf with concordant cooling, we find that the necessary excess accretion rate is only 27% of the quiescent one. Accordingly, the white dwarf expands to approximately its double size within the about three months rise of the optical outburst. The cooling is moderate: the temperature decreases by only 35%.

AG Dra could either be a symbiotic nova with a turn on before 1855, or the first example of the wide binary supersoft source class.

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This paper is a very short summary of: Greiner J., Bickert K., Luthardt R., Viotti R., Altamore A., Gonzales-Riestra R., Stencel R.E.: 1996, **The UV/X-ray emission of the symbiotic star AG Draconis during quiescence and the 1994/1995 outbursts**, *Astronomy and Astrophysics*, submitted.

PROPERTIES OF THE SUBGIANTS IN THE ECLIPSING BINARY SYSTEMS OF DIFFERENT TYPES

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ABSTRACT. The properties of subgiants from eclipsing binary systems are considered . The necessity of their dividing into different groups on masses and orbital periods is suggested. It allows to find the significant correlations between the main characteristics of supergiants and the corresponding systems' characteristics. It is shown that low-mass subgiants from short-period systems quickly lose the mass. They possess the largest temperature and radii excesses, but with mass and period increasing the temperature excesses are replaced by the temperature deficiency, which are maximal for massive subgiants of AR-systems.

Key words: stars, eclipsing binary stars, subgiants.

I. Subgiants can be found in three different classes of eclipsing binary systems (Svechnikov, 1986): semi-detached (SD-systems), with detached subgiant (DS-systems) and AR-systems. In SD and DS - systems more massive star belongs to main-sequence and subgiant is an evolved companion. Shain (1928) described the main properties of the subgiants:

a) they have less masses than second star of the pair,

b) they do not fit "mass-luminosity " relation, showing greater luminosity excesses,

c) they have earlier spectral types than main-sequence stars with the same masses;

d) their luminosity excesses increase with decreasing of the mass ratio q for stars of the system.

Further it was shown that subgiants in SD-systems fill in and DS and AR-systems do not fill in their Roche lobes.

Let us consider the general properties of the subgiants in SD, DS and AR-systems. In Table 1 we give averaged characteristics of the subgiants from SD, DS and AR-systems that were derived on the base of the catalogue (Karetnikov and Andronov, 1989). Designations are the following: n-number of the stars, lg A-distance between the stars, lg R-radius of the star, lg M and $q = M_2/M_1$ - mass and mass ratio respectively, Δ lg R and Δ lg T - averaged radius and temperature excesses for subgiants. Here we also give the mean values of averaging procedure Δ. R_iA - degree of the Roche lobe filling. This value is calculated using formula (Iben and Tutukov, 1984):

$$RR_i = 0.52 \cdot A \cdot (M_i/M)^{0.44},$$

where $M = M_1 + M_2$ and $R_iA = R_i/RR_i$.

The differences in degrees of the Roche lobe filling are caused by the differences in the evolution of these stars under the different initial characteristics of stellar pairs: their masses and sizes of the orbits. Using the data from Table 1 we immediately reveal that mean sizes of orbits A are close to 13.2 $R_\odot$ for SD-systems, 32.4 $R_\odot$ for DS and 15.5 $R_\odot$ for AR-systems. Detached subgiants belong to the more wide systems. Nevertheless, it should be noted that observed sizes of orbits for numerous class of DS and AR-systems embrace all possible values and therefore such a comparison is not completely correct.

II. Using models from (Mengel et.al., 1979), we can construct the evolutionary tracks for stars of the different masses up to subgiants phase. Resulting "luminosity-temperature" diagram is shown in Fig.1. It is seen that depending upon the mass all the tracks can be divided into two groups:

1) those of low-mass stars, i.e. $M_i < 1.5M_\odot$ and

2) of intermediate-mass stars: $1.5M_\odot < M_i < 3.5M_\odot$.

Note that more massive subgiant are not numerous and therefore their tracks in (Mengel et.al., 1979) are not calculated. Stars from the first group show a smooth increasing of the luminosity; they quickly pass to giant stage practically without any delay. Stars from the second group demonstrate sinuous evolutionary tracks having the parts of strong increasing and decreasing of the temperature. Accordingly to (Masevich and Tutukov, 1988), differences in evolutionary tracks of stars with different masses are defined by different processes of the energy production. Let us isolate on Fig.1 the following parts of the tracks: aa) formation of burnt stellar core, bb) core contraction, cc) helium core burning, while the star evolves to giant branch. The part "aa" is transitional stage between dwarfs and subgiants. Therefore, properly subgiant phase is referred to "bb" and "cc" regions of the diagram, where the luminosity and temperature suffer very complicated changes.

It is clear that if not taking into account the division

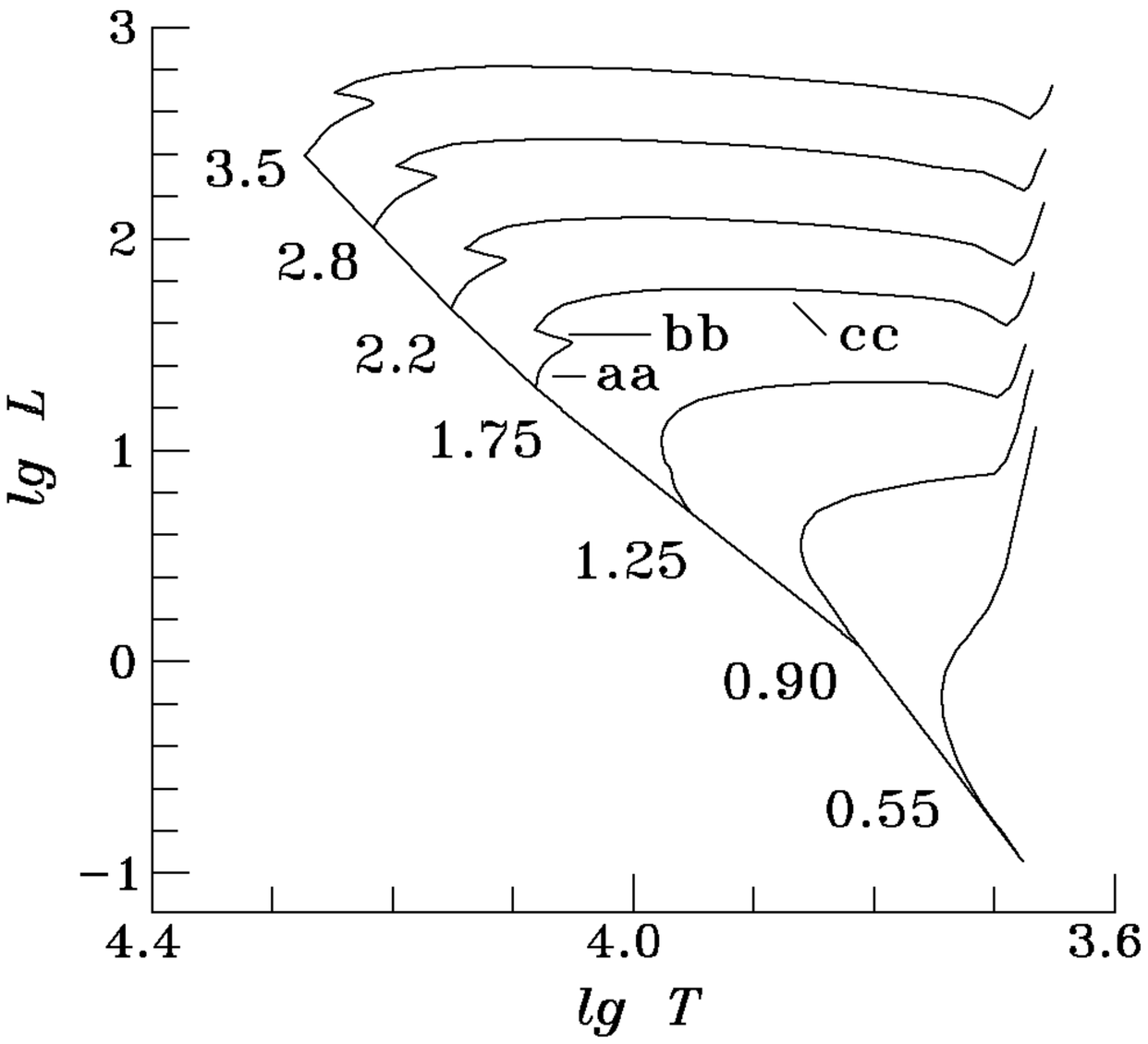


Figure 1.

of subgiants on their masses, we can intermix completely different relation for their masses and luminosities. Probably, only stars located within "bb" region can be considered as subgiants, while stars of "aa" region have the properties of main sequence stars and those of "cc" region resemble giants. Therefore, it is necessary to separate this stars and to search for some relation within separated groups. It seems, that such a separation has never been done and different kinds of objects were ranked as subgiants.

An important feature of the stars constituting SD and DS-systems is confidently observed gas streams that lead to a great mass loss from subgiant. Accordingly to observations, some part of the lost material is accreted by neighbor star of the V luminosity class. Processes of gas loss and subsequent accretion lead to the changes in the mass ratio q of the system. Results of investigation show that mass ratio q correlates with subgiant mass: for SD systems coefficient is 0.69, for DS - it is negligible and for AR systems k=0.82. This fact obviously testifies about mass ratio change for the systems.

Another important factor which also requires a separation of the stars on their masses is the mechanism (or mechanisms) operation that leads to changes of the orbital momentum and semi-major axis of the system. It is know that stars with mass less than 1.5 $M_\odot$ possess a rather strong magnetic wind which favors to the angular momentum loss and therefore leads to semi-major axis decreasing. All the stars can have an usual stellar wind which is stronger for more massive stars. Such a wind presence can increase the distance between the stars. An interaction of these winds must influence on the main parameters of the stellar system.

III. Let us isolate among the different kinds of eclipsing binaries (SD, DS and AR systems) the following clusters:

– cluster "a" contains the stars with masses less than $1.5M_\odot$;

– cluster "b" consists of the stars with masses $1.5M_\odot < M_1 < 10M_\odot$ and $M_2 < 1.5M_\odot$;

– cluster "c": stars with masses $1.5M_\odot < (M_1 + M_2) < 10M_\odot$;

– cluster "d" consists of the stars with $M_1 > 10M_\odot$ and $M_2 > 1.5M_\odot$;

Here M_1 and M_2 are the masses of the components and $M_1 + M_2$ is a total mass of the system.

We can also specify subclusters using the distribution on orbital periods:

– subcluster "1a" contains the systems of "a" cluster with $P < 1.5^d$;

– subcluster "2a" - with $1.5^d < P < 2.5^d$;

– subcluster "3a" - $2.5^d < P < 3.5^d$;

– subcluster "4a" - $3.5^d < P < 6^d$;

– subcluster "5a" - P more than 6^d.

Detailed classification for "b","c" and "d" clusters can be made in the similar way. Note that each cluster of DS-a, DS-c, AR-b and AR-c types contains only one star, therefore they are excluded from this consideration.

As it shown in (Karetnikov, 1990), such a separation of the stars into different groups (clusters) with simultaneous accounting of any possible mechanisms of mass and angular momentum transfer gives as a possibility to prognosticate the possible evolutionary scenario for stars of system. For example, M.A. Svechnikov proposed that subgiants of AR systems are formed from low-mass binary systems with great orbital period initially containing main-sequence stars that never filled in their Roche lobes. Having rather slow evolution they became subgiants without suffering the stage of the "role-change" (Crawford, 1955), which is usual phase for SD and DS systems.

IV. Let us analyze the subgiant group properties using their separation on the classes, clusters and subclusters. One can use the characteristic of the stars from catalogue (Karetnikov and Andronov, 1989). Firstly, we investigate the relations between mass ratio q and subgiant masses. Then we investigate the relation between radius and temperature excesses of subgiants and their masses, mass ratio q and system sizes A. For this aim we will use a formula $y = a + b \cdot x$, where argument will be a subgiant mass M_i or the total mass M of the system, or mass ratio q or orbital size lg A. As a function we will use mass ratio q and excesses of the radius Δ lg R and temperature Δ lg T.

Results of comparison are gathered in Table 2, where we give the coefficients A and B, and sigma values $\sigma(A)$ and $\sigma(B)$ (significance level more then 0.95). Here we also give the correlation coefficients k and $\sigma(k)$. One can see that correlations between the mass ratio q and mass of the less massive star M_2 in SD and DS are most significant. Nevertheless, in some cases, the cor-

relations have a small significance (less than 0.95) as for SD-c and SD-d clusters. They are not included in Table 2. On the corresponding places we give the blanks.

Obtained results indicate the clear decreasing of the subgiant mass in SD and DS systems. Most rapid mass decreasing (and correspondingly q-value decreasing) takes place for SD-a and especially for subcluster SD-1a. For cluster DS-b subgiant mass decreasing is more rapid than for cluster SD-b. For AR-a cluster the mass decreasing is going more rapidly. This poses a question about mechanism of mass loss in AR systems which consist of two "detached" subgiants. It is seen that with subgiant mass growth and increasing of the orbital period, the rate of q change generally slows down. The q value clearly correlates with subgiant masses. The level of significance for such a correlation often achieves 1. There also exists rather high significance for two correlation between q and M_1 in SD system and subcluster SD-2b and for four correlation of "q-M" type. In this case B coefficients have the same sign which means that with decreasing of q value the mass of the system has a tendency to be decreased. The changes of q value are of evolutionary character. Last two facts are of great interest, because an interpretation of the mass transfer for detached subgiants is now complicated.

Let us consider subgiant luminosity characteristics separating them on their contribution of the radii and temperatures in resulting luminosity. We will use for calculations the mean relation "mass-radius" and "mass-temperature" (Karetnikov, 1991). As before we employ the linear formula, where a function will be either radius excess $\Delta \lg\ R$ or $\Delta \lg\ T$ and argument is subgiant mass M_2. Results are gathered in Tables 3 and 4. These data allow to make a conclusion that proposed separation of the subgiants on the groups gives a possibility to investigate reliably the group properties of the subgiants from different kinds of stellar systems and to separate the systems having different characteristics.

It should be noted that subgiant luminosity excesses demonstrate a complex behavior. The fact of luminosity excess increasing with subgiant mass increasing is well established. One can also note an increasing of luminosity excess with an increasing of system size. It is obviously seen that DS systems having the least subgiant masses, at the same time possesses the greatest luminosity excesses mainly due to radii excesses. In SD systems, in average, the radii excesses are less, but temperature excesses are slightly greater. Nevertheless, for low-mass subgiants of SD systems with great orbital period the radii excesses as well as temperature excesses are dominating among all subgiants from the binary systems. An exceptional position of DS systems is excogitated.

The coefficients k(RA), k(RM) and k(Rq) define the reliability of mutual connections of the subgiant radii excesses $\Delta \lg\ R$ with distance between the stars ($\lg\ A$), subgiant masses ($\lg\ M$) and mass ratio q. Coefficients k(TA), k(TM) and k(Tq) give the reliability of connection between the temperature excesses $\Delta \lg\ R$ of subgiants and those of systems. A dependence between radii and temperature excesses and system parameters has been searched in the form $y = a + b \cdot x$. All calculated values are accompanied with standard deviation values. The designation are the same as above.

V. Data from Table 3 clearly testify that correctness of the made supposition concerning the presence of the great radii excesses in detached subgiants takes place only for DS systems. For detached subgiants and AR systems the radii excesses are minimal. Most of SD systems confirm the conclusion about radii excesses increasing with subgiant mass decreasing and with increasing of the system size. It is seen very well from the comparison of the radii excesses for SD systems when dividing them on the mass groups. Note that among SD systems there are subgiants having very great radii excesses (subcluster SD-4b) and subgiants with small radii excesses (subcluster SD-1b).

For subgiants of SD systems the reliable relations between radii and system sizes are obtained. An exception can be made only for SD system of the great masses. One can also assess as reliable the formula for relation between radii and mass excesses in subgiants of SD-b group and their separation on the base of orbital period value. In the last case, the most short-period SD-1b pairs give the less reliable results than low-mass systems with long period. The same picture takes place when we compare the radii excesses with mass ratio q values for this type of stars.

After averaging procedure for all subgiants of AR class, the temperature deficiency is seen. Such a deficiency is more pronounced for more massive companion. Similar situation takes place for SD systems with subgiant mass greater than $1.5 M_\odot$. Moreover, for more massive SD systems such a deficiency is two times less, than for AR systems. Subgiants from DS systems possess the small temperature excesses, while in subgiants from SD systems excesses are seen for low-mass systems. One can see from the Table 1 that, if dividing the SD-b into groups according to orbital period, the temperature excesses increase with the increasing of system sizes $\lg\ A$. This increase is caused by the decrease of the subgiant mass (the correlations with $\lg\ M$ and q are statistically significant). The dependencies of $\Delta \lg\ T$ on $\lg\ A$ are not significant.

Comparison of the group average values of $\Delta \lg\ R$ and $\Delta \lg\ T$ shows, that they contribute to the luminosity excess differently. The contribution in this excess of the radius exceeds the contribution of the temperature excess of a subgiant star by hundreds times. Therefore the temperature deficiency, which is sometimes detected for subgiants, does not significantly affect the

common luminosity excess. At the same time (as it was noted by Karetnikov and Andronov (1989)), the temperature excess for a SD-class correlates with the luminosity excess better, than the radius excess. This fact is confirmed by the values of the correlation coefficients listed in Tables 3 and 4. Unfortunately, the correlation between the temperature excess and the sizes of SD-systems, which was suggested by Karetnikov (1990), was not found here.

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Table 1. Mean characteristics of the subgiant stars in close binary systems and r.m.s. deviation of the data from the mean.

Type of systems	n	$\lg A$	$\lg R$	$R_i A$	$\lg M$	q	$\Delta \lg R$	$\Delta \lg T$
SD	82	1.12	0.54	1.00	-0.06	0.31	0.48	0.06
		.26	.26	.10	.42	.15	.22	.15
DS	11	1.51	0.74	0.67	-0.15	0.29	0.73	0.05
		.14	.16	.16	.19	.09	.19	.13
AR1	12	1.19	0.47	0.53	0.15	0.89	0.27	-0.10
		.10	.21	.19	.09	.16	.20	.08
AR2	12	1.19	0.43	0.51	0.08	0.89	0.26	-0.06
		.10	.18	.20	.13	.16	.21	.07
SD-a	6	0.74	0.15	1.03	-0.46	0.26	0.33	0.17
		.14	.12	.06	.18	.11	.16	.11
SD-b	58	1.08	0.50	1.01	-0.20	0.28	0.52	0.08
		.20	.18	.09	.25	.12	.22	.14
SD-c	12	1.23	0.60	1.00	0.31	0.36	0.38	-0.03
		.12	.10	.07	.09	.10	.09	.14
SD-d	6	1.69	1.13	0.93	0.95	0.55	0.41	-0.05
		.18	.26	.21	.34	.28	.27	.16
SD-1b	15	0.84	0.29	0.98	-0.13	0.38	0.26	0.04
		.08	.10	.10	.16	.11	.10	.11
SD-2b	14	1.03	0.45	1.00	-0.19	0.29	0.46	0.07
		.06	.08	.06	.24	.12	.11	.12
SD-3b	14	1.15	0.55	1.04	-0.21	0.23	0.58	0.09
		.08	.11	.05	.26	.08	.07	.15
SD-4b	15	1.32	0.70	1.03	-0.29	0.22	0.78	0.12
		.10	.09	.12	.28	.09	.16	.15
DS-b	9	1.56	0.79	0.64	-0.17	0.29	0.77	0.05
		.66	.32	.15	.04	.08	.17	.15
AR-a	10	1.10	0.45	0.52	0.05	0.89	0.26	-0.07
		.30	.16	.20	.11	.17	.15	.08

Clusters DS-a, DS-c contain one star: RU Cnc and Z Ori, respectively; clusters AR-b, AR-b contain also one star: SZ Psc and SZ Cen, respectively.

Table 2. Values of the coefficients A and B, correlation coefficient K, standard errors σ. Here $M = M_1 + M_2$ is the mass of the binary, M_1 and M_2 are masses of the primary and secondary stars, respectively. The dash means the absence of significant correlation.

Type of	Number	$q = A + B \cdot M$			$q = A + B \cdot M_1$			$q = A + B \cdot M_2$		
systems		A	B	k	A	B	k	A	B	k
SD	82	+0.24	+0.01	0.60	+0.24	+0.02	0.51	+0.26	+0.03	0.69
		.02	.00	.09	.02	.00	.10	.01	.00	.08
SD-a	6	-0.50	+0.42	0.85	-	-	-	+0.02	+0.64	0.99
		.24	.13	.26				.02	.04	.06
SD-1a	4	-0.63	+0.49	0.90	-	-	-	+0.02	+0.65	0.99
		.32	.17	.31				.02	.05	.07
SD-b	58	-	-	-	-	-	-	+0.12	+0.23	0.71
								.02	.03	.09
SD-1b	12	-	-	-	-	-	-	+0.09	+0.38	0.84
								.07	.08	.17
SD-2b	10	+0.03	+0.09	0.87	0.00	+0.14	0.78	+0.13	+0.24	0.95
		.06	.02	.18	.10	.04	.22	.03	.03	.11
SD-3b	17	-	-	-	-	-	-	+0.11	+0.18	0.64
								.04	.06	.20
SD-4b	12	-	-	-	-	-	-	+0.14	+0.14	0.81
								.03	.03	.18
SD-5b	6	RY Per excluded					-	-0.01	+0.45	0.96
								.03	.06	.13
DS	11	-	-	-	-	-	-	-	-	-
DS-b	9	-	-	-	-	-	-	+0.01	+0.42	0.89
								.06	.08	.17
AR	12	-	-	-	-	-	-	+0.57	+0.25	0.58
								.14	.11	.26
AR-a	10	-	-	-	-	-	-	+0.25	+0.55	0.82
								.16	.14	.20

Table 3. Coefficients of correlation between radius excesses $\Delta \lg R$ and $\lg A$, $\lg M$, $\lg g$ in the case when k is statistically significant. Standard deviations are also given. Dash means that significance level is negligible.

Type of systems	n	a_1	b_1	$k(RA)$	a_2	b_2	$k(RM)$	a_3	b_3	$k(Rq)$
SD	82	0.00	0.42	0.51	0.46	-0.22	-0.42	0.07	-0.73	-0.70
		.09	.08	.10	.02	.05	.10	.05	.08	.08
DS	11		-			-			-	
AR1	12		-			-			-	
AR2	12		-			-			-	
SD-a	6	-0.46	1.08	0.93		-			-	
		.15	.20	.18						
SD-b	58	-0.50	0.94	0.83	0.41	-0.54	-0.68	0.02	-0.84	-0.78
		.09	.08	.08	.03	.09	.11	.06	.09	.08
SD-c	12	-0.46	0.68	0.88		-			-	
		.15	.12	.15						
SD-d	6		-			-			-	

Table 3 (continued).

Type of systems	n	a_1	b_1	$k(RA)$	a_2	b_2	$k(RM)$	a_3	b_3	$k(Rq)$
SD	82	0.00	0.42	0.51	0.46	-0.22	-0.42	0.07	-0.73	-0.70
		.09	.08	.10	.02	.05	.10	.05	.08	.08
DS	11		-			-			-	
AR1	12		-			-			-	
AR2	12		-			-			-	
SD-a	6	-0.46	1.08	0.93		-			-	
		.15	.20	.18						
SD-b	58	-0.50	0.94	0.83	0.41	-0.54	-0.68	0.02	-0.84	-0.78
		.09	.08	.08	.03	.09	.11	.06	.09	.08
SD-c	12	-0.46	0.68	0.88		-			-	
		.15	.12	.15						
SD-d	6		-			-			-	
SD-1b	15		-		0.22	-0.33	-0.56		-	
					.03	.14	.23			
SD-2b	14		-		0.38	-0.39	-0.88	0.18	-0.48	-0.79
					.02	.06	.14	.05	.09	.18
SD-3b	14	1.20	-0.54	-0.60	0.53	-0.23	-0.89	0.35	-0.34	-0.74
		.24	.20	.23	.01	.03	.13	.06	.08	.20
SD-4b	15		-		0.63	-0.51	-0.88	0.28	-0.70	-0.85
					.03	.08	.13	.06	.08	.14

Table 4. Coefficient of correlation between temperature excesses $\Delta \lg T$ and $\Delta \lg R$ and $\lg A$, $\lg M$, $\lg g$ in the case when k is statistically significant. Standard deviations are also given. Dash means that significance level is negligible.

Type of systems	n	c_1	d_1	$k(TA)$	c_2	d_2	$k(TM)$	c_3	d_3	$k(Tq)$
SD	82		-		0.04	-0.25	-0.70	-0.25	-0.56	-0.80
					.01	.03	.08	.03	.05	.07
DS	11		-		-0.03	-0.54	-0.80		-	
					.03	.14	.20			
AR1	12		-			-			-	
AR2	12		-		-0.03	-0.33	-0.56		-	
					.02	.16	.26			
SD-a	6		-		-0.11	-0.62	-0.99	-0.20	-0.61	-0.95
					.02	.04	.07	.06	.09	.16
SD-b	58		-		-0.01	-0.47	-0.86	-0.25	-0.56	-0.74
					.01	.04	.07	.03	.05	.09
SD-c	12		-			-			-	
SD-d	6		-			-			-	
SD-1b	15		-		-0.03	-0.54	-0.81	-0.25	-0.67	-0.80
					.02	.11	.16	.05	.12	.16
SD-2b	14		-		-0.01	-0.42	-0.89	-0.23	-0.52	-0.76
					.02	.06	.13	.06	.10	.19
SD-3b	14		-		-0.01	-0.48	-0.86	-0.42	-0.77	-0.75
					.03	.08	.15	.11	.16	.19
SD-4b	15		-		-0.01	-0.46	-0.84	-0.34	-0.66	-0.87
					.03	.08	.15	.06	.08	.14

LONG-TERM VARIABILITY OF THE NOVA–LIKE VARIABLE V SGE

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ABSTRACT. V Sge was studied on photonegatives of the Moscow and Odessa plate collections. In consequence of us analysis of these observations and of the AFOEV data, the two types of long-time variability were distinguished: (1) outbursts with characteristic time $\sim 212^{\rm d}$; (2) transitions between the high and low luminosity states with a cycle length $\sim 250^{\rm d}$; (3) variations with amplitude about $2^{\rm m}$ and smaller and at different time scales.

Key words: Stars: Cataclysmic; Individual: V Sge

Introduction

V Sge is one of the most attracting cataclysmic variables. Being very bright ($8\overset{\rm m}{.}6 - 13\overset{\rm m}{.}9$ Kholopov et al., 1987), it was discovered at the beginning of the century. The estimate of the orbital period $P = 0\overset{\rm d}{.}514195$ (Herbig et al., 1965) was slightly corrected ($P = 0\overset{\rm d}{.}514198$) by Koch et al. (1986) The period variations were found by Smak (1995). In the Catalogue by Aslanov et al. (1989) also mentioned the slow photometric cycle of $550^{\rm d}$ and fast coherent (47.7 s) oscillations.

Recent interest to the object is partially connected with observational and theoretical study of the winds from the accretion disks in cataclysmic variables (Vitello and Shlosman 1993, Mauche 1994, Nafar et al. 1992). In 1995 the international campaign for photometric observations of this star was initiated by Hric et al. (1996).

Šimon (1996) distinguishes the following types of the brightness variations:

1) large outburst with an amplitude about $2^{\rm m}$;

2) transitions from the high to the low state and vice versa;

3) small outbursts (about $0\overset{\rm m}{.}7$);

4) year–to–year brightness variations.

We shall use his terminology for uniformity to describe the variability of V Sge.

In this paper we discuss results of photographic photometry and of the visual estimates from the AFOEV database (Schweitzer, 1993). The analysis of the UBV photoelectric observations one may find in Marsakova et al. (1997).

Table 1. UBV-magnitudes of comparison stars.

stars	V	B	U
x	8.680	8.870	9.040
z	9.192	10.641	11.698
a	10.696	11.001	11.301
b	10.439	11.531	-
c	10.937	11.824	-
d	11.021	12.238	-
e	11.699	12.797	13.498
f	12.597	13.156	13.185
g	12.752	13.465	-

Photographic Observations and their Analysis

V Sge was studied on 277 photonegatives of the Moscow and Odessa plate collections covering the interval JD 2414309–48884. In both cases the emulsion ORWO ZU–21 was used, thus only minor differences between the instrumental systems were achieved. The UBV–magnitudes of the comparison stars were obtained by S.Yu. Shugarov (Marsakova et al. 1997), they are listed in the Table 1 and are shown in the finding charts (Fig. 1).

The shape of the phase light curve varies depending on the luminosity state. In Fig. 2 (up) the crosses correspond to the "low" state with more deep minima; the circles – to the "high" state where the orbital variability is not pronounced in photographic observations.

We have suggested the mathematical model of orbital variability to reduce its influence on the long–period variability (cf. Marsakova 1998) where the amplitude of the phase light curve changes lineally from that of the trigonometric polynomial fit of the low state light curve (solid line) to zero at the magnitude $10^{\rm m}$.

The results of the periodogram analysis (using the

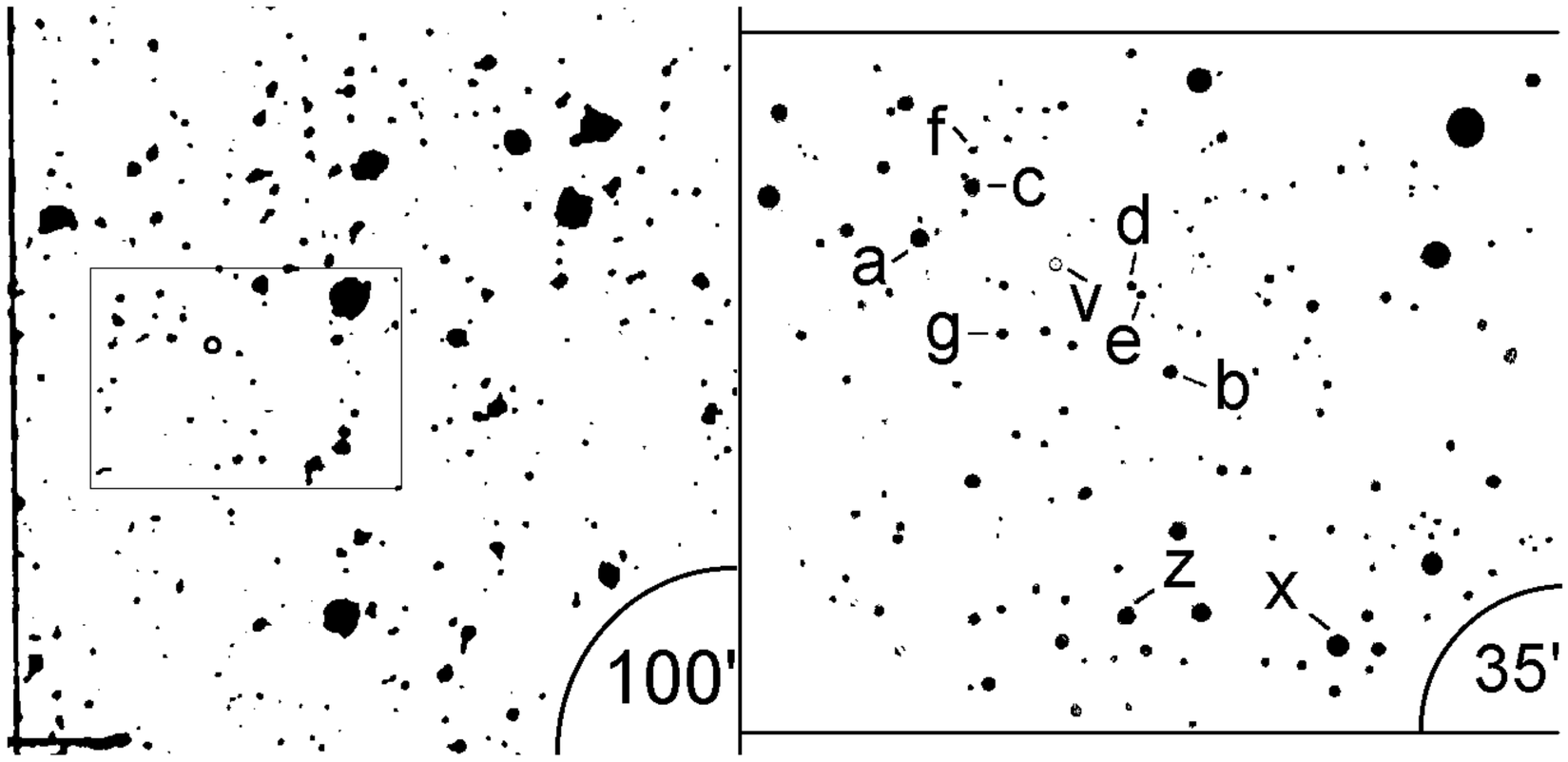


Figure 1. Finding charts for V Sge

Figure 2. Phase light curve corresponding to the elements by Smak (1995) at the interval JD 2445700-47600 for the photographic observations (up) in "high" (circles) and "low" (crosses) states with a trigonometric polynomial fit of 4-th order (solid line) and for the AFOEV observations (bottom).

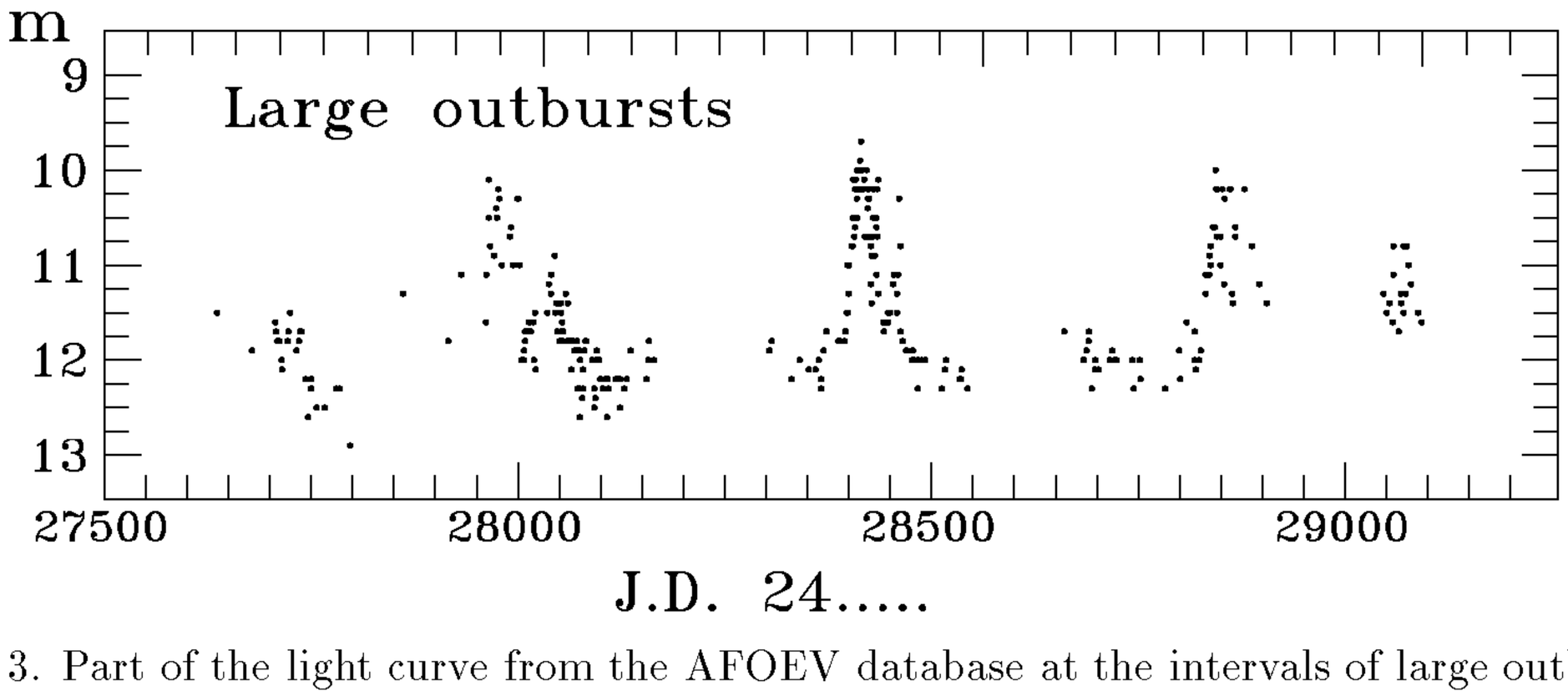


Figure 3. Part of the light curve from the AFOEV database at the intervals of large outbursts.

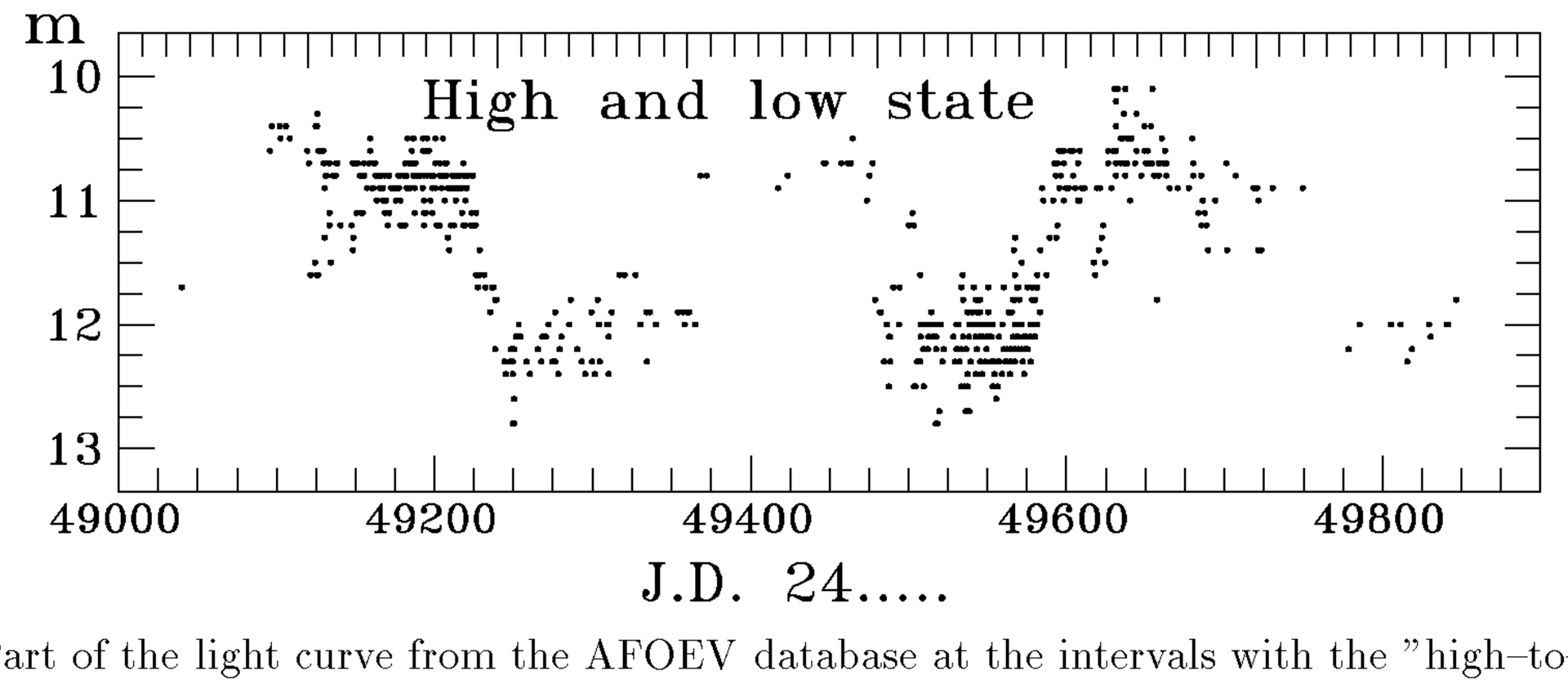


Figure 4. Part of the light curve from the AFOEV database at the intervals with the "high–to–low state" transitions.

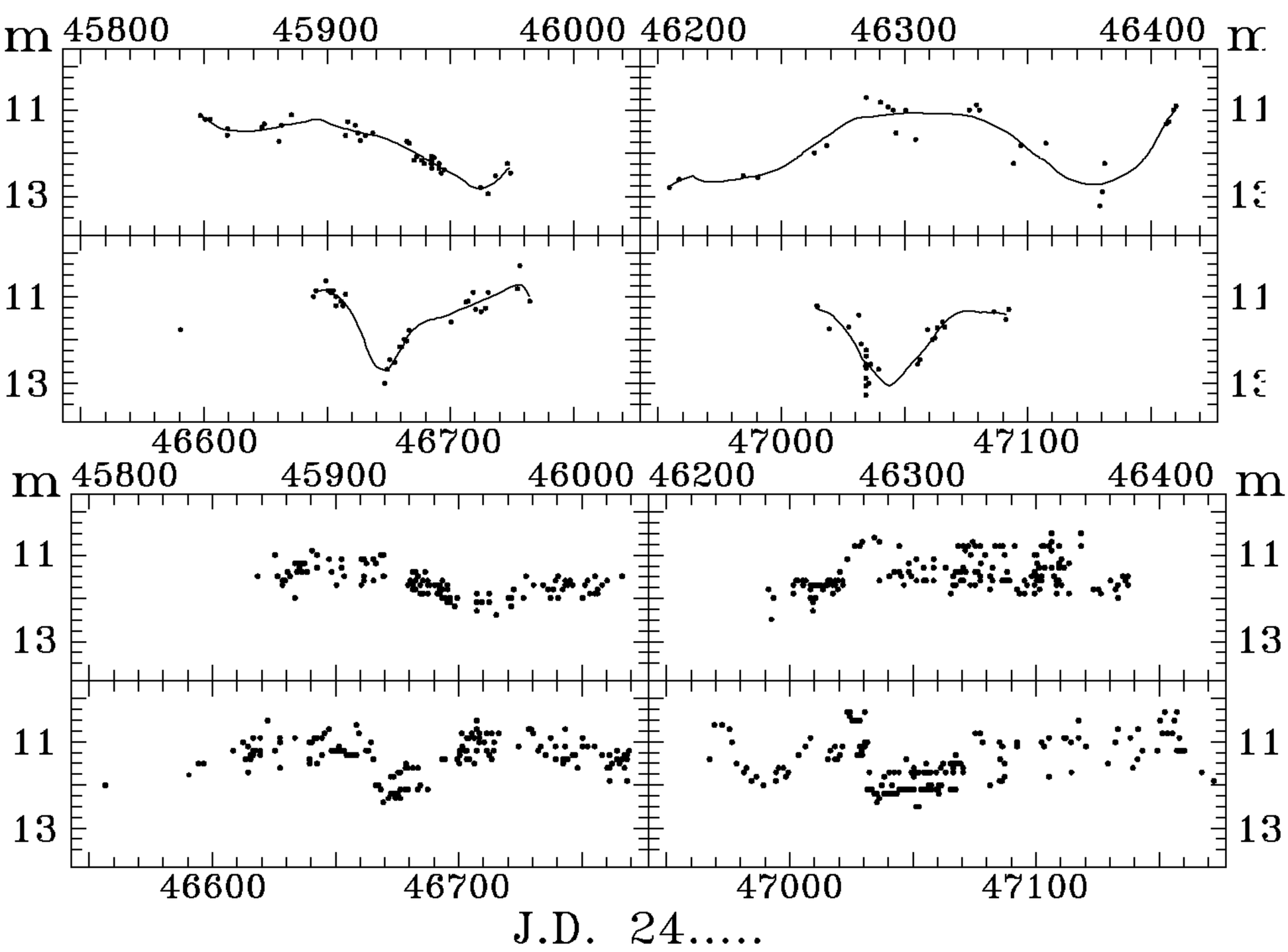


Figure 4. Part of the light curve for the photographic observations fitted by running parabolae (up) and for the AFOEV observations (bottom) in the interval JD 2445700-47600 (the type (3) of changes with smallest cycle length).

Table 2. Results of periodogram analysis of photographic observations. See the text for explanations.

JD 24.....	P	$S(f)$	L_p	P_{O-C}
initial				
44300-48090	914	0.19	9.3	36.7
39600-48890	73.0	0.21	9.9	211*
45850-48890	923	0.25	10.4	36.7
45850-47100	60.6	0.45	14.2	208*
reduced				
44300-48090	215*	0.20	10.4	40.8
39600-48890	896	0.23	10.9	91.2
45850-48890	929	0.28	12.2	87.7
45850-47100	60.6	0.46	14.5	210*

Table 3. Results of the periodogram analysis of the AFOEV observations.

interval JD 24.....	P	$S(f)$	$-\lg Pr$
25700–29000	212	0.46	40.06
49000–50000	243	0.71	93.27
29000–31500	1394	0.11	2.23
39300–42500	356	0.18	21.01
42800–44300	605	0.09	5.85
44600–45700	463	0.13	14.47
45700–47600	74.0	0.11	21.29
47600–49000	464	0.11	15.13

program FOUR-0 by Andronov (1994)) in some observational intervals for both cases (initial observations and the ones with reduced orbital variability) are shown in Table 2. There P is the best fit period; $S(f) = \sigma_C^2/\sigma_O^2$ is the maximum value of the periodogram, 10^{-L_p} is the "false alarm probability", i.e the probability to obtain a peak of a given height at one of the "independent frequencies", if the data are pure white noise (cf. Terebizh 1992, Andronov 1994,1996); P_{O-C} is the best fit period computed for the residual of the observations "O" from the best sine fit "C" to the original data; the values of period corresponding to a cycle length close $212^{\rm d}$ are marked by "*".

Results of the Analysis of the AFOEV Data

The AFOEV visual estimates also were used for the period search. The variance of observations (related to differences of individual system of many observers) was so large that the orbital variability can't be extracted (see Fig 2.). The three types of variability were distinguished from the long–time light curve:

1) large outbursts with a characteristic time ~ 212 days and a range $\sim 10 - 13^{\rm m}$,

2) transitions between the "high" ($\sim 10\overset{\rm m}{.}5$) and "low" ($\sim 12\overset{\rm m}{.}5$) state with a cycle length $\sim 250^{\rm d}$,

3) variations in a range about $10\overset{\rm m}{.}5 - 12\overset{\rm m}{.}5$, the amplitude and their characteristic times are different in different time intervals.

All types of variations are shown in Fig. 3,4. In the interval JD 244570-47600 the characteristic time is equal to about $74^{\rm d}$ (corresponding to 61 days in the same interval derived from the photographic observations). These variations were approximated by a running parabola fit (Andronov, 1997) with a filter half-width $50^{\rm d}$ (JD 2446200-46420) and $25^{\rm d}$ (the rest) (see Fig 4). In the intervals JD 2444600–45700 and 2447600–49000 it is equal $464^{\rm d}$($\approx 930^{\rm d}/2$ in photographic data). The results of the periodogram analysis are listed in detail in Table 3.

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MV LYRAE IN THE LAST LOW STATE IN 1995-1996

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ABSTRACT. The detailed TV photometry of novalike variable MV Lyr in the low brightness state covered 25 nights of observations in 1995-1996 years is made. Its brightness was B = 18.$^{\rm m}$2 - 16.$^{\rm m}$2. The flash with amplitude of about 0.$^{\rm m}$5, lasted half an hour was detected twice in two separated nights and the sequence of similar flashes but with amplitude reached 2$^{\rm m}$ was detected once. The quasi-periodic variations with typical time 0.$^{\rm m}$13 - 0.$^{\rm m}$14 and amplitude 0.$^{\rm m}$1 were found.

Key words: Stars: cataclysmic, novalike, MV Lyr

Introduction

MV Lyr is the unusual novalike variable. It spends most of its time in a high brightness state. Once every decade or so its brightness abruptly decreases by a factor of 100. The decrease of luminosity could be caused by a decrease or even a cessation of mass accretion onto the white dwarf in the system. The previous low state lasted approximately ten years. The brightness of MV lyr reached 18$^{\rm m}$, varied from 18$^{\rm m}$ to 17$^{\rm m}$ and sometimes the short-term outbursts (several days) up to 15$^{\rm m}$ have been detected. Marsakova and Shugarov (1995) detected the beginning of the last low state that occurred in April 1995. In the last decade of August, 1996 (Andronov, 1996) MV Lyr already was in the high state, so we could claim that the last low state lasted 1.5 years.

Observations

The observations of MV Lyr were undertaken in 1995-1996 years at TV-complex of 0.5m telescope of Crimean astrophysical observatory from August 1, 1995 till July 7, 1996 during 25 nights. The shortest row of observations was 0.5 hours and the longest – close to 5 hours. The exposure time varied from 0.75 minutes to 3 minutes depending from the conditions of observations. We obtained the observations in integral light. Taking into account that TV tube has maximum sensitivity at 4000 Å, we used the B-magnitudes of comparison stars (Andronov and Shugarov, 1982) in the vicinity of MV Lyr for brightness estimates. The typical error of a single estimate was 7%.

Results

One could note some peculiarity of MV Lyr behaviour in the last low brightness state: the absence of a several-days outbursts in compare with previous low state. At the same time the short-lived outbursts were detected (Pavlenko and Shugarov, 1996), but that events happened rarely. Its looked like single flash per night lasted 20-40 minutes with amplitude 0.$^{\rm m}$5, or like the quasi- periodic sequence of flashes with the same typical time but the huge amplitude up to 2$^{\rm m}$. Fig.1 shows the behavior of MV Lyr for the selected nights.

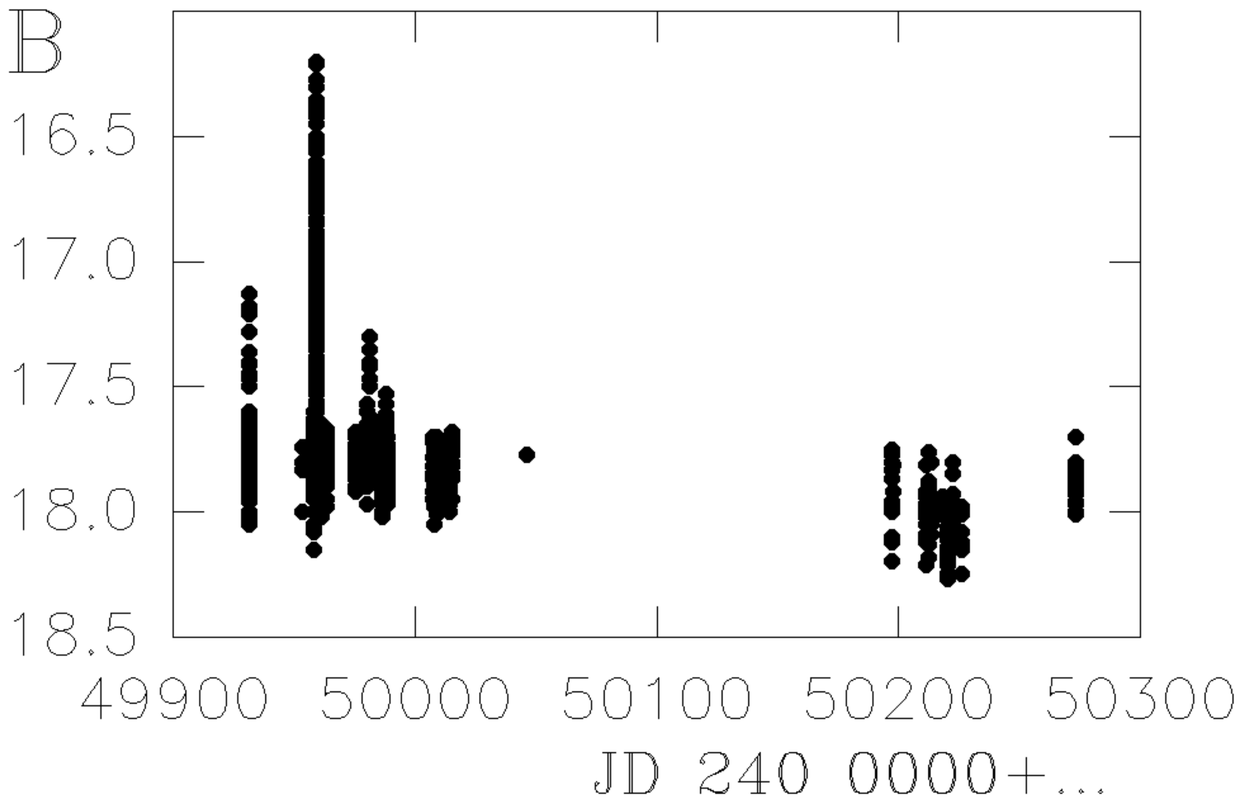


Figure 3. The last low state of MV Lyrae in 1995-1996.

Some of light curves showed the slow brightness variations with time scale 0.13-0.14 days, but with low amplitude of 0.$^{\rm m}$1. The periodogram for all data in 1995 is given in Fig.2. Several strongest peaks in the vicinity of the spectroscopic period (0.$^{\rm d}$133) as well as the position of period itself are marked. The side-band peaks are separated by day, another peak is close to the photometric period 0.$^{\rm d}$138, discovered by Borisov (1991) in the bright state and no coincided peaks with spectroscopic period. So we could say about the existence of small-amplitude (0.$^{\rm m}$1) light variations with rather typical time of 0.$^{\rm d}$13 - 0.$^{\rm d}$14, close to spectroscopic period, then exact periodic variations.

The light curve in the scale of tens months is performed in the Fig.3. It is seen that the mean brightness of MV Lyr (if we ignore the flashes) decreased with time from 17.$^{\rm m}$8 to 18.$^{\rm m}$1.

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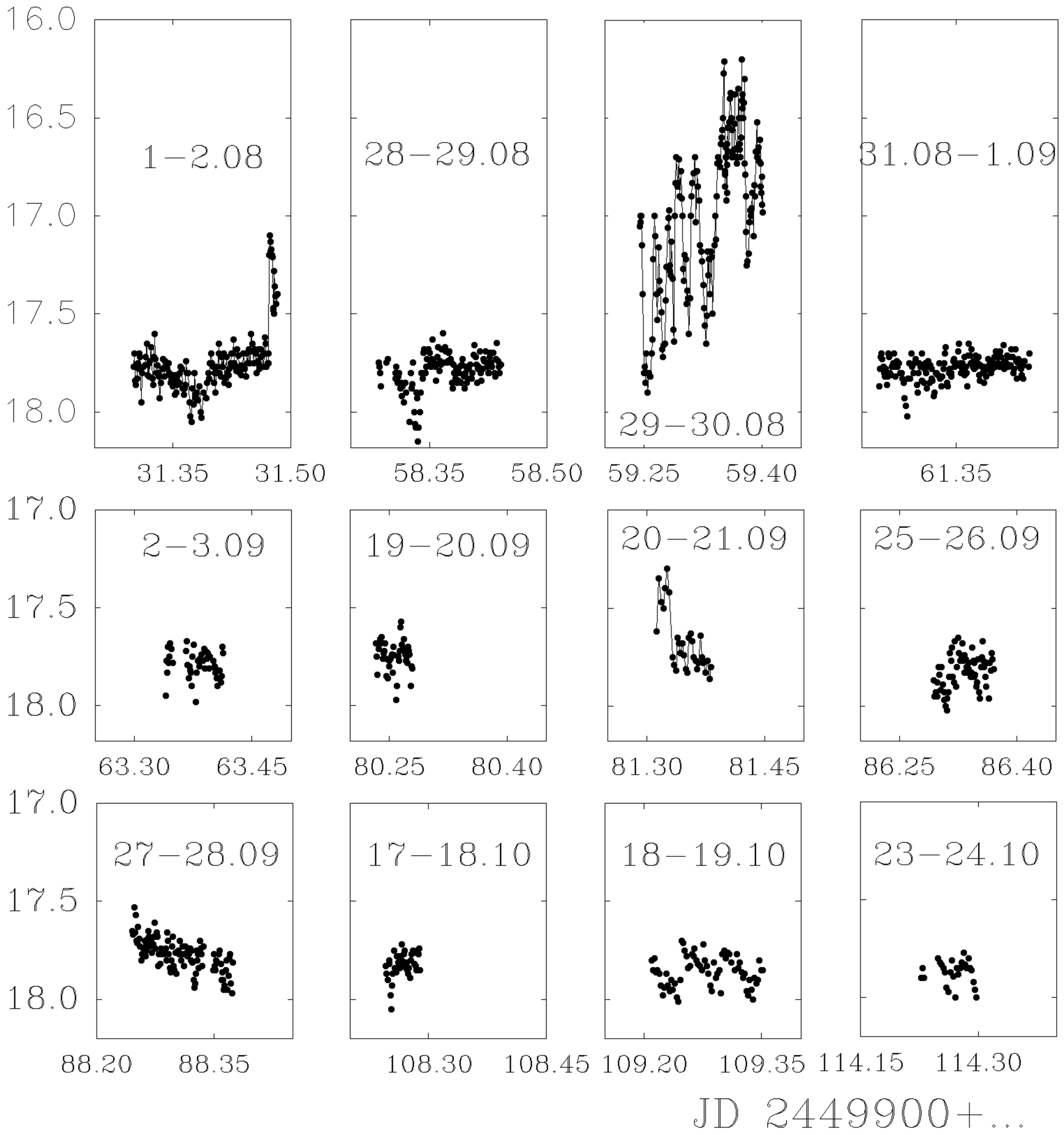


Figure 1. The behaviour of MV Lyrae for selected nights in 1995.

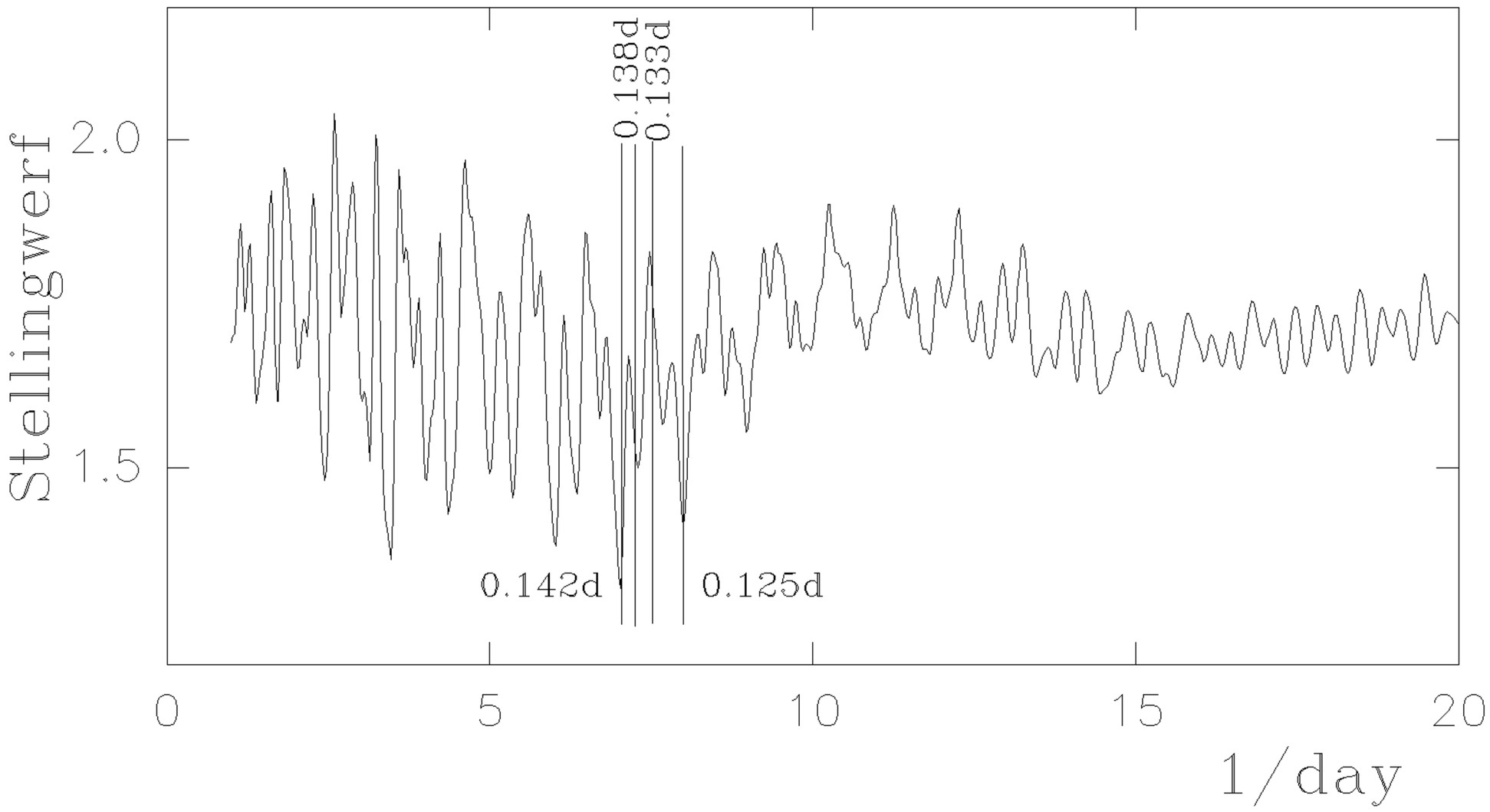


Figure 2. The periodogram for MV Lyrae in the vicinity of the spectroscopic period computed using the method by Stellingwerf (1978).

THE ROLE OF MAGNETIC STELLAR WIND AND MASS TRANSFER IN CLOE BINARIES OF THE EARLY SPECTRAL TYPE

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ABSTRACT. We suggest the results of calculations of mass transfer rate using orbital period changing and changing of orbital semi-major axis due to magnetic stellar wind and mass transfer in close binaries of early spectral type.

Key words: stars: contact early binary systems, magnetic stellar wind, mass transfer.

38 systems have changing orbital periods among 100 researched contact binaries of the early spectral type. Mass transfer from one component to other and mass loss by system total are the reasons of orbital period changing.

To know what parts magnetic stellar wind and mass transfer in tvjlution of close binaries systems with conservative mass transfer were studied. By the orbital period changing the rate of mass transfer was counted:

- for systems with loss orbital period (20 systems, a primary com-ponent loses mass) the mass changing rate is $M_1 = 10^{-7} - 10^{-6} M_\odot$/year;

for systems with increasing orbital period (18 systems, a secondary loses mass) the mass changing rate is $M_2 = 10^{-8} - 10^{-6} M_\odot$/year.

According Fedorova and Tutukov (1994) magnetic stellar wind take place and leads to the orbital period loss in several contact early binaries with less-massive secondaries with convective envelope.

Calculations shown, that the part of magnetic stellar wind into orbital semimajor axis loss makes up 1-10% from orbital semimajor axis loss due to mass transfer that is $10^{-6} - 10^{-7} R_\odot$ /year.

For systems with increasing orbital period magnetic stellar wind opposes for increasing of orbital semimajor axis and period due to mass loss of a secondary.component

The results of calculations may be used by study of evolution and connection of different types of close binaries, for example semi-detached systems R CMa-type, W UMa-type, contact early binaries, especially less-massive.

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LONG–TERM PHOTOMETRIC MONITORING OF CATACLYSMIC VARIABLES: PRELIMINARY RESULTS FOR T CRB, CQ DRA AND GK PER

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ABSTRACT. The preliminary results of the long-term photometric monitoring (LTPM) of cataclysmic variables (CVs) T CrB, CQ Dra and GK Per are presented. All the observational data were obtained in the frame of the international campaigns of the observations of cataclysmic and symbiotic stars.

Key words: Stars: Cataclysmic Variables – T CrB – CQ Dra – GK Per

Although it is impossible to perform detailed studies of the structure of the observed objects while using small telescopes which cannot cope with the HST, NTT and Keck telescopes, for example, the primary comparative advantage of small telescopes is obvious. There is much less problem in obtaining the observational time at some of these smaller instruments at any period of time, so that much more complete coverage of the light behaviour of selected object in various activity stages can be achieved. This is the main goal of our observational campaign (Hric, Urban and Petrik 1996) – a good coverage of the light variations on various time scales as important clues to the nature of the physical processes taking place within as broad sample of CVs as possible. As the first set of main observational targets (out of about 100 objects considered to be suitable for our LTPM), we have selected 3 classical novae (CN), 5 dwarf novae (DN), 2 recurrent novae (RN) and 5 novalike stars (NL). A network of participating telescopes has been created in the frame of our campaign consisting of, at the present, the following ones: three 0.6 m Cassegrain telescopes equipped by single channel pulse-counting photoelectric photometers at the Skalnaté Pleso, Stará Lesná and Hlohovec Observatories in Slovakia, a 0.6 m one equipped by three channel photoelectric photometer at Mt. Suhora Observatory in Poland, a 1.2 m one equipped by single channel photoelectric photometer at the Kryonerion Observatory in Greece, a 0.8 m one equipped by single channel photoelectric photometer at Tartu Observatory in Estonia, a 0.5 m one equipped by the CCD camera at Baja Observatory in Hungary, a 0.4 m Nasmyth equipped by single channel photoelectric photometer and the CCD camera at Brno Observatory in the Czech Republic, 0.25 m Cassegrain equipped by the CCD camera at an amateur observatory in Beluša, Slovakia. Moreover, there are several groups of amateur visual observers cooperating with our efforts. During the first period of our LTPM activity, we have obtained data for the following stars: V603 Aql, TT Ari, V705 cas (Petrík et al. 1996), Nova Cas 1995, T CrB, CQ Dra, GK Per and V Sge.

The recurrent nova **T CrB** was the first CV which has been studied spectroscopically during its first recorded outburst in May 1866. In contrast with a typical structure of a CV, it consists of a M3 III giant and a hot companion of as yet unclear nature, presumably the white dwarf, in a wide orbit with P_{orb} about 227.5 days. Our photometry covers the time span of over 6 years. Recent brightening of the system, best pronounced in the U colour, amounts to a maximum extreme of all our LTPM of this star (U_{max} around 10.3 mag). While no flickering has been detected in 1993 by Dobryzcka et al. (1996), we have detected an intense flickering in several nights in April 1996, suggesting that the activity of the hot component has increased again (see Figure 1). It seems that the amplitude of the large variations in the LTPM light curve of T CrB are increasing slowly. Does it mean that we are approaching another recurrent nova outburst in this object? On the basis of phase diagrams, it is apparent in all three colours that the minioutbursts are independent

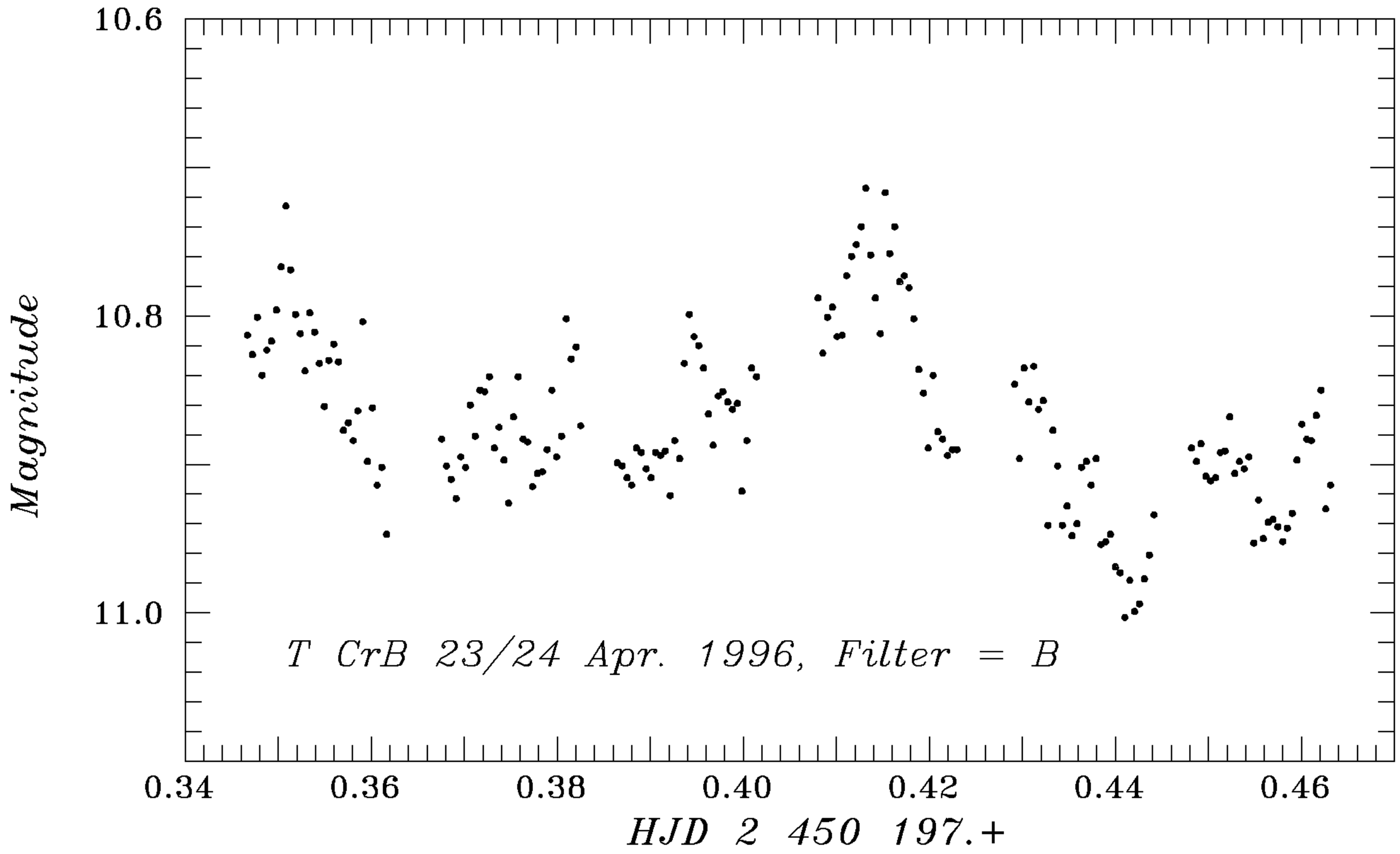


Figure 1. An example of the long run in the B band.

on the phase of the 227.5 days orbital cycle.

Another CV with strange behaviour is the triple system **CQ Dra** (= 4 Dra). The bright (m_v about 5 mag) M3 III star and a hot UV source component in a wide orbit of about 1703 days resemble a symbiotic binary (red giant + hot companion). It seems on the basis of the UV data that the hot companion itself is a close binary system with probable orbital period of about 4 hours (Reimers et al. 1988). Our data for CQ Dra now cover the time interval of over 7.3 years (more than a full orbital cycle of the wide system). We have detected neither the rapid light variations (flickering) nor any periodicity similar to the 4 hr UV period in our observational runs (with an accuracy to about 0.03 mag in the U colour). Thus we can conclude that, unfortunately, there is no definite evidence in the optical supporting the CV nature of the hot companion as yet (see also Urban et al. 1996).

The last CV of our programme we would like to mention is the classical nova **GK Per**. Its nova outburst has occurred in 1901 and the system has exhibited a series of a dwarf nova-like outbursts of lesser extent since then. These smaller outbursts have occured with an approximate period of about 3 years during the last decades. We have observed the most recent DN-like outburst of this star (Feb-Apr 1996) photoelectrically and also with the use of the CCD cameras in V, R and I colours. The brightness level increased towards the longer wavelengths from V to I. This phenomenon is probably caused by the extended dust envelope existing in this system.

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PERIOD CHANGE IN THE CONTACT SYSTEM AW UMA

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ABSTRACT. Nine new minima were determined from the UBV photelectric observations obtained in 1992 and 1995-6. They were used to derive the new ephemeris of AW UMa. The mid-eclipse brightening best visible in U colour was detected. Possible reasons of the observed orbital period decrease are discussed.

Key words: Stars: eclipsing binaries, AW UMa

Introduction

AW UMa is a bright (V_{max}=6.84^m) F0-F2 A-type W UMa system (orbital period P = 0.43873 days) discovered and classified by Paczynski (1964). It has the lowest known mass ratio ($\approx$ 0.075) among W UMa binaries. Changes of the form of the light curve were found by Kalish (1965), Dworak and Kurpinska (1975), Woodward et al. (1980), Istomin et al. (1981), Hrivnak (1982), Derman et al. (1990) and Bakos et al. (1991). During 1989-90 observing seasons unusually strong light and colour variations as large as 0.15^m were observed by Derman et al. (1990) in a few days time interval. The orbital period change was found by Woodward et al. (1980) and Istomin et al. (1981). Hrivnak (1982) considered either sudden or continuous decrease of the period. Demircan et al. (1992) discussed following mechanisms for the period decrease: (i) a mass transfer from the more massive to the less massive component, (ii) an interaction with a disk or a shell around the system. Very slow mass transfer from the less massive to the more massive component slows the period decrease.

The last spectroscopic study of AW UMa was made by Rucinski (1992). He assumed the inclination angle $i = 80^o$ and the mass ratio $q = 0.075$ from the light curve solutions. Two sets of spectroscopic data obtained in 1988 (I) and 1989 (II) lead to the masses of the components as follows: $M_1^I = 1.28 \pm 0.14$ M$_\odot$, $M_2^I = 0.096 \pm 0.012$ M$_\odot$ and $M_1^{II} = 1.79 \pm 0.28$ M$_\odot$, $M_2^{II} = 0.134 \pm 0.023$ M$_\odot$.

Light curves, times of minimum and period study of AW UMa

Our UBV photoelectric observations of AW UMa were obtained at the Skalnaté Pleso and Stará Lesná observatories in 1992 and 1995-6, respectively. In both cases a single-channel pulse-counting photoelectric photometer installed in the Cassegrain focus of the 0.6m reflector was used. Integration time of one measurement was 6-10 seconds. BD +31^{o}2270 served as the comparison star.

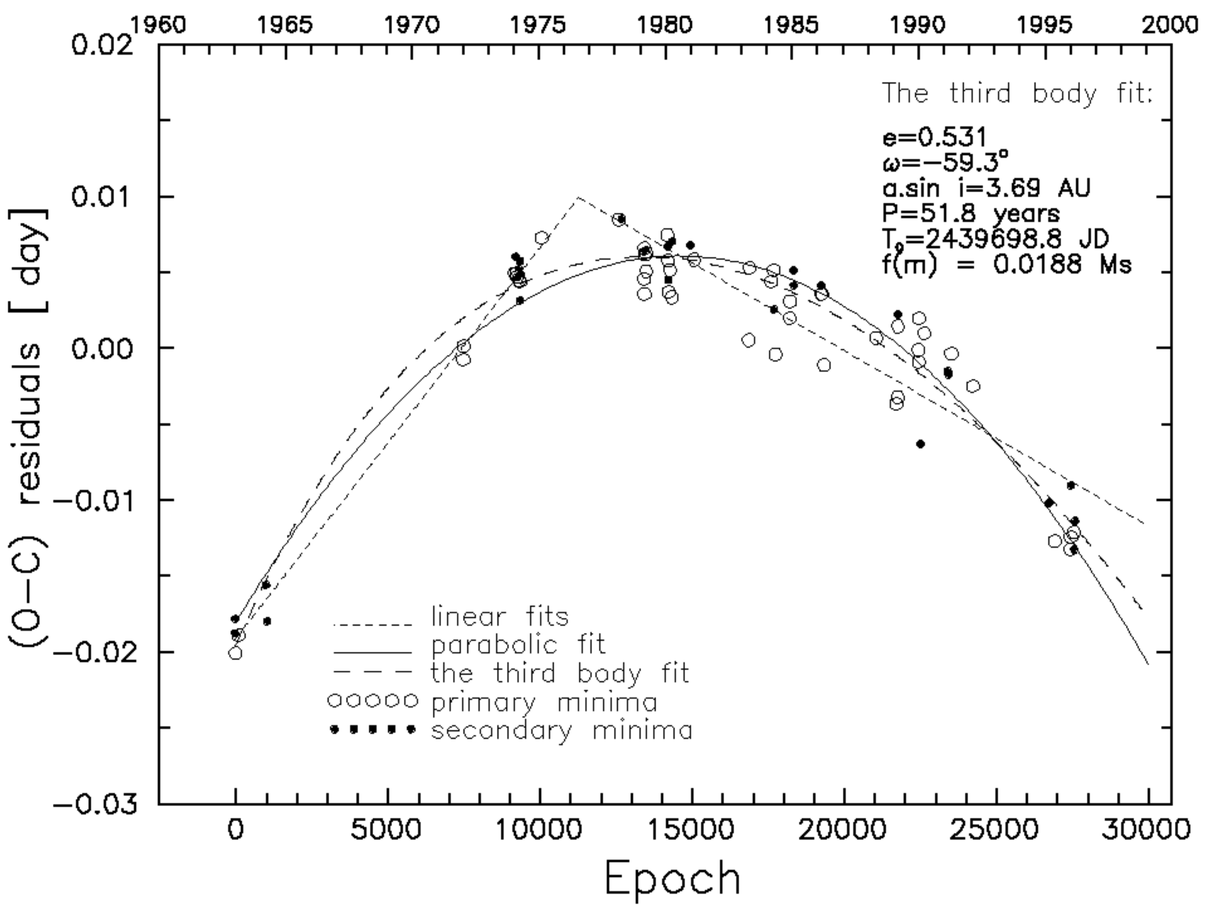


Figure 1: The (O-C) diagram for the times of the primary and secondary minima calculated using the ephemeris (1).

Our U,B,V light curves of AW UMa are plotted in Fig. 2. The light curves seems to be without complications described by Derman et al. (1990) and Bakos et al. (1991), suggesting the decrease of activity in the system. In the secondary minimum (when the smaller component was totally eclipsed) a mid-eclipse brightening, best visible in U colour, was registered.

Nine heliocentric times of minima determined from our UBV observations are listed in Table 1. They were used together with published photoelectric times of minima (see Bakos et al., 1991 and Demircan et al., 1992) to study period change.

The (O-C) residuals (Fig. 1) were calculated using the HJD ephemeris:

$$Min\, I = 2\,438\,044.8004 + 0.43872974 \times E. \quad (1)$$

The period change given in Fig. 1 may represent either 1) a sudden period change from one constant period to another constant period or 2) a continuously changing period (real or apparent). The first explanation implies that the period changed in 1976. The ephemerides be-

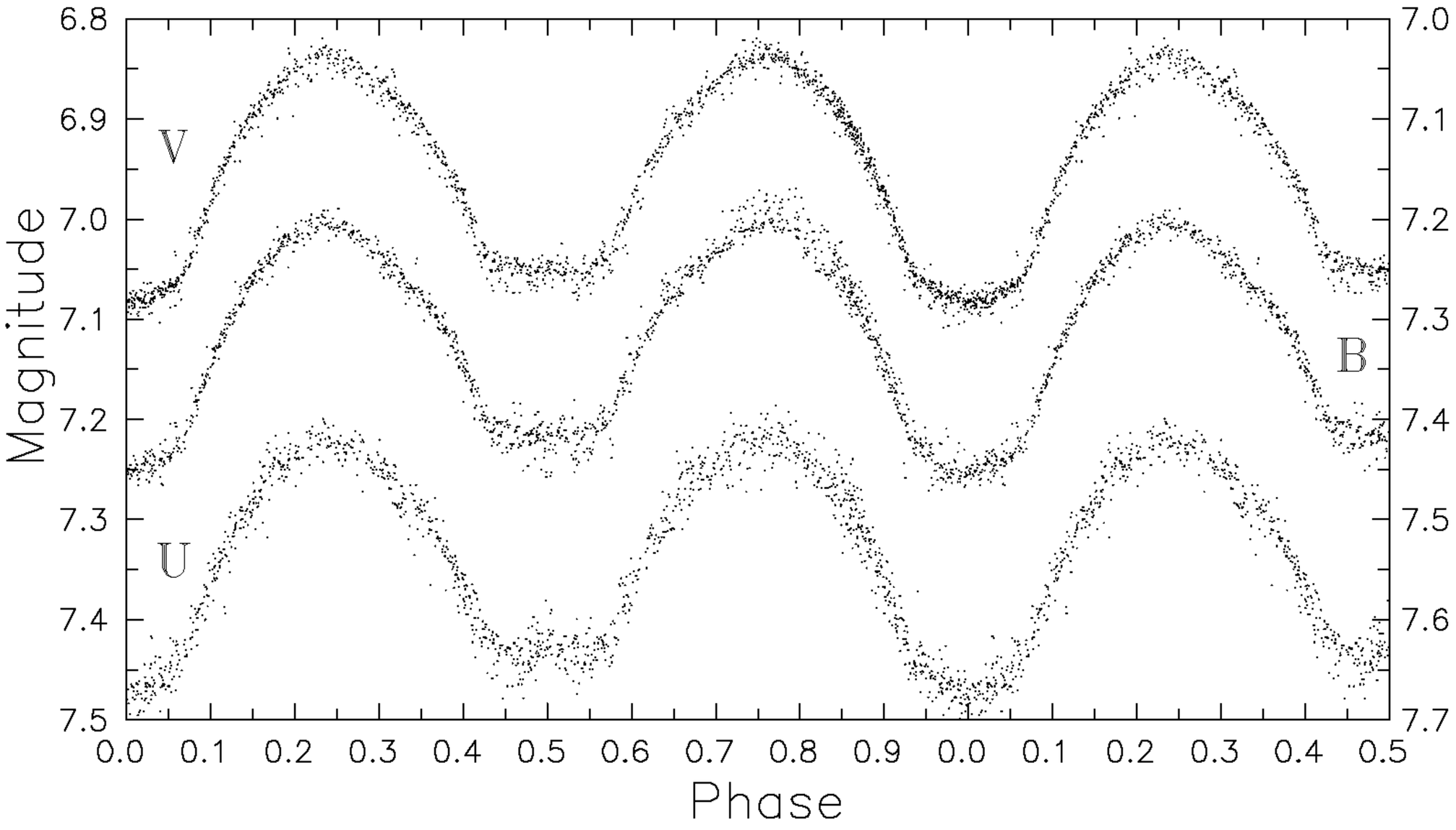


Figure 2: U,B,V light curves of AW UMa. Phases were calculated using the ephemeris (4).

Table 1: New times of minima for AW UMa

Epoch	JD Hel.	Error	Observatory
24249	48683.5554	0.0005	S. Pleso
26744.5	49778.39774	0.0002	S. Lesná
26936	49862.4120	0.0008	S. Lesná
27469.5	50096.478	0.001	S. Lesná
27472	50097.5706	0.00004	S. Lesná
27474	50098.44886	0.00002	S. Lesná
27567	50139.4693	0.0002	S. Lesná
27572	50141.4447	0.0004	S. Lesná
27617	50161.4076	0.0004	S. Lesná

fore (E< 11 286) and after this change are as follows:

$$Min\,I = 2\,438\,044.7813 + 0.43873231 \times E. \quad (2)$$

$$Min\,I = 2\,438\,044.8234 + 0.43872858 \times E. \quad (3)$$

The ephemerides indicate a period jump $\Delta P/P = -8.5\,10^{-6}$, caused by the sudden mass transfer burst from the more to less massive component.

The ephemeris for the real continuously changing period was found by fitting the residuals with a quadratic fit as follows:

$$Min\,I = 2\,438\,044.7824 + 0.438733046 \times E - 1.132\,10^{-10} \times E^2. \quad (4)$$

The times of future minima can be estimated using this ephemeris. Real continuous decrease of the period ($\Delta\ P/P\ = -2.26\,10^{-10}$) is caused by the continuous mass transfer between the components and/or interaction with the circumstellar disk or shell.

Apparent change of the period is caused by a light time effect due to the presence of the third body in the system. The third body fit and corresponding spectroscopic elements found by the simplex method are given in Fig. 1. The derived elements are very uncertain, because only the part of possible 51.8 years light time curve is covered. Using the mass function f(m) = 0.0188 $M_\odot$ and the total mass of the binary (Rucinski, 1992), one can easily find the mass of the third body (in the case of coplanar orbits) as 0.40 $M_\odot$ (M_{1+2} = 1.376 $M_\odot$) or 0.49 $M_\odot$ ($M_{1+2} = 1.924\,M_\odot$). The sum of squares of residuals for the third body fit ($2.61\ 10^{-4} d^2$) is better than that for the quadratic fit ($3.22\ 10^{-4} d^2$) or two linear fits ($3.86\ 10^{-4} d^2$). Therefore the sudden period change is the least probable.

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PRECATACLYSMIC VARIABLES: OBSERVATIONAL DATA AND MODELS

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ABSTRACT. We summarize the first results of modelling light curves of precataclysmic binaries with strong reflection effect. Our approach is based upon modified Napier's technique and explicit computation of emergent radiation intensity using the source functions given by Strittmatter and Sobieski.

Key words: Planetary nebulae, precataclismic binaries

Introduction

Precataclysmic binaries (PCB) is a small group of detached close binary systems, which are observed at the centre of planetary nebula, consisting of a hot white dwarf or a subdwarf accompanied by an essentially unevolved low mass cool companion $M_2 \leq 1M_\odot$. PCB orbital periods are so short (typically less than two days) that they can only have been formed via a common envelope evolution (see, for instance, Bond et al 1992, Ritter 1986).

Recently we have started a systematic reevaluation of the existing observational methods of analysis hitherto applied to PCB-s. Our current activity in this field has been motivated by the following considerations:

I) Although PCB-s are detached binaries, reflection effect may not be the only first order proximity effect caused by irradiation from the hot component. Soft X-ray and UV radiation should considerably alter the structure of chromosphere and corona of the cool companions. Thus, significant departures from the standard mass radius relation valid for main sequence stars (and often used in the estimates of the relevant evolutionary time-scales) may be expected.

II) Detailed data on X-ray and EUV fluxes from hot primaries impinging upon atmospheres of the low mass cool companions are still lacking. Modelling the properties of evaporative wind for this class of objects and its observable manifestations can shed some light upon the energy distribution of the hot irradiating primaries (or at least set upper limits for the fluxes in these spectral ranges).

III) There are still uncertainties in our knowledge of the physical parameters for the component stars involved in PCB (among others, the velocity of axial rotation and radii of cool companions). Available statistics of well studied PCB-s is still far from being adequate (with the exception of BE UMa, see Ferguson and James, 1994). Yet in the existing catalogues (Ritter, 1986, Bond et al, 1992) precataclysmic binaries present themselves as rather heterogeneous group of objects. Specifically it remains to be clarified what is the relation between PCB, Abel-35 type nuclei and recently discovered with the aid of *ROSAT* EUV all-sky survey wide binary systems like *2REJ 044+093* consisting of a hot white dwarf and an ultra-rapidly rotating K-dwarf (Jeffries and Stevens, 1995).

Here we report the first results of our investigations.

We have elaborated a method that would permit us to construct light curves of these systems caused by the reflection effect. In absence of eclipses, this effect is the main factor causing periodic luminosity variations of a binary. Conservative estimates indicate that such systems should constitute 10-15 % of all precataclysmic binaries.

In the present work the improved Napier's algorithm (Napier, 1968) is used. Intensity of the emerging radiation is calculated using the standard approach of the radiation transfer theory. For determination of the temperature distribution in the photosphere two methods are alternatively applied: those of Sobieski 1965 and Strittmatter, 1974. Absorption coefficients are taken into account separately for 3 cases: absorption by neutral hydrogen, by H^- ions and the grey case. Calculations of the absorption coefficients are performed according to the formulae given by Grey, 1976; the Planck mean absorption coefficient is used. The entire luminosity received from the cool companion is calculated by integration of the emerging radiation over its disk; it is the sum of contributions from the illuminated and unilluminated portions of the disk. The light curve is normalized with the total brightness of the system in the minimum phase.

According to the foregoing considerations we have composed a set of computer programs in *Turbo Pascal 7.0*. It enables one to construct light curves of detached binary systems. As initial parameters it receives fractional radii of the components, their effective temperatures and the orbit inclination angle. An ab-

sorption coefficient and a method for determination of temperature distribution must be specified also. If the Strittmatter's method is used, it is necessary to specify values of the coefficients α and q, α being absorption albedo and q being the ratio of optical depths in the X-ray and visible range.

Our model is based upon the following main assumptions: a) the validity of the local thermodynamic equilibrium in the photosphere of cool component; b) absorption by only one agent; c) constancy of the monochromatic to mean absorption coefficient ratio within the photosphere; d) the hot star irradiates as the absolutely black body; e) the components are spherical and there are no other effects affecting the light curve except for the reflection effect.

With the use of the improved method we have modelled the light curves of the detached binary *EC11575-1845*. In the paper of Chen et al (1995), the orbital period of 7.86 days has been established for this system and 5 light curves for different photometric bands are given. There are no eclipses in the system and its variability is caused by the reflection effect. To simplify the calculations, we have approximated the observed light curves by the Fourier series. Thereafter a number of sets of parameters modelling the observational data were found. Some of them were refined later. The agreement between the observed and the calculated data was quite satisfactory. In the Fig.1 two theoretical light curves are given for the I-band obtained with the aid of the two methods and with different absorption coefficients. Points represent the observational data.

The analysis of the temperature distributions in the heated photosphere indicates that in some cases a temperature inversion may be present. Its existence is predicted both by the Sobieski's and by the Strittmatter's method. Due to this effect in the regions where the inversion occurs, the limb-darkening coefficient behaves peculiarly: the emerging radiation tangent to the surface may be more intensive then the radiation along the normal (limb-brightening).

Acknowledgements. The authors are thankful to Estonian Science Foundation for a supporting grant ETF 2629.

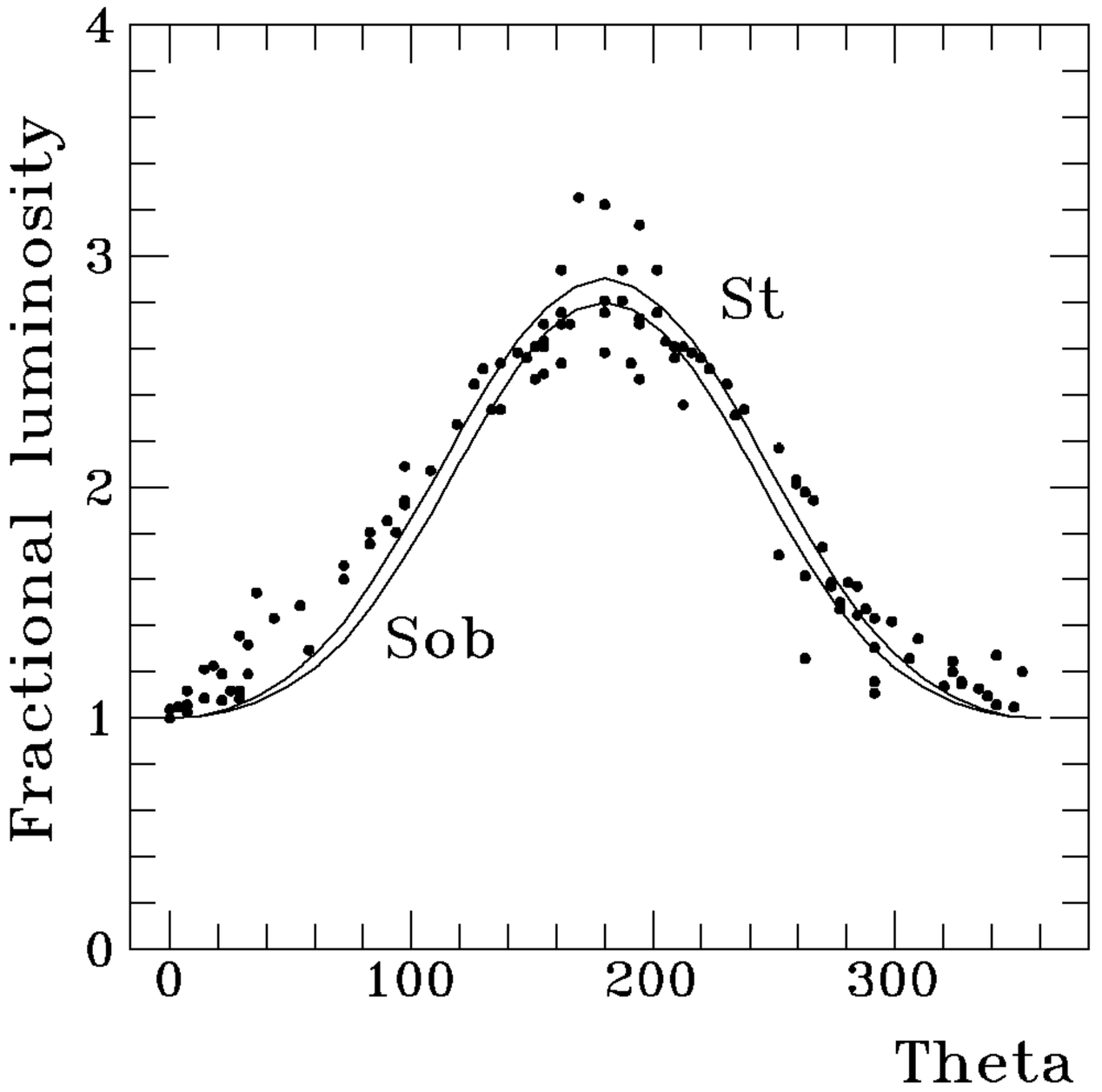


Figure 1. The theoretical light curves of the system *EC11575-1845* in the I-band calculated with use of different methods (solid lines). The points present the observational data. The curve marked with **St** has been modelled using the Strittmatter's method with H^- ion as the absorption agent. The set of parameters is as follows: $a_1 = 0.021, a_2 = 0.110, T_1 = 125000K, T_2 = 3500K, q = 9.5, \alpha = 0.50$. The curve marked with **Sob** corresponds to the Sobieski's method in the grey case. $a_1 = 0.038, a_2 = 0.225, T_1 = 108000K, T_2 = 3500K$. Here a is a stellar radius in units of semi-major axis of relative orbit, T its effective temperature. The index 1 refers to the illuminating, 2 to the illuminated star.

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GEOMETRY OF GEMINGA ROTATION ACCORDING TO LIGHT CURVES IN GAMMA-REGION

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ABSTRACT. Light curves and spectrum of Geminga in a hard gamma region are investigated in this paper and their properties are discussed. The geometric parameters of pulsar rotation, such as the inclination angle of rotational axis, the angle between rotational and magnetic axes and the cone spread angle of gamma radiation are evaluated. All the results are based on the data of EGRET instrument.

Key words: Pulsar, Geminga, rotation, gamma-radiation

Energy radiation and light curves

EGRET mission has been launched in April, 1988. Now we have at least 9 periods of observations where Geminga was at a distance less than $R = 30°$ from the center of a view field.

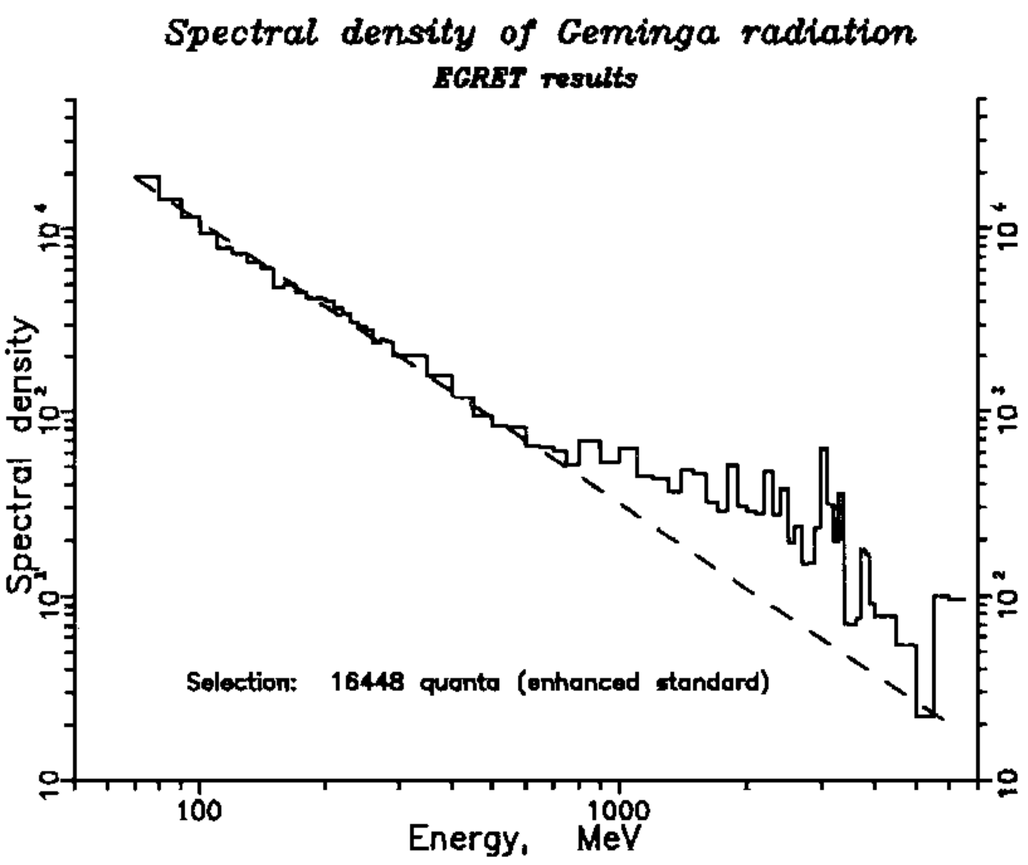


Figure 1: Geminga spectrum with a background after a rough corection over the instrumental effects

The spectrum of Geminga after rough correction over the instrumental effects is presented in Fig. 1. Every narrow stair includes full energy, radiated by the pulsar in appropriate energy band divided by the width of the stair. The energy refers to the sensitive area $S = 800$ cm^2 during the total observation time.

The hump in spectrum for $E > 850$ MeV means that we observe a pulsar above the background. The pulsar power in this spectral hump is

$$W = 1.9 \cdot 10^{31} \cdot \left(\frac{R}{50\,\mathrm{ps}}\right)^2 \ \mathrm{erg/s}, \qquad (1)$$

where R is a distance, expressed in parsecs. It is the lowest estimation of pulsar power.

The pulsar light curve has two-peak shape (Fig. 2). But, the higher is the energy band, the lower is the left hand peak with respect the the right one and both peaks become more narrow. At $E \approx 3500$ MeV the right hand peak has the width of 0.11 of a period, the left hand peak is totally disappeared. Poor statistics does not spoil this conclusion, because right hand peak still contains more than 20 quanta of 38.

φ, deg.	α, deg.	i, deg.
19.8	80.1	9.9
19.9	79.1	9.0
20	78.5	8.5
21	75.9	6.9
22	74.1	6.1
23	72.5	5.5
24	71.1	5.1
25	69.7	4.7
26	68.4	4.4
27	67.1	4.1
28	65.9	3.9
29	64.7	3.7
30	63.5	3.5
31	62.3	3.3
32	61.2	3.2
34	58.9	2.9
36	56.6	2.6
38	54.4	2.4

Table 1: Possible solutions for φ, α and i when $E = 3500$ MeV

Pulsar rotation

The structure of the light curves can be explained by the geomery of pulsar rotation. The main geometric parameters are presented in Fig. 3.

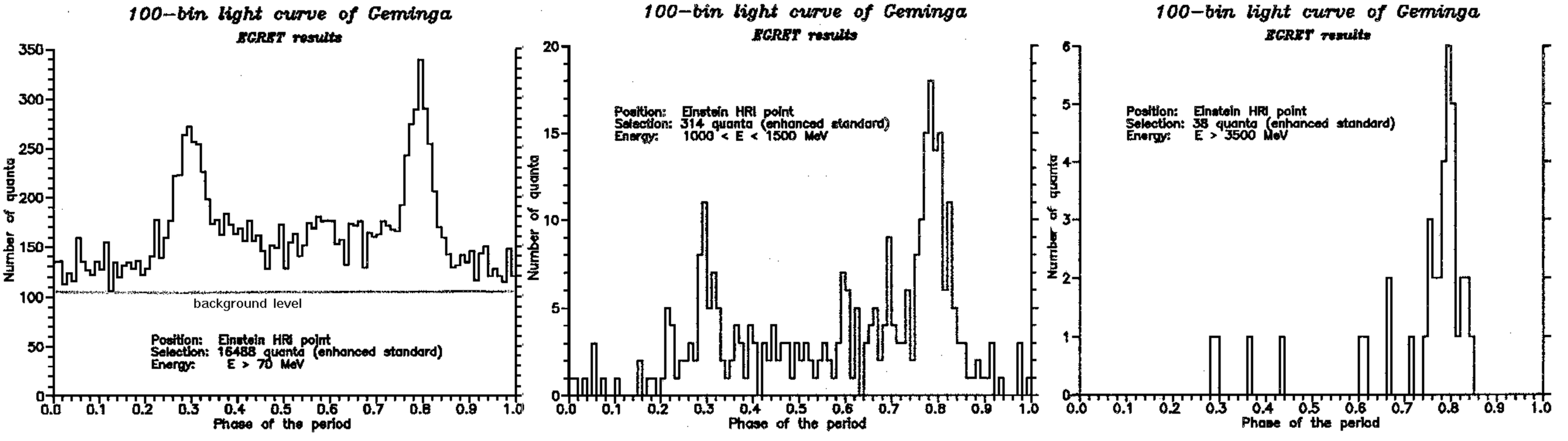


Figure 2: Light curve of Geminga, in different spectral bands

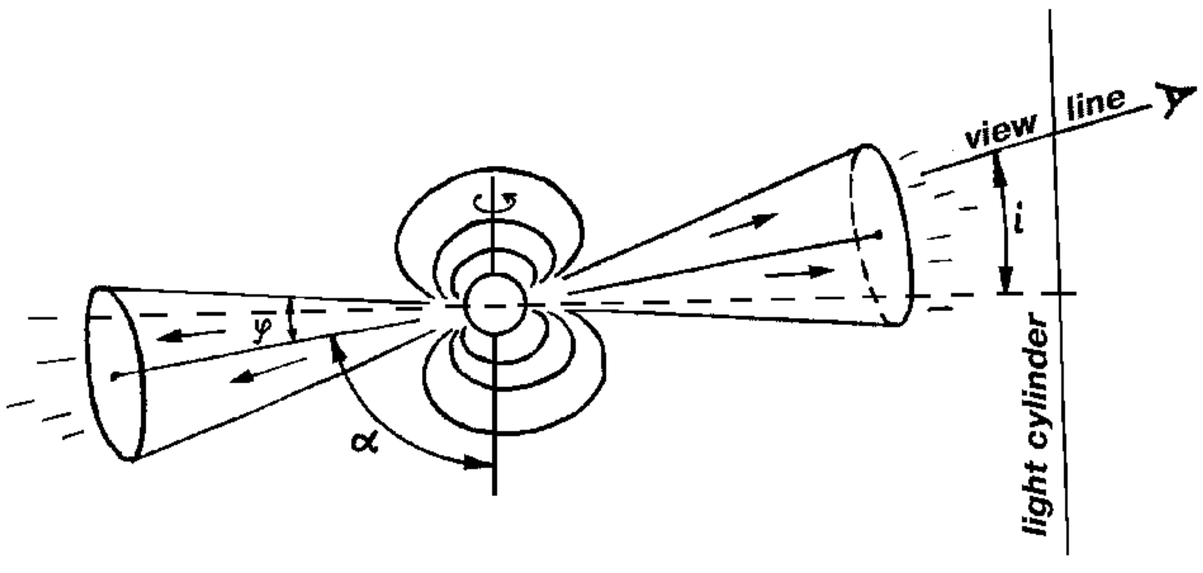


Figure 3: Geometry of pulsar rotation

The situation looks like the primary high energetic γ-quanta are generated in magnetic pole caps close to the surface, then they fly out the pulsar in narrow cone, but, scattering in pulsar magnetosphere, some of them loose the energy and, deviating after Compton scattering, they encrease the cone spread angle 2φ. The cone widening mechanism can have another nature (it may be connected with γ-quanta generation), but the main conclusion is the same: the cone spread angle depends on the quanta energy.

If the observer is not in the equtorial plane, and the cone spread angle does decrease when the energy encreases, then we are to come to position when a view line slips along the forming line of one of the cones. At that marginal position one cone becomes invisible and the observer can see for the first time only one peak in light curve.

Simplifying the geometry, we come to the following corespondence between the angles

$$\begin{cases} \sin^2(i+\alpha)\tan^2\varphi - \cos^2(i+\alpha) &= \tan^2\delta_1 \\ \sin^2(i-\alpha)\tan^2\varphi - \cos^2(i-\alpha) &= \tan^2\delta_2 \end{cases} \qquad (2)$$

where δ_1 and δ_2 are the half-part of a period in the interval $[0, 2\pi]$ when the observer is inside the appropriate cone. For $E = 3500$ MeV $\delta_2 = 0$, $\delta_1 = 2\pi \cdot (0.11/2) \approx 0.35$ and $\tan^2\delta_1 = 0.1296$.

We have two equations for three variables and the system cannot be solved directly. But, for every fixed value of φ angle we can obtain a solution for α and i. A number of possible solutions for the system (2) is summarized in Table **??**.

The full article is submitted to As. Ap..

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LIGHT CURVE OF NOVAE IN THE "OUTBURST AMPLITUDE, ENVELOPE RADIUS" COORDINATES AS THE BASIS FOR THE CLASSIFICATION OF NOVAE ON TYPES

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ABSTRACT. The representation of light curves of novae in the "outburst amplitude, envelope radius" coordinates reveals the existence of five types of novae. In addition to the outburst amplitude and shape of the whole light curve, every type is possibly characterized by the shape of ejected envelope and some other common physical characteristics. The outburst amplitude in the range from 12 to 15^m in the DQ Her type is likely to depend on the inclination of the binary orbit and therefore on the inclination of the dust belt that reaches its maximum optical thickness on a distance of about 5.9×10^{14} cm. The dust condensation at a definite belt inclination can lead to a temporal increase of a nova visual light up to 2^m (V 1668 Cyg, DN Gem) at the transition instead of its decline.

Key words: Novae: light curves.

From the review of photometric and spectral development of novae we come to the conclusion that this development occurs on the scale of the ejected envelope radius more simple than on the time scale (Rosenbush 1996a) and this can be used for classification of novae (Rosenbush 1996b). The transition stage of a outburst on the scale of nova envelope radius always corresponds to the radius range $(2.8\text{-}40)\times10^{14}$ cm. If the dust condensation occurs at the transition, which takes place in a number of novae, this dust shell reaches its maximum optical thickness at a radius of about $(5.9\pm3)\times10^{14}$ cm. As a velocity of ejected envelope is often not known, the logarithmic time scale can be used: $\lg r=\lg t+\lg v_{exp}$. Hereafter we will use the lgt scale. We suggest to use the outburst amplitude as the basis of the second scale. Below we will attempt to summarize and to exploit these results, adding new data recently obtained.

The representation of light curves on these scales for about 50 of about 200 novae known to the present showed almost single distribution of them on 5 groups: CP Pup, GQ Mus, DQ Her with the subgroup of novae without dust, RR Pic, and PU Vul or symbiotic novae. It seems that symbiotic novae represent a transition from classic novae to symbiotic stars, i.e., to novae with a very small outburst amplitude: $5\text{-}6^m$ and less (V 1016 Cyg, HM Sge, etc.). It is possible that the neon novae of the V 1974 Cyg type form a separate group, but the visual light curve is similar to the DQ Her group, and additional IR light curve or spectral data are necessary for a certain classification. The necessity of separating the CP Lac subgroup from the DQ Her group is connected with certain pecularities: a more smooth light curve, the absence of dust, and a higher outburst amplitude than in the DQ Her group. It is quite possible that some recurrent novae with a smooth light curve are the prolongation of this subgroup toward low outburst amplitude.

In the first instance, the distinction of novae groups is the outburst amplitude (Table 1), and the shapes of light curves distinguish at the same amplitude. The proposed separation in types reflects also the distinction of other characteristics. Apparently an ejected envelope has unique observed shape typical for every group. Novae with very identical light curves are found within a group: RR Pic and V 4077 Sgr, PU Vul without temporal light decline and RR Tel. Therefore we may expect a likeness of other characteristics also, including the characteristics before the outburst.

One can also to determine the type of old novae only by their visual light curves. The type of modern novae is possible to define from the outburst amplitude already after first days of the outburst. Additional data (spectroscopy, IR photometry) help us to make certain selection in a doubtful case. This classification allows us to expect further behaviour of a nova with some range of confidence and therefore to plan our observations.

The dust condensation at the same radius of ejected envelope points to the equality of temperatures and luminosities of nova remnants. The existence of a common light curve on which a nova comes earlier or later, except for the GQ Mus group (the X-ray novae?), means the existence of a parameter that determines the whole outburst development. The outburst energy can be this parameter.

The comparison of nova visual light curves with the group typical curve gives us a possibility to estimate

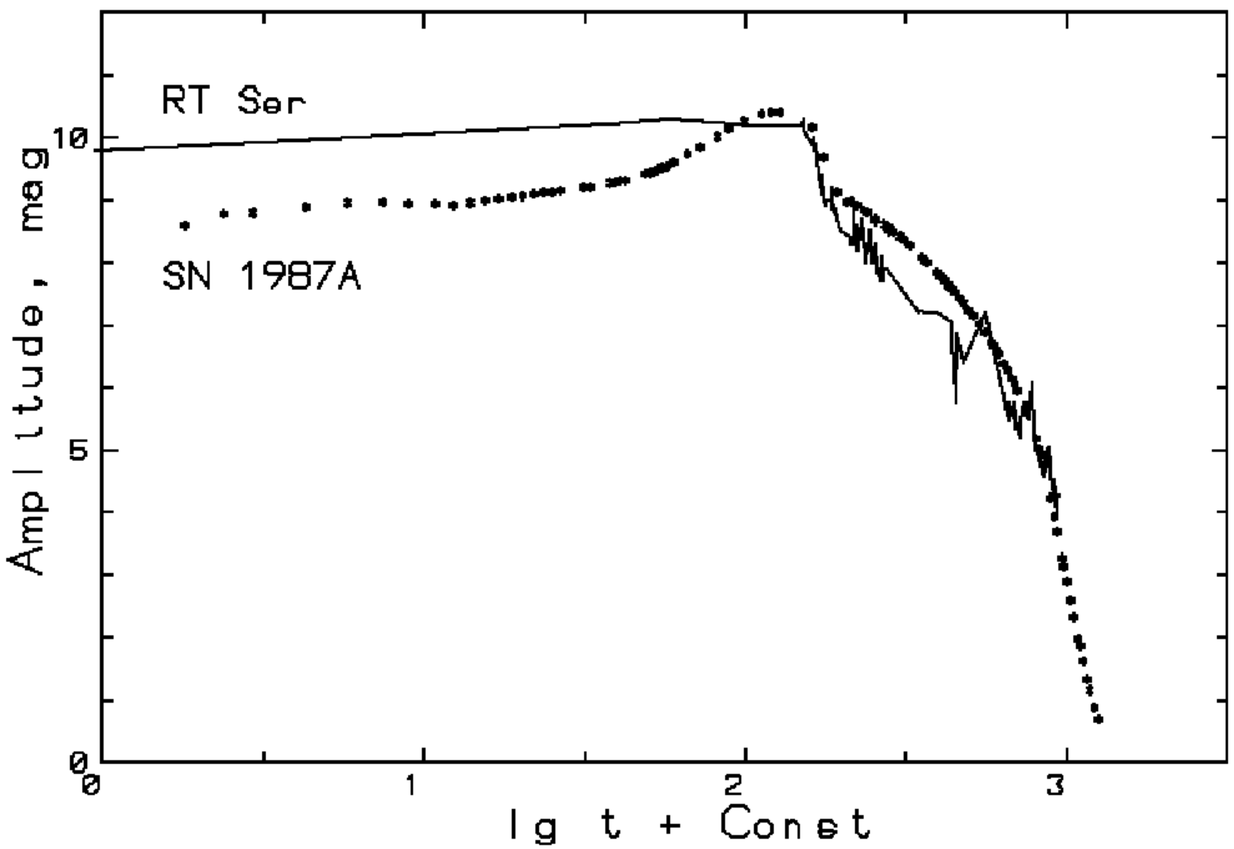


Figure 1. Light curve of RT Ser and SN 1987A. The ordinate is the outburst amplitude of SN 1987A.

the ejection velocity of the envelope.

The division of novae in groups by the outburst amplitude means also the absence of the "absolute magnitude, light decline rate" relation. It is associated rather with the outburst amplitude, the presence of heterogeneities in the envelope, and their orientation with respect to the line of sight. The DQ Her type novae with the smooth light curve at the transition stage have the outburst amplitude in the main higher than novae with the RCB type minimum. These minima are observed when the dust belt is oriented along the line of sight.

The brightness of a nova remnant is very likely to decline proportionally to $\lg t$ as well.

Table 1. Novae groups

Novae type	Amplitude outburst	Novae
DQ Her	$12-15^m$	with RCB minimum and/ or IR excess, DN Gem
CP Lac	15-18	V1500 Cyg, V446 Her
CP Pup	12-14.5	GK Per, V603 Aql, V476 Cyg, Q Cyg
GQ Mus	15-16	V351 Pup, EL Aql
(the X-ray novae?)	9.5-10.5	CT Ser,V1301Aql,V518 Per,V841Oph,V616 Mon
V1974 Cyg	14	V368 Aql,QU Vul V528 Aql, V693 CrA,
RR Pic	10-11	V1819 Cyg, HR Del, V4077 Sgr, N Cas 1995, DO Aql,PW Vul,V356 Aql
Symbiotic	7-8	RR Tel, RT Ser

For a further discussion on the use of this approach to the study of light curves of eruptive variables, we give a comparison of two objects unique in their way: RT Ser and SN 1987A (Fig.1). Some differences may be explained by pecularities of the energy distribution in the spectra of these objects because of the different energy categories.

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THE SIGNIFICANCE OF USING HIGHER ORDER POLYNOMIALS TO DESCRIBE THE (O-C) DIAGRAMS OF ECLIPSING BINARIES

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ABSTRACT. The principal aim of the present study is to underline the significance of using higher order polynomials to describe the (O-C) diagrams of eclipsing binary systems.

Key words: Stars: Binaries: Eclipsing: RT And, GO Cyg, AH Vir.

Introduction

In a recent paper (Kalimeris et al., 1994a;) we proposed a new method for the (O-C) diagram analysis of eclipsing binary systems: that is to describe an (O-C) diagram using a higher order polynomial and not to be limited to a second order one (the well-known and widely used parabola). Do ing so, we were also able to compute in a very simple and accurate way the orbital period changes of the system and its rate of variation. The choice of the appropriate polynomial depends mainly on its RMS error, which reflects to the accuracy with which the description of an (O-C) diagram is made. The latter will in consequence affect the accuracy of determination of the orbital period variations. So it is of great importance to make the right choice. In the present paper we shall show how significant information of the orbital period changes of a system is coming out applying our method, or might be lost using the old way.

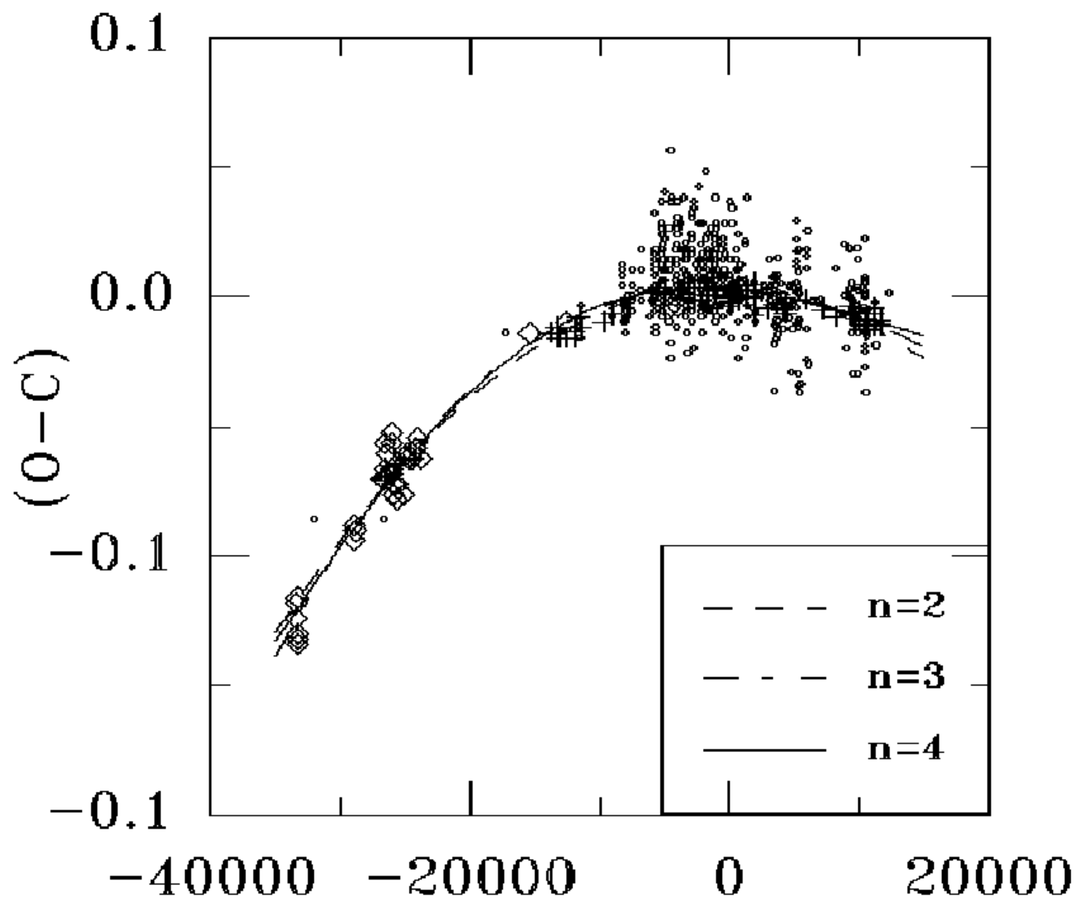
The data and their analysis

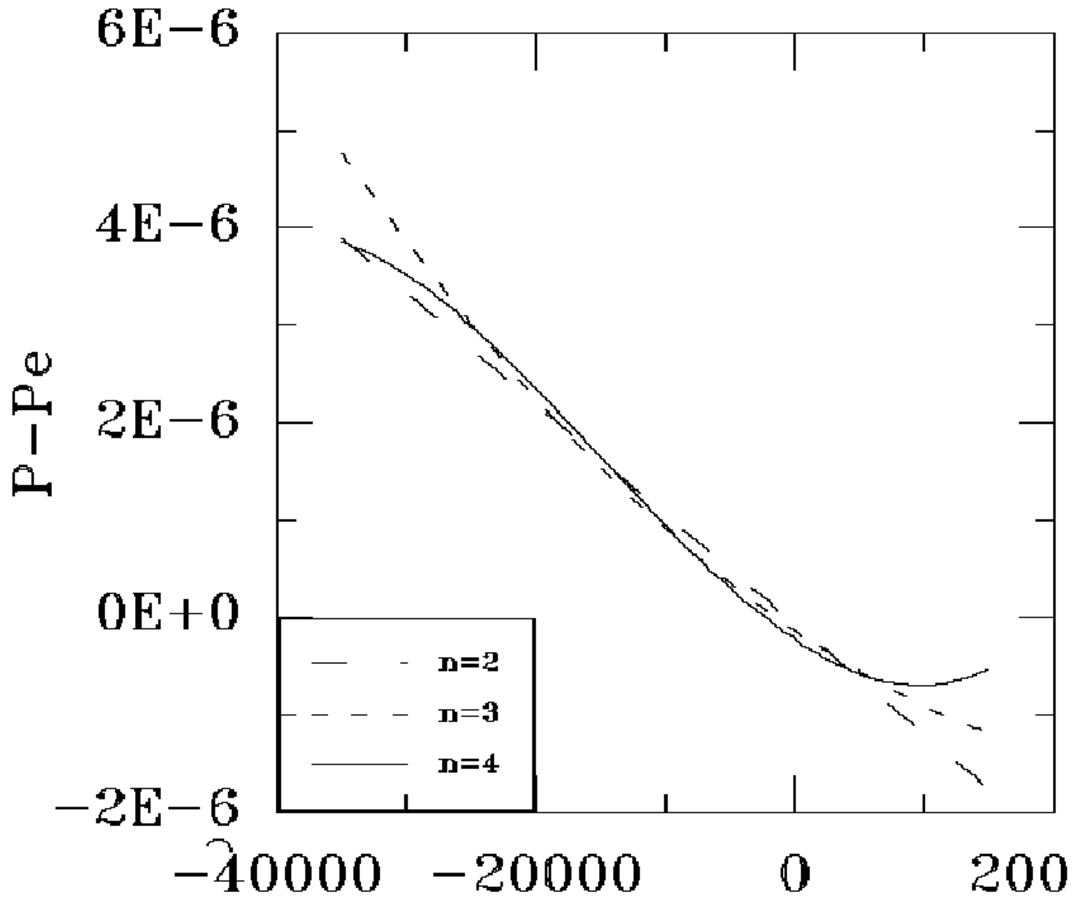
The eclipsing binaries RT And (HD 218915, of RS CVn's type) and AH Vir (a contact star) are the systems, which we select as examples in the present study. One can find the data for their construction in Rovithis-Livaniou et al. (1994) and Demircan et al. (1991), respectively. Applying our new method to RT And, we described its (O-C) diagram by a second, a third and a fourth order polyno mial presented in Fig.1. Table I lists their corresponding coefficients and RMS errors of approximation. For AH Vir (Fig.2), the description is rather complicated, since one has to apply three different least-squares polynomials connected by two spline interpolants to achieve a good fit (Kalimeris et al., 1994a). The orbital period variations and their rates of change for both systems were computed (applying Eqs. 5 and 6 of Kalimeris et al., 1994a) and are presented in Figs. 3, 4 and 5. In both cases we have adopted the same weights: 0.1 for visual , 0.3 for photographic and 1.0 for photoelectric observations.

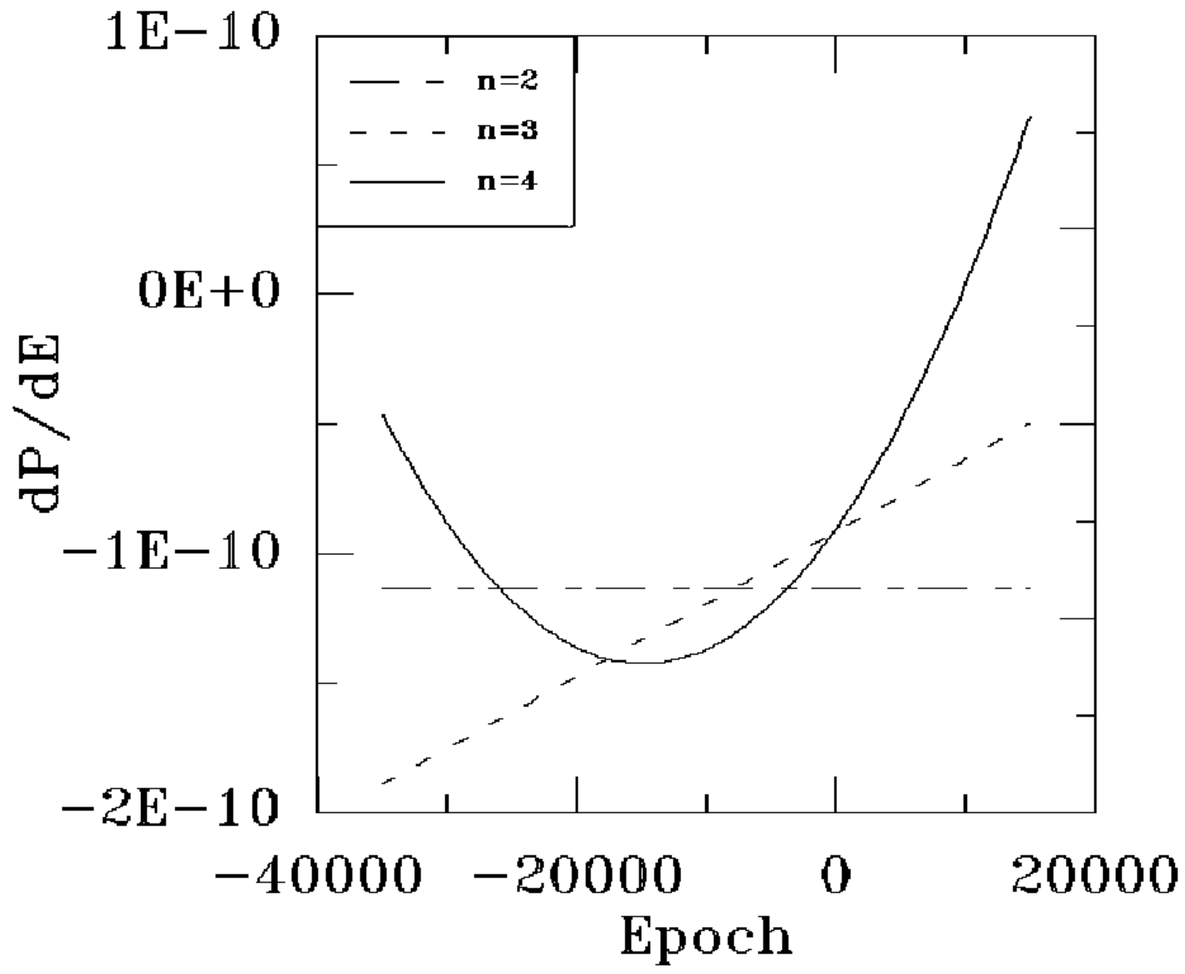
Discussion

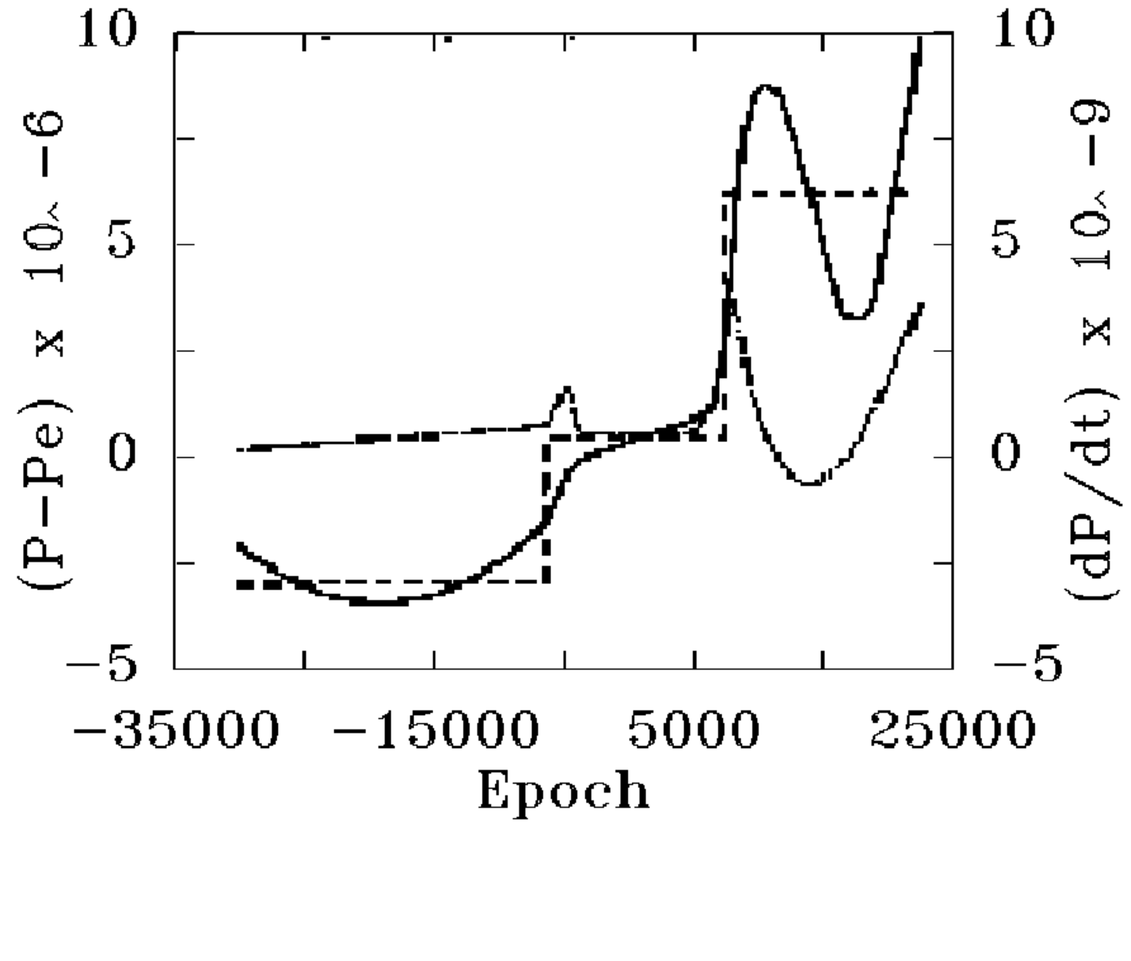
From Fig. 1, where a second, a third and a fourth order polynomial have been employed to fit the (O-C) diagram of RT And, one could say that all of them are describing it quite well. This is directly coming from the values of their coeffi cients and RMS errors, which are very close to each other. However, if one pays attention to RMS errors of approximation, will choice the fourth-order polynomial as the most appropriate one. It does not only describe better the (O-C) diagram, but it must be recruited to compute the orbital period changes of RT And (continuous line in Fig. 3). As regards the contact binary AH Vir, three different polynomials (connected by spline) have been adopted to describe its (O-C) diagram. Therefore, we do not give separate coeffi cients as we did before. In Fig.5, where its orbital period variations are presented by a continuous line with what we should have if the old method was used (long dashed line), one can see how much valuable information can be lost.

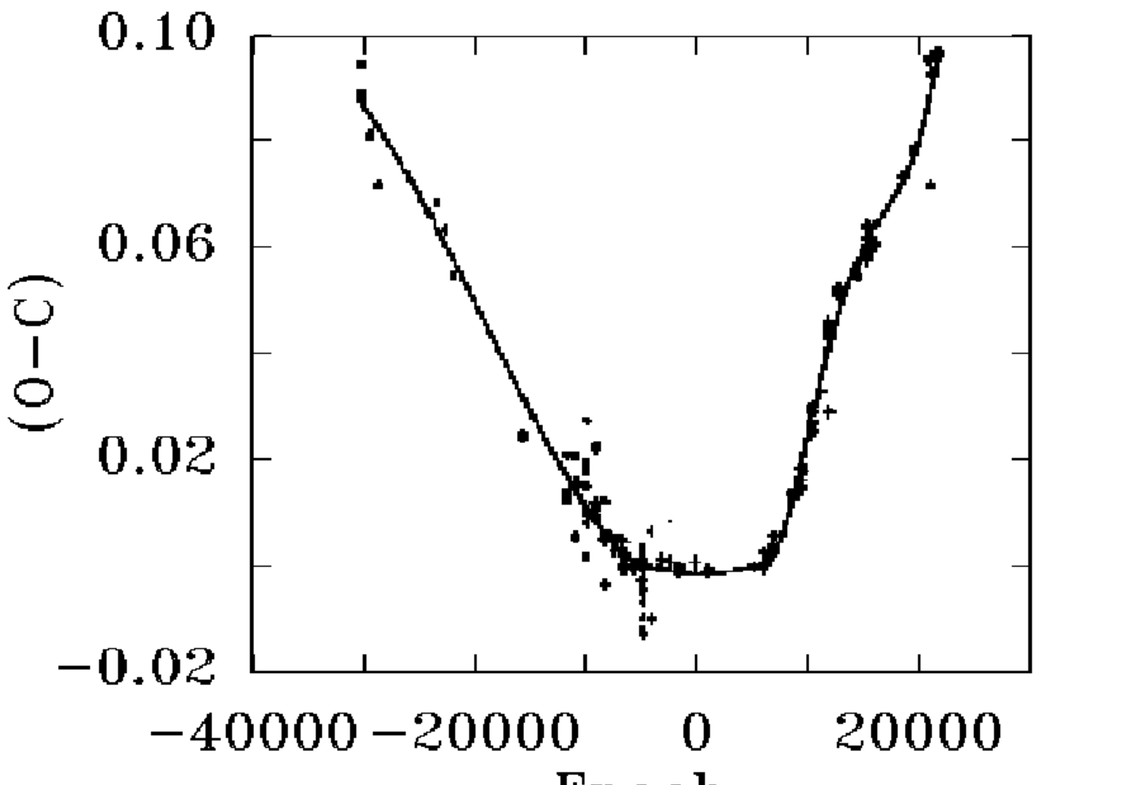
The same is true for the period changes of other systems as well (Kalimeris et al 1994a; 1994b; 1995). And although the (O-C) diagram of RT And for instance could be described well enough by a parabola, from the point of view of RMS errors obviously a fourth-order polynomial must be employed for it, respectively.











Figs.1–5. (O–C) & P–Pe diagrams (up), dP/dE for RT And & P–Pe for AH Vir (center), (O–C) for AH Vir (bottom).

Table 1.

	$n=2$	$n=3$	$n=4$
a_0	+0.00193	+0.00145	+0.00138
a_1	−0.00742	−0.01420	−0.02306
a_2	−0.56600	−0.45660	−0.45060
a_3		+0.46589	+1.17348
a_4			+1.97352
RMS	+0.00214	+0.00212	+0.00211
Sc. f.	+100000	+100000	+100000

Doing so, different pictures for their period changes are found, as one can notice from Figs. 3 and 4, where the P-Pe is presented for different order approximations.

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THE SEARCH FOR SS433 OBJECTS: Hα PHOTOMETRY OF BLUE STARS IN M33.

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ABSTRACT 549 blue stars with Hα excess in the galaxy M 33 selected as candidates into unique objects of SS 433 and LBV (luminous blue variables) types are studied. These objects were divided by morphological types on Hα images in the following way: 81 stars, 154 diffuse nebulae, 180 bubble-type nebulae and 117 common intermediate objects. The diffuse objects are HII regions with an exciting star. The bubbles are probably the envelopes around WR stars or the remnants of supernovae. Among the stars a group of 20 brightest ones is selected which by their average properties agree satisfactory with the parameters of blue supersupergiants or the objects of LBV type. The interstellar absorption determined by bright stars is equal to $A_V = 0.93 \pm 0.05$.

Key words: galaxies: M33: stars – LBV: nebulae – diffuse – bubble

The blue objects with Hα excess in the galaxy M 33 selected in (Fabrika et al., 1996a) as candidates into unique objects of SS 433 and LBV type are studied. The basic criterion of selection was the presence of a hot star with a strong emission line Hα. To select objects an identification and photometry of blue stars was fulfilled from the catalog by Ivanov et al. (1993) in Hα images of M 33 by Courtes et al. (1987). 549 candidates with emission were selected from 2332 OB stars with $((U-B)<0, (B-V)<0)$ up to $V = 19.5$ by the criterion of exceeding flux in Hα line in comparison to stars of the same stellar magnitude in V filter (see Fig. 1).

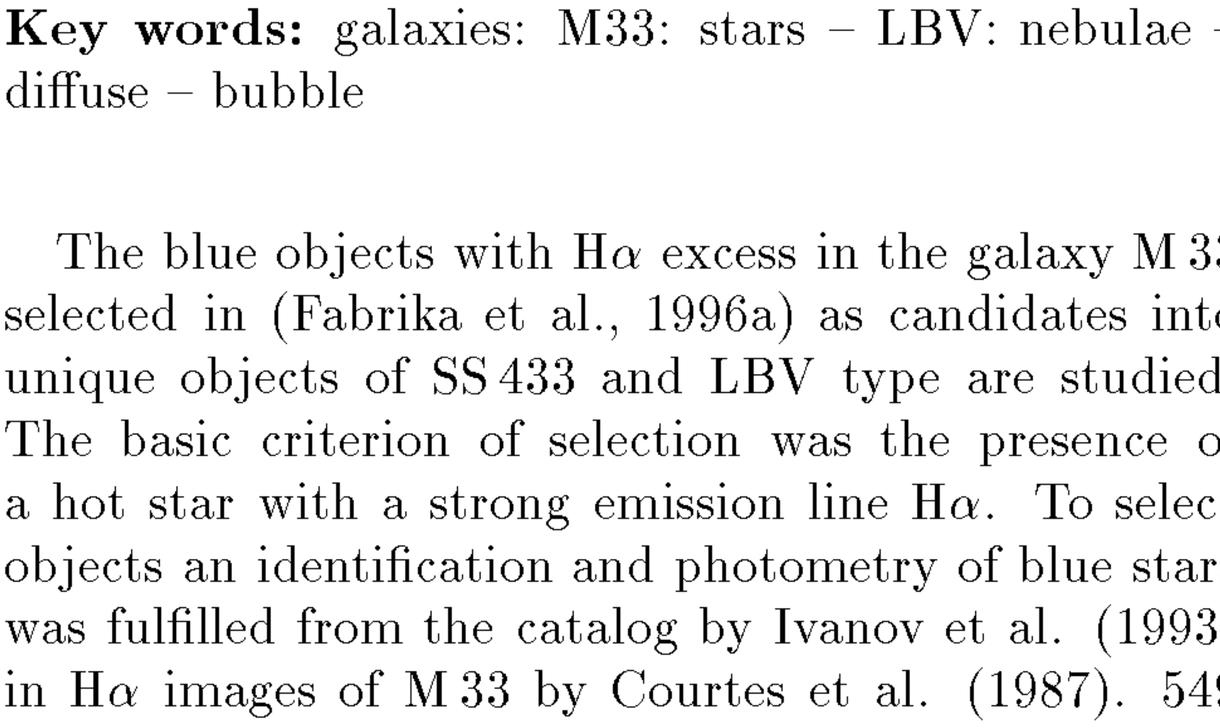


Figure 1

Upon analyzing objects in Hα the objects were divided into 5 groups by morphological types. In Table 1 we adduce the average values of basic characteristics of these objects: 81 stars (s), 154 diffuse nebulae (d), 180 bubble-type nebulae (b), 117 common intermediate nebulae (c) and 17 objects with nominally zero size (zs). The table columns give the object types, number of objects, stellar magnitude V, the colors $U-B$, $B-V$ and $V-$Hα, surface brightness SB (the flux in Hα in relative units over a square arcsecond) and also the S parameter by which the emission objects were selected. This parameter is the excess of flux in Hα line in (F(Hα), V) diagram over the basic sequence of stars without emission (see Fig.1) expressed in standard deviations of the stars of the basic sequence.

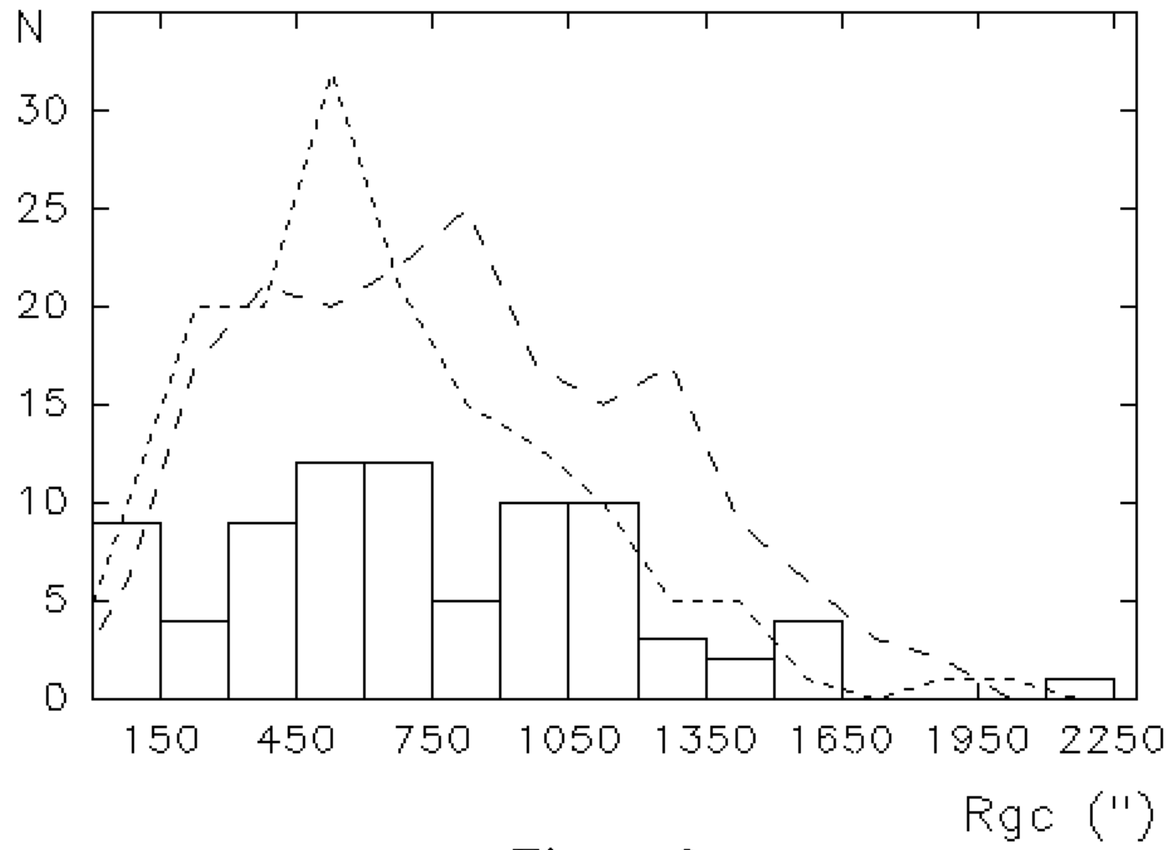


Figure 2

The objects of these groups are distinguished by a number of characteristics (Fabrika et al., 1996b): luminousity, color, flux and surface brightness in Hαline, size, and their distribution over the galaxy. The maximum of nebula size distribution falls onto the size FWHI = 10 – 14 pc. The disposition and properties of nebulae are determined by parameters of interstellar

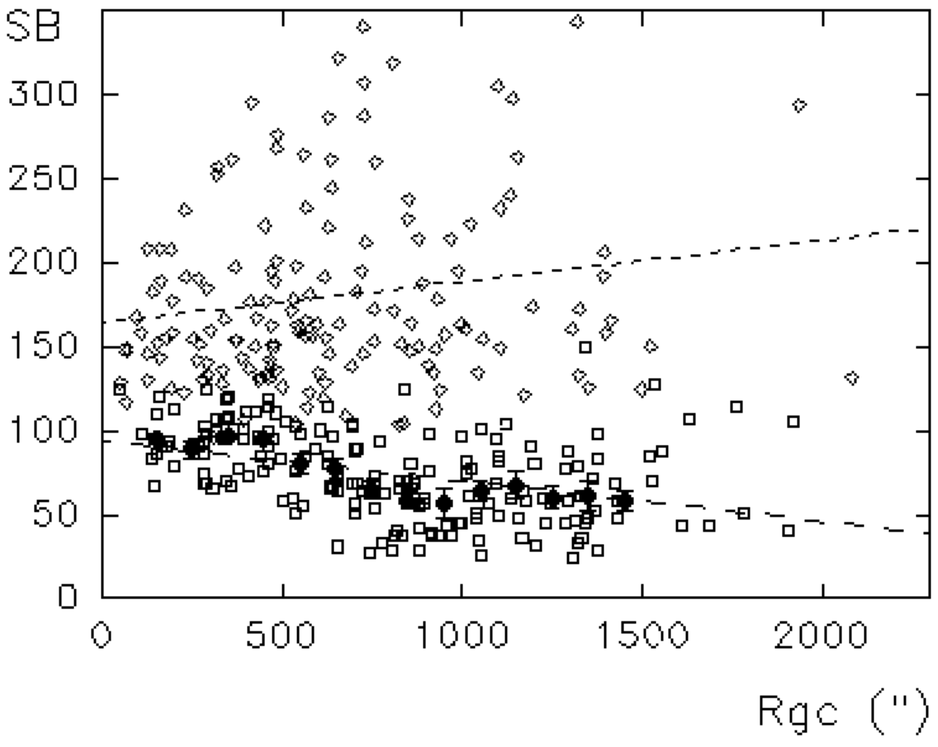


Figure 3

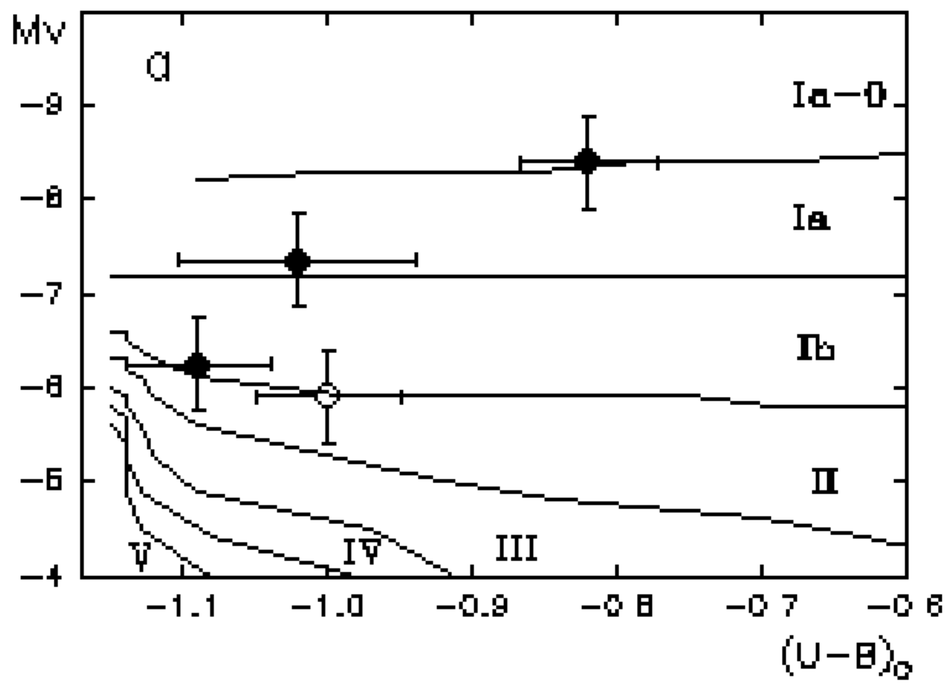


Figure 4

gas and are related to spiral branches.

Figure 2 shows the distributions of selected objects over galacto-centric distance R_{gc}. The solid lines show the star distribution histogram, the long-dashed line is for nebulae of b type, the short-dashed line is for diffuse ones. From this figure it follows that all the three types of objects belong to different populations.

An analysis shown (Fabrika et al.,1996b), that diffuse objects are HII regions with an exciting star. The bubbles are probably the envelopes around WR stars or the remnants of supernovae. It is well seen, for example, from the dependence of surface brightness in Hα $\mathrm{SB} = \mathrm{F}(\mathrm{H}\alpha)/d^2$ on the galacto-centric distance of the objects (Fig.3). Beside an evident division of nebulae into two types (the bubbles are denoted by squares, and the diffuse are diamonds), the surface brightness reveals also the effect of its decrease for bubbles with the ditance from the galaxy center and when the nebula is in a spiral. The size of bubbles depends on gravitational potential and on the pressure of interstellar gas.

Figure 4 shows the color-luminosity diagram for stars. Among them a group of 20 the brightest ones is selected which by their average characteristics agree satisfactory with parameters of blue super-supergiants or LBVs. The stars of intermediate luminosity correspond perfectly to the brightest supergiants with a mean spectral class of B1Ia. The interstellar absorption determined by these two types of stars is equal to $A_V = 0.93 \pm 0.05$. At such an absorption it is impossible to classify the weakest stars (the lower filled circle). They correcpond to blue Ib supergiants and their average absorption is $A_V = 0.6$. They are not seen through the whole thickness of the galaxy, but only in the part nearer to an observer.

Table 1. Parameters of emissions objects
(r. m. s. are in the bottom)

Type	n	m_V	U-B	B-V	V-$H\alpha$	SB	S
s	81	18.23	– 0.78	0.08	2.26	277	19.7
		0.10	0.04	0.03	0.11	9	2.0
d	154	18.35	– 0.85	0.08	2.52	180	28.0
		0.07	0.03	0.02	0.11	5	2.9
b	180	18.83	– 0.68	0.04	1.65	75	6.9
		0.03	0.02	0.02	0.05	2	0.6
c	117	18.85	– 0.82	0.05	1.60	625	4.2
		0.04	0.03	0.02	0.05	218	0.2
zs	17	18.55	– 0.98	0.01	3.14		92.9
		0.20	0.07	0.09	0.36		34.5

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LINE FORMATION IN SPECTRA OF X-RAY NOVAE

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ABSTRACT. Results of X-ray Novae (XN) optical spectra computation are presented. The continuum and Balmer line are calculated. The model of XN as a self-irradiated accretion disk is used. Local (for given radius) disk atmospheres as model stellar atmospheres, heated due to external X-ray radiation are treated. Changes of spectra shape and equivalent widths of the Balmer lines depending from the luminosity and some others accretion disk parameters are investigated. The comparison of GRO J0422+32 observed spectra with model spectra are curried out.

Key words: accretion: accretion disk - novae: cataclysmic variables, line formation, atmospheres of - stars, individual: GRO J0422+32, X-ray irradiation - stars

I.Introduction

The X-ray Novae (XN) are low-mass X-ray binary systems in which a compact object accretes material from low-mass secondary (Bradt and McClintoc, 1983; Karitskaya, 1996). Sometimes the accretion rate dramatic increases and this system can be seen as XN. X-ray Novae to generate a greater interest because among them there are the most reliable candidates in black holes: V616 Mon (McClintoc and Remillard, 1986), XN Muscae 1991 (Remillard et al, 1992), V404 Cyg (Casares et al, 1992) etc. The optical radiation of these systems is caused by the reprocessed emission from the X-ray irradiated disk. Emission spectra of such disks were computed in approach of photoionization model and photon escape probability method by Ko and Kallman (1994). In given work the optical spectra of such disks have been calculated with use of X-ray irradiated LTE model stellar atmospheres (Sakhibullin and Shimansky 1996).

II. Method of computation

As model XN on given luminosity level a geometrically thin optically thick steady state accretion α - disk (Shakura and Sunyaev 1973) has been considered. The method of computation of such disks and amount of falling X-ray flux on their surface due to self-irradiation has been described by Suleimanov (1996). The spectrum of a disk is summarized from spectra of its rings. The spectrum of each ring has been calculated by numerical solution of an radiation transfer equation as a spectrum of model stellar atmosphere with same T_{eff} and $log\ g$ on surface, and irradiated the same X-ray flux. A method of calculation of such model atmospheres and programs, offered by Sakhibullin and Shimansky (1996) have been used. X-ray flux has been set as power spectrum $F_\nu \sim \nu^{-s}$ in interval from 0.1 up to 200 kev. The effect of differential rotation of a disk to profile of spectral lines has been taken into account.

III. Results

With use of a described above method optical continuous spectra, profiles of 10 Balmer lines and their equivalent width for 45 models of accretion disks have been obtained. As base a sequence of models with parameters $M_{bh} = 5\ M_\odot$, $\alpha = 1$, $s = 1.5$, $R_{out} = min(10^{11}$ cm, R (T_{eff}=7000K)) and luminosities0.5, 0.1, 0.05, 0.01 and 0.005 Eddington luminosity was chosen. In other sequences of models one of parameters was changed, whereas other were constant. Sequences of models with $M_{bh} = 3$ and 10 $M_\odot$, $\alpha = 0.1$ and 0.01, s = 1 and 2, $R_{out} = min(6\ 10^{10}$ cm, R (T_{eff} = 7000K)) and $min(8\ 10^{10}$ cm, R (T_{eff} = 7000K)) were computed. The spectra of each model were calculated for four angles of an disk inclination to line of sight $\mu = cosi$ = 1, 0.8, 0.5 and 0.1.

It is shown, that than black hole mass and parameter α is less, and than it is more angle of an inclination of a disk to line of sight, it luminosity and radius, that it is more intensity of an emission component of Balmer lines. The most emission is shown by H_α, and with increasing of line number its emission components are decrease. Absorption components are well appreciable only from disks with small inclination. The model spectrum of XN GRO J0422+32 also was calculated and a comparison with observed spectrum in 1992 November by Callanan et al (1995) was curried out (Fig.1). Parameters of this system were taken from Karitskaya (1996). Width of absorption components ($\sim$ 100 Å) and separation of double-peaked emission com-

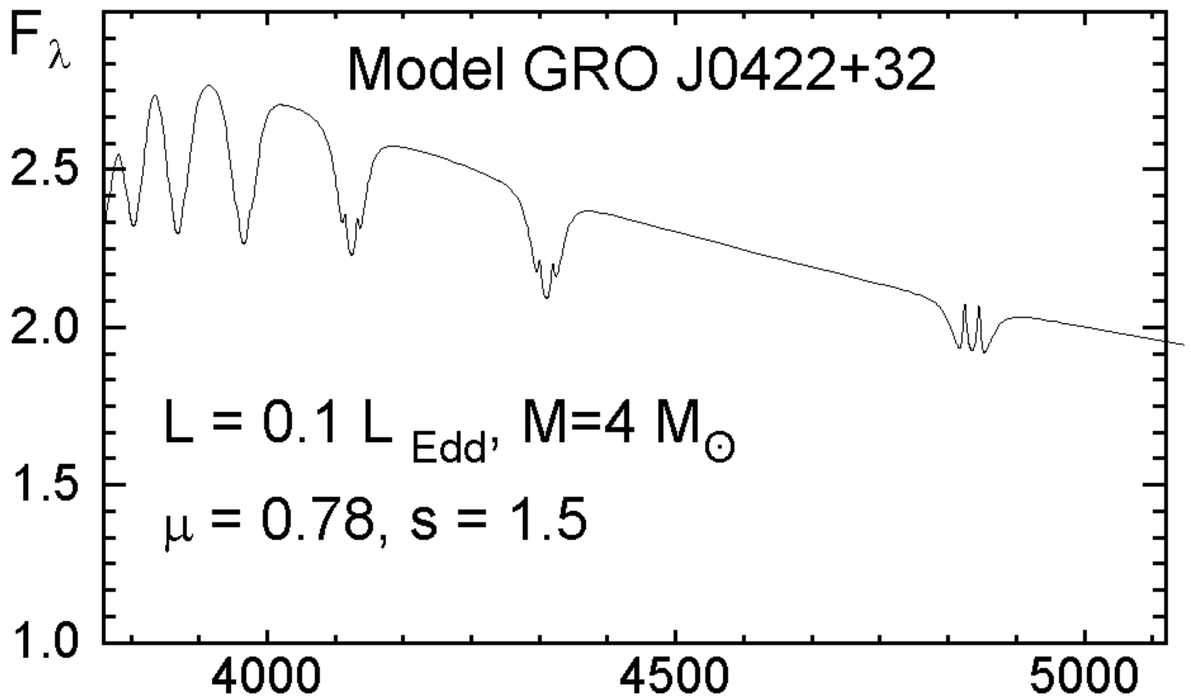


Figure 1. The model spectrum of GRO J0422+32.

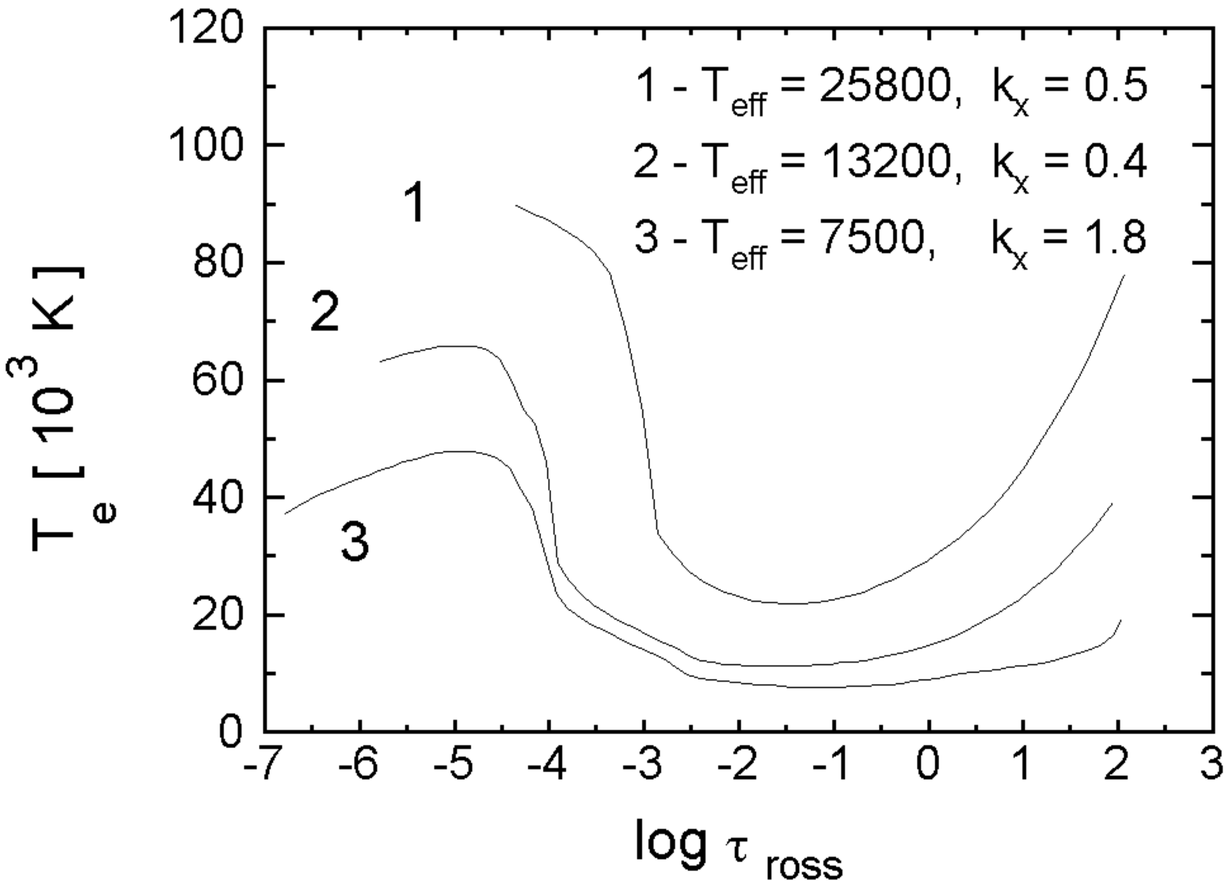


Figure 2. The temperature vs Rosseland optical depth for model atmospheres of three rings of the model of GRO J0422+32 accretion disk.

ponents (~ 1000 km/c) of Balmer lines are close to observed ones, but the observed continuum slope is more flat than the theoretical one, may be due to influence of a hot corona. On Fig.2 the temperature structure of three ring model atmospheres are shown.

IV. Conclusion

The obtained model spectra are similar to observed spectra of GRO J0422+32. Because of the modeling of XN spectra has much potential for yielding information about these systems.

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OBSERVATIONS AND INTERPRETATION OF THE PHOTOMETRIC VARIABILITY OF TT ARI

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ABSTRACT. Simultaneous WBVR photometric observations of TT Ari during 94/95 years are presented. The periodogram analysis of the obtained light curves and colours are curried out. The photometric period equal 3.2 h and its one day aliases are found from light curves, but the period equal spectroscopic (3.3 h) are found from B-V colours in the observations, performed in 1994. The quasi-periodic oscillations (QPO) with period from 47 to 16 minutes, changing from night to night are found too. A new model of the tilted precessing accretion disk together with reflection from secondary or hot spot is suggested to explanation of the photometric variability of TT Ari. It is proposed that QPO is possibly connected with orbiting blobs in the accretion disk.

Key words: Stars: cataclysmic variables - individual: TT Ari, photometry - accretion, accretion disk

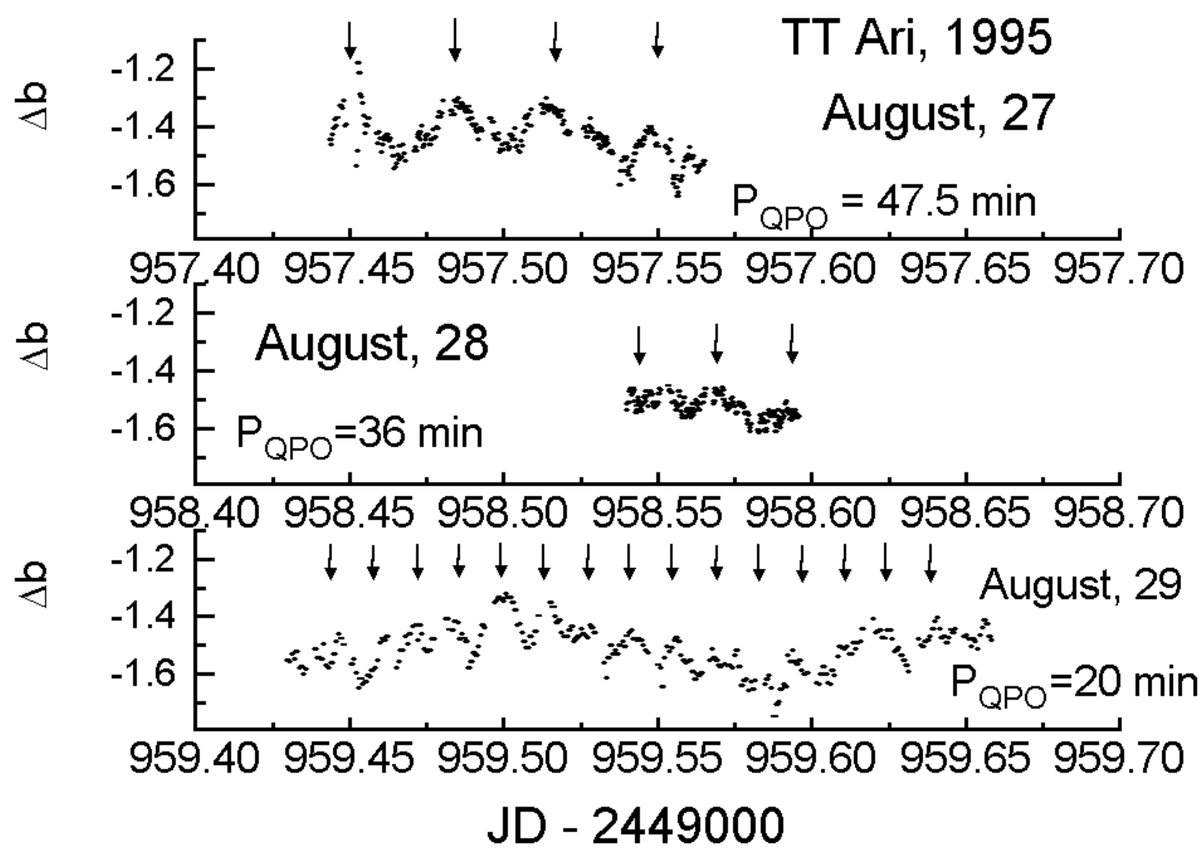


Figure 1. The light curves of TT Ari in August 27, 28, 29, 1995.

I.Introduction

The bright (V $\sim 10^m.5$) cataclysmic variable TT Ari (BD+14°341) has photometric period equal 3.2 h (Smak and Stepien, 1975) with the amplitude about $0.^m2$ - $0.^m3$. The orbiting period (3.3 h, Cowley et al, 1975) is non equal photometric one and this fact is usually connected with the precessing accretion disk (Whiterhurst, 1988).

Moreover, TT Ari shows a quasi-periodic oscillations (QPO) on time scales decreasing from 27 minutes in 1962 to 15 minutes in 1988 (Semeniuk et al, 1987; Hollander and van Paradijs, 1992; Tremko et al., 1996). A reason of this oscillations is not found and further observations and theoretical investigations of this binary are necessary.

II. Observations

Simultaneous multicolour photometric observations of TT Ari were obtained during 6 nights in October 6,7,8 1994 and August 27,28,29 1995. The observations were carried out with the 60-cm reflector of Special Astrophysical Observatory (Russia). The telescope was equipped with 4-channel photometer of Kazan State University.

Duration of individual runs was from more than 6 hours to 2.5 hour. Integration time was 10 s. Object observations were interrupting by observations of background and comparison star (d star from Götz (1985)) every 15–20 minutes. The observations were reduced in the standard way and were obtained the instrumental magnitudes in four bands, which are close to bands of WBVR system. The error of individual observation not exceeded $0.^m01$ in B and V bands and $0.^m03$ in W band. Red observations did not analyzed because signal at R channel was low.

III. Results.

The periodogram analysis was performed using program (based on Fourier analysis) writen by Yu.Kolpakov (SAI, Moscow).

The photometric period equal 3.2 h was obtained from light curves in **w**, **b** and **v** filters as in 1994 as in 1995 years. Most grate amplitudes are in **w** filter.

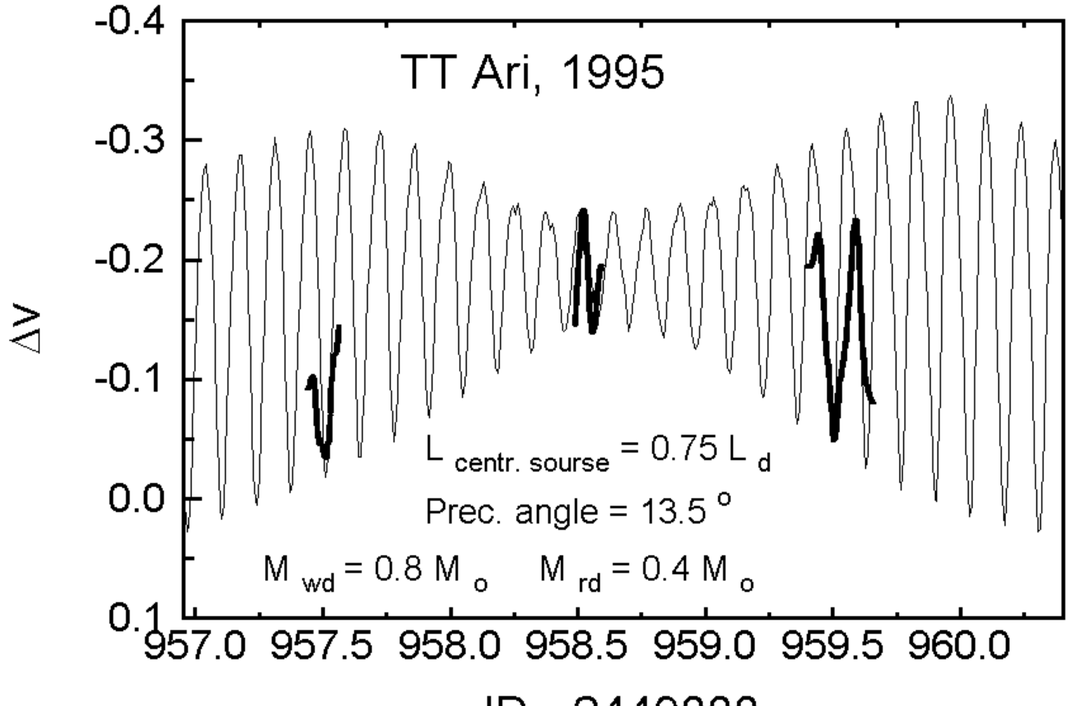


Figure 2. The theoretical and averaged over 200 points observed light curves of TT Ari.

However, in 1994 year **w-b** colour demonstrate rather half photometric period (1.6 h), and in 1995 it is obvious (1.68 h). The variation of **b-v** colour have period (3.28 h) in 1994 close rather to spectral period than to photometric.

The most significant QPO period in 1994 is 16.7 min (October, 7 and 8). In October 6 there are not significant oscillations. The most interesting change of QPO periods was during 3 consecutive nights on August 1995. The QPO period decreases from 47.5 min at August 27 to 36 min at August 28 and to 20 min at August 29 (see Fig.1). Sometimes the QPO periods in colour light curves are the beat periods between half orbital period and QPO periods in filters, as **w-b** QPO period (16.7 min) in August 29, 1995.

IV. Interpretations and discussions.

For interpretation of the photometric behaviors of TT Ari we suggest the improved model of the precessing tilted accretion disk (Barrett et al,1988) completed by reflection effect from a secondary or a hot spot and we calculate the theoretical light curves of TT Ari (reflection from secondary, see Fig.2). Details of the radiation flux calculations from disk and secondary was described by Suleimanov (1996) and Suleimanov and Shakura (1994). The colour variability with spectral period confirmed our model.

Consecutive decreasing of QPO period during 3 successive nights at August, 1995 suggests that QPO are connected with Kepler periods of any inhomogeneities (blobs) of the disk, and that the change of QPO period is connected with the diffusion of these blobs along the radius of the disk. Simple evaluations give the Kepler period on outer disk radius of TT Ari about 50 min, and diffusion time about 0.1 - 1 day.

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PREDICTION OF THE COMPONENTS MASS RATIOS AND THE SPECTRAL CLASSES OF THE MAIN COMPONENT FOR W UMa–TYPE ECLIPSING VARIABLE STARS

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ABSTRACT. The new approach to estimation of components mass ratios for close binary systems is suggested. 225 unknown from spectroscopic observations magnitudes of mass ratios for W UMa-type contact binaries are restored by statistical method ZET. 204 magnitudes of the spectral classes of the main component for this type systems are defined by analogous way. The evolutionary types of some stars are specified as a matter of record. ZET-method efficiency for predict these characteristics of W UMa-type contact systems is shown.

Key words: Stars: Binaries, Contact, Component mass ratios, ZET method.

In this paper the mass-ratios of the less massive to more massive component $q = M_2/M_1$ and the spectra of the more massive component Sp_1 for W UMa-type close binary systems are computed by statistical method, namely, ZET algorithm (Zagoruiko et all. 1985). The statistical approach necessity is stimulated by imposibility to obtain the sufficiently reliable values of q for W UMa-type systems by the used at present the method of synthesis of the theoretical light curves because of observed light curves assimmetry and their variance from night to night and from season to season.

ZET algorithm is intended to predict uncertain elements in empiric tables "object-property" and to verify the table or part of it. In tables "object-property" with dimension $M * N$ lines (objects) have numbers $1, 2, .., i, ..M$ and columns (properties) - $1, 2, .., j, ..N$. Uncertain element $a_{i,j}$ in ZET algoritm is predicted on the basis of local linearity principle, i.e. under assuming linear dependence between lines and/or columns, most similar with line i and/or column j.

The approximate values from these columns a_{ij} (lines a_{ij}) are computed on the basis of the linear regression equation:

$$a_{ij}^k = b_{jk} a_{ik} + c_{jk},$$

where b_{jk} and c_{jk} - the linear regression coefficients, calculated on the basis of the certain elements of j and k columns.

The obtained values are averaged with the weights Q , proportional to linearity degree and mutual filling of the columns:

$$a_{ij}^{col} = \frac{\sum_{k=1}^{p} a_{ij}^k Q_{kj}}{\sum_{k=1}^{p} Q_{kj}},$$

$$Q_{kj} = |r_{kj}|^{\alpha} L_{kj},$$

where r_{kj} - the coefficient of the linear correlation, L_{kj} - the number of unempty pairs of elements for k and j columns, p - the number of columns, which have no gaps in i line. The minimum of the average prediction error for all certain elements of column with the filled gap is the criterion for choice of parameter . The prediction by lines is carried out by the analogous way. The final value is that one for which the prediction error of certain elements j column (i line) is least.

Four characteristics of stars from Svechnikov, Kuznetsova (1990), most informative for predicting the mass-ratios and spectra were used to restore uncertain magnitudes q and Sp_1: the absolute bolometric magnitude M_{1b} of the more massive component, the mass of this component M_1, the value of orbital majior semiaxis A and the value of orbital inclination . The table with 6 parameters such as $q, Sp_1, M_{1b}, M_1, A, i$ for 295 KW-type stars according to Svechnikov's classification (Svechnikov et all. (1980)) were compiled. The certain values of q and the corresponding informative characteristics (altogether 70 values) were taken from Svechnikov (1986), Webbink (1991) and a number of original articles. The spectroscopic observation data from Svechnicov and Kuznetsova (1990) and the data from mentioned literature sources were taken as a certain value of Sp_1 (altogether 91 values). Gaps were plased instead of the rest of q and Sp_1 values.

All the certain elements of the first and second columns were verified. The average errors of verification

were 11.8 % and 3 % respectively. This result shows application expediency of ZET method for restoration of uncertain mass ratios and spectra for W UMa-type systems.

Actually, when predicting 225 uncertain values q on the basis of this table 218 magnitudes were restored with the error about 5 % and 7 magnitudes - with the error about 10 %.

The spectra of the main component were predicted by analogous way. When predicting 204 uncertain values Sp_1 198 magnitudes were defined with the error about 5 % and three each magnitudes - with the error about 10 % and 15 % accordingly.

The obtained values of Sp_1 are similar to spectra approximately estimated by Svechnicov and Kuznetsova (1990) for majority systems. But the obtained values of Sp_1 differ from spectra estimated by Svechnikov and Kuznetsova more than at one spectral class for approximately 1/5 systems. The spectra of some of these stars are earlier than F5. So such systems as V 520 Cas, OP Cen, AY CrA, V 940 Cyg, DG Lup, V 878 Oph, V 938 Oph, V 940 Oph, AY Pup, V 842 Sco, AH Vir, perhaps, belong to contact systems of early spectra of primaries (according to Svechnikov's classification).

The obtained results allow us to conclude that prediction of mass ratios q and spectra Sp_1 for KW-type systems by ZET method are possible.

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PRELIMINARY RESULTS OF MODELING OF LIGHT CURVES OF WW AND

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ABSTRACT. In this work we present the preliminary results of modeling of Olson's Iybv light curves of an Algol-type binary WW And. A model of a binary star containing an accretion disk around the primary star is deployed. We present a solution for the mass ratio fixed at q=0.20.

Key words: Stars: binary, accretion disks

Introduction

WW And is a long period (P=23.3 days) eclipsing binary star. The earliest spectroscopic study of the system was done by Wyse(1934) and Struve(1946). The latter study confirmed Wyse's speculation of Hα been in emission. Struve estimated spectral types of components to A5 and F3 and derived mass function f(m)=0.048 $M_{\odot}$. Until 1993, only fragmentary photographic photometry of WW And has been published. Elias (1993) reported tentative discovery of radio emission from this system.

Recently Olson and Etzel (1993) published five-colour, uvbyI photometry of WW And. The authors obtained also CCD spectra of Hα, Hβ, MgII and OI lines. The photometric data allowed Olson and Etzel to improve value of the period of WW And (P=23.285213 days). The primary minimum is partial and of about 0.6mag depth in the yellow filter. The light curves show clear ellipticity effect indicating one component been significantly distorted. The CCD spectra, covering wavelengths from 6400 to 6700 angstroms, revealed strong, double-peaked Hα emission at all phases and times, suggesting existence of an accretion disk around the hotter component. Olson and Etzel also obtained the radial velocity curve of the cool component, determining mass function f(m)=2.21 $M_{\odot}$, K_2=97km/s, and γ=-14km/s.

The authors solved the photoelectric Iybv light curves using the latest version of the Wilson-Devinney code. First, they attempted to find a semidetached solution but failed. Finally they argue that a good fit to observations can be achieved only if potentials of both stars were allowed to be free parameters. They conclude that a model with both components been well within their Roche lobe can describe observations. Simultaneously, spectroscopy shows that a permanent accretion disk exists in the system. Taking the photometric and spectroscopic solutions into account, Olson and Etzel computed the absolute parameters of components of WW And (Table 1).

Table 1: Absolute parameters of WW And

hot star	cool star
i= 80º.4	
q=0.10	
T_1=9500*	T_2=4359
R_1=2.04	R_2=9.45
M_1=2.84	M_2=0.28

* - not adjusted

In this paper we present a preliminary solution of modeling of Iybv light curves using a code that accounts also for presence of an accretion disk in a binary system. For comparison, also a search for a solution within a standard Roche lobe model is made.

Modeling of the light curves

From all individual points, the normal ones were calculated, 73 in each light curve. These points were used to obtain a solution both within the Roche model (ver. 1993 of the Wilson-Devinney code, Wilson 1993) and accounting also for existence of an accretion disk around the primary, hotter component. Details of the latter computer model were given in Zoła (1991) and Zoła (1992). However, in both approaches the Monte Carlo search method was used instead of the differential correction one, included in the DCMP code.

First we performed computations to search for the best fit using the LC program along with the Monte Carlo search method. Also, the third light was set as a free parameter. Domains to be search for other parameters were set as wide as possible. Computations were done until the difference between the best and worst elements in the search array was less than 1 percent. We achieved solution for similar parameters to those derived by Olson and Etzel, apart from the

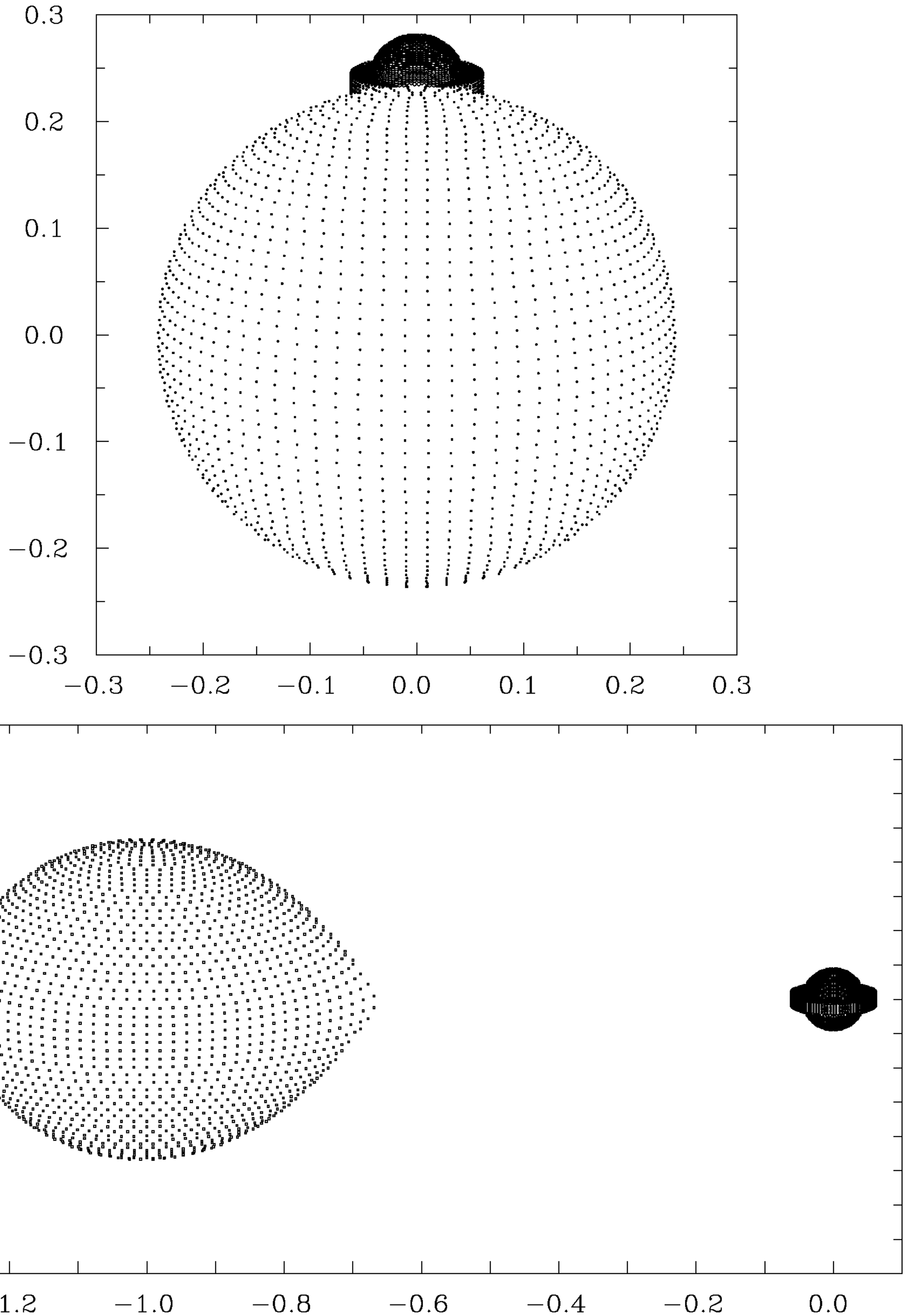


Figure 1. Projections of the system onto the plane of view at the main minimum (phase 0) and at phase 0.25. The co-ordinates are marked in units of the orbital separation.

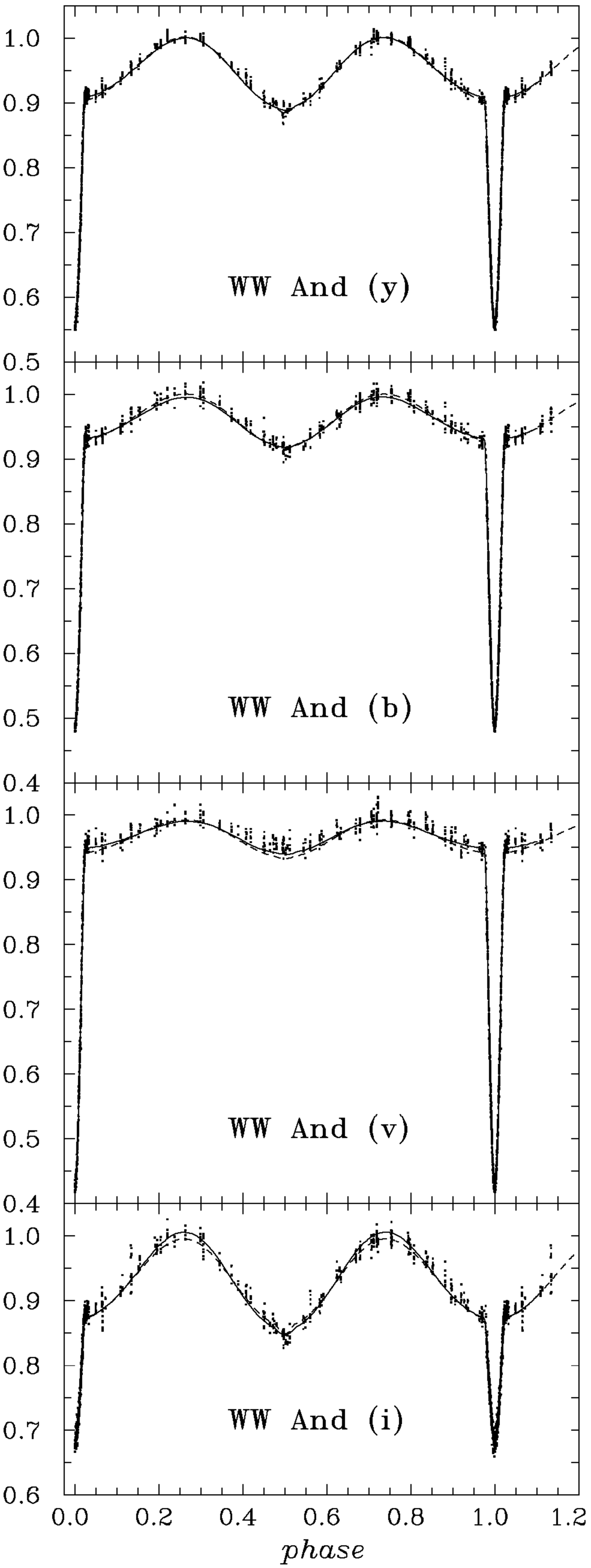


Figure 2. Observational versus theoretical light curves of WW And in the filters *ybvi*.

primary component temperature, which was obtained T_1=12000K (Olson and Etzel assumed it to be 9500K), and the third light which in our solution amounts to 14, 10, 6 and less than 1 percent of the total light for I, y, b and v light curves, respectively. The secondary star was also found to be marginally smaller than its Roche lobe.

Next the computations were proceeded by using a computer model that accounts also for effects from a disk around the primary star. The preliminary computations were done for a fixed mass ratio q=0.20. It was assumed that there is no third light in the system and the mass losing star exactly fills its Roche lobe. Again, the iterations were stopped when difference between the best and worst elements of the search array was less than 1 percent. The model of WW And as viewed at phases 0.0 and 0.25 is presented in Fig. 1. The theoretical light curves, obtained in both approaches, plotted against the observational data are shown in Fig. 2.

Conclusions

It is possible to obtain a reasonably good fit to observations both within the standard Roche model and within a model which includes an accretion disk around the mass gainer. Although, the quality of the fit (measured by the sum of residuals) is slightly better for the former model, the theoretical light curves are almost undistinguishable, except for the I light curve, near the maxima. However, both these light curves fit observations within the observational errors/intrinsic scatter of the data (see Fig. 2).

A thorough search is being done also for other mass ratio values, between 0.05-0.50. The preliminary results show that the radius of the disk, partly obscuring the hotter star, is about 0.06 A (an orbital separation), independently of the q value. The disk contribution to the total light is significant, from about 20 percent for I light curve to about 50 percent for v one.

Acknowledgements. The author would like to thank Prof. Ed Olson for sending his five-colour observations of WW And. The Monte Carlo computations were done at ACK Cyfronet in Cracow, under the grant No. KBN/UJ/004/95 which I gratefully acknowledge.

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G-STARS: OBSERVATIONS AND THEORETICAL MODELING

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ABSTRACT. The comparison of spectral energy distributions and synthetic spectra for a few G-giants is presented.

Key words: Stars: late-type giants: spectral energy distribution, synthetics spectra

The preliminary results for G-stars are presented here. The compilative catalogue of stars energy distributions (Dragunova et al., 1994, Komarov et al., 1996) prepared in the astrospectroscopy department of Odessa astronomical observatory with authors' participation is used as observational data. The calculations of synthetic spectra were made by the complex of programs STARSP (Tsymbal, 1994). Parameters for calculations (T_{eff}, lg g, [Fe/H]) were given accordingly to concrete stars and were determined earlier on the base of spectrophotometry and photometry data (Korotina et al., 1988, 1989). The Kurucz's (1979) grid of atmospheric models has been used. Theoretical spectra were calculated in the spectral region 320 - 900nm per 0.1Å and then the values of appearing flux were averaged in 50Å-segments. The results are presented in the figures. All the data in Figures 2 - 5 (spectral energy distribution and theoretical spectra) were reduced to the spectral value in the point λ=715 nm of "a mean G-star".

Some preliminary conclusions may be done:

1). Comparison shows that the T_{eff} of stars may be obtained from theoretical spectra with better accuracy than 150K given by photometry.

2). The theoretical spectra in ultra-violet region are different from observed spectra very much. It is necessary to define the new sources of absorption at this spectral region.

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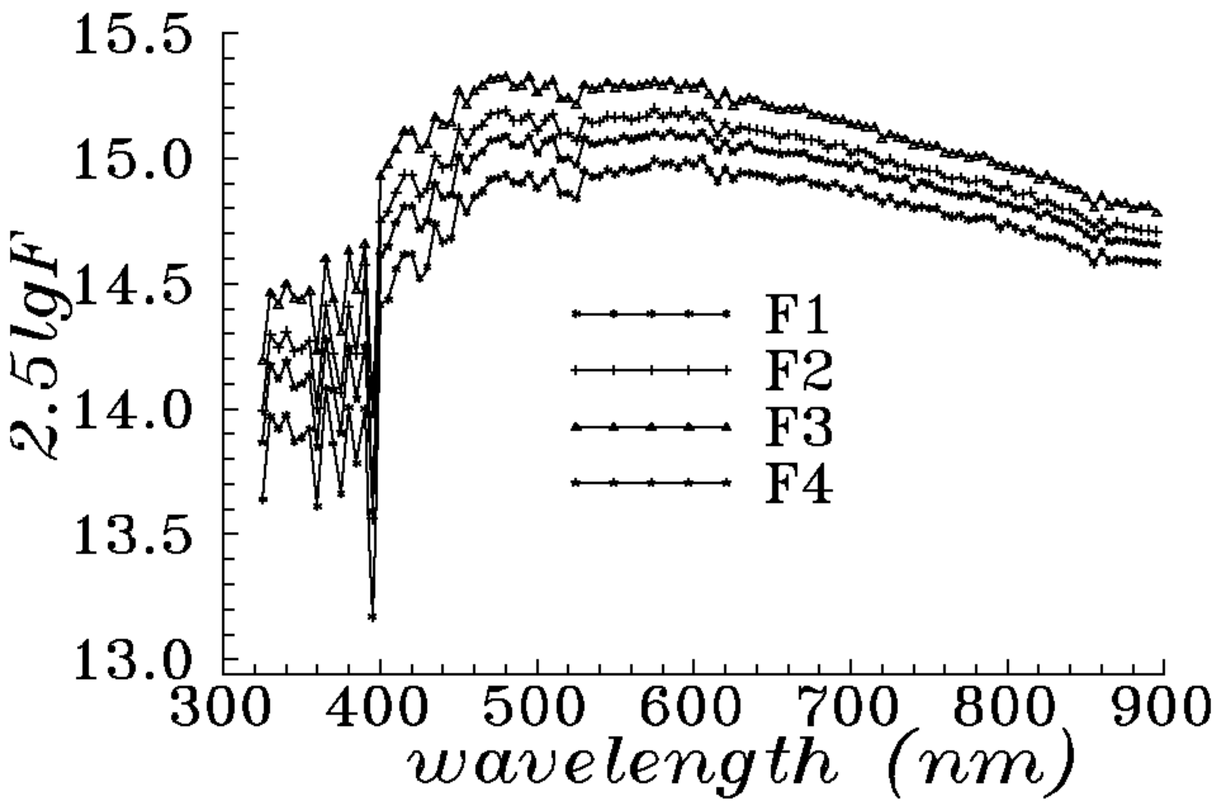


Figure 1. The theoretical spectra: F1 (T_{eff} = 4810K, lg g=2.7, [Fe/H]=0.0); F2(4900, 2.7, 0.0); F3(4960, 2.7, 0.0); F4(5080, 2.7, 0.0).

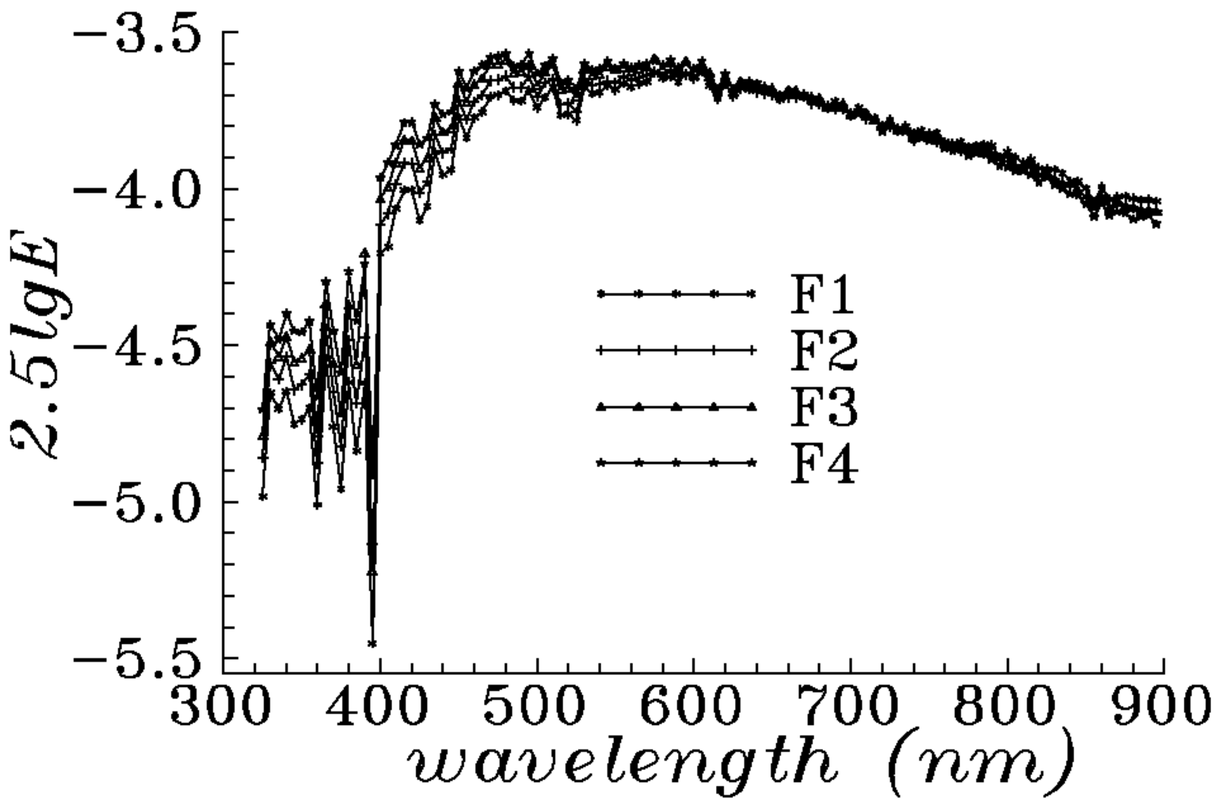


Figure 2. The theoretical spectra F1 - F4 from Fig.1 reduced to mean spectrum of G-star (averaging was made for four stars with parameters: T_{eff}=4960K, lg g = 2.7) in point 715nm.

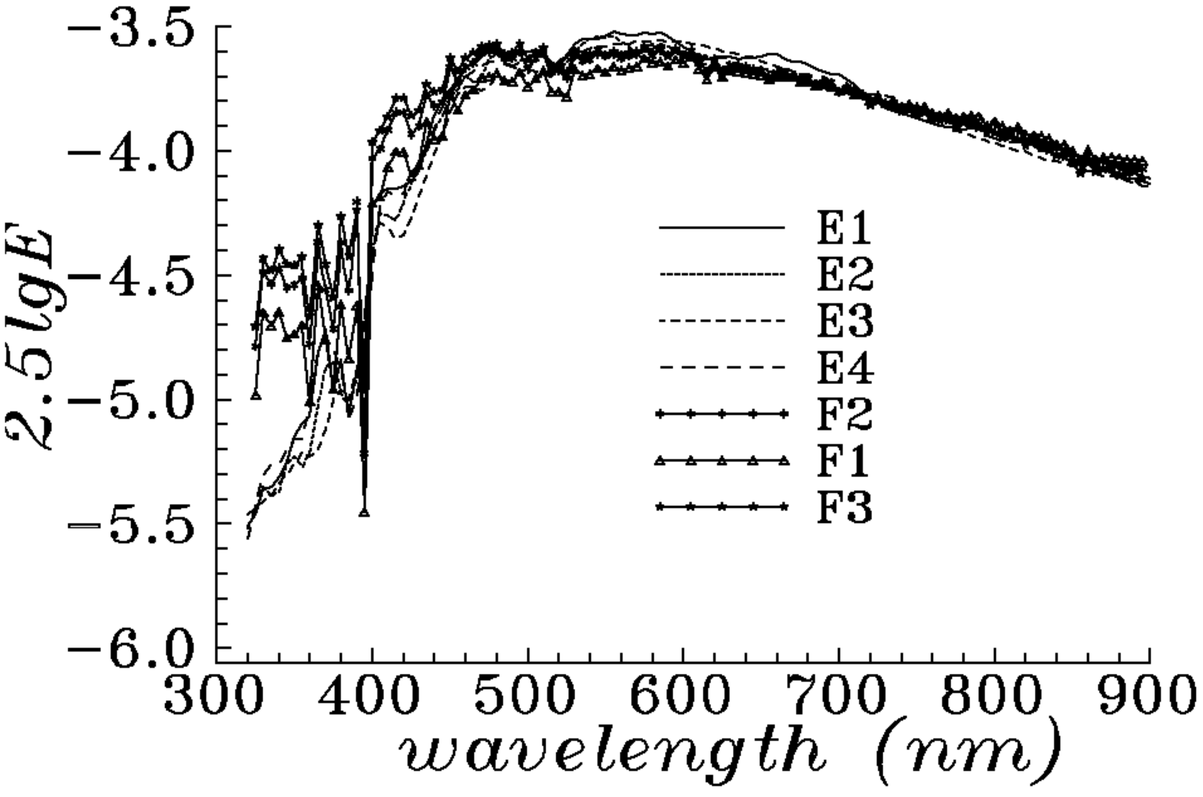


Figure 3.The theoretical spectra F1 (4810, 2.7, 0.0), F2(4960, 2.7, 0.0), F3(5080, 2.7, 0.0) - solid lines and observing spectra of stars: E1(BS1995: G8III, 4960, 2.7, -0.35), E2(BS5602: G8III, 4960, 2.7, -0.23), E3(BS6770: G8III, 4960, 2.7, -0.19), E4(BS8684: K0III, 4960, 2.7, -0.31).

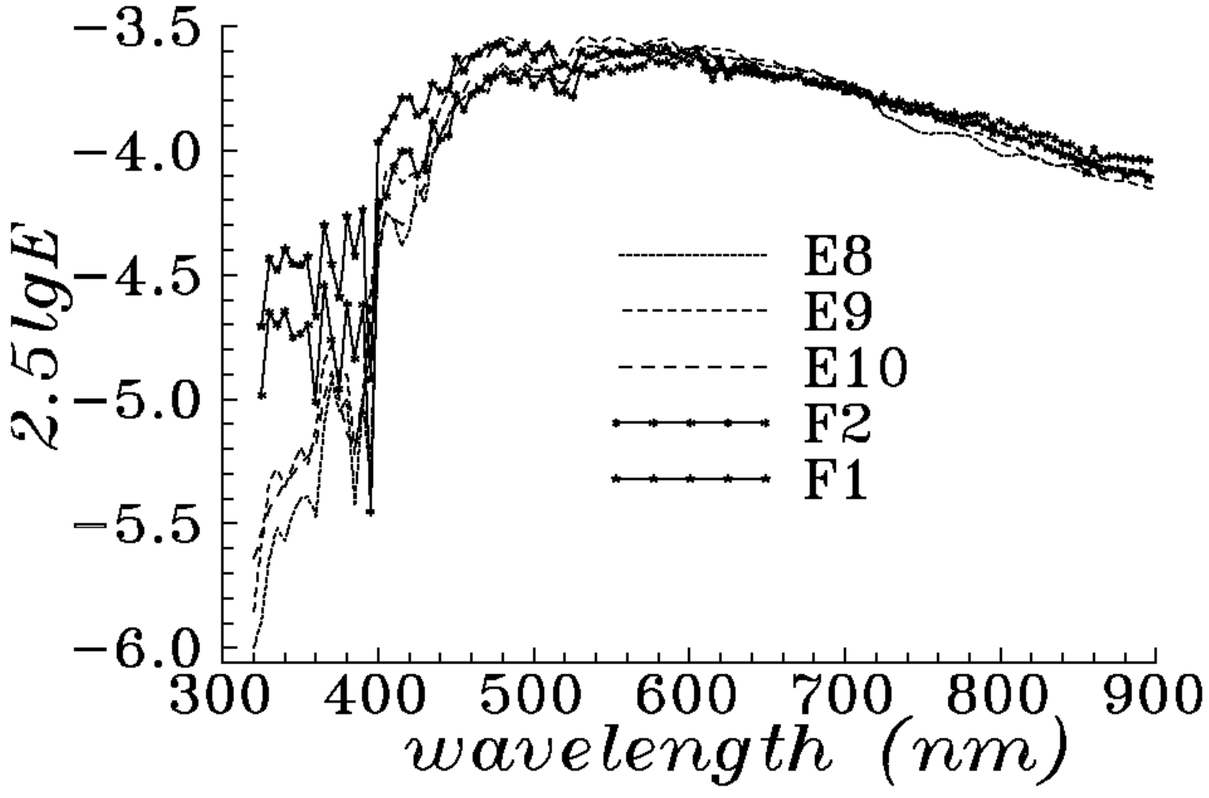


Figure 5. The theoretical spectra F1 (5080, 2.7, 0.0), F2(4810, 2.7, 0.0) and stars: E8(BS1373: K0III, 5080, 2.7, 0.02), E9(BS4932: G9III, 5080, 2.7, -0.14), E10(BS8923: G8III, 5080, 2.7, -0.09).

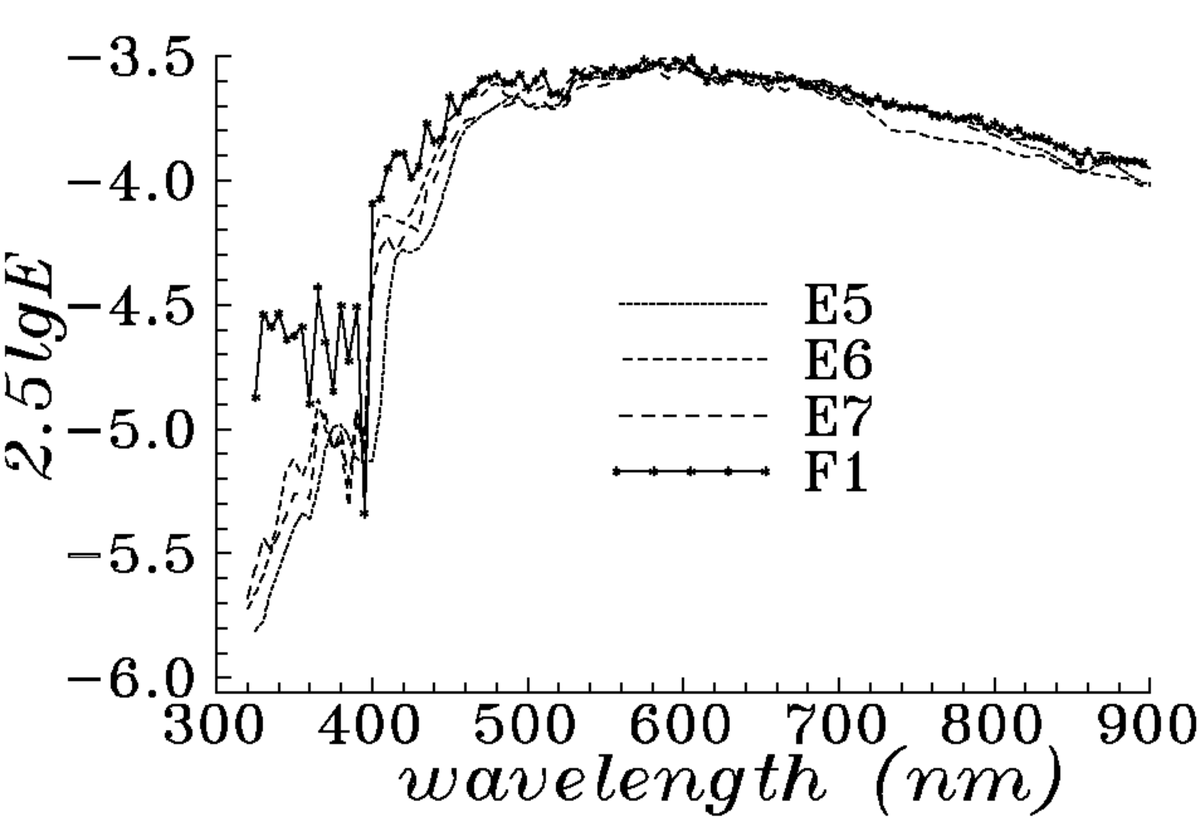


Figure 4. The theoretical spectrum F1 (4810, 2.7, 0.0) and stars: E5(BS442: G8III, 4810, 2.6, -0.42), E6(BS4471: G9III, 4810, 2.6, -0.42), E7(BS5787: G8III-IV, 4810, 2.6, -0.42).

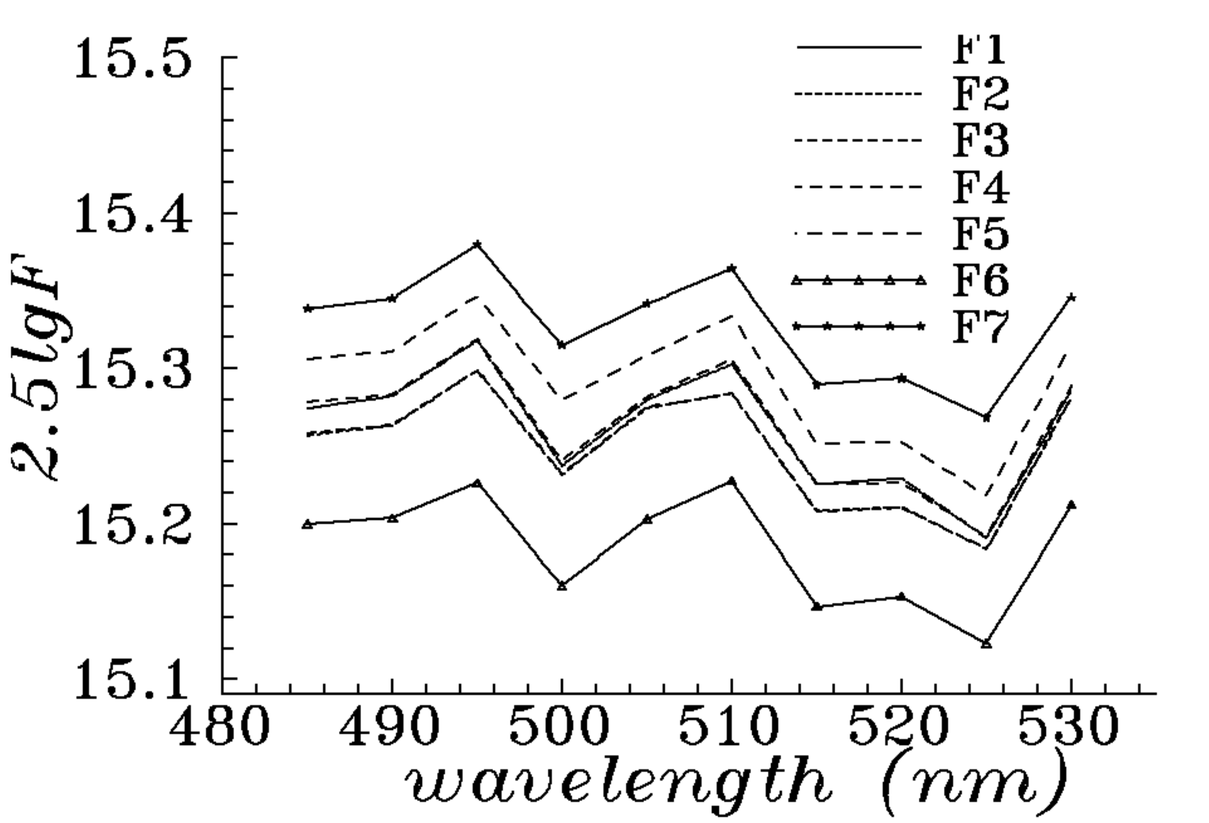


Figure 6. The theoretical spectra, calculated with different values of lg g: F1 (5000, 2.5, 0.0), F2(5000, 2.6, 0.00), F3(5000, 2.7, 0.00), F4(5000, 2.8, 0.0), F5(5000, 2.9, 0.0), F6(4960, 2.7, 0.0), F7(5080, 2.7, 0.0).

NonLTE ANALYSIS OF THE Na1 LINES IN THE SOLAR SPECTRUM

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ABSTRACT. Solar spectrum of Na1 lines by method of the nonLTE analysis is investigated. It shown, that in atmosphere of the Sun the Na1 is in moderate "overrecombination". The analysis of influence of atomic data, models of atmospheres and damping constants for nonLTE deviation and sodium abundances is made. Observational solar spectrum of strong lines Na1 has been synthesized in good approximation. On summary data of 15 lines the sodium abundance is determined:-5.78dex.

Key words: line: formation - line: profile - Sun: atmosphere

Use spectrographes of the superhigh resolution at observations of stellar spectra and powerful computers for their theoretical processing has made possible to begin mass determine nonLTE abundances with errors, smaller 0.1 dex. Such researches claim large accuracy for used model atoms and model atmospheres and definition of the base solar abundance. To the purposes of the decision these two problems this work is devoted.

In work the Solar Flux Atlas Kurucz et al, (1984) ($\lambda = 2900 - 13000\mathring{A}$, $\frac{signal}{noise} = 9000$, $\frac{\Delta\lambda}{\lambda} = \frac{1}{522000}$) was used. For selected 16 lines with application of a graphic package Origin 3.0 equivalent width W_λ were defined, the results of research are given in Table 1.

Table 1: The Na1 lines measured in Solar Flux Atlas.

$\lambda\mathring{A}$	W ($m\mathring{A}$)	$\lambda\mathring{A}$	W ($m\mathring{A}$)
5889	830	5895	640
8194	328	8183	254
5688	144	5682	121
6160	61.0	6154	38.1
4982	89.3	4497	35.9
5148	13.5	12679	142
10834	51.4	9961	21.1
10746	22.2	3302	159

For account nonLTE populations and lines a complex of the programs NONLTE3 (Sakhibullin, 1983) which is based on the linearization method proposed by Auer and Heasley with allowance for of all continuous sources of opacity, lines and molecules is used. In applied 21-levels model of atom Na1 [Mashonkina et al., 1993] ($n \leq 7, l \leq 3$), containing 46 transitions in detal and 54 fixed transitions, the energy of levels and ionization cross-sections were redefined according to data by Hofsaess (1979) and Yakovlev et al. (1990). The accounts are carried out for models of atmospheres: by Kurucz (1979, 1993), Holweger and Muller (1974) and Bell (1975) - at various significances of collisional cross-sections with hydrogen (with factor k = 0.0, 0.1, 1.0). At investigation of theoretical line profiles Doppler and Stark broadening, Van der Waals damping with C_6 constants by Unsold (1955), Deridder and Van Rensbergen (1976), radiative damping, microturbulence ($V_{turb} = 1.0, 1.2, 1.4 km/s$) and rotation velosities ($V \sin i = 1.0 - 2.5 km/s$) were taken into account. The sodium abundance is accepted according Anders and Grevesse (1989): [A] = -5.75

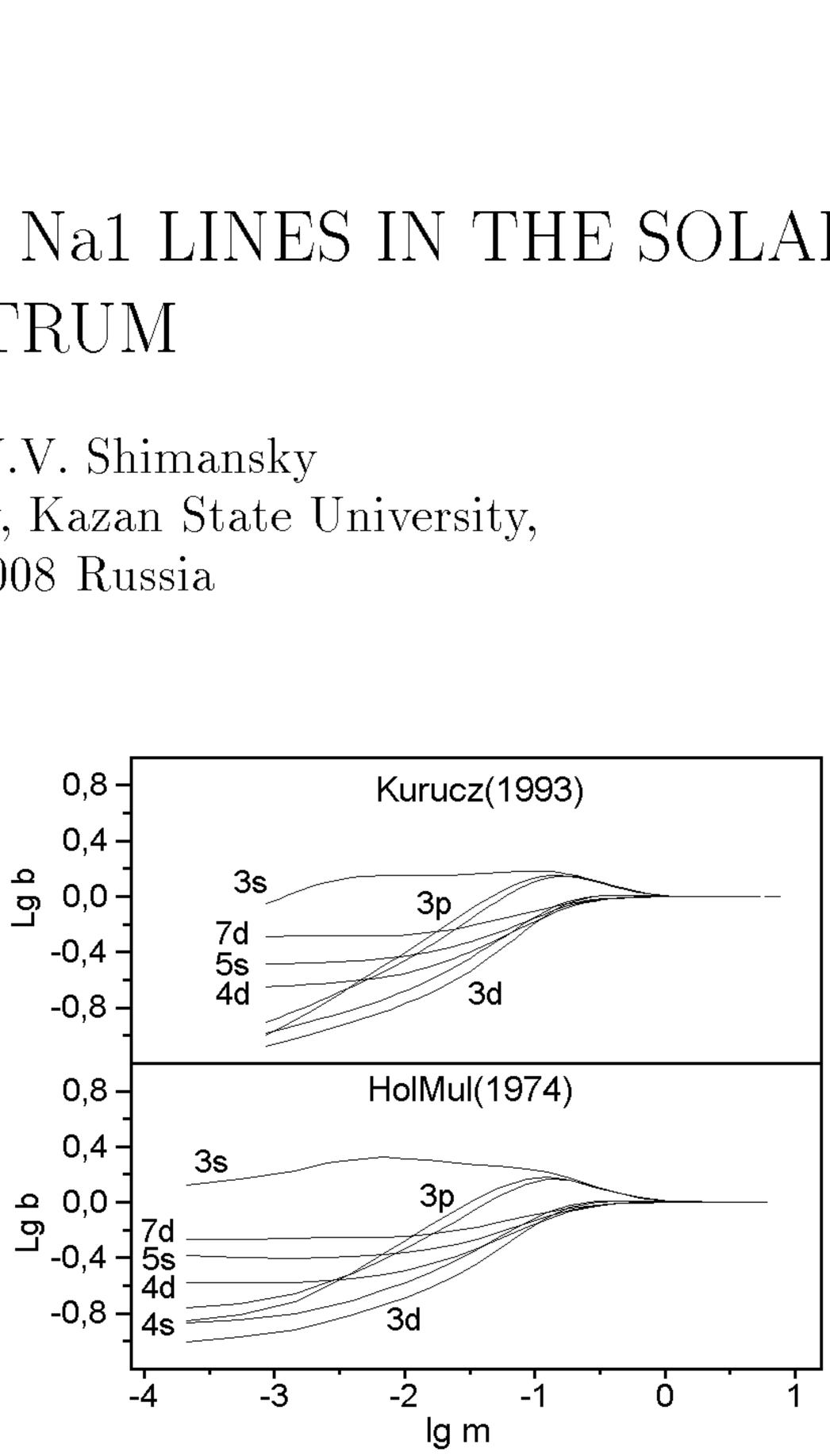


Figure 1. Departures from LTE for populations of Na1 levels in $b = n_{nonLTE}/n_{LTE}$.

At analysis of nonLTE-populations of Na1 levels moderate "overrecombination" for ground state $3s$ and level $3p$ is confirmed (Figure 1). "Overrecombination" is determined by small ionization cross-section and strong scattering in lines of resonance transition $3s - 3p$. The

"overrecombination" effects are maximum for models by Kurucz (1979) and by Bell and minimum for model by Kurucz (1993), and tend to strengthening and shifting in higher layers at increase of collisional processes.

The results of the LTE and nonLTE abundances definition on 15 lines (except $\lambda = 3302\AA$) are resulted in Table 2. Deviations from LTE are large for $\lambda = 8194$, 8183 Å (ΔX = -0.17 dex), essential for $\lambda = 5688$, 5682 Å (ΔX = -0.07 dex) and insignificant for other lines (ΔX < 0.05 dex). The minimum deviations for all lines are reached in model by Kurucz (1993), maximum ones - in models by Kurucz (1979) and by Bell and considerably decrease with growth of collisional processes at $k = 1.0$ Microturbulence velosity does not practically influence deviations from LTE.

Table 2: Solar sodium abundances and dispersions in dex.

Model	K	V_{turb}	nonLTE	LTE
		km/s	$\Delta X \pm \sigma$	$\Delta X \pm \sigma$
Kurucz n.	0.1	1.0	-0.012 0.045	0.032 0.048
		1.2	-0.020 0.046	0.024 0.045
		1.4	-0.028 0.049	0.017 0.041
	0.0	1.2	-0.017 0.047	
	1.0	1.2	-0.001 0.043	
Profiles	1.0	1.2	-0.034 0.023	
Deridder	1.0	1.2	-0.001 0.047	
Kurucz o.	0.1	1.0	-0.075 0.057	0.023 0.052
HolMul	0.1	1.0	0.047 0.046	0.105 0.059
Bell	0.1	1.0	-0.075 0.060	0.016 0.054

The heaviest abundances are received for model HolMul, the least ones - for models by Kurucz (1979). At V_{turb} increase of 0.2 km/s Δ X decreases on 0.008 dex. Dispersions of the abundances, received on 15 lines are minimum for models by Kurucz (1993) and HolMul, and poorly depends from V_{turb} and k.

For lines with $W_\lambda > 20m\AA$ synthesis of observable profiles was performed, the results for some lines are shown on Figure 2. The resonance spectral lines ($\lambda =$ 5889, 5895 Å) and subordinate ones $\lambda = 8194\AA$ have the good theoretical description. There is the difficulty in description of observable wings of more weak lines $\lambda = 8183, 6160, 6154, 4982, 5682\AA$. Such wings, increased with reduction of equivalent width of a line, are not described theoretically with change $V_{turb}k$, and damping constants. At research of lines profiles of md-nf transitions a necessity of C_6 constants by Unsold increase (with factor 5 for $\lambda = 12679$ and with factor 30 for $\lambda = 9961$) and efficiency of C_6 constants by Deridder is shown. Simultaneously the constants by Deridder are not suit for lines of ms-np transitions. The line

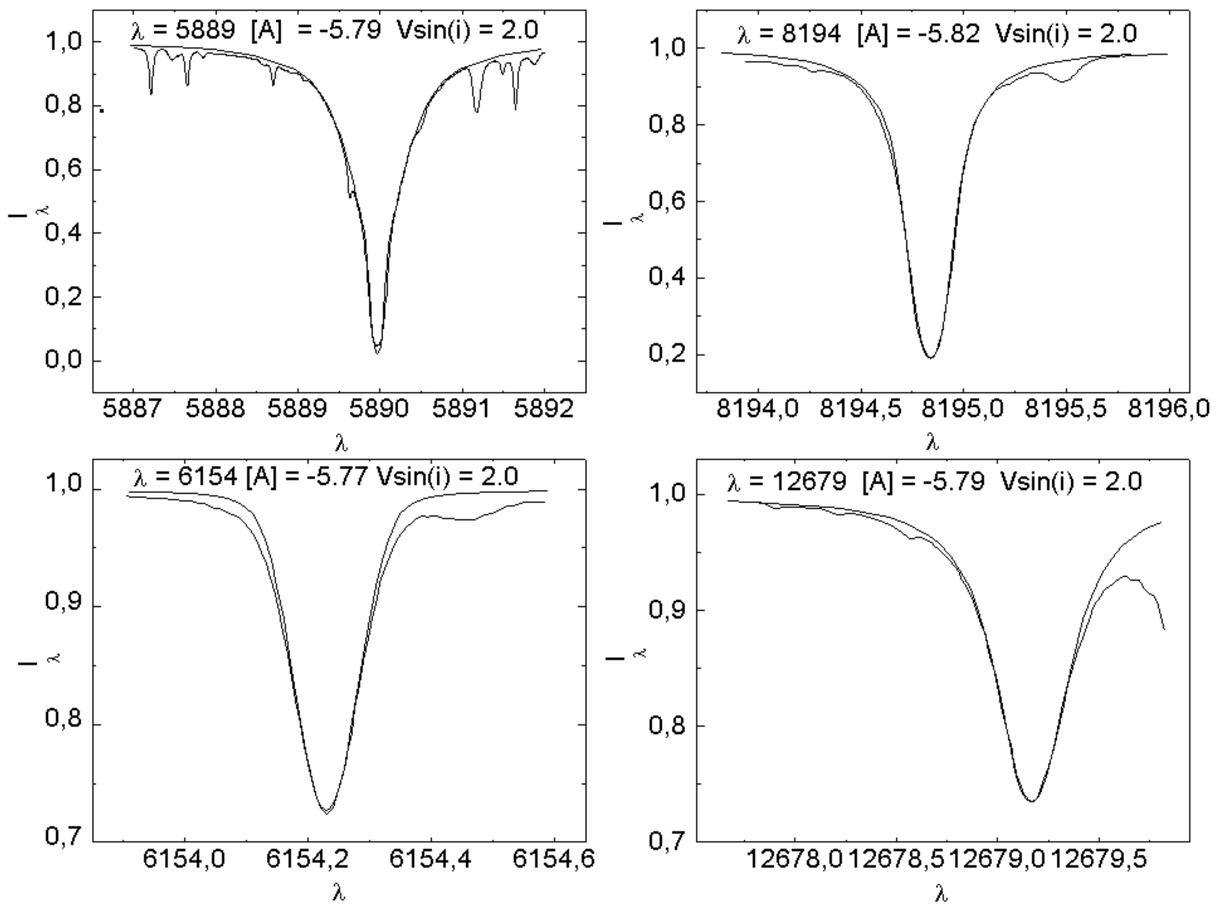


Figure 2. Profiles of some lines Na1.

$\lambda = 3302\AA$ does not yield to adequate theoretical synthesis.

At investigation of profiles and equivalent width of all lines the following best significances are received: $[A] = -5.779 \pm 0.023 dex, k = 1.0, V_{turb} = 1.0 km/s, V \sin i = 2.0 km/s$.

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THE COOL GIANT STARS AND CHEMICAL EVOLUTION OF GALAXY

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ABSTRACT. The fundamental characteristics and abundances of cool giant stars is discussed. The possible evolution of nuclides in process evolution of Galaxy was very shortly described.

Key words: Cool giant stars, evolution of stars

Introduction.

The main goal of modern astrophysics is the determination of abundances in atmospheres of stars, in particularly, in atmospheres of cool giant and supergiant stars. Spectra of these stars contain great number of atomic and molecular lines of absorption which are formed at various optical depths of their atmospheres. This gives a possibility to study the structure and parameters of atmospheres of G,K,M - giant and supergiant stars belonging to various Populations of Galaxy. This is necessary for testing theories of evolution of stars and of nuclides. Really stars of Galaxy Disk, and possible Halo, are product of subsequent generation of stars through interstellar medium. The interstellar medium was formed of matter proceeded of stars' nuclear synthesis and so was enriched by products of various nuclear processes. According to the modern concept of theory the time of evolution of the stars' being at the certain locus essentially depends on its mass, initial abundances and on nuclear processes. Cool giant and supergiant stars have been leaving from early epoch of the origin of Galaxy up till now and contain the records of abundances of elements and their isotopes in different epoch of evolution of Galaxy. The determination of abundances in their atmospheres can give information about chemical evolution of Galaxy.

"Standard" abundances of elements and isotopes.

The sources of information about evolution nuclides in process of evolution of Galaxy are their abundances and their distribution from number of proton - Z, or number of neutron - N, or of mass number - A=N+Z. They have been received with using the earths' crust, meteorites, solar atmosphere (photosphere, chromosphere, corona), solar wind, interstellar medium, planetary nebulae, galaxies, quasars, cosmic rays.

In Table 1 are tabulated "cosmic", "normal", "standard" abundance of elements Anders & Grevesse (1989) - $\log \epsilon_{st}$ and values abundance of elements in atmosphere of Sun - $\log\epsilon_{\odot}$. The izotopic abundances (nuclides) for the solar system determined from meteorites are presented in Table 2. These ratios can be determined in the atmospheres of cool giant stars.

The curve of distribution of abundances have characteristics: their values exponentially decrease with the growth of mass number up to A=100 and then a considerably slowing down; large fluctuations in abundance of light elements; presence of peaks in distribution of abundances with certain mass numbers. These peculiarities must be explained by the theory of initial formation and evolution of all nuclides. The analysis of abundances in stellar atmospheres show on their descrepances (for example, stars of population I and II of our Galaxy, stars of type R CrB, peculiar & metallic-line stars, carbon stars etc). It should be noted that chemical composition of interstellar gas in H II-regions around nearly forming stars and planetary nebulae (objects were formed at later stage of evolution of stars) is close to that of the solar system. Moreover, the abundances in other galaxies and quasars (the oldest objects of the Universe) differs slightly from the solar one. All this must be explained by one theory of evolution of abundances of chemical elements and their isotopes. A great compilation arises due to a small number of stable isotopes among multitude of unstable isotopes. Therefore, the distribution of abundance of nuclides must be changed as a result of radioactive decay which may differ under these or other conditions (up to decay absence). This should be especially taken into account in analysis of abundances of meteorites, unevolved and evolved stars and etc. The atmospheres of unevolved stars do not contain the products of stellar nucleosynthesis. On the contrary the atmospheres of evolved stars can be diluted with products of stellar

nucleosynthesis and be different from the abundances of progenitory matter.

Fundamental characteristics of cool giant stars, model atmospheres and their evolution status.

We shall mainly dwell upon the results of determination of abundances and of fundamental characteristics of cool giant stars. It is evident that during evolution of stars their abundances can be essentially change. So the peculiarity of stars says about their the advanced stage of evolution.

The information about atmospheres of giant stars is a key to the solution of many problems on the evolution of stars and stellar systems, formation of nuclides with mass more then mass of H, enrichment of star atmospheres by heavy and light elements and isotopes. However, here we come across a paradox - the presence of a tremendous number of atomic and molecular lines of absorption permits to determine abundance of many nuclides and, unfortunately, at the same time these mainly hinder both the investigations of parameters of atmospheres of cool giant stars and the construction of mathematical model of atmospheres of stars.

New data about giant stars are obtained at the Astronomical Observatory of Odessa State University, and namely, the temperature, gravity, microturbulent velocity, radius, mass and total luminosity.

According to the data of Komarov et al. (1996) parameters of cool giant stars in oxygen sequence of field of Galaxy disk up till now being in the solar neighbourhood (in the spectral interval from G to M) for temperature range from 2500 to 5500K, for gravity from 0.00 to 3.00 dex, for metallicity from -0.7 to 0.4 dex. The luminosity of stars are markedly varied from spectral type (by the order of a value), radii vary from 5 to $30R_\odot$, whereas masses - from 0.7 to $1.4M_\odot$. Mean values metallicities within spectral types G0-K0, K0-K5 and M0-M4 are equal to -0.20, -0.07 and -0.20dex respectively. Cool giant stars in solar neighbourhood of Galaxy disk at the increase of metallicity are shifted towards higher temperatures and larger luminosities. Masses of cool giant stars belonging to open clusters and moving groups range from 2 to $3M_\odot$! It is likely to show that *field stars* have already passed the stage of belonging to a certain group of stars and refer to the Population of the old Galaxy disk.

One impressive result discovered by us should be emphasized: the age of majority cool giant stars of Galaxy field can be compared with that of the oldest objects of Galaxy - globular clusters (15×10^9). We finded also two flares in formation of stars that determine the various number of giant stars in certain spectral tapes accordingly their metallicity.

The model of atmosphere of cool giant star can be calculated after determining of fundamental characteristics of star and by usual simplified assumptions. We must underline that are not model atmospheres adequate to the structure of the real stars even when unknown processes in their atmospheres are absent.

Table 1. The "standard" and "solar" abundances of elements.

Z	El	$\lg \epsilon_{st}$	$\lg\epsilon_\odot$	Z	El	$\lg\epsilon_{st}$	$\lg\epsilon_\odot$
1	H	12.00		44	Ru	1.82	
2	He	10.99		45	Rh	1.09	
3	Li	3.31	1.16	46	Pd	1.70	
4	Be	1.42	1.15	47	Ag	1.24	0.94:
5	B	2.88	2.53	48	Cd	1.76	
6	C	8.60		49	In	0.82	1.66:
7	N	8.00		50	Sn	2.14	2.0
8	O	8.86		51	Sb	1.04	
9	F	4.48		52	Te	2.24	
10	Ne	8.09		53	I	1.51	
11	Na	6.31		54	Xe	2.23	
12	Mg	7.58		55	Cs	1.12	
13	Al	6.48		56	Ba	2.21	2.13
14	Si	7.55		57	La	1.20	
15	P	5.57	5.45	58	Ce	1.61	
16	S	7.27		59	Pr	0.78	
17	Cl	5.27	5.5	60	Nd	1.47	
18	Ar	6.56		62	Sm	0.97	
19	K	5.13		63	Eu	0.54	
20	Ca	6.34		64	Gd	1.07	
21	Sc	3.09		65	Tb	0.33	
22	Ti	4.93		66	Dy	1.15	
23	V	4.02		67	Ho	0.50	0.26:
24	Cr	5.68		68	Er	0.95	
25	Mn	5.53	5.39	69	Tm	0.13	0.29
26	Fe	7.51		70	Yb	0.95	
27	Co	4.91		71	Lu	0.12	0.76:
28	Ni	6.25		72	Hf	0.73	0.88
29	Cu	4.27		73	Ta	0.13	
30	Zn	4.65		74	W	0.68	1.11:
31	Ga	3.13	2.88	75	Re	0.27	
32	Ge	3.63		76	Os	1.38	
33	As	2.37		77	Ir	1.37	
34	Se	3.35		78	Pt	1.68	
35	Br	2.63		79	Au	0.83	1.01:
36	Kr	3.23		80	Hg	1.09	
37	Rb	2.40		81	Tl	0.82	
38	Sr	2.93		82	Pb	2.05	
39	Y	2.22		83	Bi	0.71	<1.9:
40	Zr	2.61		90	Th	0.08	0.23
41	Nb	1.40		92	U	-0.49	<-0.47
42	Mo	1.96					

Table 2. The abundances of nuclides.

Z	Nuc	A	logϵ_{iz}	Z	Nuc	A	logϵ_{iz}
1	H	1	12.00	20	Ca	43	3.53
		2	7.22			44	4.69
2	He	3	7.08			46	1.89
		4	10.99			48	3.64
3	Li	6	2.22	22	Ti	46	3.85
		7	3.31			47	3.82
5	B	10	1.83			48	4.82
		11	2.43			49	3.70
6	C	12	8.60			50	3.68
		13	6,67	26	Fe	54	6.29
7	N	14	8.00			56	7.50
		15	5.51			57	5.87
8	O	16	8.84			58	5.05
		17	5.41	28	Ni	58	6.09
		18	6.15			60	5.67
12	Mg	24	7.50			61	4.33
		25	6.60			62	4.82
		26	6.65			64	4.29
14	Si	28	7.55	40	Zr	90	2.37
		29	6.24			91	1.71
		30	6.07			92	1.89
20	Ca	40	6.36			94	1.90
		42	4.18			96	1.11

The abundances in atmospheres of cool giant stars.

Cool dwarf stars - stars of main sequence (MS) - of Galaxy disk have the abundances of elements of CNO-group near to the solar ones, and namely, [C/H]=-0.03±0.1,[N/H]=0.02±0.1 and [O/H]=0.00±0.1. At the same time abundances of metals-group can vary from 0.3 to -0.7dex. The mean level of metallicity can change for various open clusters. No distinct dependence upon the age is found. The atmospheres of stars of MS in the spectral region from F to early K have abundances elements from C to Sc in limits from 0.08 to -0.04.

Progenitors of cool giant stars of G-M spectral types are dwarf stars of F-K spectral types. Is the progenitory matter in atmospheres of giant stars diluted with products of nuclear synthesis? Indeed, the average ratio abundances is equal C/N=0.9 for open clusters of the Hyades and Praesepes (Mishenina et al., 1991, Komarov & Basak, 1992) while for the Sun C/N=4.8. The average value C/N=2.3 is obtained for cool giant stars of Galaxy field. That means the abundance N grows while abundance C decrease. It should be noted that theory of evolution of single star predicts ratio C/N=2.0 after mixing. Light elements Li,Be and B are easily destructed at low temperatures (nearly from 2×10^6 to 5×10^6) that must decrease abundance of these elements in atmospheres of giant stars especially of Li. These nuclides cannot be formed during the stellar evolution (during the processes of nuclear synthesis), except may be ^{7}Li. However, abundance of ^{7}Li in some giant stars exceeds the cosmological abundance! Abundance ^{7}Li in meteorites and in the solar atmosphere differs by nearly two orders. Now it is necessary to determine the abundances of these elements in atmospheres of oldest Galaxy stars with big deficiency of metals. The ratio of izotopes ^{12}C/^{13}C for atmospheres of cool giant stars are much less than the solar (terrestrial) one. Ratios of abundances of nuclides due to circulations, He-flares, deeply penetrating convection and mass loss can be changed in the stellar atmospheres. The ratio ^{12}C/^{13}C in atmospheres of these stars can vary from 4 to 40. The values ^{12}C/^{13}C from 20 to 30 range for the stars with M> 2M$_\odot$. This ratio swiftly decrease for stars with more little mass according to observations and that contradicts to the theory. To explain this effect it is necessary to suppose unknown mechanism of mixing. During further evolution of stars with M< 1.5M$_\odot$ they proceed in sequence of spectral types M-MS-S-SC-C (R or N). This sequence is caused by the variation in ratio C/O.

The nuclides of s-process can be synthesized only in the entrails of giant and supergiant stars with M>1.5M$_\odot$. It is shown ,that atmospheres of giant stars of field of the Galaxy disk in spectral range G-K with solar metallicity have almost solar abundances of elements of s-process. Gopka and Komarov (1990), Gopka et al.(1990) have shown that the atmosphere of α Tau have "solar" abundances of Fe and elements s-process, whereas for α Boo these elements exhibit the same deficiency relatively to their abundance in the atmosphere of Sun. The abundances of nuclides of the s,r-processes in atmospheres of giant stars of the Galaxy Halo must be deficient with respect to the solar abundances because nuclides of Fe are primordial nuclei for s,r-processes. This is confirmed by observations and treatments of spectra of giant stars belonging to the globular clusters. The evolution of elemental abundances in atmospheres of cool giant stars belonging to the first or second branches of giants remains unknown. This is associated with our insufficient knowledge of processes in outer layers of these stars. It is enough to say that in region of spectral type K are stars of various types - "solar" and "nonsolar" types. Conditional character of such a division is clear enough.

The abundances of the atmospheres of cool giant stars belonging to the galactic disk in neighbourhood of Sun are in a fair agreement with ones for dwarf stars in the interval of metallicity from -2.4 to 0.35 dex. Whereas the elements of α-process are overabundant for metal deficient stars and odd-elements Na, Al are deficient relatively to elements of α-process (Edvardson et al., 1993). It is noted that the overabundance Na in atmospheres of giant stars from 0.3 to 0.8 dex has been found by Komarov et al. (1985). It is correlating with

luminosities of stars (and namely with gravities) - the larger stellar luminosity conform to greater Na-excess. This correlation is due to dependence of luminosity of stars upon its mass or its age.

We can be sure that abundances of elements and their izotopes of stars of oxygen sequence in the galactic disk are different for groups of stars accordingly their formation and their being in various ascending branches, or their being in the horizontal branch, or their being in the asymptotic branch. Now the age of single star cannot be determined only upon their location on the HR-diagram. Some supplementary criterion for the age or mass is needed. Such criterion may be parameter of the activity of chromosphere (in particular level of emission in H,K Ca II and H,K Mg II lines). The position of stars belonging to open clusters and moving groups would seem to be better because there is a possibility to estimate their age. But here we come across paradox! As is stated by Komarov et al. (1996) a relative number of stars with "standard" abundances for spectral types G5 III-K0 III must be small whereas the relative number of stars in the spectral region K2 III-K5 III prevails. However, in the closest open cluster of Hyades the giant stars (spectral type K0 III) have "standard" abundance for almost all elements (excepting some elements, for example, carbon, oxygen, sodium) while in the best studied moving group Boo of star α Boo have deficient of all elements. The stars of galactic disk have been formed since on 10^9 years. However, we and Edvardson et al. (1993) have found of the stars with ages comparable with that of globular clusters. It is necessary to take into account that even oldest stars with metallicity from -1.5 to -3.5 dex have the ratios of abundances of heavy elements approximately in the same proportion as for the Sun. Now the under- and/or over-abundances in these or those elements or their izotopes must be found.

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THE ABUNDANCE OF HELIUM AND STELLAR PULSATION

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ABSTRACT. Radial gradient of relative amplitude of the light variation F_V for galactic classical Cepheids is found. The gradient has different signs for two cases: $P > 8^d$ and $P < 8^d$. For $P > 8^d$ the gradient is negative. This gradient is caused by gradient of helium content in the primordial clouds, where Cepheids were born. In agreement with theoretical calculations, the amplitude increase with an increasing of the helium content. For this dependence the following calibration was obtained:

$$[He/H] = (F_V - 0.54)\ dex$$

$$Y = 0.55 F_V - 0.03$$

In case $P < 8^d$ the amplitude (and also asymmetry parameter M-m) is mainly affected by metallicity.

Key words: Stars - abundances, Stars - classical Cepheids

Introduction

Determination of helium abundance in the classical Cepheids is an essential problem, because [He/H] value becomes a crucial parameter in the theoretical modelling of the pulsating stars. Here we propose a new method of determination of the He content for Cepheids with $P > 8^d$. A dependence between amplitude and He abundance follows also from the numerical calculations by Stobie (1969), Cogan et al.(1980).

It is known, that light amplitudes for Cepheids strongly depend on period P, therefore we can use a relative amplitude F_V (amplitude parameter, Kraft 1960). The amplitudes were taken from the compilative cataloques by Berdnikov (1987) and Fernie (1995).

It appeared that there exists the radial gradient of F_V for our Galaxy and for two cases $-P < 8^d$ and $P > 8^d$ this gradient has different signs. It means that in this two cases the amplitude is affected by two different factors. Let us consider these two cases separately.

Cepheids with $P > 8^d$

The following gradient of amplitude upon galactocentric distance R_G were obtained:

$$dF_V/dR_G = -0.009\ kpc^{-1} \qquad (1)$$

Little is left to be supposed that for the case $P > 8^d$, the amplitude gradient is mainly affected by the gradient of the helium content, which generally exists in the Galaxy. HII region were used for determinations of the He abundance gradient:

$$d[He/H]/dR_G = -0.009\ kpc^{-1} \qquad (2)$$

Knowing that the Cepheids (the descendants of B-stars) are formed from the molecular clouds with different chemical composition, one can suppose that gradient of He (and other elements) content found using the Cepheids, reflect the galactic gradient.

During the evolution from the main-sequence B-star to the red giant, a Cepheid rapidly ($\approx 10^3$ yr) crosses the instability strip. In the red giant region Cepheids suffer the dredge-up and their envelopes become helium enhanced (Iben 1965). Therefore, crossing the instability strip for the second time, the Cepheids must pulsate with an increased amplitude.

It is clear that primordial helium abundance (which is inherent to B-stars and HII regions) can take place only in the Cepheids that first crossing the instability strip. Up to now we have found only two such Cepheids: V1162 Aql (Andrievsky et al. 1996) and V636 Cas (Kovtyukh et al. 1996). Both Cepheids have a small amplitude and solar - like CNO abundances.

The helium abundance in HII-regions is similar to that in B-stars from the solar neighbourhood (average abundance $log\ He/H = -1.08$, Adelman 1986). One can suppose that Cepheids first crossing the instability strip have the same mean abundance as for the B-stars ($-1.08\ dex$). The average F_V amplitude for Cepheids first crossing the instability strip is equal to 0.54. Therefore, comparing (1) and (2) we obtain the following calibration (for Cepheids with $P > 8^d$):

$$[He/H] = F_V - 0.54 \quad (dex) \qquad (3)$$

$$Y = 0.55 F_V - 0.03 \qquad (4)$$

The relations (3 - 4) allow to obtain the helium content in upper layers of the Cepheids' atmosphere. It is useful for calculation of the Cepheids pulsational models. It can be also used as a diagnostic tool in a study

of helium abundances in different stellar systems and for investigation of the He gradient in other galaxies.

Cepheids with $P < 8^d$

The metallicity, as well as helium content, strongly affects the pulsational activity of Cepheids with $P < 8^d$. A presence of positive amplitude gradient for Galaxy (232 stars):

$$dF_V/dR_G = 0.018\ kpc^{-1} \qquad (5)$$

testifies about dominant role of metallicity in the influence on the amplitude comparing with influence of helium content. Therefore, in this case we have to calibrate the dependence $[Fe/H] \sim A$.

For the $[Fe/H] \sim A$) calibration we used, first of all, well known determinations of Cepheids metallicity based on the high-resolution spectral analysis and data obtained in Washington photometrical system.

The following relation between the various parameters of classical Cepheids are taken:

$$[Fe/H] = 0.739\ (M-m) + 0.064\,P - \qquad (6)$$
$$-0.284\,F_V - 0.425$$

(asymmetry parameter $M-m$ is the interval between the phases of maximum (M) and minimum (m) of the light curves).

This solutions is valid for Cepheids with $P < 8^d$ and has a standart deviation σ (one star) =0.15 dex, which is only slightly poorer than the best spectroscopic determination.

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ON THE GF–VALUES FOR SOME DIATOMIC MOLECULAR SPECTRA

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ABSTRACT. In view of rich structure of the energy levels and the variety of transition types which are observable, molecules are the useful tool for investigation of physical parameters of stellar atmospheres, interstellar and circumstellar matter, such as gas density, its temperature, chemical and isotopic composition, ionization degree, radiation field density, kinematics, etc. The success of investigations is defined to a considerable extent by the amount and reliability of spectral information used. The molecular radiative coefficients must be calculated for a huge number of spectral lines, involving rather weak lines. These calculations are performed using spectral line lists containing such parameters as positions of line centres, lower level energies, transition probabilities, and, in a number of cases, broadening parameters.

Key words: Molecular spectra: Molecular bands: Oscillator strengths.

At present several scientific teams are engaged in the creation of such lists. The most complete lists for diatomic molecules are prepared by Kurucz (1993). These lists contain more than fifteen million lines belonging to various electronic spectra H2, CH, OH, NH, MgH, SiH, C2, CO, CN, TiO. Only a small part of lower level energies and transition frequences are from laboratory data, all values gf are calculated. The functions of electronic transition moments nedeed for such calculations were taken from quantum-chemical researches or proper experimental measures.

The most of Kurucz' calculations were made more than fifteen years ago. Since then a large amount of results, both experimental and theoretical, have been obtained extending and refining our knowledge about the structure of energy levels for molecules indicated and their radiative properties. Therefore, refining and extension of Kurucz's data base are supposed, and the first step must be the analysis of all information available on spectral and radiative properties of astrophysically important diatomic molecules for selection of the most reliable values.

We do such a work for some molecular systems, commonly used for determining the abundances of the light elements (C,N,O) and isotopic ratio 12C/13C in the late-type star atmospheres, on the base of information and program units containing in the RADEN data bank (Moscow) and program complex "MOLEC" (Kiev).

The most reliable information about electronic transition moments for relatively light molecules can be obtained from quantum-chemical calculations controlled by lifetime measurements. Note that for the light molecules, taking into account of vibrational-rotational interaction is rather essential. The influence of rotation on vibronic wave function can be taken into account in the solution of Schredinger's nuclear equation with effective interatomic potential, involving the rotation energy. We have calculated the gf-values for some rotational lines according to the normalization rule from (Whiting et al. 1980) and have compared them with the Kurucz's data.

In Table 1. we compare the Kurucz's values of gf with our ones calculated in a) R-centroids approximation, using the data from Kuznetsova (1987); b) with ab-initio calculation of $f_{\nu'\nu''}$, controlled by lifetime measurements and c) those as b) but with rotational correction of $f_{\nu'\nu''}$. The asterisk in a) means the constant S_e for the system (see Kuznetsova (1987)). The data used for ab-initio calculations are taken from papers (Hettema and Yarkony (1994) for CH, Kirby and Goldfield (1991) for NH, Arnold and Landhoff (1978) for C_2, Kirby et al. (1979) for MgH, Larsson (1987) for SiH). We noted that Kurucz's list for Swan C_2 system ($D^3\Pi - A^3\Pi$) included only one lambda component of $^{12}C_2$ but two lambda components of $^{13}C^{12}C$ lines with the same values of gf. In the case of homonuclear molecule $^{12}C^{12}C$ the statistical weight of level must be twice as much as for heteronuclear $^{13}C^{12}C$ (even-odd alternation). For Swan system $^{12}C_2$ lines of Kurucz's list we can double the gf-values. Note that our value f_{00}=2.91E-02 for $C_2(D^3\Pi - A^3\Pi)$ system almost the same as f_{00}=2.8E-02 in Grevesse et al. (1991).

The isotopic ratio $^{12}C^{13}C$ is often determined from the spectra of the CN red system near 8000 Å. We have noted that positions of ^{13}CN lines in Kurucz's list are displaced on 0.7-0.8 Åin the violet relative the

Table 1. $\lg gf$-value

	wavelength (Å)	Kurucz's value, 1993	our values a)	b)	c)
CH($A^2\Delta - X^2\Pi$)					
(0-0) $R_{1c}(10.5)$	4248.941	-1.30	-1.40*	-1.43	-1.44
(1-1) $R_{2d}(10.5)$	4247.562	-1.36	-1.38*	-1.49	-1.50
(2-2) $R_{2d}(11.5)$	4262.594	-1.39	-1.35*	-1.51	-1.53
(0-1) $Q_{1c}(16.5)$	4835.268	-2.49	-3.17*	-2.55	-2.66
(3-4) $Q_{1c}(11.5)$	4835.224	-2.32	-3.87*	-2.51	-2.58
NH($A^3\Pi - X^3\Sigma^-$)					
(0-0) $Q_3(24)$	3365.196	-0.41	-0.71*	-0.69	-0.80
$C_2(D^3\Pi - A^3\Pi)$					
(0-0) $P_1(45)$	5135.57	0.03	0.37	0.42	0.40
(0-0) $P_2(44)$	5135.58	0.02	0.36	0.41	0.39
(0-0) $P_3(43)$	5135.68	0.01	0.35	0.40	0.38
MgH($A^2\Pi - X^2\Sigma^+$)					
(1-0) $P_2(15.5)$	4835.216	-1.42	-1.01*	-1.26	-1.26
(2-1) $P_2(23.5)$	4835.314	-0.95	-0.53*	-0.52	-0.58
SiH($A^2\Delta - X^2\Pi$)					
(1-3) $R_{21}(28.5)$	4835.285	-4.90	-4.72	-5.15	-4.71

observed wavelenghts (Wyller 1966). The gf-values for CN ($A^2\Pi - X^2\Sigma^+$) lines of Kurucz are approximately the same as our ones.

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OBSERVATIONAL MANIFESTATIONS OF EARLY MIXING IN B– AND O–TYPE STARS

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ABSTRACT. The helium and nitrogen enrichment of the atmospheres of early B-type stars during the main sequence (MS) evolutionary phase is re-analysed. It is confirmed that the effect depends on both the age t and the stellar mass M. For example, the helium abundance He/H increases by 0.04 (60-70% of initial value) for stars with $M = 8 - 13M_{\odot}$ and by 0.025 (about 30%) for stars with $M = 6M_{\odot}$. The nitrogen abundance rises by three times for $M = 14M_{\odot}$ and by two times for $M = 10M_{\odot}$. According to the latest theoretical computations, the observed appearance of CNO-cycled material in surface layers of the stars can be a result of the rotationally induced mixing, in particular, of the turbulent diffusion. Carbon is in deficiency in B stars, but unexpectedly does not show any correlation with the stellar age. However it is shown that the total C+N abundance derived for early B stars conflicts with the theory.

Basing on modern data the helium enrichment is first examined in O-type MS stars, as well as in components of binaries. As compared with early B stars, the He abundance for more massive O stars and for components of binaries show a different relation with the relative age t/t_{MS}. Namely during the first half of the MS stage the normal value $He/H = 0.08 - 0.10$ is conserved, whereas in the short time between $t/t_{MS} \approx 0.5$ and 0.7 a sharp jump is observed up to $He/H = 0.2$ and more. In particular, such a jump is typical for fast rotating O stars ($v \sin i \geq 200$ km s^{-1}). Therefore the effect of mixing depends on mass M, relative age t/t_{MS}, rotational velocity v and duplicity.

The mass problem (the discrepancy between M_{ev} and M_{sp}) is also analysed, because some authors consider it as a possible evidence of early mixing, too. It is shown that the accurate data for components of binaries lead to the conclusion that the discrepancy is less than 30%. Such a difference can be removed at the expense of the M_{ev} lowering, if the displacement of evolutionary tracks owing to the rotationally induced mixing is taken into consideration.

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Key words: Stars: Structure: Mixing

INVESTIGATION OF COMPONENTS OF THE BINARY SYSTEM 38 PER

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ABSTRACT. Radial velocities V_r of components of the binary system 38 Per are measured using high resolution and high signal/noise ratio spectra. The orbital elements were updated on the basis of these data and early published measurements of V_r. The following values of effective temperature and surface gravity for the secondary component (star B) are found from its spectral type B2 V and the statistical relation of de Jager and Nieuwenhuijzen (1987): $T_{eff} = 21000 \pm 1500$ K $\lg g = 4.0 \pm 0.2$. Using these values we found the fundamental parameters for the primary component (star A): $T_{eff} = 22700 \pm 1500$ K and $\lg g = 3.4 \pm 0.2$. The rotational velocities of the components are measured from HeI lines: $v \sin i = 80 \pm 7$ km s^{-1} for A and $v \sin i = 95 \pm 10$ km s^{-1} for B.

The atmospheric helium abundance is determined; it is relatively high for A (He/H = 0.19 ± 0.06) and nearly normal for B (He/H = 0.11 ± 0.03). From evolutionary tracks the relative ages of the components $t/t_{MS}(A) = 0.96 \pm 0.05$ and $t/t_{MS}(B) = 0.54 \pm 0.03$ are determined, i.e. the primary is near the end of the main sequence (MS) phase and the secondary is near the middle of this phase. This investigation together with our previously results for α Vir (Lyubimkov et al., 1995), V380 Cyg (Lyubimkov et al., 1996) and 45 ε Per (Tarasov et al., 1995) confirms the correlation between the helium abundance and the stellar age. An explanation may be connected with mixing already on the MS phase.

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Key words: Stars: binary: 38 Per

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LAWS IN BEHAVIOUR OF NonLTE EFFECTS FOR THE NaI AND MgI ATOMS FOR K - A STARS.

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ABSTRACT. NonLTE calculations for the NaI and MgI atoms were performed for model atmospheres of T_{ef} = 4000 - 12000K, $\log g$ = 0.0 - 4.5, [M/H] = 0.5 - (-4). Departures from LTE result in strengthening the NaI spectral lines and weakening the MgI ones. For 8 NaI spectral lines and 9 MgI ones used usually in abundances determinations nonLTE abundance corrections were found. They are very individual for each spectral line and for specific parameters of stellar atmosphere. Even for the weakest spectral lines they are not small: they can reach to (-0.15dex) for the NaI $\lambda\lambda 615.4, 616.0$nm and 0.17dex for the MgI λ457.1nm, λ571.1nm. The errors in abundances will be particularly large in the case of metal deficiency stars because the strong spectral lines are used in abundances determinations: for the NaI resonance lines nonLTE abundance corrections reach to $(-0.8$dex) and for the $\lambda\lambda 517.2, 518.3$nm they consist of 0.3dex. We conclude that nonLTE analysis is necessary in each case of sodium or magnesium abundance determination.

Key words: line: formation - Stars: atmospheres - Stars: abundances.

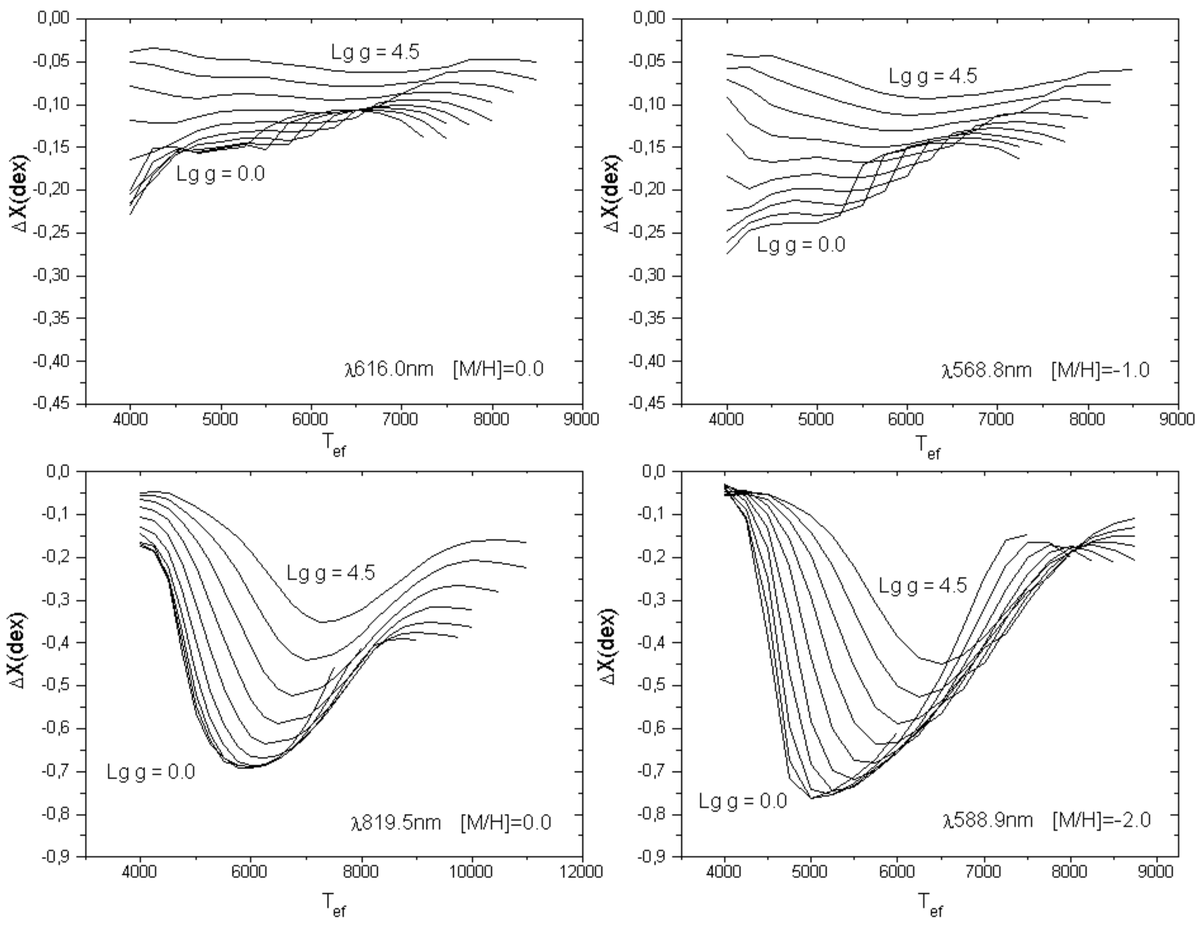


Figure 1. NonLTE abundance corrections ΔX versus T_{ef} at various $\log g$ for some NaI spectral lines.

Sodium and magnesium are important elements in consideration of the problems of chemical abundances evolutionary changes in stellar atmospheres and chemical evolution of our Galaxy. For decision of these problems numerous determinations of the sodium and magnesium abundances for various spectral types stars, belonging various Galaxy populations and being at various evolutionary stages are carried out. In majority of cases these determinations are executed within the framework of LTE assumption. The purposes of the present work are the study of the NaI and MgI lines formation for stars in wide range of parameters: T_{ef} = 4000 - 12000K, $\log g$ = 0.0 - 4.5, [M/H] = 0.5 - (-4) on the basis of statistical equilibrium analysis of these atoms and maintenance of a good theoretical basis for any work on sodium and magnesium abundances determination.

A nonLTE method for these atoms, developed by us early (Mashonkina et al. 1993, 1996) is advanced. In the NaI model atom (21 levels) thin splitting of the 3p level is taken into account. More exact photoionization cross sections (Hofsaess, 1979; Yakovlev et al., 1990) are used. In opacity calculations the contribution of numerous spectral lines and molecular absorption with data, kindly given by Pavlenko Ya., were taken into account by the direct method. The calculations were performed with model atmospheres by Kurucz (1994) at V_{turb} = 1.5 km/s.

For the NaI "overrecombination" effect, found out early by us (Mashonkina et al., 1993) and other authors for solar type stars, exists in whole range of parameters, and it intensifies with T_{ef} increasing and with $\log g$ decreasing. It results in amplification of the NaI spectral lines and reduction of the abundances determined on them. For the MgI there is the opposite effect of "overionization" in atmospheres of stars with $T_{ef} > 5500K$, where the MgI stage of ionization does not dominate. Alongside with it an influence of radiative b-b transitions on the populations of bottom levels, between which investigated lines are formed, is great. As it was shown by Mashonkina et al. (1996), their W_λ can be as more, and less of the LTE - magnitudes.

We have obtained nonLTE abundance corrections

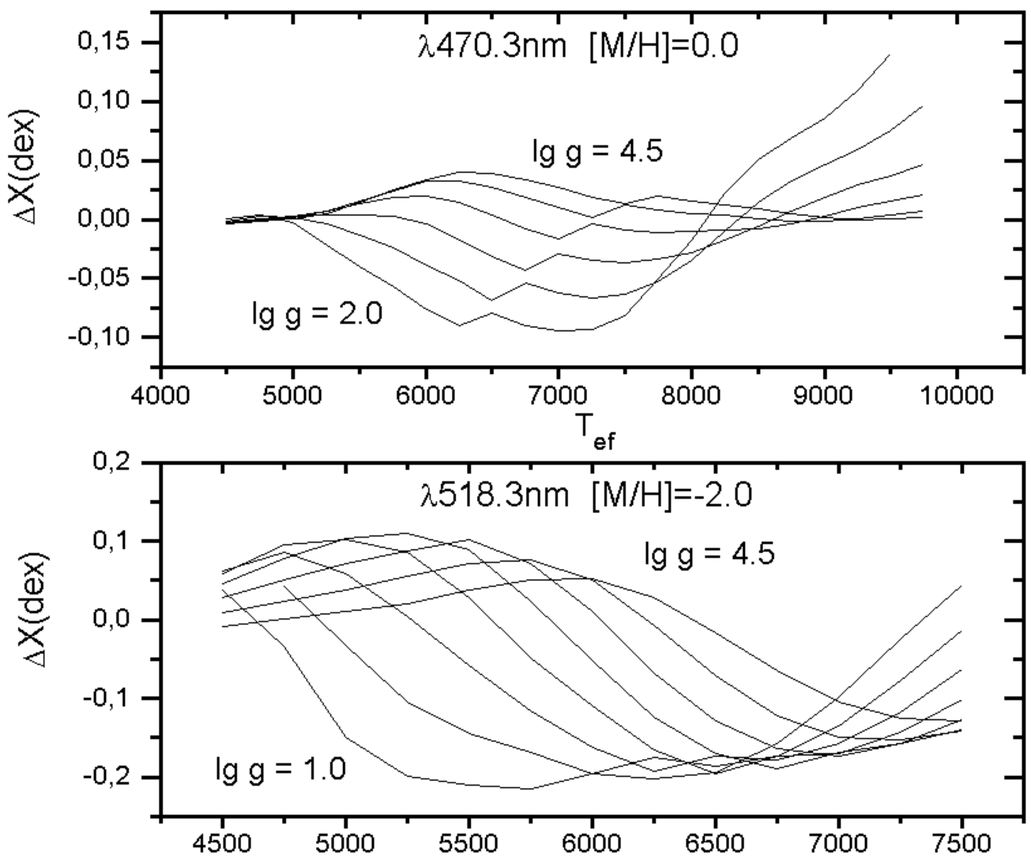


Figure 2. NonLTE abundance corrections ΔX versus T_{ef} at various $\log g$ for some MgI spectral lines.

ΔX as logarithmic displacements of nonLTE and LTE curves of growth at W_λ, calculated by LTE method with normal for given model atmosphere abundance. The part of results in kind of dependences ΔX - T_{ef} is presented on fig. 1, 2.

At analysis of sodium abundances the preference is usually given back the NaI doublets $\lambda\lambda 615.4, 616.0$nm and $\lambda\lambda 568.2, 568.8$nm. The calculations show, that only for the first of them deviations from LTE are small in whole range of parameters: $(-\Delta X) \leq 0.08$dex for main sequence (MS) stars and $\leq$0.15dex for supergiants. For $\lambda\lambda 568.2, 568.8$nm $(-\Delta X)$ are small for MS stars (<0.11dex), but can reach to 0.32dex for supergiants.

The NaI resonance lines $\lambda\lambda 588.9, 589.5$nm are used in abundance determinations basically for stars with metals deficiency. Despite significant weakening of lines in this case, the deviations from LTE appear rather large, as for stars with normal metallisity. (fig. 1). Even for MS stars nonLTE abundance corrections can reach to 0.5dex at T_{ef} = 6000 - 6500K.

Due to progress in infrared detectors there was the possibility to use at abundance analysis the NaI doublet $\lambda\lambda 818.3, 819.5$nm, which can be measured up to T_{ef} = 10000K. But it is necessary to mean, that for stars with [M/H] $\geq$ -1 the deviations from LTE for these lines are the same, as for resonance lines. For stars with more essential heavy elements deficiency they are less, but in whole range of parameters $(-\Delta X) \geq 0.1$dex.

For all the MgI spectral lines the absolute magnitudes of nonLTE abundance corrections do not exceed 0.25dex in whole range of investigated stellar parameters. For the λ457.1nm, λ571.1nm ΔX are positive and do not exceed 0.17dex. For the λ470.3nm, λ552.8nm $\Delta X < 0.04 dex$ for MS stars. For stellar atmospheres with $\log g \leq$3.0 there is the strong dependence of nonLTE abundance corrections from T_{ef} (fig. 2b) and they can have a different sign for stars with T_{ef}, distinguishing in limits 1000K.

For metal deficiency stars the $\lambda\lambda 517.2, 518.3$nm and $\lambda\lambda 382.9, 383.2, 383.8$nm are used at magnesium abundance determinations. If deviations from LTE are not taken into consideration the dispersion of abundances for them can reach to 0.3dex.

So, both for the NaI and for the MgI the nonLTE abundance corrections are very individual for each spectral line and for specific parameters of stellar atmosphere, and without realization of nonLTE calculations even the sign of these corrections cannot be predicted beforehand.

Astrophysicists interested in the results of nonLTE calculations for the NaI and MgI for the specific stars may address by e-mail to Mashonkina L.I. (Lyudmila.Mashonkina@ksu.ru) or Shimansky V.V. (Slava.Shimansky@ksu.ru).

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THE CHEMICAL COMPOSITION PECULIARITIES OF G,K GIANTS

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ABSTRACT. The review of the observed chemical composition in different groups of G, K - giants with peculiarities in spectra is presented. The old and young disk giants, Ba- and CH- stars, CN-week and CN-strong giants, R stars, Li-strong giants, SMR stars have been discussed.

Key words: stars:abundances - stars:atmospheres - stars:evolution

Introduction

G,K giants are evolved stars. Elemental abundances in these stars represent the chemical composition of matter whith that star formed and are test nucleosynthesis process and mixing events.

Among the giant stars of types G and K, a some stars have been observed to have Ba II, Sr II, Li I lines, CN and/or CH bands of abnormal intensity in their spectra. Such stars were divided into a few separate groups. The peculiar groups include (1) stars with Ba II, Sr II strong lines - Ba-stars, (2) giants with Li strong lines - Li-strong, (3) stars having the CN bands definitely weaker than the average for stars of the same temperature and luminosity - CN-week, (4) - stars with CN excess - CN-strong, (5) stars with CH strong bands - CH-giants and CH-subgiants, (6) strong individual atomic line stars having the metallicity excess - SMR-stars. What is the chemical composition of these group stars? What are causses of their peculiarities? That questions which we will be solved.

In this little survey we examined the G,K giant peculiar groups and connection with other groups of stars having similar metallicity, temperatures and luminosities.

Table 1 summarizes the elemental abundances of different groups of G,K stars.

Metallicity [Fe/H]

The one of main parameters of the chemical composition (with the exception of H and He) is metallicity (in the usual notation [Fe/H] = log $(Fe/H)_*$ - log $(Fe/H)_\odot$). The values of [Fe/H] reflect the metallicity of interstellar matter from which the stars formed and characarize their population-membership in the Galaxy. As can see from Table 1 the different peculiar groups of G,K giants have the metallicity within the metallicities of disk dwarfs (Edvardsson et al., 1993) and therefore belong to disk of the Galaxy. However taking into account the kinematic characteristics of disk giants Hartwick & McClure (1980) considered the old disk stars with large space motions ($V_{tot} > 65$ kms^{-1}) and young disk giants with $V_{tot} < 65$ kms^{-1}.

There are also other determinations of subsystems of the Galaxy (Spite 1992, Norris 1994), but the notation of Hartwick & McClure (1980) have been used in paper of Cottrell & Sneden, 1986. The authors carried out the study the old disk giants and found <[Fe/H]> = -0.45. Recently, Shetrone et al. (1993) reanalysis the papers of Cottrell & Sneden (1986), Lambert & Ries (1981) and Kjaergaard et al. (1982) and were found for the young disk <[Fe/H]> = +0.04 and for the old disk giants - <[Fe/H]> = -0.52. Ba-stars and CH-subgians have metallicity close to the old disk giants or to the thin old disk giants by Spite (1992); we have eliminated CH-giants since their [Fe/H] < -1.00. CN-week stars have intermediate metallicity of disk. Li-strong, CN-strong have [Fe/H] as one of the young disk giants. SMR-stars have metallicity higher than 0.2 dex. Taylor (1991) SMR status confirmed only for 31 Aql. Are these stars only moderately metal enriched with respect to the Sun, or do they constitute a distinct sybsystem with metallicities substancially above that of the Sun? Rich (1988) was studied K bulge giants and obtained that the mean value of [Fe/H] > 0.3 dex. Gratton & Sneden (1990), Cayrel de Strobel (1991) proposed that bulge giants and SMR stars belong to a distinct sybsystem with [Fe/H] >> $[Fe/H]_\odot$. McWilliam & Rich (1994) found that the mean [Fe/H] is -0.25 for the bulge. They perform an abundance analysis for 11 stars from Rich (1988) ranging from [Fe/H] = -1 to 0.45. The authors find that one of the most metal-rich Baade's window stars has approximately the same metallicity as the disk giant μ Leo. Note, that Taylor (1996) reconside the list of SMR stars and μ Leo no get the SMR status with highres reliable degree.

Table 1. The elemental abundances of different groups of G,K stars

	[Fe/H]	Li	$^{12}C/^{13}C$	[C/Fe]	[N/Fe]	[O/Fe]	[C/O]	[s-elem]
1.Normal (1)	-0.09	+0.1	18	-0.24	+0.38	+0.01	0.28	solar
Giants		(3)						(4)
2.Old Disk(5)	-0.45	-0.12						
Giants (6)	-0.52		15	-0.09	+0.02	+0.11		
3.Young Disk	+0.04		22	-0.22	+0.24	-0.04		
Giants (6)								
4.Ba-stars(7)	-0.5	+0.56	5-20	+0.06	+0.47	+0.17	0.19-0.59	
(8)	-0.20	-0.01						0.4(Y),0.8(Ba)
5.CH-subgians	0 -0.4						0.40-	0.2-
(9)							2.00	2.0
6.Li-strong								
(10)	0.0	2.14	9-24	-0.26	+0.12	-0.03		
7.CN-week								
(11)	-0.20	-0.55	5-28	-0.27	+0.21	+0.05	0.30	solar
8.CN-strong								
(12,13,14)	+0.02	+0.09		-0.17	+0.25	-0.08	0.46	solar
9.R stars								
(15)	near solar		7	+0.6	+0.38	+0.02	1.6	0.2
10.SMR-stars								
μLeo (16)	+0.34		18	-0.15	+0.60	+0.02		0.3
	+0.15							
(1)	+0.11		18	-0.09	+0.55	+0.17		
31 Aql (17)	+0.32	+1.20		-0.12	+0.22	-0.02		0.3
11.Bulge (18)	+0.3					near		near
Giants(19)	-0.25					solar		solar
12.Disk dwarf	+0.20-							
(20)	-0.90							

Notes:1- Lambert & Ries, 1981 (32); 2- Kjaergaard et al., 1982 (34);
3- Braun et al., 1989 (644); 4- Gopka et al., 1991;
5- Cottrell & Sneden, 1986 (34); 6- Shetrone et al., 1993 (31);
7- Barbuy et al., 1992 (11); 8- Zacs, 1994 (17);
9- Smith et al., 1993 (9); 10 -Berdyugina & Savanov, 1994 (8);
11-Luck,1991 (30); 12-Mishenina et al., 1995 (5);
13-Mishenina & Kutsenko,1996 (3); 14-Mishenina & Tsymbal,in press(9);
15- Dominy, 1984 (11); 16- Gratton & Sneden, 1990 (1);
17- Mishenina, 1996 (1); 18- Rich, 1988 (88);
19- McWilliam & Rich, (12); 20- Edvardsson et al., 1993 (189).

Our study of SMR star 31 Aql (Mishenina 1996) show that this star have metallicity larger than that solar, and the abundance patterns for 31 Aql follow to that of metal-rich disk dwarfs. So, the metal-rich stars are exist, but it is necessery to study the question about their belonding to a distinct sybsystem.

Li and CNO abundances

The Li and CNO abundances changed during the evolution of the star. The standard stellar evolution models (Iben 1967, VandenBerg 1992 etc) predicted convective dilution of Li of factors of 30-60 in ordinary disk giants. Though the "primordial" abundance of log A(Li) = 3.0 (Rebolo et al 1988), Li have destructed significantly before the onset of subgiants convective envelope dilution. The solar value of log A(Li) = 1.02 (star of the MS), thus the disk giants ought to have log A(Li) << 1.00. Braun et al., 1989 carried out the Li abundance determinations for 644 giants. The authors found the mean value of log A(Li) = +0.1. This result agrees with the canonical theory for giants. But, they also found a few stars with log A(Li) > 2.0. The evolutonry status of giants with high lithium abudances have been discussed in work of Berdyugina & Savanov (1994). The authors found that giants with larger Li abudance are on the first ascent of the giant branche, the other giants it possible are in the phase of helium burning in the core.

The predictions of internal stellar nucleosynthesis followed by convective mixing on the RGB, the first dredge-up, indique that the red giant relative to its main progenitor should have the following abundances:
- a reduced ^{12}C abundance; - a lower isotopic abundance ratio $^{12}C/^{13}C$ to about 25 or 30 from an assumed initial solar ratio of 89; - a higher ^{14}N abundance; - a very similar ^{16}O abundance (Iben 1967).

As can see from Table 1 the total CNO abundances (except Ba-, CH-, R stars) confirm the general prediction from stellar evolution theory that first-ascent red giants mix CN-processed material to their surfaces via their deep convective envelopes. Problems for standard stellar evolution exist as the $^{12}C/^{13}C$ ratios in many giants are less than 20. Two possible mechanisms have been hypothesized to account for the low values of $^{12}C/^{13}C$: 1) mass loss or 2) internal mixing. Recent calculations of Charbonnel (1994) suggest that the extra-mixing process occurs in giants with M < 2 $M_\odot$.

Ba-, CH-, R stars have the overabundances of carbon and CN-strong giants are sligtly C-rich (C/O > 0.5). Ba-giants and CH-subgiants have also overabundant s-process elements.

According the evolution theory in stars less than about 2.3 $M_\odot$, ignition of ^4He by the triple-alpha process occurs in a stellar core in which the electrons are degenerate. When degeneracy in the core is lifted, the core expands and quiescent core He-burning is established at a lower luminosity than the star had reached at the tip of the first ascent RGB. The role that the He core-flash may play in producing surface abundance changes is still an open question. Quasistatic models of the core-flash (Iben 1967) do not lead to the mixingof the products of He-burning into the H-rich envelope, however, Despain (1982) speculates that convective overshooting might lead to contact between the core and envelope. For the explanation of R stars - hot carbon stars Dominy (1984) suggests that the core He-flash with rapid core-rotation may provide the source of C-rich low-luminosity giants. Such rapid mixing inhibits $^{13}C(\alpha,n)^{16}O$ and thus none, or very few, neutrons are liberated with no subsequent s-processing. The theory and modeling of the core flash deserves much future attention. Recently Keenan & Heck (1994) suggest that CN-strong giants are marginal R stars. The found C overabundance for CN-stong stars (Mishenina & Tsymbal 1996) may be the support to the hypothesis of Keenan & Heck (1994).

A probable understanding of the Ba star phenomenon was McClure at al. (1980) discovery that all Ba stars are binaries with white dwarf companions, and that the abundance peculiarities are due to mass transfer from the companion during its pre-white dwarf evolution, presumably as a cool star. The stars on the AGB are the carbon giants. The dredge-up of ^{12}C during this phase of evolution (the third dredge-up) will produce carbon stars at luminosities log $L/L_\odot > 4.1$ and s-process enriched stars at log $L/L_\odot > 4.3$ (Iben & Truran 1978). For CH-subgiants Smith et al. (1993) show evidence of mass transfer onto main-sequence companions and judging by value of C abundance these stars probably are progenitors of Ba-giants.

Conclusion

The G-, K- giants by metallicity belong to young and old disk, SMR stars probable belong to metal-rich population of disk.

The Ba-giants, and CH- subgiants phenomena are mass transfer products. The R stars possible have undergone a core helium flash and some of CN-strong giants are probable marginal R stars.

The Li-rich giants probable reflect the Li overabundance in matter whith these stars formed.

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ABUNDANCES OF HEAVY ELEMENTS IN SIRIUS (Z>72)

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ABSTRACT. The abundances of eight heavy elements: Hf, Ta, W, Re, Os, Ir, Hg and Pb are found in the atmosphere of Sirius A. The Copernicus UV spectral atlas is used. The investigated elements show the overabundances with respect to the Solar system values in the range 0.7–2.7 dex.

Key words: Sirius – *r*-, *s*-process elements – stellar abundances.

In the last decade the abundances of heavy elements in the atmosphere of Sirius were investigated by Savanov (1987), Sadakane et al. (1987) and Sadakane (1991). The review of elemental abundances in the atmosphere of this Am star were made by Lyubimkov (1995). The present study is intended to determine the abundances of elements with atomic number Z>70 in the atmosphere of Sirius A (Sirius B is white dwarf).

The Copernicus Ultraviolet spectral Atlas of Sirius (Rogerson, 1987) was used as an observational spectrum. The atlas covers the wavelength region from 1649 Å to 3170 Å, the spectral resolution is 0.1 Å, signal to noise ratio can reach 100. The comparison of this atlas with recent GHRS/HST spectra of Sirius show the excellent agreement - the width of rotation profile of Sirius ($v \sin i$=12 km/s) exceed the width of instrumental profile of both spectrographs.

For investigation of abundances in the atmosphere of Sirius we used Kurucz (1995) atmosphere model with the following parameters: $T_{\rm eff}$=10000 K, lg g=4.3, [M/H]=0, $v_{\rm turb}$=2 km/s. We calculated the synthetic spectra of Sirius in the wavelength region covered by observed spectrum using Tsymbal (1996) program. Careful comparison of calculated and observed spectra permit us to identify the lines of iron group elements and heavy elements.

We made an attemp to check the abundances of iron group elements and adopted the abundances of these elements derived by Savanov (1987). It should be noted that the large difference (up to 1.2 dex) exist between the abundances of iron group elements derived by Savanov (1987) and Sadakane & Ueta (1989).

Abundances of selected heavy elements were derived using our software for automatic spectrum synthesis. The main part of it is SYNTHE code (Kurucz, 1995). In each case synthesis was performed taking into account all possible blending by atomic lines with measured wavelengths and oscillator strengths from Kurucz (1995) database (CD–ROMs 1,18,23). Synthetic spectra were broadened by rotation and instrumental profile.

Table 1: Lines of heavy elements in the spectrum of Sirius

Z	Ion	λ (Å)	log N	log gf	ref.
72	Hf II	2393.362	2.76	–0.70	CB
		2496.993	3.28	–0.30	CB
73	Ta II	2272.600	2.31:	0.48	CB
		2285.276	2.26	0.36	CB
		2400.637	1.63:	–0.26	CB
74	W II	2026.091	3.87	–0.98	CB’
		2030.001	3.78	–0.62	CB’
75	Re II	2504.563	2.31	1.00	CB
		2608.497	2.08	1.35	CB
76	Os II	2067.230	2.25	1.20	CB
		2194.403	1.88:	0.72	CB
		2580.024	2.31	1.62	CB
		2596.047	2.27:	2.14	CB
77	Ir II	2242.631	3.15:	2.14	MC’
80	Hg II	1942.313	2.49	–0.14	MIG
82	Pb II	1642.127	4.13	–0.56	MIG’
		2203.534	4.03	–0.10	MIG’

References:
CB – Corliss & Bozman, 1962a
CB’ – Corliss & Bozman, 1962b
MC’ – Meggers et al., 1975
MIC – Migdalek, 1976a
MIC’ – Migdalek, 1976b

The used lines are listed in Table 1: the charge of nuclei (Z), identification of ion, wavelength, abundance in the scale log N(H)=12.00, oscillator strength (log gf) and reference for log gf.

The mean values of abundance of investigated elements are shown in Table 2: the charge of nuclei, identification of element, number of used lines, abundance in the atmosphere of Sirius, solar or meteoritic abundance according to Grevesse & Noels (1993), relative

Table 2: Abundances of heavy elements in the atmosphere of Sirius

Z		N	$\log N$	$\log N_\odot$	$\Delta \log N$
72	Hf	2	3.02	0.88	+1.88
73	Ta	3	2.06	0.13	+2.28
74	W	2	3.82	1.11	+2.71
75	Re	2	2.20	0.27	+1.93
76	Os	4	2.18	1.45	+0.73
77	Ir	1	3.15	1.35	+1.80
80	Hg	1	2.49	1.09	+1.40
82	Pb	2	4.08	1.85	+2.23

abundance of the element in the Sirius atmosphere with respect to the solar system one.

We must to mention that Sadakane et al. (1987) determined the value of abundance of Hg in the atmosphere of Sirius very close to this study. Sadakane (1991) investigated the abundances of Mo, Cd, W and Pb in Sirius. Our results for W and Pb agree with Sadakane (1991) after correction of oscillator strengths.

All elements, investigated in this study show the large overabundances with respect to the solar system abundances. The abundances of two of them - Ta and Re are not known even for the Sun.

New measurements of oscillator strengths are desired to obtain a more precise result.

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THE CHEMICAL COMPOSITION OF PROCYON

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ABSTRACT. The review of last studies on the chemical composition of Procyon showed that the abundances of 55 elements were investigated in the atmosphere of Procyon. The abundances of majority of elements are near Solar systems values. The exceptions are Li, Be, B, Se, Te. The possible explanation of tellurium overabundance is proposed.

Key words: $r-, s-$process elements – stellar abundances.

Procyon is one of the brightest F-stars. The chemical composition of Procyon was investigated repeatedly. The review of elemental abundances in the atmosphere of Procyon A (Procyon B is a white dwarf) were made by Lyubimkov (1995) and Drake & Laming (1995). The present study will review the latest investigations of Procyon and propose the possible explanation of tellurium overabundance in the atmosphere of this star.

The abundances of Li, Be, B were investigated by Lemke et al. (1993) using GHRS spectra. They found that Procyon is highly depleted in Li and Be, and depleted in B by a factor at least 3. The lithium abundance in Procyon was investigated by Ferluga et al. (1995). These authors used spectra with high signal to noise ratio (500) and resolving power 110,000 but were not able to detect lithium lines near λ 6708 Å. The Li abundance in Procyon was investigated by Gerbaldi et al. (1995). A NLTE studies of elemental abundances in Procyon were published by Kiselman (1994) for boron, Takeda (1994) for CNO, Takeda & Takeda-Hiday (1994) for sodium, Takeda et al. (1996) for potassium, and Mashonkina et al. (1995) for Na, Mg, K, Ba.

The abundances of Th, Te, Re in Procyon were determined by Yushchenko & Gopka (1994), Gopka et al. (1995a), Yushchenko & Gopka (1996a). The abundance of Er in the Procyon atmosphere was redetermined by Gopka & Yushchenko (1995). The determination of abundances of Ge, Mo, Ag, Cd, Te, Ho, Hf, Os, Ir in Procyon and a review of abundances of 34 *r*-, *s*-process elements was made by Yushchenko & Gopka (1996b).

The abundance pattern in Procyon consist of Li, Be, B, C, N, O, Na, Mg, Al, Si, S, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni and 34 *r*-, *s*-process elements. The abundances of 55 elements in the atmosphere of Procyon A are known and it is one of the highest level of completeness of stellar elemental abundance distributions (Sun - 72 elements).

The detailed abundance pattern in Procyon can help to answer Steffen's (1985) question: whether the white dwarf companion has contaminated the atmosphere of Procyon A with nuclear processed matter when loosing (explosively ?) a great fraction of it's mass. The elemental abundance distribution for Procyon show that the abundances of majority of the heavy elements are near Solar system values ($\pm$0.1 dex).

We must to mention that all but few abundance determinations for Procyon were made with Kurucz (1979) models. Yushchenko & Gopka (1996b) showed that new grid of Kurucz (1992) models may led to small overabundance (near +0.1 dex) of heavy elements in the atmosphere of Procyon A, but new investigation of atmospheric parameters is necessary.

Only two of the heavy elements show large discrepancies from Solar system values. These are Se, Te. The underabundance of Se (-2.4 dex) were found by Farragiana et al. (1986) from 1 line in IUE spectrum of Procyon and must be confirmed by high signal to noise observations and determinations of $\log gf$ for this line.

The overabundance of Te (+0.8 dex) in the atmosphere of Procyon A with respect to the meteoritic value was found by Gopka et al. (1995) using weak line λ 3175.147 Å. Second line of Te λ 2142.822 Å confirmed this result (Yushchenko & Gopka, 1996b).

The location of tellurium (Z=52) on the plot of relative abundances of *r*-, *s*-, *p*-process nuclei as a function of their mass number at the maximum of r-process can partly explain it's overabundance. But second r-process element, thorium show solar abundance.

The structure of above mentioned plot of relative abundances was explained by Burbidge et al. (1957). Another explanation of maximum of the plot of relative abundances near Te and Xe was proposed by Selinov & Frenkel (1950), Selinov (1958, 1964): the decay of superheavy nuclei. Kramarovskij & Chechev (1987) pointed that Selinov's prediction was confirmed by Lougheed et al. (1985). Lougheed et al. (1985) found

decay $^{260}_{101}Md = {}^{132}_{50}Sn + {}^{128}_{51}Sb$. If nucleosynthesis in r-process can reach the region of superheavy β-stable nuclei with Z=100-114, the results of decay of these nuclei can strongly influence on the structure of the plot of relative abundances in the region near mass number A=130.

New measurements of oscillator strengths and observations of Procyon with better signal to noise ratio and high spectral resolution in the UV spectral region are desired to obtain a more precise result.

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SUBDWARFS: ABUNDANCE OF LIGHT ELEMENTS

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ABSTRACT. CNO abundances in the atmospheres of seven metal-deficient stars were derived by model atmosphere method on the basis of high dispersion Echelle spectra obtained using the 6-m telescope of the Special Observatory of the Russian Academy of Sciences. The O abundance are derived from lines of IR-triplet OI 7773 A. The C_2(0,1) bandhead of the Swan A^3II_g-X^3II_u system, at 5635.5 A is used to derive the C abundances. To derive the nitrogen abundances, the CN red system A^2II-$X^2\Sigma$ was used, the CN(5,1) 6332.18 Å and 6478.48 Å were considered. The obtained [O/Fe] values confirm the trend of [O/Fe] vs [Fe/H]. For stars of our sample with [Fe/H] > -1.00 we found that nitrogen is overabundant relative to iron, carbon - underabundant.

Key words: stars:abundances - stars:atmospheres - stars:evolution

Introduction

The stars with large proper motions represent the old population of the Galaxy. Its atmospheres reflect the chemical composition of the interstellar medium at the time the stars formed and the study of element abundances in atmospheres of the unevolved stars permit to testify the process in early evolution of the Galaxy.

In this work we investigated CNO abundances in the atmospheres of metal-deficient stars (with large proper motions) by the synthetic spectral method from atomic and molecular spectral features.

Observations and atmosphere parameters

The program stars were selected from Laird et al. (1988) survey and (Carney et al., 1994). The observations have been carried out at the 6m telescope echelle spectrometer LYNX (Panchuk et al., 1993). equipped with a CCD of 530x580 pixels. The spectral resolution R = 25000, S/N ratio is more than 100 within the wavelength range 5200-8800 Å. Echelle spectra have been processed using the program of Galazutdinov (1992). Basic data and model atmosphere parameters are given in Table 1 (in detail, see Klochkova et al., 1995).

Table 1. The main data of the stars

Star	V	T_{eff}	log g	[Fe/H]	V_t
HD 64090	8.28	5370	3.0	-1.76	2.5
G29-20	9.17	5030	2.0	-0.91	1.2
G122-57	8.36	5040	3.0	-0.33	1.0
G182-7	8.10	5500	4.2	-0.14	2.0
G188-22	10.05	5860	3.5	-1.43	1.7
G246-38	9.91	5240	3.5	-2.00	3.5
G265- 1	8.37	5500	3.0	-0.65	1.5

Synthetic spectra for CNO abundance determination

CNO abundances are derived with the synthetic spectral method by the program STARSP (Tsymbal ,1994). The model atmospheres for each star are obtained by interpolations in the grids of model atmospheres by Bell et al (1976) and Kurucz (1979). Control of the parameter atmosphere choice was accomplished by the Fe I lines in the region of the spectral features using for this analysis. The accuracy of these abundance determination is 0.3 dex. The input list of atomic and molecular lines was compiled from (Kurucz 1993). Oscillator strengths $\log gf$ for atomic lines were taken from (Kurucz,1993). FMHM = 0.25 Å.

Oxygen. The O abundance are derived from lines of IR-triplet OI 7773 A. As find by King and Boesgard (1995) for T_{eff} < 6200 K no systematic difference between the [O] 6300 Å and 7774 Å abundances for metal-poor giants or dwarfs.

Carbon. The C_2(0,1) bandhead of the Swan A^3II_g-X^3II_u system, at 5635.5 A is used to derive the C abundances. In the molecular line list of this feature were include the blend line of CN molecule but its influence become visible for temperatures lower 5000 K. $\log gf$ for C_2 lines were corrected according to (Shavrina and Kuznetsova 1996). A dissociation potential of D(C_2) = 6.15 eV was used.

Nitrogen. To derive the nitrogen abundances, the CN red system A^2II-$X^2\Sigma$ was used, the CN(5,1) 6332.18 Å and 6478.48 Å were considered. The dissociation potential adopted was D(C_2) = 7.76 eV.

As for atomic carbon and nitrogen lines, the availa-

Table 2 Relative CNO abundances

Star	[C/Fe]	[N/Fe]	[O/Fe]
HD 64090	-	-	+0.39
G29-20	-0.10	+0.30	+0.35
G122-57	-0.20	+0.30	+0.15
G182-7	-0.16	+0.10	-0.36
G188-22	-	-	+0.50
G246-38	-	-	+0.80
G265- 1	0.00	+0.26:	+0.29

ble molecular bands are too week (not measurable) in metal-deficient stars in which [Fe/H] < -1.00 and T_{eff} > 5000 K. As shown our calculations, the bands are measurable at [Fe/H] < -1.00 on the temperatures lower 4500 K. C and N abundances have been obtained for stars with [Fe/H] > -1.00 .

The results are given in Table 2.

Discussion of results

Oxygen. According recently stellar evolution theory, oxygen is transformed into nitrogen in deep layers and is not mixed to the surface. Therefore, O abundance in case of unevolved and evolved stars reflects the matter from which stars formed. For all investigated stars have been obtained that O is overabundant relative to iron. Our values [O/Fe] confirm also the trend of [O/Fe]vs[Fe/H] shown by many authors (for example, Sneden et al. 1979; Barbuy 1983 etc) which testify that the halo was overenriched in oxygen with respect to iron at early times. Matteucci and François (1992) discuss the behavior of [O/Fe]vs[Fe/H] and a change in slope in the [O/Fe] ratio occurring at [Fe/H] = -1.7, as claimed recently by Bessel et al. 1991. They show that a change can be reproduced by a model where the star formation rate is almost linear with gas density and the iron production from massive stars is lower than previously assumed. A squared dependence of the star formation rate on the gas density will produce an almost constant [O/Fe] ratio between -3 and -1 in [Fe/H].

Carbon and nitrogen. The standard theory predicts that the matter enriched by CN-cycle products transferred to surface layers of stars and in evolved star atmosphere we must observe C underabundance and N overabundance. For stars of our sample with [Fe/H] > -1.00 we found that nitrogen is overabundant relative to iron, carbon - underabundant.

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BROWN DWARFS: MYSTERY AND SHOW

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ABSTRACT. Results of the numerical simulation of the spectrum of the brown dwarf candidate Teide1 discovered by Rebolo et al. (1995) are discussed.

Key words: brown dwarfs: spectra: lithium abundances.

INTRODUCTION

Low luminosity M-dwarfs of the bottom of Main Sequence are the best brown dwarf candidates. Rebolo et al.(1992) and Magazzu et al. (1993) put forward the idea of *lithium test* for search these substellar objects. Last year Basri et al. (1995) reported the discovery of Li I resonance lines in spectrum of M-dwarf PPL15 in Pleiades. PPL15 lays on the boundary between brown dwarfs and low mass stars. Recently Rebolo et al. (1995) using a deep IR survey of the Pleiades center found a cluster of very low luminosity objects. Strong enough Li lines were observed in spectra of two members of the group labeled Teide1 and Calar3 (Rebolo et al. 1996).

PROCEDURE

Computations of LTE synthetical spectra were performed by WITA30 program (Pavlenko 1996) for Allard and Hauschildt (1995) model atmospheres.

OBSERVATIONAL MATERIAL

In this paper we use Teide1 spectrum $\lambda\lambda$6200-9300 Å observed with effective resolution 3.0 Å by Rebolo et al. (1996) at 10 m Keck telescope(Mauna Kea, Hawaii).

RESULTS

The fit of low-resolution Teide 1 spectrum by JOLA: 6200-9000 Å region

The shape of the visible region of Teide1 spectrum is governed by the absorption of TiO and VO bands (Fig.1, see also Kirkpatrick at al.1991).

We found:

– Teide 1 spectra may be fitted by JOLA in the visible region, at least around Li I lines $\lambda\lambda$6708 and 8126 Å.

– the comparison of observed and computed spectra shows that the effective temperature of Teide1 $T_{eff} \approx$ 2700 K.

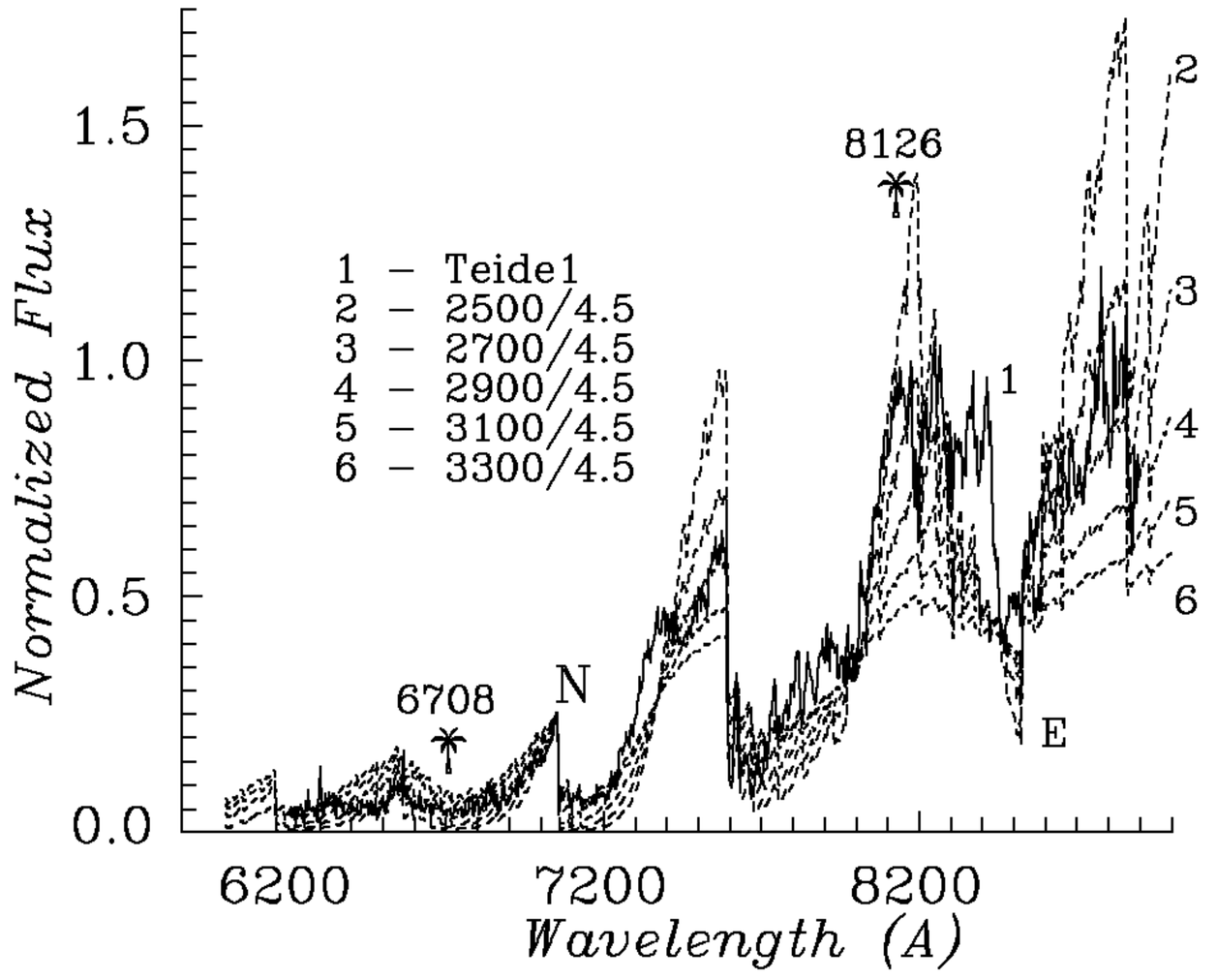


Figure 1: Observed Teide1 spectrum (solid line). Dashed lines show theoretical JOLA fluxes normalized to equal value at 6709 $\mathring{A}$

Equivalent width's analysis

Rebolo et al. (1996) obtained the "pseudoequivalent widths" of $\lambda\lambda$6708 and 8126 Å Li I doublets (W_λ =1.0± 0.2 Å and 100 ± 25 mA, correspondingly) in Teide1 spectrum. These W_λ were measured with respect to the spectrum (pseudocontinuum) of M-dwarf (VB10) of the same T_{eff} , which does not show any Li lines. For several model atmospheres we computed theoretical "pseudoequivalent widths" $W_\lambda^J = f(logN(Li))$ (Fig.2):

$$W_\lambda^J = \int (1 - H_\nu^{JOLA+Li}/H_\nu^{JOLA}) d\nu$$

Note, even for $logN(Li)$ =3.5 the W_λ^J is much lower than measured by Rebolo et al. (1996) in spectrum Teide 1 .

The spectrum nearby λ 8126 $\mathring{A}$ line is less blended. So the equivalent width determination should be more confident here. For W_λ^J= 100 mA we have got $logN(Li) = 2.9$.

Let me note another important result:
W_λ^Jvalues *for both lithium doublets* are practically the

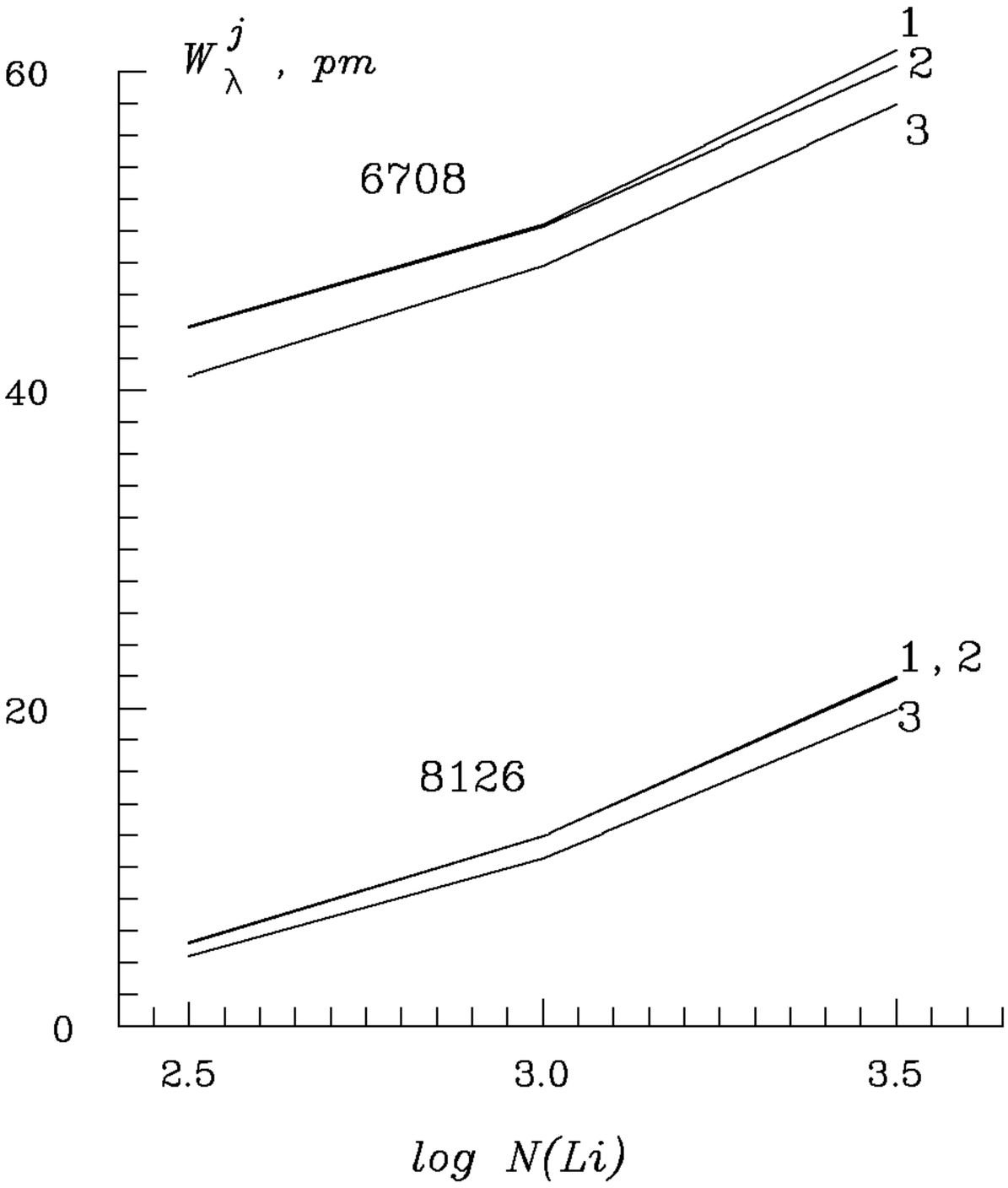


Figure 2: Pseudoequivalent width of Li I lines computed for model atmospheres from AH95 grid: 2500/5.0 (1), 2700/5.0 (2) 3000/5.0 (3)

same for 2500/5.0 and 2700/5.0 model atmospheres in the wide range of $logN(Li)$.

DISCUSSION

From analysis of pseudoequivalent widths of resonance and subordinate lithium lines in Teide1 we obtaine high lithium abundances in its atmosphere. So we have got strong argument to identify Teide1 as the *real brown dwarf*.

The results obtained in this paper are model dependent. We used theoretical model atmospheres, simplified model of molecular absorption. Our computations were performed in the frame of LTE.

On another hand we could fit low resolution spectrum of Teide1 using these input data and physics. Differences in $logN(Li)$ obtained for resonance and subordinate lines are caused by a few reasons. Saturated Li I resonance lines are formed in the outermost atmospheric layers which may be affected by non-classical phenomena: NLTE, chromospheres, etc. In that sense the use of subordinate Li I line 8126 Å should give better results.

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LTE and NLTE LITHIUM ABUNDANCES IN ATMOSPHERES OF LITHIUM RICH RED GIANTS

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ASTRACT Results of the computations of the statistical balance of lithium in atmospheres of a sample lithium rich G-K giants are discussed. Investigations were performed for 20-level model lithium atom by complete linearisation method. Blocking effect due to the radiation absorption by atoms, ions and molecules was taken into account. The abundances of lithium in atmospheres of 13 red giants have been reconsidered taking into account NLTE effects.

Key words: red giants: NLTE: lithium abundances

PROCEDURE

To solve the system of statistical balance and radiative transfer equations (NLTE problem) for 20-level lithium atom we followed the modification of the linearization method proposed by Auer and Heasley (1976). Opacity in frequencies of lithium bf and bb transitions were computed taking into account continuum, atomic and molecular absorptions. Our computation procedure was described elsewhere (Pavlenko 1989, 1992, 1995, 1996). In the frame of this investigation we compare the new NLTE results and obtained by Pavlenko (1989, 1992) for 6-level lithium atom. The system of ionization-dissociatiom equilibrium equations was solved in the frame of LTE for 98 species.

MODEL ATMOSPHERES

We used the model atmospheres of red giants computed by SAM71 program (Pavlenko 1991). Molecular opacity due to 21 molecular bands absorption was taken into account by JOLA approximation (see details in Pavlenko et al. 1995). The comparison of the newest Kurucz's (1993) model atmospheres and computed by SAM71 shows a good agreement ($\Delta T < 50K$ at given depths).

RESULTS

We note a few important items(see Pavlenko 1996 for details):

– NLTE curves of growth (COG) of lithium lines are significantly different for given G-K giants. The value of the NLTE abundance correction $\Delta_{\rm nlte} = logN_{nlte}(Li) - logN_{lte}(Li)$ varies in large scale: from -0.4 dex (for HD 112127) up to 0.2 dex(for Cappella B).

– In the case of G-K giants with $T_{\rm eff} < 4500$ K the NLTE curves of growth of lithium lines are much less sensitive to $T_{\rm eff}$ and μ parameters in comparison with LTE.

– Results obtained for 20-level and 6-level model atoms of lithium agrees well enough.

Using results of LTE & NLTE computations of curves of growth we reconsidered lithium abundances in atmospheres of a few lithium rich red giants taking into account NLTE effects (Table 1).

DISCUSSIONS

Our investigation shows the different impact of the NLTE effects on Li I resonance and subordinate lines. The NLTE abundance corrections $\Delta_{\rm nlte}$ for Li I subordinate lines are always positive. For resonance Li I lines we have found the NLTE correction sign and values depend on the effective temperature, lithium abundance, metallicity(see also Pavlenko (1991, 1992, 1995), Carlsson at al. 1994).

The NLTE COG's show weaker dependence on μ and log g which usually are not known for many giants with high accuracy (Pavlenko 1996, see also Pavlenko & Magazzu 1996).

For saturated resonance lines NLTE effects shift lithium abundances toward lower values. In same cases (HD9746, HD112127) this effect may weak or even cancel the problems of interpretation of high lithium abundances in red giant atmospheres.

Anyway, *NLTE computations give more confident results of Li abundance determination in red giant atmopspheres.*

Effects of spherical geometry, chromospheres, inhomogeneity of the stellar atmosphere were not considered in this study. So we may treat these results as a necessary step towards better understanding of the Li lines formation processes in atmospheres of red giants.

Table 1. Lithium abundances in G-K giant atmospheres

Star, HD	T_{eff}	$\log g$	$[\mu]$	Ref.	$\log N(Li)$ LTE	$\log N(Li)$ NLTE	Δ
787	4220	1.5	0.07	1	1.8	1.71	-0.09
9746	4420	2.3	-0.13	1	2.7	2.40	-0.30
30834	4190	1.5	-0.17	1	1.8	1.73	-0.07
108471	4970	2.8	-0.02	1	2.0	2.07	0.07
112127	4340	2.1	+0.31	1	2.7	2.30	-0.40
120602	5000	3.0	-0.07	1	1.9	1.98	0.08
126868	5440	3.2	-0.25	1	2.3	2.34	0.04
148293	4640	2.5	+0.23	1	2.0	2.14	0.14
183492	4700	2.4	+0.08	1	2.0	2.15	0.15
205349	4480	0.6	0	1	1.9	1.89	-0.01
Capella A	4800	2.6	0	2	0.86	1.03	0.17
Capella B	5550	2.9	0	2	3.10	2.94	-0.16
9 Boo	4200	1.0	0[4]	3	2.00	2.10	0.10

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ABOUT PROBABILITY OF RESEARCH OF THE NN Ser SPECTRUM BY MODEL ATMOSPHERES METHOD

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ABSTRACT. The spectrum of close binary system NN Ser is investigated by a models atmospheres method. It is show that the atmosphere near the centrum of a hot spot on surface of red dwarf has powerful chromosphere, arising from heating in Laiman continua. Four models of binary system with various of parameters are constructed and their theoretical spectra are obtained. Temperature of white dwarf $T_{ef} = 62000\,\mathrm{K}$, radius of the red dwarf $R_r = 0.20 R_\odot$ and angle inclination of system $i = 82°$ are determined. The spectrum having the good coincidense with data of observation is received.

Key words: Line: formation - Stars: atmospheres

In the several previous work (Sakhibullin and Shimansky, 1996) we have developed a method for account of irradiated stellar atmospheres in half-grey approximation for quantitative description of close binary systems spectra. To test this method in our work we use close binary system, for which there are the high quality observations, several of main parameters were determined and complicating phenomenones (accretion disk and gas envelope) are absent.

We used the results of spectroscopic observations, published in work Catalan et al. (1994). Given observations were made on 4.2-m William Hershel Telescope for several phases and have the average resolution of 5A in studied range. The main accounts were performed by us for average on phases 0.25 - 0.80 spectrum with use of the following parameters, determined in the work Catalan et al. (1994): binary separation $a = 0.95 R_\odot$, red and white dwarfs masses $M_r = 0.12 M_\odot$, $M_w = 0.57 M_\odot$. For other parameters in work Catalan et al. (1994) the limits of changes are given only. We have attempted to obtain the best approximation of observable and theoretical spectra NN Ser and have changed the parameters in available limits. In Table 1 we give these parameters for four various models of the system.

The account of a complete spectrum of double system is made with the complex of the codes SPECTR with use the BINARY3 - code for blanketed model atmospheres and the BINARY2 - code for the inclusion

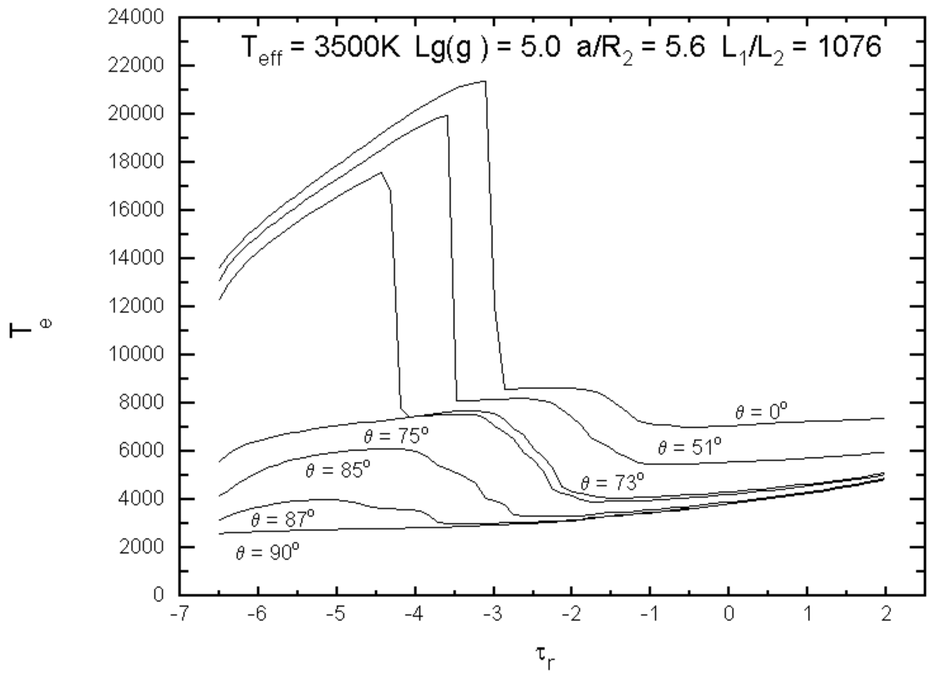


Figure 1. Distributions of temperature in model atmosphere for some angles Θ.

of reflection effect. The technique of account of stellar spectrum with external irradiation was developed in previous work (Sakhibullin & Shimansky, 1996). Model atmospheres of white dwarfs with $T_{ef} = 55000\,\mathrm{K}$, $60000\,\mathrm{K}$, $62000\,\mathrm{K}$ and $\lg(g) = 7.75$ were obtained by code BINARY3 with blanketing effect in 1500 lines and their spectra were calculated by code BINARY2. We received a complete synthetic spectrum of all system with allowance for the radial velocities of the components, the inclination angle and spectral resolution of $5A$. By this way we have computed intensities for spectral lines at 36 phases of rotation in CBS. The oscillator strengths for lines under investigation were taken from different sources (Kurucz and Peytremann, 1975; Wiese et al., 1969; Radzig and Smirnov, 1985). Line profiles were computed with Doppler broadening, Stark effect, Van der Waals broadening included according to the data by Kurucz (1975) and Unsold (1955).

In Fig. 1 we represent the distributions of electronic temperature T_e versus depth τ_r for some rings with different inclination angle Θ of incident radiation. The atmosphere near to centrum of a hot spot has powerful chromosphere, arising from heating in Laiman continua. On greater depth secondary chromospheres will be formed from heating in continua of the Ca 2, C 1, Si 1 and Fe 1. In peripheral areas of a spot the external radiation is not enough for heating atmosphere down to zone of temperature instability $T_e = 8000 - 14000$ K and "hydrogen" chromosphere will not be formed.

Obtained by us theoretical fluxes in continua for four

Table 1: Red and white dwarfs parameters for four models NN Ser, theoretical and observable fluxes: F^1 - average on phases 0.25 - 0.80, F^2 near to phase 0.00

Model	**I**	**II**	**III**	**IV**	
$T_w(K)$	55000	60000	62000	62000	
$R_w(R_\odot)$	0.019	0.019	0.019	0.019	
$T_r(K)$	3500	3500	3500	3500	
$R_r(R_\odot)$	0.20	0.20	0.17	0.20	
$\lambda(A)$	$\frac{F^1_{the}}{F^2_{the}}$	$\frac{F^1_{the}}{F^2_{the}}$	$\frac{F^1_{the}}{F^2_{the}}$	$\frac{F^1_{the}}{F^2_{the}}$	$\frac{F^1_{obs}}{F^2_{obs}}$
5500	$\frac{1.54}{1.04}$	$\frac{1.72}{1.06}$	$\frac{1.47}{1.02}$	$\frac{1.64}{1.04}$	$\frac{1.65}{1.06}$
5200	$\frac{1.62}{1.16}$	$\frac{1.77}{1.14}$	$\frac{1.55}{1.12}$	$\frac{1.71}{1.13}$	$\frac{1.72}{1.16}$
5000	$\frac{1.65}{1.19}$	$\frac{1.80}{1.19}$	$\frac{1.61}{1.19}$	$\frac{1.76}{1.19}$	$\frac{1.75}{1.19}$
4800	$\frac{1.70}{1.26}$	$\frac{1.84}{1.26}$	$\frac{1.66}{1.26}$	$\frac{1.80}{1.26}$	$\frac{1.78}{1.26}$
4700	$\frac{1.73}{1.32}$	$\frac{1.87}{1.32}$	$\frac{1.69}{1.31}$	$\frac{1.82}{1.32}$	$\frac{1.80}{1.32}$
4600	$\frac{1.77}{1.37}$	$\frac{1.92}{1.37}$	$\frac{1.74}{1.37}$	$\frac{1.86}{1.37}$	$\frac{1.85}{1.37}$
4200	$\frac{1.94}{1.61}$	$\frac{2.07}{1.61}$	$\frac{1.93}{1.61}$	$\frac{2.04}{1.62}$	$\frac{2.12}{1.64}$
4050	$\frac{2.01}{1.70}$	$\frac{2.13}{1.70}$	$\frac{2.01}{1.71}$	$\frac{2.11}{1.70}$	$\frac{2.17}{1.70}$
3700	$\frac{2.44}{1.93}$	$\frac{2.60}{1.93}$	$\frac{2.39}{1.95}$	$\frac{2.54}{1.94}$	$\frac{2.52}{1.92}$
3640	$\frac{2.38}{1.97}$	$\frac{2.53}{1.98}$	$\frac{2.37}{2.01}$	$\frac{2.48}{2.00}$	$\frac{2.60}{2.00}$

models and observable ones are submitted in table 1 for several frequencies. Results show, that the best exists at increase of red dwarf radius over established limit in $0.18R_\odot$ up to $0.20R_\odot$. White dwarf temperature is defined correctly only on observations of a hot spot. We assume, that true white dwarf temperature is about $T_{ef} = 62000K$. The inclination angle of system equal to 82° can be appreciated from red dwarf radius.

On Figure 2 the final spectra are given for the model **IV**. The best coincidense with observable spectrum is present for lines H_β, H_γ and H_δ and for lines of Paschen series of the hydrogen. Theoretical intensities of the line H_α and the lines after H_δ are less than observable ones. The He 1 emmision theoretical lines also are a little bit more weak than observable ones, that it shows on probable "overionization" for He 1. Absorption part of lines have the good theoretical description, except for the wings of the line H_γ. The existence " over-recombination" in irradiated atmospheres was shown early (Sakhibullin & Shimansky, 1995) for "cool" lines of a type Ca 2. Therefore the accounts with allowance for of departures from LTE are especially important for line Ca 2 λ3933Å. As a whole we ascertain the good consent with observations as for continua and for lines.

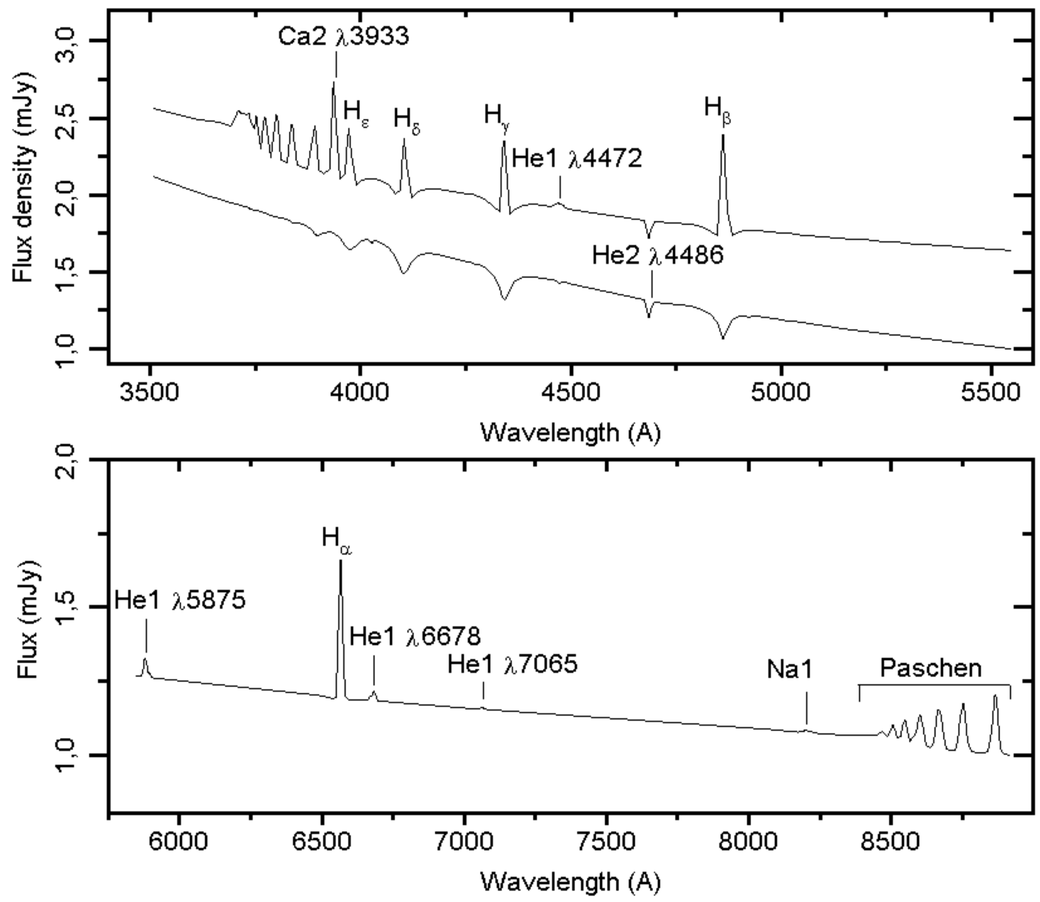


Figure 2. An average spectrum NN Ser for phases 0.25 - 0.75 and spectrum near to phase 0.00 for parameters of system $a = 0.95$, $i = 82°$, $T_w = 62000\,\mathrm{K}$, $T_r = 3500\,\mathrm{K}$, $R_w = 0.019$, $R_r = 0.20$.

Acknowledgements. We would like to thank V. Suleymanov and V. Neustroev for initiation of the present work and useful discussion. The authors are grateful to the Russian Basic Research Foundation (Grant 96 - 02 - 16306 - a) for the financial support of this work.

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ON THE SPOTTEDNESS OF RED DWARF STARS

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ABSTRACT. A new approach for analysis of the spottedness of red dwarfs based on their multicolor photometry is shortly described and main results of such an analysis are presented.

Key words: Stars: spots.

The usually used algorithm for starspot parameters estimations from a photometry of a star gives a hierarchical model of its spottedness: firstly, parameters of "a main spot" are defined, and then parameters of one or two less essential starspots are calculated in consecutive order. However, this algorithm gives often large circumpolar starspots and is apparently not adequate for a task of a surface heterogeneity study of red dwarfs with the activity of the solar type, since sunspots occur only within rather narrow low latitude intervals.

Within the framework of a general approach to calculate theoretical light curves of spotted stars, the simplest model of a stellar zonal spottedness with the least number of free parameters is proposed: a totality of starspots are approximated by two spotty belts that are symmetrical relatively to the stellar equator and have variable filling factors along longitudes. Such a model is described by 4 free parameters: distances of spotty belts from the stellar equator, their widths, a parameter of a filling factor variation along the stellar longitudes and a ratio between brightnesses of spotted areas and of the quiet stellar photosphere. An algorithm for estimation of these parameters from $BVRI$ photometry is developed. Application of the methodics developed to 19 epoches of observations of the flare spotted star EV Lac has shown a possibility to represent observational data successfully within the framework of the model proposed.

This new approach to analysis of periodic brightness variations of BY Dra-type dwarfs, where in the first time general features of spotted stellar areas are considered instead of traditional estimations of parameters of individual starspots, has been realized to analyze the all available long–term $BVRI$ observations of such stars – 174 epoches of 17 red dwarfs. The analysis carried out allows to make the following conclusions.

1. The simplest model of a zonal spottedness permits to represent main parameters of observable $BVRI$ light curves of each star with a high accuracy.

2. The proposed model represents observations without a hypothesis on existence of large cool circumpolar starspots, their existence is often suggested in the hierarchical model of stellar spottedness but it contradicts to the known picture of the solar spottedness and meets difficulties from the point of view of the stellar magnetism theory.

3. Within the framework of the model of a zonal spottedness an increase of a mean brightness of a star from a season to another season may be accompanied both by an increase and by decrease of an amplitude of a rotational modulation of its brightness – as it is observed in reality – while whithin the framework of traditional models one should expect a decrease of this amplitude only unless one suggests essential reconstruction of a large circumpolar starspot.

4. The whole observed variety of main parameters of light curves of spotted red dwarf stars – mean season brightresses, amplitudes of brightness rotational modulation and ratios of amplitudes in the $BVRI$ bands – succeeds in representating within the framework of the simplest 4–parameters model of a zonal spottedness with distances from stellar equators to spotty belts from 0 to 21^o, with widths of the belts from $1.^o6$ to 33^o, with the least filling factors within the belts from 0.00 to 0.93, and with ratios between brightness of spots and brightness of quiet photosperes in the V band from 0.03 to 0.62. As a result, models considered give the total spottedness from 1.9 to 42% of the whole stellar surfaces.

5. The combined consideration of all calculated models permits to note some statistical regularities.

For cool stars of our sample – $V - I > 1.^m5$ – calculations give a merging of two suggested symmetrical to an equator belts into one structure. For a half of warmer stars calculations give two separated belts, as we see in the solar case. Among the warmest stars of our sample, which have the spectral class G, the same as the Sun has, we find objects with the largest rotational periods, with the least spottednesses and with the least extention of spotty belts along their latitudes. In other words, a tendency to merging of the solar spottedness characteristics and parameters of our calculated models is outlined. The same tendency appears in consideration of temperature features of starspots: if one constructs a dependence between the stellar colour indices

$V - I$ and starspot temperatures, the sunspots meet this dependence as well. These results give a ground to suggest that the found models of zonal spottedness of stars have essential features of surface heterogeneities of red dwarfs indeed.

This study is described in four papers by authors: in *Astron.Zhurn.* v.73, N 4, 1996 (two papers), in *Astrofizika*,v.39, N 1, P.67, 1996 and in *Astron.Zhurn.* v.74, N 1, 1997 (in press).

TWO NEW VARIABLES (MIRAS?) IN OPHIUCHI

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ABSTRACT. Two new variables, possible Mira–type stars, are discovered in Ophiuchi constellation in 1995 year.

Key words: Stars: Mira

Observations

During the monitoring of the X-ray Nova Oph 1993 = V 2293 Oph ($\alpha = 17^h16^m$, $\delta = -24°58'$, Eq. 1950), two new variable stars were discovered. The first variable is localized at 2 arc minutes to the west (star "a") and the second one – at 2.5 arcminutes to the north (star "b") from Nova Oph. Observations have been carried out at TV complex MTM-500 of the Crimean astrophysical observatory in 1995-1996 years. The rough brightness estimates were made in R and V standard colour system using the secondary photometric standards around RT Ser (Bochkov et al., 1994). They are given in Table 1.

Table 1. V and R magnitudes for two new variables.

JD	V ("a")	R ("a")	V ("b")	R ("b")
2449981.23	17.5	12	> 19	16 :
2450213.43	18.5 :	12.5	18 :	11
2450220.49	19 :	13	> 19	11
2450274.33	> 19	16.5	> 19	13

The large amplitude of brightness variations in R, very red colours together with space localisation of variables define that variables could be the Mira–type stars.

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CONTEMPORARY PROBLEMS OF ASTRONOMY: THE CHEMICAL COMPOSITION OF CEPHEIDS AND RELATED STARS

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ABSTRACT. In the short form we present the main results of spectroscopic analysis of the different kind of Cepheids and related stars: double-mode Cepheids, s-Cepheids, non-variable supergiants situated inside the Cepheids instability strip and Cepheids first time crossing the instability strip.

Key words: Stars: abundances - stars: supergiants

Introduction

In spite of rather great number of works devoted to the Cepheid abundances, this thematic remains essential nowadays too. There are several reasons:
a) new CCD observations enable to get the high-resolution spectral material with high signal-to-noise ratio in the wide spectral region;
b) updated numerical codes applied for abundance determination, spectral synthesis, new grids of the atmosphere models, modern data on the oscillator strengths and recent more accurate solar abundances (as a reference point) make it possible to obtain for Cepheids the results of the high quality.

Present short review is based on the results of series of works devoted to a systematical investigation of classical Cepheids' chemical composition which have been carried out in Astronomical Observatory of Odessa State University during several years.

Double-mode Cepheids

These are Cepheids having unusual pulsational activity that consists of the excitation of two pulsational modes: fundamental one (period P_0) and first overtone (period P_1). For the solution of double-mode Cepheids (DMC) problem (the discrepancy between observed period P_1/P_0 ratios and those predicted by pulsation theory), the revision of the opacities, which are used in model calculation, has been proposed by several authors. The calculations with new opacities have shown the strong sensitivity of the resulting period ratio to the adopted elements' abundances.

Taking this into account, we have checked the supposition that differences in P_1/P_0 ratios among the DMC may be caused by differences in their metallicities. For this aim we derived abundances for EW Sct, VX Pup, BQ Ser TU Cas and estimated [Fe/H] values for 7 additional DMC (Andrievsky et al., 1993; Andrievsky et al., 1994a). The main result was following: P_1/P_0 ratio correlates with iron content. With [Fe/H] decreasing, the period ratio has a tendency to increase.

For four detaily investigated stars we obtained: carbon is deficient (a sign of the dredge-up phase) and sodium shows a normal abundance (that is unusual for supergiants).

s-Cepheids

s-Cepheids are small-amplitude pulsating stars with almost sinusoidal light, color and radial velocity curves. Rather weak pulsational activity could be caused by the small helium content in the atmosphere of the star that is crossing the instability strip towards the red supergiant region.

In order to check this hypothesis, we investigated chemical composition of 18 s-Cepheids paying more attention to CNO-abundances. The results on abundance analysis are given in Andrievsky et al.,1994b; Andrievsky et al., 1996 and Kovtyukh et al., 1996. From that works it is obviously seen that carbon is deficient, while nitrogen is overabundant.

Surface C abundance must be decreased and N abundance increased if the star has evolved from a red supergiant. Taking this into account, we conclude that s-Cepheids are probably not crossing the instability strip for the first time.

If s-Cepheids are not crossing the instability strip for the first time, then we should expect the helium content in their envelopes to be comparable with that of the classical Cepheids. This means that there exists another origin of the weak pulsational activity (small amplitudes) of these stars than merely low helium content (lower than for usual Cepheids), expected for the stars of the first time crossing the instability strip.

Non-variable supergiants inside the instability strip

An extremely weak pulsational activity is demonstrated by non-variable supergiants (NVS) situated inside the instability strip. In spite of their location, they practically do not pulsate (or pulsate with an amplitude under the detection limit).

It is interesting to know the physical reasons of such behaviour and to find the most important stellar parameters that could crucially affect a pulsational activity.

Before answering a question about possible origin of the pulsational activity suppression in these stars, it is worth to compare their chemical composition with that of the Cepheids. Such a comparison can give us an important information about NVS evolutionary stage.

We have investigated 17 NVS from the instability strip and two hotter supergiants (Andrievsky and Kovtyukh, 1996). The comparable analysis of the program stars' chemical composition and that of the small-amplitude Cepheids has shown that there is no essential differences in the elemental abundances of two stellar groups. It means that NVS are probably at the same evolutionary stage as s-Cepheids: i.e., these stars have already undergone the first stage of core helium burning.

The Young Cepheids

The Cepheids crossing the instability strip for the first time can be considered as young Cepheids. In our survey, we have found three possible candidates. In addition, two similar stars were found among the NVS. All these stars have normal or increased carbon abundance. It means that CNO-processed material has not been mixed with the atmosphere gas and these stars have never been in the red giant phase. All results concerning this kind of stars will be presented in the special paper.

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CYCLE–TO–CYCLE VARIATIONS OF THE SYMBIOTIC BINARY R AQR

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ABSTRACT. The observations of R Aqr from the AFOEV database are analyzed. The corrected value of the period $P = 387.509 \pm 0.029^{\rm d}$ was determined from a 5–th order trigonometric polynomial fit with a corresponding initial epoch for the maximum $T_0 = 2444733.76 \pm 0.93^{\rm d}$ and asymmetry $A = 0.409 \pm 0.011$. The cycle–to–cycle variations of the phase curve are present which are studied by using "running parabolae", "running sines", "asymptotic parabolae" and "linear fit" approximations. The range of variations is $5.7-8.0^{\rm m}$ (brightness at maximum), $10.6-12.3^{\rm m}$ (brightness at minimum), $7.1-34.1$ days/mag (slope of the ascending branch at $m = 9^{\rm m}$), $25.7-44.6$ days/mag (slope of the descending branch at $m = 9^{\rm m}$). The corresponding full amplitudes of the phase variations are 0.069, 0.136, 0.120, 0.256, respectively. The most stable in phase is the maximum, for which no secular period variations detected, but a secondary cycle of $P_2 = 3955 \pm 50^{\rm d}$ and amplitude $(0.032 \pm 0.005)P$ may be suggested. The characteristics of the individual cycles are tabulated.

Key words: Stars: Binary, Pulsating, Symbiotic, R Aqr

Introduction

R Aqr exhibits characteristics of many types of astrophysical objects in the same system. This is a symbiotic binary with a composite spectrum. One of the components is a Mira–type variable. The star is a prototype of the subclass of symbiotic binaries the light variations of which are characteristic for a long–periodic variable. Other subclasses are Z And with a number of small ($\approx 3^{\rm m}$) year–scale outbursts and AG Peg with outbursts of an amplitude $\approx 4^{\rm m}$ lasting dozens of years (cf. Boyarchuk 1983). The system is surrounded by a planetary nebula, the central part of which is highly variable in radio wavelength and shows jet–like structures. It is also a X–ray source (cf. reviews by Kenyon (1986), Friedjung (1993)). This is the only symbiotic showing detectable SiO maser emission (Lepine et al. 1978). The light curve shows Mira–type variability with a mean period $P = 386.96^{\rm d}$ and initial epoch $T_0 = 2442398$ (GCVS IV, Kholopov et al. 1985).

This work continues our study of symbiotic variables with Mira–type components. Previous results were published by Chinarova et al. (1994), Hric et al. (1994) and Chinarova (1995). The part of the AFOEV light curve of R Aqr and its brief analysis were published by Skopal et al. (1992).

Observations

The observations were obtained by the members of the AFOEV in 1935–1996 (JD 2428088–50096) and are stored in the AFOEV database (Schweitzer 1996). From all data we deleted "not sure" values and estimates "fainter than", thus 1521 data points remained. The most numerous data were obtained by the observers: M.Duruy ($n = 150$), P.Vedrenne (130), A.Mizser (94), B.Thouet (83). We thank the amateur astronomers who contributed to these data.

The total range of the brightness variations is $5\overset{\rm m}{.}5 - 12\overset{\rm m}{.}5$ with a sample mean $8\overset{\rm m}{.}32$ and a r.m.s. deviation $1\overset{\rm m}{.}45$. The time light curve is shown in Fig. 1. It exhibits well pronounced Mira–type variations with apparent cycle–to–cycle changes.

Analysis: Multiharmonic Fits

For the trigonometric polynomial fit we have used the computer code FOUR–N (Andronov 1994). The degree s was determined by using the Fischer's test. The probability P_r that one more harmonic will have amplitude statistically distinct from zero was computed for each number of harmonics. Its limiting value was set to 0.005. The general characteristics of the fits dependent on s were computed: where σ_n is a biased r.m.s. deviation of the observations from the fit, i.e. $\sigma_n^2 = \frac{1}{n}\Sigma(O-C)^2$, for the unbiased value $\sigma_*^2 = \frac{1}{n-2m-1}\Sigma(O-C)^2$, σ_s is a r.m.s. value of the standard error of the fit averaged through the period P, L_p characterizes the probability P_r, i.e.

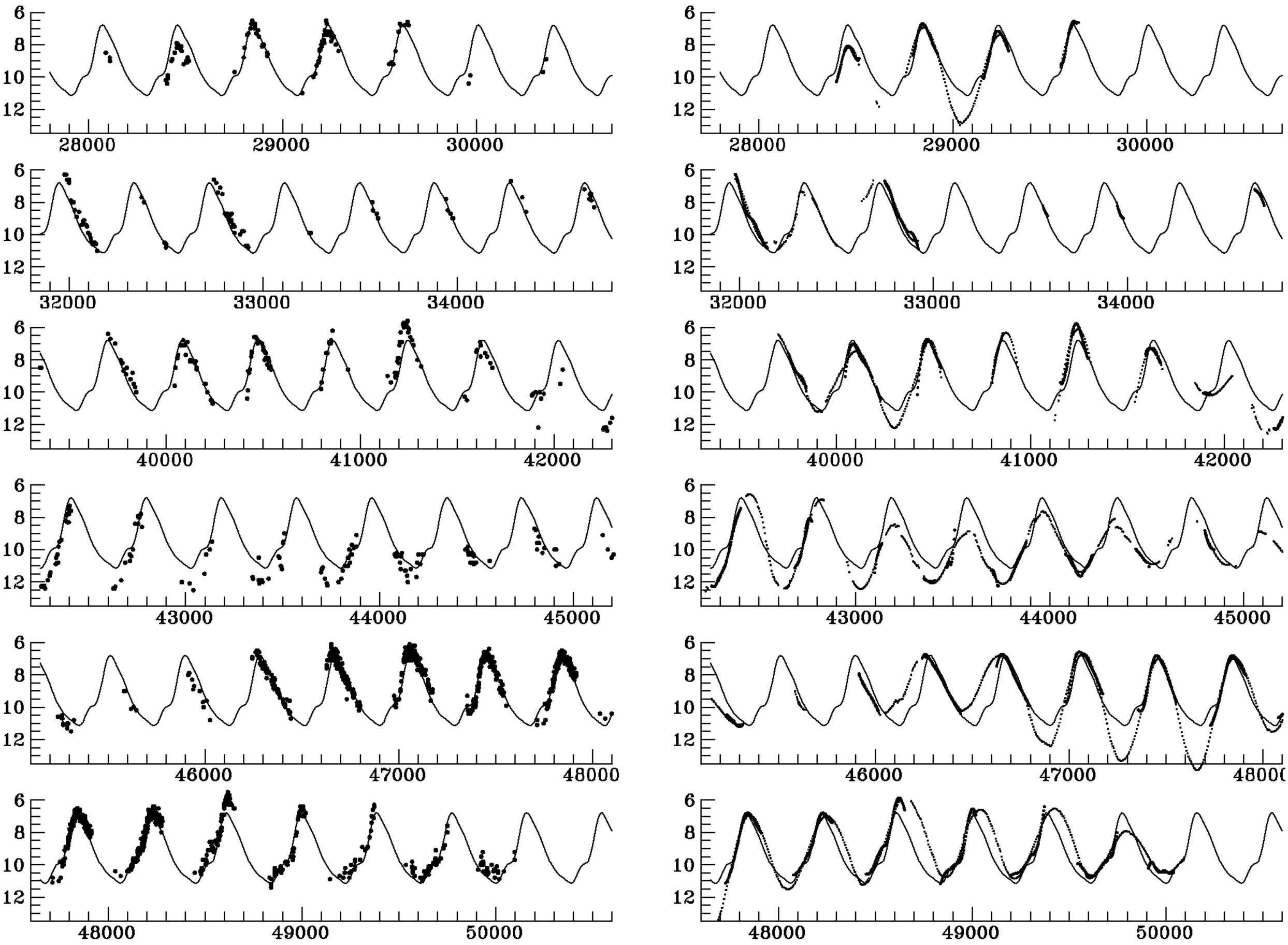


Figure 1. *Left:* Light curve of R Aqr (filled circles); *right:* fits of the light curve of R Aqr: "running parabolae" with $\Delta t = 57^{\rm d}$ (large dots), "running sines" with $\Delta t = P/2 = 193.48^{\rm d}$ (small dots) and the best 5-th order trigonometric polynomial (=4–harmonic fit) (line).

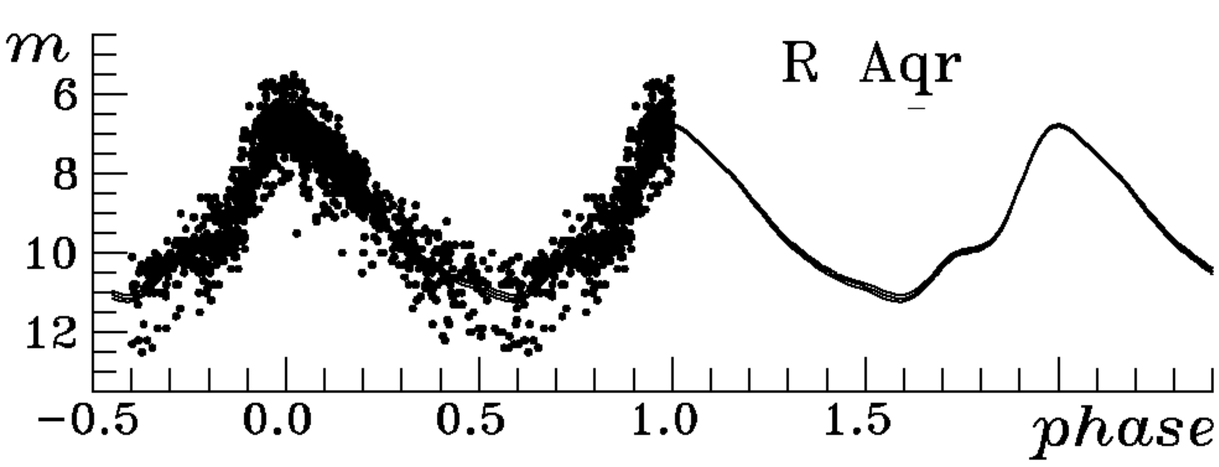


Figure 2. Phase light curve of R Aqr (filled circles) and its 4–harmonic fit (lines $m(\phi)$, $m(\phi) \pm \sigma(\phi)$).

Table 1. Parameters of the harmonics for the best 5–th order trigonometric polynomial fit.

r_j	ϕ_{0j}	r_j/r_1	$\phi_{0j} - j \cdot \phi_{01}$
1.920±0.028	0.045±0.002	1.000±0.000	0.000±0.000
0.394±0.028	0.044±0.010	0.205±0.016	-0.048±0.012
0.211±0.026	0.043±0.020	0.110±0.014	-0.092±0.021
0.196±0.026	-0.107±0.022	0.102±0.014	-0.288±0.023
0.085±0.024	-0.267±0.042	0.044±0.012	-0.493±0.044

Table 2.

Event	n	ϕ	$\sigma[\phi]$	$\sigma_n[\phi]$	V	σ[V]	σ_n[V]
Max	16	0.001	0.020	0.005	6.61	0.40	0.10
Min	7	0.594	0.045	0.019	11.04	0.70	0.28
Incl	22	0.878	0.021	0.005	16.71	6.32	1.38
Decl	19	0.223	0.043	0.010	38.43	3.89	0.92

$P_r = 10^{-L_p}$; "max" and "min" are extreme values of the fit; $A = (t_{max} - t_{min})/P$ is asymmetry and Δm is the amplitude. One may note that σ_n is monotonously decreasing with s, whereas σ_* as nearly at "standstill" for $s \geq 4$. The value of σ_s increases with s what is usually expected for relatively low signal/noise ratio. The period's estimates are the same within errors for $s \geq 2$, the extreme values of the brightness, amplitude and asymmetry are close for $s \geq 4$. This indicates that the results are rather stable and $s = 5$ is a realistic value although the contribution of the 5-th wave (=4-th harmonic) is much smaller than of the other ones. This fit is shown by a solid line in Fig. 1. The mean epoch for maximum ($6\overset{\mathrm{m}}{.}78 \pm 0\overset{\mathrm{m}}{.}03$) is JD $2444733.76 \pm 0\overset{\mathrm{d}}{.}93$, minimum ($11\overset{\mathrm{m}}{.}15 \pm 0\overset{\mathrm{m}}{.}09$) JD $2444575.1 \pm 4\overset{\mathrm{d}}{.}0$. The asymmetry $A = 0.409 \pm 0.011$ coincides with the value $A = 0.42$ listed in the GCVS, despite the best fit period value $P = 387\overset{\mathrm{d}}{.}509 \pm 0\overset{\mathrm{d}}{.}029$ significantly differs from that $386\overset{\mathrm{d}}{.}96$ listed in GCVS. One may note an apparent hump at the ascending branch. It is not seen in all individual cycles, but is statistically significant at the mean phase curve shown in Fig. 2.

The extreme slopes of the fit occur at the phases computed in respect to the maximum are $\phi = -0.098$ (ascending branch, $dt/dm = 15.4 \pm 0.5$ days/mag) and $\phi = 0.217$ (descending branch, $dt/dm = 30.6 \pm 2.5$ days/mag). The ratio of the slope to that expected for the sine with the same period and full amplitude is $B = 1.84 \pm 0.06$ and $B = 0.92 \pm 0.08$, respectively.

However, there are cycle–to–cycle changes of the phase curve shape. Moreover, one may suggest that the magnitude at minimum was distinctly fainter by 1.5^{m} at JD 2442200–44200 than in the later dates. This agrees with the earlier light curve published by Mattei and Allen (1979) where one may see a time interval JD 2425600–27200 when the amplitude was ≈ 4 times fainter than in other years. However, there are large observational gaps preventing more detailed study of this phenomenon.

The Fourier coefficients for the light curves of pulsating variables were studied for Cepheids by Kukarkin and Parenago (1937) and recently in a number of observational and theoretical papers for RR Lyr–type stars (e.g. Antonello 1994, Kovacs et al. 1986 and references therein) and Mira–type objects (Chinarova 1995, Kudashkina and Andronov 1996). In Table 1 are listed the following parameters of individual harmonics: j the number of trial harmonic, r_j is semi-amplitude, ϕ_{0j} is phase of the maximum of the harmonic in respect to the maximum of the fit. Amplitudes and phases relative to the first harmonic and their standard errors are computed by using the formulae by Petersen (1986). Please note that our definition ϕ_{0j} (phase at which the maximum occurs) differs from that of Petersen (1986) by sign. All phase shifts are reduced to the interval (–0.5,0.5).

Analysis: Individual Cycles: Methods

The period of the star is close to 1 year, its declination is low. Thus there are significant gaps in observations and the individual cycles are not fitted completely. As an attempt to solve this problem, we have used several fitting routines. They are listed below.

RP – Method of "Running Parabolae". It was proposed by Andronov (1990, 1997). To determine the optimal value of the filter half–width Δt we have computed the smoothed values at the times of the original observations and then the "signal/noise" ratio for some range of Δt as described by Andronov (1997). Both the maximum of S/N=17.55 and the unbiased estimate of the r.m.s. deviation of the observations from the fit σ_0 occurred at Δt=57^{d}. The results of the fit are shown in Fig.1 by the large dots. This fit is in excellent agreement with the observations. Owed to large gaps, it was computed only for 1434 data points from 1521. The value $\sigma_0 = 0.24^{\mathrm{m}}$ is in reasonable agreement with the accuracy of visual observations. The r.m.s. accuracy of the fit 0.08^{m}. However, the fit was not computed if the number of observations in the subinterval $t_0 - 0.5 \cdot \Delta t, t_0 + 0.5 \cdot \Delta t$ was less than 4 or if all the observations were located from one side of the trial time t_0 or if the accuracy estimate of the smoothed value exceeds 0.5^{m}. Such strong restrictions allow to obtain a good fit, but for the case of R Aqr may not help to receive more complete curve.

RS – Method of "Running Sines". To extend the time interval for running fit one may use periodic function instead of aperiodic parabolae. In our previous paper (Chinarova et al. 1994) we have proposed the method of "running sines" which was applied to the Mira-type component in the symbiotic binary UV Aur. However, the curve is asymmetric, the statistically significant degree of the trigonometric polynomial is $s = 5$ thus one may suggest to extend the method of "running sines" to "running multiharmonic fit", when to compute the value at trial time t_0 one uses the multiharmonic fit in the subinterval $t_0 - 0.5 \cdot \Delta t, t_0 + 0.5 \cdot \Delta t$. In other words, the interval used for fitting has duration equal to the mean period and is centered to trial time t_0. We have tried to apply this method for $s = 1$ and $s = 2$. Although the case $s = 2$ corresponds to better fit at the branches of the light curve well covered by the observations, the uncertainty of the "interpolated" branches far from data is significantly larger and one may see apparent semi-amplitude variations of the light curve. The use of $s = 1$ allows to obtain "true–like" fit at the gaps as well, despite some "minima" of unjustified large depth are seen (e.g. at JD 2446900 and 2 subsequent minima).

AP – Method of "Asymptotic Parabolae". This method is proposed by Andronov (1995) and described in more detail by Marsakova and Andronov

(1996). It was found to be the best for our type of gaped data. It is efficient for the curves with nearly linear ascending and descending branches, the transition between which may be fitted by a parabola. The number of observations used for the fit is larger than that for the "RP" as the transition is shorter than the transition + (ascending + descending) branches, but is more local than "RS" using the whole period.

LF – Linear Fits. As additional "characteristic events" which may be used for study of changes of the period and shape of individual cycles we have computed the times of the crossings of the fit and a constant value (set to $9^{\rm m}$) and the corresponding slopes dt/dm. This is slightly similar to the crossings of the $\gamma-$ value by the radial velocity curve. The parameter dt/dm (the characteristic time in days needed for brightness change by $1^{\rm m}$) was also introduced in the chapter "Multiharmonic fits" for the mean phase curve. Such additional times are more numerous for R Aqr (20 for descending branch, 22 for ascending branch as compared with 16 maxima and 7 minima).

Analysis: Individual Cycles: Results

The characteristics of the maxima and minima obtained by using the "AP" method are listed in Table 3. The "LF" results are listed in Table 4. The time behaviour of the phases of the "four characteristic points", the brightness in the maxima and minima and of the slopes of the descending and ascending branches is shown in Fig. 3.

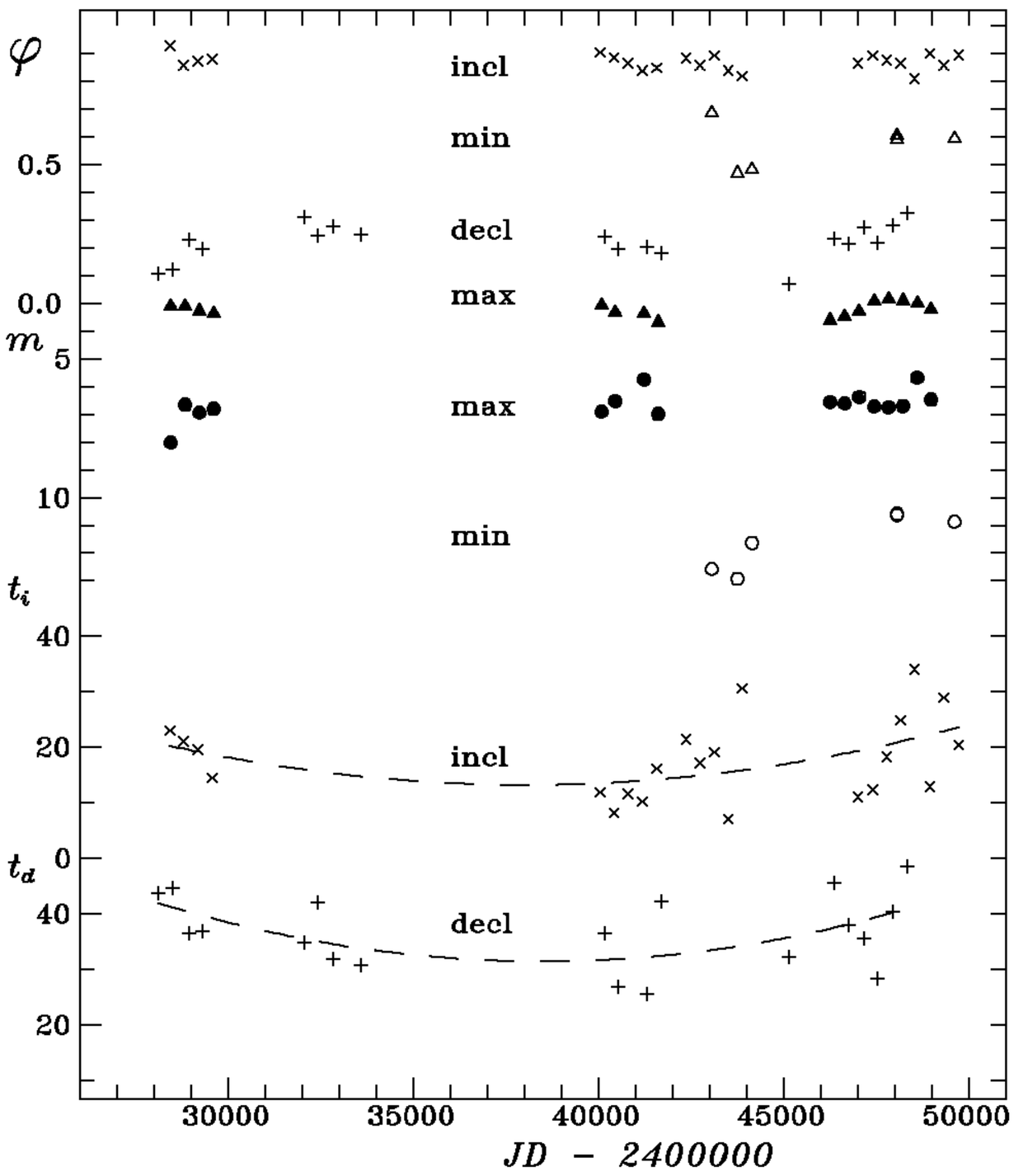


Figure 3. Time dependence of the phases of maxima, minima, crossings of $m = 9^{\rm m}$, brightness of the extrema and slopes dt/dm of the brightness incline (t_i) and decline (t_d) at the crossings.

The phases of crossings $m = 9^{\rm m}$ show apparent parabolic shape which is shown by dashed lines. Obviously, this is only formal approximation, as no secular variations of the shapes may be achieved for the period constant during the observations. However, the estimates of t_i and t_d are independent, thus the seemingly similar parabolic fit is very surprising.

The mean characteristics of the parameters obtained by means of "LF" are: standard error of the determination of time $1.46^{\rm d} = 0.0038P$, standard deviation of the brightness from the linear fit $0.235^{\rm m}$ in excellent agreement with the value $0.239^{\rm m}$ estimated from the "RP" fit with optimal value of the filter half-width Δt. The mean slopes are $t_i = 16.8 \pm 1.5^{\rm d}$ and $t_d = 39.6 \pm 1.1^{\rm d}$ for incline and decline, respectively. The value of t_i is close to that obtained from the 4–harmonic fit (15.4 ± 0.5), but t_d differs significantly from 30.6 ± 2.5.

One may introduce the parameter $A_l = t_i/(t_i + t_d)$ equal to the asymmetry if the light curve is composed of the linear ascending and descending branches with zero–length transitions. For R Aqr its mean value is equal to 0.298 ± 0.019. For the 4–harmonic fit $A_l = 0.335 \pm 0.020$, i.e. coinciding with the "LF" value within error estimates. The mean phases and values of the extrema and crossings are listed in Table 2.

Here σ is a r.m.s. deviation from the weighted mean, σ_n corresponds to the standard error of the mean. The parameter V is equal to the magnitude of maximum or minimum and dt/dm for the crossings of $m = 9^{\rm m}$ during incline or decline. One may note that rounding errors of the error estimates may affect the values of the weighted mean and r.m.s. deviations. This may be seen from comparison of the data from this table (values of σ rounded as in Tables 3,4) with that mentioned above with 2 additional digits. However, these differences do not exceed the error estimates. The "unit weight" error σ_0 is also listed.

One may note that the values of $\sigma[\phi]$ are practically equal within pairs (maximum, incline) and (minimum, decline). The asymmetry 0.405 ± 0.049 derived from the mean phases of minima and maxima coincides with that of the 4-harmonic fit within error estimates, but its accuracy is worth than from the fit using all 1521 observations instead of 16+7 extrema.

The periodogram for the phases of maxima (one–harmonic approximation, cf. Andronov 1994) shows the highest peak corresponding to the secondary period $P_2 = 3955 \pm 50^{\rm d}$ and amplitude $(0.032 \pm 0.005)P$. The "false alarm probability" for this peak is $10^{-2.45}$, i.e. this wave may be statistically significant.

Acknowledgements. The research is based on the observations from the AFOEV database. It was partially supported by the Ukrainian State Committee for Science and Technique (DKNT).

Table 3. Characteristics of the maxima and minima.

t_e	n	E	ϕ_e	m_e
		Maxima		
28456.9± 3.8	26	-42	-0.004±0.010	8.02±0.10
28843.9± 3.4	22	-41	-0.005±0.009	6.66±0.10
29225.1± 1.8	41	-40	-0.021±0.005	6.94±0.08
29609.1±10.3	10	-39	-0.030±0.027	6.81±0.36
40083.7± 4.5	23	-12	0.000±0.011	6.91±0.12
40460.8± 3.1	28	-11	-0.027±0.008	6.53±0.10
41234.1± 2.3	31	-9	-0.031±0.006	5.75±0.14
41609.4± 5.4	11	-8	-0.063±0.014	7.00±0.25
46262.3± 4.6	76	4	-0.056±0.012	6.57±0.04
46654.9± 3.8	110	5	-0.042±0.010	6.62±0.07
47049.5± 2.4	105	6	-0.024±0.006	6.37±0.06
47452.1± 1.3	124	7	0.015±0.003	6.73±0.06
47841.6± 1.2	178	8	0.020±0.003	6.74±0.05
48227.6± 1.8	153	9	0.016±0.005	6.70±0.07
48611.3± 1.2	61	10	0.006±0.003	5.70±0.07
48989.6± 1.9	21	11	-0.017±0.005	6.47±0.14
		Minima		
43063.8±15.8	8	-5	0.691±0.041	12.58±0.65
43755.2± 7.8	22	-3	0.475±0.020	12.93±0.24
44148.0±11.9	20	-2	0.488±0.031	11.63±0.41
48064.9±11.1	50	8	0.596±0.029	10.63±0.13
48070.6± 3.9	179	8	0.611±0.010	10.58±0.81
48070.7± 3.9	179	8	0.611±0.010	10.58±0.82
49616.4± 7.1	23	12	0.600±0.018	10.87±0.11

Table 4. Characteristics of the crossings.

t_c	n	E	ϕ_c	dt/dm	σ_0
		Descending branch (decline)			
28112.2±5.2	3	-43	0.107±0.013	43.7±14.7	0.127
28505.1±4.2	17	-42	0.120±0.011	44.6±2.4	0.209
28934.7±2.9	16	-41	0.229±0.008	36.5±1.0	0.140
29308.5±6.5	19	-40	0.194±0.017	37.0±4.0	0.169
32066.4±2.4	24	-33	0.311±0.006	34.8±0.3	0.324
32427.5±2.1	5	-32	0.243±0.005	42.1±0.7	0.100
32827.6±2.0	21	-31	0.275±0.005	31.8±0.5	0.262
33591.0±6.2	4	-29	0.245±0.016	30.8±8.5	0.225
40177.1±1.4	11	-12	0.241±0.004	36.5±0.4	0.123
40547.1±4.2	15	-11	0.196±0.011	26.8±2.3	0.207
41324.5±4.3	9	-9	0.202±0.011	25.7±1.7	0.182
41704.3±1.3	5	-8	0.182±0.003	42.3±1.2	0.020
45147.6±3.8	3	1	0.068±0.010	32.3±3.8	0.087
46374.6±1.4	79	4	0.234±0.004	45.5±0.2	0.198
46753.7±1.3	96	5	0.213±0.003	38.1±0.1	0.228
47164.2±2.6	49	6	0.272±0.007	35.6±0.5	0.228
47531.2±1.9	38	7	0.219±0.005	28.3±0.4	0.243
47942.8±3.8	82	8	0.281±0.010	40.3±0.9	0.202
48346.9±5.8	59	9	0.324±0.015	48.5±1.4	0.235
		Ascending branch (incline)			
28430.5±1.4	10	-43	0.928±0.004	23.0±0.5	0.179
28790.2±3.4	9	-42	0.856±0.009	21.0±1.5	0.183
29183.5±1.2	19	-41	0.871±0.003	19.6±0.3	0.200
29574.2±2.5	5	-40	0.879±0.007	14.5±1.2	0.204
40046.0±3.1	5	-13	0.903±0.008	11.9±1.6	0.367
40426.7±1.2	8	-12	0.885±0.003	8.3±0.4	0.362
40806.0±1.4	5	-11	0.864±0.004	11.6±0.8	0.239
41183.7±1.6	11	-10	0.839±0.004	10.2±0.5	0.319
41574.8±1.3	3	-9	0.848±0.003	16.2±0.5	0.023
42363.2±1.4	5	-7	0.883±0.004	21.4±0.8	0.146
42740.9±1.7	12	-6	0.857±0.004	17.2±0.5	0.325
43141.4±7.1	5	-5	0.891±0.018	19.1±4.7	0.352
43508.5±2.3	5	-4	0.838±0.006	7.1±1.2	0.383
43888.3±5.4	15	-3	0.818±0.014	30.7±1.8	0.281
47005.6±0.7	22	5	0.863±0.002	11.1±0.2	0.175
47403.9±0.5	39	6	0.891±0.001	12.3±0.1	0.227
47785.3±0.6	52	7	0.875±0.002	18.3±0.1	0.210
48168.3±1.3	46	8	0.863±0.003	24.9±0.4	0.247
48534.6±1.5	62	9	0.808±0.004	34.1±0.2	0.321
48957.4±1.2	14	10	0.899±0.003	12.9±0.3	0.261
49328.3±2.8	11	11	0.857±0.007	29.0±1.9	0.263
49730.5±1.5	4	12	0.894±0.004	20.4±1.3	0.131

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ABOUT THE FLASHES' ACTIVITY OF A0535+26 IN OPTICAL BAND

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ABSTRACT. After the great multipulse outburst of Oct. 1995 (JD 2450019) was recorded we followed the optical activity of Be/neutron star binary system A 0535+26. The information on optical flares during 25 years of photoelectric observations was replenished by the photovisual observations of the 7-camera astrograph collection of Odessa Astronomical Observatory during 24 years. The particularities of each from 10 revealed flashes are given.

Keywords: Stars: Binaries: Individual: V 795 Tau

A pulsar A 0535+26 (V 725 Tau, HDE 245770) belongs to a small group of the recurrent transient X-ray source. This Be/neutron star binary system is actively observed in a range from X-ray to infrared (see, for example, Giovannelli & Graziati, 1992; Gnedin et al., 1988, Motch et al., 1991). The X-ray outbursts of the system occur with period 111.4 day (Priedhorsky & Terrel, 1983; Motch et al., 1988) and go on from 2-4 to 50 days. Photometric behaviour of V 725 Tau (V=$8.^{\rm m}8$, reddened B0 IIIe) is described using the authors' and all published photoelectric observations during many years in the papers by Lyutiy et al. (1989), Giovannelli & Graziati, 1992, Hao et al. (1996).

We observed A 0535+26 taking part in the Program "Monitoring of Unique Astrophysical Objects" of Russian Ministry of Science. The 2-3 hours' observational runs were made with dual channel photometer attached to 0.8 m Ritchey-Chretien telescope at the Mt. Dushak-Erekdag observational station of Odessa Astronomical Observatory (Dorokhov et al., 1994)

The great multipulse outburst was recorded in the night 28/29 Oct. 1995 (JD 2450019) during 1.7 hour (Dorokhov & Dorokhova, 1996). The outburst light curve in relative magnitudes is presented in Fig.1. This consists of a great number of transitory individual pulses. The intensity at the burst's peak was about five times as large as that on the bottom level on this night (Δm=$1.^{\rm m}74$). On an average A 0535+26 became brighter by $0.^{\rm m}2$-$0.^{\rm m}25$.

We are interested in how often optical flashes occur in A 0535+26 and what their character is. The similar pulses are described in the article by Urasin and Shaimukhametov (1987). They reported about short-time optical flashes with amplitudes $2^{\rm m}$-$3^{\rm m}$ and durations 0.2-0.3 sec.

Besides some observers mention optical flares with large ($\Delta V \geq 0.^{\rm m}15$) amplitudes. The observers usually did not present light curves and durations of the flares. It was only Maslennikov (1986) reported that the star returned to initial level of the brightness after 40 min.

The data on flares were so scanty, and we replenished these by the photovisual ones (close to Johnson's V) of the 7-camera astrograph collection of Odessa Astronomical Observatory. An exposition for each plate was 30 min. HD 36893 (m_{pv}=$8.^{\rm m}34$, B8), HD 246370 (m_{pv}=$8.^{\rm m}89$, G5), sometimes in addition HD 245562 (m_{pv}=$9.^{\rm m}14$, K5), were used as comparison stars. The photovisual magnitudes were obtained by applying photoelectric standards of square Champ 13 (Kazanasmas et al., 1981).

It should be noted that the photo plates data were presented in the papers by Rößiger (1979) for Sonneberg's archives and Stier & Liller (1976) for Harvard's archives, but the individual data were integrated for observational seasons in long-term light curves. We are interested in the transitory brightenings above the common light curve by $0.^{\rm m}2$-$0.^{\rm m}3$. Five of such brightenings were found during 24 years' (from 1968 to 1992) observational interval. An accuracy of such observations is not higher than $0.^{\rm m}05$.

In Table 1 all the data on the optical flashes' activity of A 0535+26 are collected. In remarks under the table we noted particularities of each flash.

For imaging the photometric behaviour of the system we take off the data from the graphs in the papers by Lyutiy et al. (1989) and Hao et al. (1996). In Fig.2 this light curve and the 7-camera astrograph data are presented. The flashes are marked by arrows.

What are the reasons of these processes? What is their influence on the Be/neutron star system? Why did the outburst of 28 October so much like the X-ray outbursts of similar objects occur in the optical band? We cannot answer these questions yet. In conclusion we request to the observers of V 725 Tau: please inform us, if you have got any unpublished data on the optical flashes.

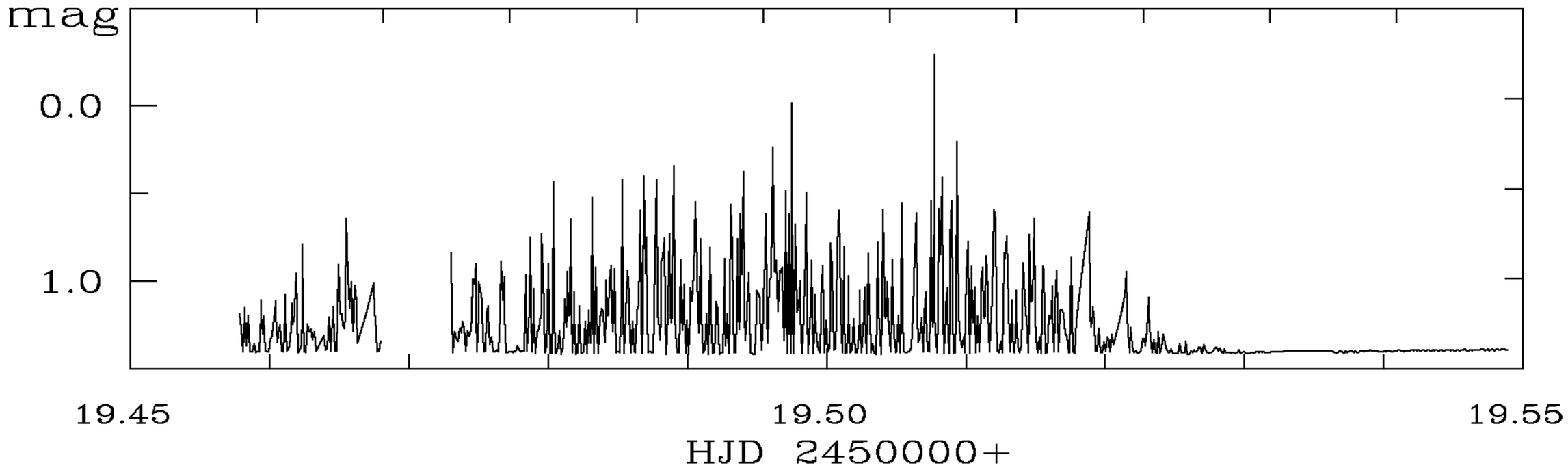


Fig. 1. The magnitude variable-comparison star differences of dual-channel observations of 28/29 Oct. 1995 outburst.

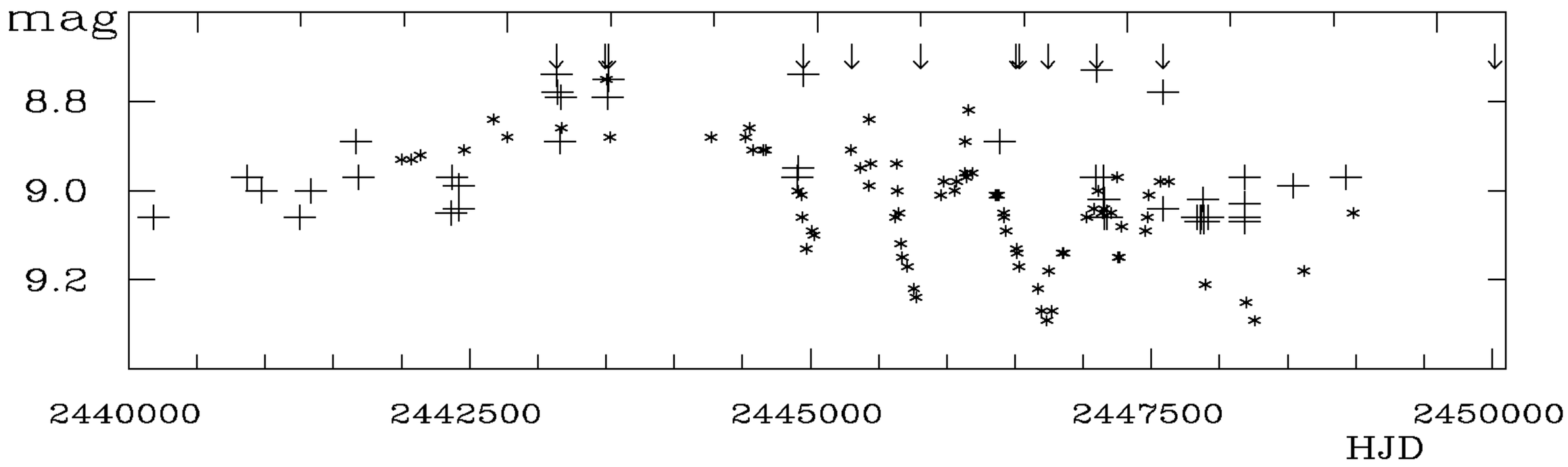


Fig. 2. The secular light curve of HDE 245770 in Johnson's filter V: by asterisks are shown the data taken off the graphs in the papers by Lyutiy et al. (1989) and Hao et al. (1996), cross - photovisual data of the 7-camera astrograph collection of Odessa Astronomical Observatory. The arrows on the graph mark the optical flashes.

Table 1. The data of the optical flashes' activity of A0535+26

JD	Date	Source
43135.39	22.12.76	7-camera astrograph OAO [1]
43496.41	19.12.77	Rößiger (1978)
43519.35	10.01.78	7-camera astrograph OAO [1]
44943.43	04.12.81	7-camera astrograph OAO
45300.00	26.11.82	Gnedin et al.(1988) [2]
45807.13	16.04.84	Maslennikov (1986) [3]
46507.25	17.03.86	Urasin et al. (1987)[4]
46530.25	09.04.86	Urasin et al. (1987)[4]
46740.33	05.11.86	Berdnik et al. (1990)
47097.53	28.10.87	7-camera astrograph OAO
47581.24	23.02.89	7-camera astrograph OAO [5]
50019.50	28.10.95	Dorokhov & Dorokhova(1996)

[1] common brightening of the light curve rather than flares;
[2] the date of the flash may be approximate;
[3] the star returned to initial level of the brightness after 40 min;
[4] transitory optical pulses with amplitudes $2^{\rm m}-3^{\rm m}$ and durations 0.2-0.3 sec.;
[5] the most certain "photo" flash, on the next day the brightness returned to initial level, $\Delta m = 0.^{\rm m}26$.

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RESEARCH OF THE VARIABILITY OF λ BOOTIS STARS BY USING THE DUAL CHANNEL PHOTOMETER

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ABSTRACT. 3 bona fide λ Boo stars were observed by using the dual-channel photometer at the Mt. Dushak-Erekdag observational station. Two peaks at frequencies $f_1 = 15.85\,\mathrm{c/d}$ and $f_2 = 27.54\,\mathrm{c/d}$ were revealed in the amplitude Fourier spectrum of HD 221756. HD 204041 and HD 38545 proved to be constant. Probably, comparison star HD 204121 has low amplitude variability.

Keywords: Stars: Instability strip, λ Boo–type.

Recently interest in λ Bootis stars has arisen again. Up to 1992 about 20 unambiguously identified objects were known (see Gray & Corbally, 1993), now their number increases quickly (Paunzen & Gray, 1996).

In the HR diagram the λ Boo stars fall into the parameter space occupied by Ap, Am, δ Sct stars etc., but their evolutionary status is not yet cleared up.

Variability of some λ Boo stars with periods in the range from 0.5 up to 4 hours and extremely low amplitudes (from 0.004 mag to 0.07 mag) was revealed and intensively investigated by the Vienna working group *Asteroseismology - AMS* (Weiss et al., 1994).

During 1994-1995 we observed 3 stars from the list of Gray & Corbally (1993) by using the dual-channel photometer (Dorokhov & Dorokhova, 1994) attached to the 0.8m Ritchey-Chretien telescope at the Mt. Dushak-Erekdag station of Astronomical Observatory, Odessa State University, in Turkmenistan.

HD 221756 (A1Va+) and a comparison star HD 221903 were observed by using dual channel mode of the photometer. We revealed two peaks at frequencies f_1=15.85 c/d (P = 1.51 hour, A = 0.011 mag) and f_2=27.54 c/d (P = 52 min, A = 0.006 mag), which could be influenced by a 1 c/d aliasing. The article on these observations was published in IBVS (Dorokhova & Dorokhov, 1996).

Besides we observed two of λ Bootis stars in single channel by using 3-star mode (see Breger, 1992).

HD 204041 was observed in Strömgren v-filter two nights on 11 and 12 Oct., 1994, 2.3 hours a night.

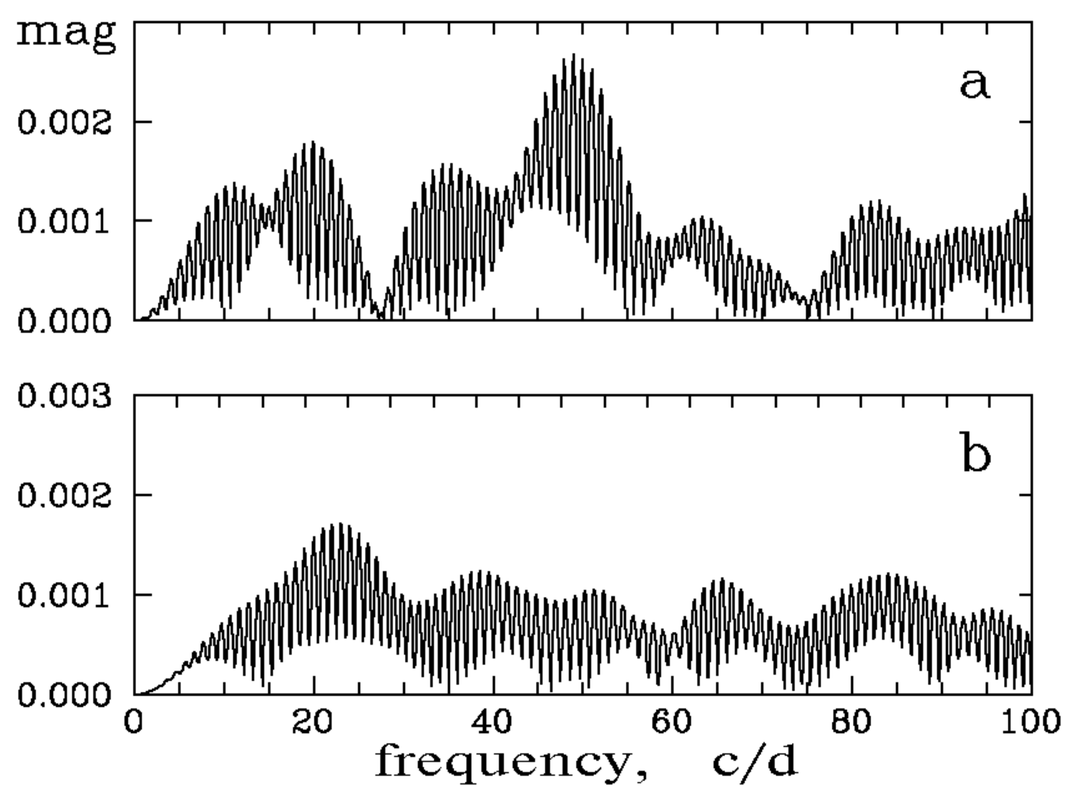


Fig.1 Amplitude spectra of differential data HD 204041 – HD 204121 (a) and HD 204041 – HD 203405 (b). The variability of C1=HD 204121 is likely to be evident.

From comparing Fig.1a, which shows Fourier spectra of the united differential data series with respect to C1 (HD 204121, m=6.4 mag, F5), and Fig.1b, with respect to C2 (HD 203405, m=6.8 mag, F2), it is seen, that, apparently, C1 has low amplitude variability. HD 204041 itself is constant within upper limits 0.003 mag (Paunzen et al. (1996a) indicated 0.002 mag).

HD 38545 (C1 HD 39098, C2 HD 39019), observed in Johnson B-filter in 20 and 22 Nov., 1995, may be constant, but the upper limit 0.005 mag is rather high (Kuschnig et al. (1996) presented 0.004 mag).

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FOURIER COEFFICIENTS FOR THE LIGHT CURVES OF 62 MIRA–TYPE STARS

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ABSTRACT. For 62 Mira–type stars the values of periods have been redetermined; the mean curves have been fitted by a trigonometric polynomial with an optimal number of harmonics; a number of the parameters of the light curve have been calculated (amplitude of the present harmonic in stellar magnitudes, phase of the maximum of the amplitude of the present harmonic, ratio of the amplitude of the harmonic to the amplitude of the main harmonic wave, shift of the phase of the present harmonic relatively to the main wave, shift of the phase of the present harmonic relatively to the maximum of brightness). The parameters of the sharpness of the both branches of the light curve are obtained: the time of the brightness changes by 1 mag, the ratio between the maximal slope of the incline to the derivative for sinusoidal signal with present amplitude and period. All these parameters are tabulated.

Key words: Stars, Mira, pulsating, correlations

The Mira–type stars are long period variables of AGB. Their light curves are generally regular, but have sometimes strong distortions changing the shape of the light curve.

Earlier it was considered that the light curve, especially in the visual range, is not the fundamental characteristic of Mira, because it is affected by molecular bands. However, the researches appeared in the eighties indicative, that the visual light curve is doubtless directly dependent on the physical properties of Mira–star (e.g. Vardya, 1987).

Many correlations have been detected between the visual, IR– and maser variations for Miras (Le Bertre, 1987; Keping et al., 1984). For example, the correlations were found between the period, amplitude at 2.2 μ, color index [3.5μ] - [10μ], OH velocity emission peaks and the presence of H_2O emission. The three kinds of the circumstellar masers possess the variability of the radiation, caused by a variability of the star itself. The maximum of the maser flux occurs later than the maximum of the visual brightness for OH and SiO by $0\overset{p}{.}1$ and for H_2O on $0\overset{p}{.}2$ (Rudnitskij, 1983).

Thus, it is very important to obtain the detailed visual light curve and accurately determined extrema. It is not easy to obtain such a light curve. The Miras have amplitudes about 5^m–7^m (and sometimes more), the periods of about 1 year, and the curve is unstable itself. We have to obtain a mean light curve to describe the star. And this curve has to contain all characteristic changes and at the same time this light curve must not to be disturbed too strongly. It is possible, if the light curve of the Mira–type star is investigated during not too long time interval, for example, 1000 days. One may note that the Miras with the periods from 100 to 500 days pass during this time from 10 to 2 cycles of variation. But we know that the Miras with small value of the period have more regular light curves, than Miras with large value of the period, which have distortion almost at the every cycle of the variation.

The observations of 62 Mira–type stars obtained by the AAVSO members (Mattei, 1979) have been used for the analysis. The initial values were converted to obtain the 10^d means, which were fitted by a trigonometric polynomial

$$m(t) = a_0 - \sum_{k=1}^{s} r_k \cos(2\pi k \cdot (t - t_k)/P), \qquad (1)$$

where r_k are semiamplitudes and t_k are initial epochs for the brightness maximum (minimum magnitude) of the wave with a period $P_k = P/k$. The value of the main period was corrected by using the method of differential corrections. The computer program FOUR–M (Andronov, 1994) was used. The phases of the individual waves are computed as ϕ_k =FLOAT($k(t_k - T_0)/P$, where T_0 is the initial epoch and FLOAT(x) = x–INT(x) is a decimal part of x defined in the range from 0 to 1.

The next parameters are calculated:

the fundamental characteristics:

T_0 – the epoch of the maximum;

P – the period of the light variation;

Δm – the amplitude of the light variation;

"$M - m$" – the asymmetry of the light curve defined as the ratio of the duration of the ascending branch to the period;

Table 1. The characteristics of the mean light curve.

Star	T_0	P	$M-m$	Δm	s	r_1	r_2	r_3	r_4	ϕ_1	ϕ_2	ϕ_3
RT Cyg	42882.9	191.3	0.484	4.60	2	2.29	0.20			0.010	-0.436	0.000
R Vir	42808.7	146.0	0.555	4.14	2	2.03	0.24			-0.036	0.308	
R Vul	42712.1	136.9	0.500	4.19	1	2.09				0.000		
RZ Sct	42819.3	160.2	0.500	3.19	1	1.59				0.000		
S Car	42718.9	151.1	0.564	2.68	2	1.33	0.36			-0.063	0.372	
SS Cas	42810.4	140.4	0.426	3.49	2	1.71	0.36			0.011	-0.027	
SS Her	42778.6	104.4	0.500	3.68	1	1.84				0.000		
T Her	42824.9	164.3	0.500	5.03	1	2.51				0.000		
V Tau	42782.0	169.8	0.500	4.88	1	2.43				0.000		
W Lyr	42705.8	197.9	0.477	3.93	2	1.95	0.20			0.017	-0.420	
X Cam	42801.4	142.6	0.438	4.45	2	2.18	0.26			0.039	-0.271	
R Ari	42827.7	186.9	0.500	4.21	1	2.10				0.000		
RR Boo	42857.0	194.3	0.432	4.09	2	1.99	0.23			0.033	-0.174	
X Aur	42811.5	163.9	0.580	4.25	2	2.06	0.40			-0.061	0.291	
SY Her	42892.0	118.2	0.500	3.36	1	1.68				0.000		
W Pup	42798.5	119.9	0.500	3.73	1	1.86				0.000		
BG Cyg	42894.7	292.2	0.529	2.55	2	1.26	0.07			-0.012	0.108	
R Aql	42888.1	284.2	0.418	4.69	2	2.25	0.33			0.040	-0.167	
R Boo	42743.1	222.6	0.500	5.18	1	2.58				0.000		
R Dra	42808.4	245.2	0.450	5.25	2	2.59	0.24			0.020	-0.121	
RS Her	42777.1	220.6	0.500	4.83	1	2.41				0.000		
RS UMa	42884.4	261.1	0.354	5.76	3	2.74	0.67	0.16		0.044	-0.032	-0.237
R Tri	42814.5	268.5	0.481	5.56	3	2.58	0.13	0.18		0.002	-0.176	0.058
S Boo	42770.0	266.9	0.529	4.69	2	2.33	0.13			-0.012	0.119	
S UMa	42848.0	228.2	0.502	3.74	3	1.80	0.32	0.15		-0.033	0.493	0.129
TU Cyg	42788.4	220.6	0.435	5.27	2	2.57	0.28			0.033	-0.192	
T UMa	42778.6	257.0	0.339	5.41	3	2.71	0.43	0.30		0.070	-0.048	-0.201
V Cas	42746.8	229.4	0.449	4.33	2	2.13	0.18			0.027	-0.215	
W Her	42846.6	278.7	0.466	5.19	3	2.66	0.12	0.08		0.013	-0.134	-0.469
Y Per	42750.6	247.1	0.479	2.01	3	0.94	0.16	0.06		0.004	-0.428	0.100
o Cet	42822.7	333.5	0.300	5.52	3	2.66	0.50	0.46		0.085	-0.042	-0.141
R Leo	42918.7	313.7	0.450	4.01	4	1.85	0.19	0.13	0.08	0.039	-0.029	-0.023
R Ser	42676.5	353.6	0.434	6.81	3	3.23	0.49	0.28		0.059	-0.132	-0.086
R UMa	42890.2	301.5	0.419	5.46	4	2.64	0.62	0.27	0.22	0.080	0.016	-0.110
S CrB	42809.7	357.8	0.395	5.27	2	2.45	0.50			0.051	-0.138	
T Cam	42697.9	374.8	0.465	5.74	4	2.61	0.69	0.27	0.13	0.002	-0.444	0.142
TU And	42865.0	318.4	0.483	4.87	4	2.23	0.16	0.22	0.13	-0.009	0.397	0.080
U Per	42821.9	327.6	0.500	3.54	1	1.76				0.000		
U UMi	42769.3	327.6	0.487	3.96	3	1.91	0.07	0.11		-0.015	-0.105	0.152
V Aur	42727.1	353.7	0.538	2.40	3	1.06	0.13	0.12		-0.013	0.238	-0.079
W And	42714.2	399.2	0.459	11.0	4	4.37	0.78	1.13	0.53	0.055	-0.420	0.068
W Peg	42795.8	344.3	0.457	4.46	4	1.92	0.18	0.29	0.09	0.035	-0.167	0.002
X Oph	42763.8	327.7	0.500	1.34	1	0.66				0.000		
R Gem	42980.5	368.9	0.396	6.46	2	3.01	0.61			0.050	-0.135	
T UMi	42707.7	316.7	0.482	5.63	3	2.45	0.52	0.36		0.019	-0.031	-0.012
U Ori	42656.9	385.6	0.337	5.51	3	2.56	0.64	0.22		0.067	-0.055	-0.173
S UMi	42959.4	326.0	0.519	4.24	3	2.02	0.15	0.15		-0.034	0.380	0.082
V Cam	42885.4	503.5	0.376	5.37	5	2.12	0.68	0.37	0.29	0.033	-0.052	0.025
χ Cyg	42974.3	421.5	0.423	8.99	4	3.93	0.61	0.33	0.32	0.080	-0.048	-0.190
R And	42631.3	426.2	0.316	7.78	3	3.54	0.95	0.40		-0.036	0.314	0.105
R Aur	42728.9	448.0	0.516	6.14	5	2.57	0.69	0.59	0.40	0.104	-0.037	0.008
R Cas	42898.8	443.9	0.369	6.25	5	2.82	0.55	0.43	0.16	0.033	-0.064	
R Cyg	42808.5	443.8	0.382	6.73	2	3.10	0.82			-0.034	0.268	-0.174

Table 1 (continued).

Star	T_0	P	$M-m$	Δm	s	r_1	r_2	r_3	r_4	ϕ_1	ϕ_2	ϕ_3
S Cep	42834.3	503.5	0.568	2.77	3	1.21	0.29	0.12		-0.075	0.227	-0.073
T Cas	42763.3	465.3	0.590	4.69	3	2.08	0.58	0.15		0.067	-0.035	-0.111
U Aur	42738.4	410.5	0.316	5.66	3	2.62	0.67	0.39		-0.082	0.252	-0.047
U CMi	42704.7	422.0	0.579	4.69	3	2.04	0.61	0.25		0.005	-0.144	0.024
U Cyg	42959.4	484.5	0.487	3.30	3	1.48	0.07	0.15		0.071	0.018	-0.007
U Her	42885.4	414.9	0.409	4.45	5	2.00	0.37	0.28	0.16	0.063	0.016	0.023
V Cyg	42756.1	423.9	0.427	3.46	4	1.63	0.23	0.15	0.10	0.073	-0.025	-0.083
W Cas	42976.2	417.7	0.470	2.81	2	1.40	0.12			0.019	-0.383	
X Cas	42660.9	441.9	0.621	1.71	2	0.81	0.26			-0.111	0.243	

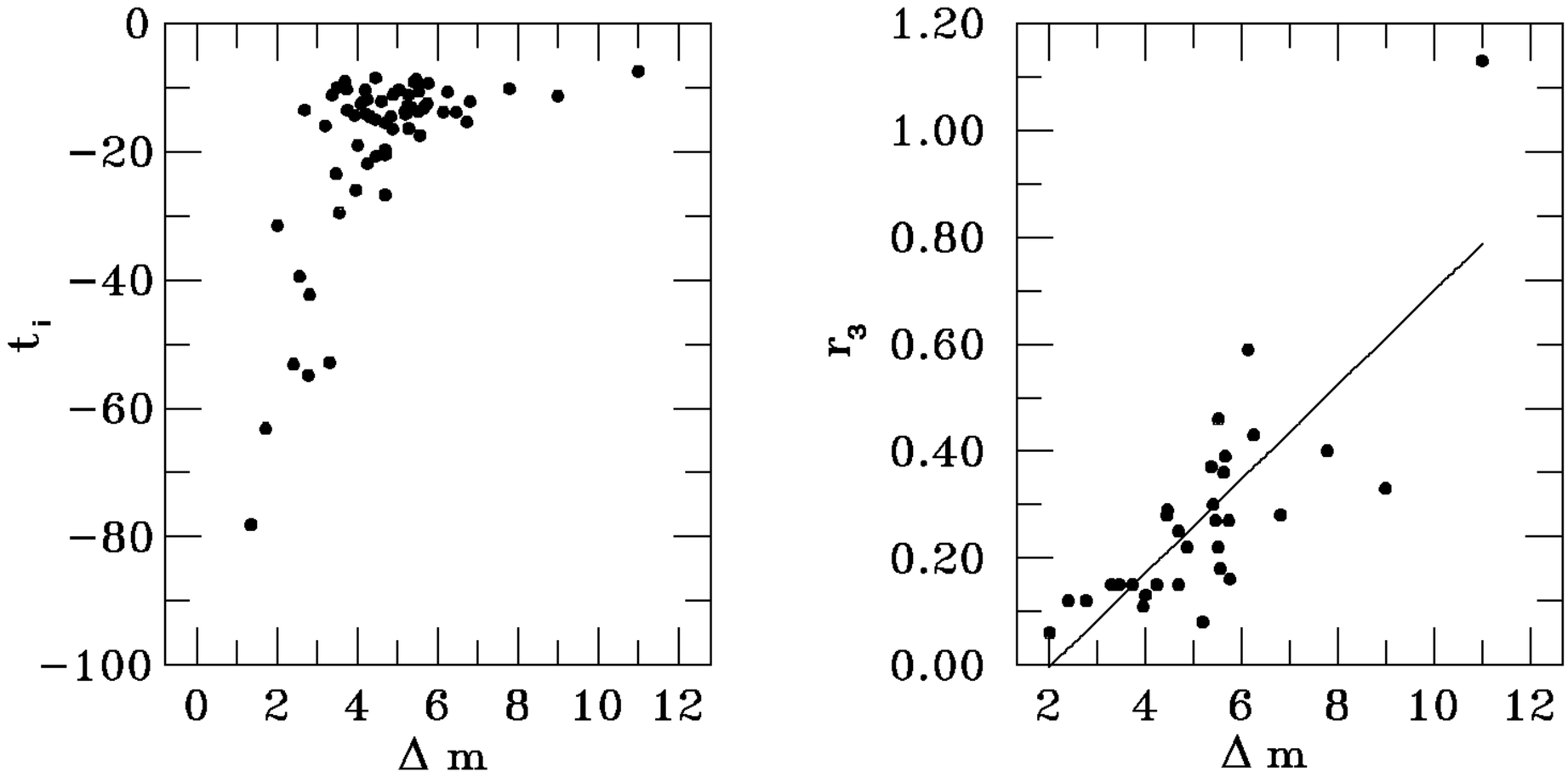


Figure 1. Several correlations between the parameters of the light curves of Mira–type stars.

the additional characteristics:
s – degree of the trigonometric polynomial which is obtained by using the Fischer's criterion and a "false alarm" probability $P_r = 10^{-3}$;
r_k – the amplitude of the wave with a frequency $k \cdot f_1$;
ϕ_k – the phase of the maximum of the wave in respect to the brightness maximum;
$\phi_{k1} = \phi_k - k \cdot \phi_1$ – the shift of the phase relative the maximum of the main wave;

the parameters of the sharpness of light curve:
m_{is} – $(dm/dt)_{curve}/(dm/dt)_{sin}$, where $(dm/dt)_{sin} = \pi(m_{min} - m_{max})/P$ – for ascending branch;
m_{ds} – the same for the descending branch;
t_i – dt/dm – the characteristic time of the increase of brightness (ascending branch) by 1^m;
t_d – dt/dm – the characteristic time of the decrease of brightness (descending branch) by 1^m.

The correlation analysis has been carried out between all pairs of these parameters. The correlation coefficients for 63 pairs from 325 exceed 3σ and were discussed in more detail by Kudashkina and Andronov (1996). Some of these correlations are expected ones (e.g. P and $1/P$). The Figure 1 shows two sample diagrams with nearly linear and non-linear dependencies. The diagram "$\Delta m - t_i$" shows the increasing $|t_i|$ with the decreasing amplitude. In the figure the sign of $t_i = dt/dm$ is negative, because during the incline the magnitude decreases. This figure shows in fact two clusters of the stars with different slopes $dt_i/d(\Delta m)$ which cross at a point $\Delta m \approx 5^m$, $|t_i| \approx 16$ days/mag. Another dependence $r_3 - \Delta m$ shows no significant change of the slope.

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Table 2. The Relationships between the Phases.

Star	r_2/r_1	r_3/r_1	ϕ_{21}	ϕ_{31}	Star	r_2/r_1	r_3/r_1	r_4/r_1	ϕ_{21}	ϕ_{31}	ϕ_{41}
RT Cyg	0.080		-0.450		R Leo	0.100	0.070	0.040	-0.100	-0.140	-0.350
R Vir	0.120		0.380		R Ser	0.150	0.080		-0.250	-0.270	
R Vul					R UMa	0.230	0.100	0.080	-0.140	-0.350	0.450
RZ Sct					S CrB	0.200			-0.240		
S Car	0.270		0.500		T Cam	0.260	0.100	0.040	-0.450	0.130	-0.070
SS Cas	0.210		-0.050		TU And	0.070	0.090	0.050	0.420	0.110	-0.090
SS Her					U Per						
T Her					U UMi	0.030	0.060		-0.070	0.190	
V Tau					V Aur	0.120	0.110		0.260	-0.050	
W Lyr	0.100		-0.460		W And	0.170	0.250	0.120	0.470	-0.100	0.500
X Cam	0.120		-0.340		W Peg	0.090	0.150	0.040	-0.230	-0.100	-0.180
R Ari					X Oph						
RR Boo	0.110		-0.240		R Gem	0.200			-0.240		
X Aur	0.190		0.410		T UMi	0.210	0.150		-0.060	-0.060	
SY Her					U Ori	0.250	0.080		-0.190	-0.380	
W Pup					S UMi	0.070	0.070	0.080	0.080	0.450	0.190
BG Cyg	0.060		0.140		V Cam	0.150	0.080		-0.110	-0.070	-0.200
R Aql	0.140		-0.240		χ Cyg	0.260	0.110	0.150	0.150	-0.200	-0.430
R Boo					R And	0.270	0.230	0.050	0.050	0.380	0.210
R Dra	0.090		-0.160		R Aur	0.190	0.150		-0.240	-0.300	0.450
RS Her					R Cas	0.260			-0.130		
RS UMa	0.240	0.050	-0.120	-0.360	R Cyg	0.240	0.100		0.330	-0.070	
R Tri	0.050	0.070	-0.180	0.050	S Cep	0.280	0.070		0.370	0.150	
S Boo	0.050		0.140		T Cas	0.250	0.140		-0.160	-0.300	
S UMa	0.180	0.080	-0.440	0.230	U Aur	0.300	0.120		0.410	0.190	
TU Cyg	0.110		-0.250		U CMi	0.040	0.100	0.080	0.080	-0.160	0.000
T UMa	0.150	0.110	-0.180	-0.400	U Cyg	0.180	0.130	0.130	0.130	-0.120	-0.220
V Cas	0.080		-0.270		U Her	0.320	0.170	0.060	0.060	-0.110	-0.160
W Her	0.040	0.030	-0.160	0.490	V Cyg	0.140	0.090		-0.170	-0.300	-0.490
Y Per	0.170	0.070	-0.440	0.090	W Cas	0.090			-0.420		
o Cet	0.190	0.170	-0.210	-0.390	X Cas	0.320			0.460		

Table 3. The parameters of sharpness of the light curve.

Star	m_{is}	m_{ds}	t_i	t_d	Star	m_{is}	m_{ds}	t_i	t_d	Star	m_{is}	m_{ds}	t_i	t_d
RT Cyg	1.088	1.012	12	13	RS UMa	1.541	0.852	9	17	X Oph	1.000	1.000	78	78
R Vir	0.923	1.183	12	9	R Tri	0.881	0.887	17	17	R Gem	1.314	0.703	14	29
R Vul	1.000	1.000	10	10	S Boo	0.921	1.094	20	17	T UMi	1.351	1.177	13	15
RZ Sct	1.000	1.000	16	16	S UMa	1.435	0.869	14	22	U Ori	1.620	0.704	14	32
S Car	1.332	1.334	13	13	TU Cyg	1.194	0.764	11	17	S UMi	1.118	0.972	22	25
SS Cas	1.284	1.137	10	11	T UMa	1.649	1.012	9	15	V Cam	1.322	0.920	13	26
SS Her	1.000	1.000	10	9	V Cas	1.153	0.822	15	20	χ Cyg	1.705	0.725	11	16
T Her	1.000	1.000	10	10	W Her	1.206	1.050	14	16	R And	1.685	1.257	10	24
V Tau	1.000	1.000	11	11	Y Per	1.240	1.006	31	39	R Aur	2.108	1.130	14	18
W Lyr	1.120	1.023	14	16	o Cet	1.818	1.088	11	18	R Cas	1.370	0.988	11	20
X Cam	1.196	0.873	9	12	R Leo	1.315	0.829	19	30	R Cyg	1.055	1.257	15	21
R Ari	1.000	1.000	14	14	R Ser	1.357	0.924	12	18	S Cep	1.182	1.141	55	46
RR Boo	1.201	0.753	13	20	R UMa	2.004	0.992	9	18	T Cas	1.762	0.893	27	28
X Aur	1.036	1.273	12	10	S CrB	1.317	0.689	16	31	U Aur	1.395	1.040	13	26
SY Her	1.000	1.000	11	11	T Cam	1.667	1.017	12	20	U CMi	0.885	0.905	21	28
W Pup	1.000	1.000	10	10	TU And	1.268	0.949	16	22	U Cyg	1.973	0.744	53	52
BG Cyg	0.925	1.096	39	33	U Per	1.000	1.000	29	29	U Her	2.252	1.132	15	40
R Aql	1.244	0.694	16	28	U UMi	1.012	1.057	26	25	V Cyg	1.663	0.880	23	44
R Boo	1.000	1.000	14	14	V Aur	0.881	0.971	53	48	W Cas	1.117	0.974	42	49
R Dra	1.156	0.870	13	17	W And	1.544	1.524	7	8	X Cas	1.302	1.413	63	58
RS Her	1.000	1.000	15	15	W Peg	1.186	0.920	21	27					

δ SCUTI STAR GX PEGASI: ADDITIONAL ANALYSIS

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ABSTRACT. Three criteria of the periodicity are discussed in the paper and their properties are investigated. These criteria are applied to investigate the periodicity properties of a variable star GX Pegasi. A number of periodic components are extracted.

Key words: variable star, periodicity, δ Scuti

Criteria of periodicity

Criterion of periodicity is a function of a sequence of "measurements" and a trial period T. This function reaches its maximum when the "measurements" have a periodic component with a period P and, inverse, it takes a "low" values for other trial periods.

Three criteria of periodicity were used in our investigation. First of them represents the simplest case of a periodogram and is known as Rayleigh criterion

$$K_1(T) = \frac{1}{\left(\sum_{j=1}^{M} x_j\right)^2} \times$$

$$\times \left[\left(\sum_{i=1}^{M} x_i \sin \frac{2\pi t_i}{T} \right)^2 + \left(\sum_{i=1}^{M} x_i \cos \frac{2\pi t_i}{T} \right)^2 \right],$$

where x_i are the measurements, t_i – the appropriate time moments, T – the trial period.

Two other criteria are some kind of epoch superposition method and analyse the structure of light curves

$$K_2(T) = \frac{m}{M} \sum_{j=1}^{m} \left(n_j - \frac{M}{m} \right)^2,$$

$$K_3(T) = 1 - \frac{max\ (1,\ min\ n_j)}{max\ n_j},$$

where m is the number of bins in a light curve, n_j – the array of bins values, M – the sum of all the "measurements", so that M/m is the mean value of the bin in a light curve.

The criteria properties have been investigated in (Gurin et.al., 1992).

freq. (μHz)	ampl. (mmag)	conf. (%)
187.2	1.62	≥ 99
197.0	0.58	≤ 20
221.9	0.56	≤ 20
224.0	0.76	≤ 20
227.6	1.78	≥ 99
230.4	2.08	≥ 99
237.5	1.80	≥ 99
240.5	2.18	≥ 99

Table 1: Periodic components, extracted by CLEAN technique (Belmonte et al. 1991)

GX Pegasi data analysis

The variable star GX Pegasi (HR8584, HD213534, $\alpha = 22^h.5$, $\delta = 29°.5$, spectrum A8V) was discovered to be a δ Scuti star by Breger (1969). The ground based observations were organized in August–September 1989. The detailes of observations, instruments and data reduction are presented in (E.Michel, 1992, see Table 2, Fig. 2 and also references there).

A number of periodic component were extracted. We reproduce here these results, Tables 1 and 2 to have a possibility for comparison.

Three criteria, described above, were applied to extract the periodic components. The results are shown in Table 3.

As one can see, we have a good agreement in all three tables. But one detail should be payed attention. The amplitudes, presented in Table 3, are slightly higher for all the frequencies than ones in Tables 1 and 2. It depends on the details of the data processing technique and cannot be explained by simple reasons. The amplitude was evaluated here as a half a difference between maximum and minimum values in light curve. The light curve can be smoothed and after smoothing this quantity may become slightly lower, but these changes are quite neglidgble.

freq. (μHz)	ampl. (mmag)	conf. (%)
187.3	1.7	≥ 99
223.6	0.8	≥ 20
227.5	2.1	≥ 99
230.4	2.3	≥ 99
237.5	1.9	≥ 99
240.5	2.2	≥ 99

Table 2: Periodic components, extracted by ISWF technique

No.	freq. μHz	ampl. (mmag)	Conf. level 1	2	3
1	187.2	2.12	99	99	99
2	196.8	0.91	97	86	90
3	227.6	2.11	94	80	82
4	230.4	2.48	98	96	92
5	237.5	2.23	98	96	81
6	240.5	2.55	97	93	78
7	277.2	0.50	99	97	95

Table 3: Periodic components, extracted by three criteria, described here

To decrease the influence of the noise the additional investigation was made. The intervals with obvious sinusoidal curves only were selected. They are the following intervals in days since the base date: 0.7–1.0, 7.68–7.85, 8.35–9.0, 10.37–10.85, 11.6–11.95, 17.35–17.75, 18.45–18.68. After that the combined time series was tested by the described criteria. The results are shown in Table 4 (only frequencies and amplitudes, the confidence levels were not evaluated, but we are sure they are high).

No.	freq. μHz	ampl. (mmag)
1	187.2	2.3
2	227.6	3.8
3	230.2	5.2
4	237.2	4.2
5	240.6	5.2

Table 4: Periodic components, extracted in the intervals with good sinusoidal structure

As we see, all the main five frequencies are presented, the amplitudes are rather higher than in full observations series and the frequencies values are quite close to that was obtained by processing the full data series.

The situation looks like the amplitudes are not the constants, but depend on the time. That dependence can be defined, but it is a very difficult and cumbersome variation problem, it takes extremely large amount of processor time. May be we turn back to this problem after the observations on the board of Mars-96 space probe, experiment EVRIS.

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ON EVOLUTIONARY STATUS OF STARS WITH THE R CRB PHENOMENON

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ABSTRACT. Two key features are important for understanding the evolution of stars with the R Coronae Borealis variability: the state of high mass loss rate and the carbon overabundance. The hydrogen deficiency is a consequence of these two characteristics. This idia allows us to build one of several possible evolutionary chains from observable states of some stars: from a low mass star of the FG Sge type with a thin hydrogen shell through the phases of V854 Cen - R CrB - UV Cas to a star of the XX Cam type with hydrogen completely lost.

Key words: R CrB stars: hydrogen-deficient stars: stellar evolution.

The first phase, the FG Sge phase, with a duration of about hundred years is characterized by a final flash of helium shell. The star flashes by 3-5 mag, its luminosity comes nearer to the Eddington limit. An intensive mass loss leads to an overabundance of carbon in the stellar atmosphere and conditions are created for the start of dust condensation that may appear at once as the R Coronae Borealis type light minimum. The star passes to the V854 Cen phase with a duration of several thousands of years. The star is surrounded by a spherical dust permanent envelope with the thinckness τ¡3. The radius of dust clusters is r*cong*0.01-0.03 micron. A denser dust layer (up to *tau*¡8, r=0.1-0.3 micron) arises sometimes on the inner boundary of the envelope as a result of pulsations. An R Coronae Borealis minimum is observed again. At this phase the hydrogen deficiency arises to 0.1-0.01. The decrease of the hydrogen abundance supports conditions of constant condensation of particles with small radii only (r¡0.01 micron): the permanent dust envelope exists but it does not influence the visual stellar brightness. But, as before, the conditions for a growth of particles up to r=0.1-0.3 micron arise sometimes, and then a visual extinction appears. As a result, we observe the R CrB phase that terminates as the UV Cas phase after tens of thousands of years: a complete end of dust condensation due to the hydrogen depletion. The mass loss is finished, the star enters the XX Cam phase: no R Coronae Borealis minima are observed (the only minimum for 100 years had a symmetric shape, and this might be an eclipse), only hydrogen tracks are found.

Stellar luminosity in this chain seems to change slightly: within an order of magnitude around 10^4 of the luminosity of the Sun. The temperature is 5000-7000 K. The stellar mass is 0.6-0.7 M_o masses of the Sun. A star has a thin hydrogen shell, with a mass of 0.01-0.1 M_o lost during about 100000 years, this shell is represented at present as a fossil dust envelope with a radius of up to some parsecs and a temperature of some tens of degrees.

The V854 phase duration should be specified after of its fossil dust envelope radius is determined, this radius may be no more than 1 arcmin against 18 arcmin in R CrB itself.

It is likely that the existence of at least two more chains has to be assumed in order to obtain the hydrogen deficit in extreme helium and cool hydrogen-deficient stars. The first chain extends from cool Wolf-Rayet stars of carbon sequence through V348 Sgr, MV Sgr and DY Cen. The second chain extends from the normal carbon stars of the early R0-R5 spectral classes through U Aqr, S Aps, RS Tel, etc.

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THE CHROMOSPHERE-LIKE ENVELOPE OF THE VARIABLE STAR T TAU

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ABSTRACT. The emission measure of the near-star chromosphere-like envelope of variable star T Tau with various mechanisms of radiation is computed. The normalization on the observed distribution of energy in continuum spectrum is carried out. The accretion disk and chromosphere models of the T Tau are discussed.

Key words: Stars: T Tau, Nebula T Tau.

Academician Ambartsumian in this classic works presented,that variations of brightness of many irregular variable stars are closely connected with variations of brightness of emission nebulae, close to them. In particular, that pertain to star T Tau and Bernham nebulae (nebulae T Taurus). Schwartz (1974, 1975) was published observations of nebula T Taurus and reduced fluxes H and He lines (in units of energy).

Zanstra method was used to calculate Lc-radiation flux giving vise to T Taurus nebulae emission. This nebulae spectral date, published Schwartz (1974, 1975) were taken. Having compared Fo value to photometric observations at IUE satellite and land observations in UBVR system we revealed that they very well by a smooth line representing T Tau continuous spectrum energy distribution curve from visual region to for UV. Besides, our theoretical estimates showed that even a half of Fo flux is enough to give vise to T Taurus nebula.

However, there arises a question, where Lc-quanta of T Tau star are taken from, as its spectral class is late F-K. This difficulty disappears as its spectral fast as we suppose that T Tau star has a chromosphere. We calculated this chromosphere emission measure $ME = Ne^2V$ for different emission mechanisms (tabl. 1). We found, that $ME = 3.55 \cdot 10^{55}\mathrm{cm}^{-3}$, that revealed to be very close to ME, got from T Tau spectral observations in far UV (Cram, 1979; Cram et. al., 1980). In table 1 we presents theoretically calculated measures of emission chromosphere-like envelope of variable star T Tau different radiation mechanisms: free-free transitions (f-f), free-bound combined (f-b) and also for two-quantum 2q-radiation. As we see, in the table 1, that value of measure of emission is dependent from what point of continuous spectrum is taken for setting norms. We emphasize that, the points of setting norms are taken from observational distribution of energy in continuous spectrum T Tau. Schwartz (1975) give some more value $ME = 2.00 \cdot 10^{56}\mathrm{cm}^{-3}$, offered before, but he do not give noting commentary. Because we are inclined to think that the most probable value of emission measure can be value $ME = 3.55 \cdot 10^{55}\mathrm{cm}^{-3}$. Consequently easy to obtain geometrical dimension of this envelope.

What observational arguments, besides this, are in witness of chromosphere in variable stars T Tau? There are two arguments. The first, emission spectrum T Tau is like spectrum of solar chromosphere, is seen well the lines H and K calcium, and lines of ionized Fe and titanium. The second, characteristic time of many variations of brightness T Tau is equal 30-40 minutes. This is give possibility to estimate electronic concentration Ne in that points stellar atmosphere, in which they took place. The estimates Ne give the value very closely to electronic concentration in solar chromosphere.

However, the assumption about presence of chromosphere variable star T Tau is not only one way to find source of L_c-quanta for excitation of nebulae T Taurus. Such source can be presence an accretion disk in variable star T Tau. Exactly the same model for star type T Tau was developed in work (Lamsin et al., 1996).

We notes, that disk sometimes can give considerable greatest flux in X-ray region, than powerful chromosphere-like envelope or chromosphere. Thus, even the most X-rays detectors do not registrate observable flux of energy in X-ray region for T Tau star.

It should be interesting to built the accretion disk model and to analyze all data of observations T Tau as the most studying representative of that kind variable stars.

However, in our opinion, now chromospheric model of T Tau is the most confirmed by observational data. In the work (Golovatyj et al., 1979) developed photoionization model of nebulae T Taurus in base on abovementioned value Fo and i the work (Golovaty V.V. and Novosyadlyj B.S.) too, in which the photoionization model of nebulae T Tau is making more precise by calculation radiation.

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Tabl.1. Measure of emission with different radiation mechanisms

n	Radiation mechanism	Setting norms	Measure of emission
1	(f-b)-transitions	$F_0 = 6 * 10^{-29}$	$3.74 * 10^{55}$
2	(f-f)-transitions	$F_{\lambda=6sm} = 5 * 10^{-30}$	$3.36 * 10^{55}$
3	2q-radiation	$F_0 = 6 * 10^{-29}$	$8.58 * 10^{55}$
4	(f-f)-transitions	$F_0 = 6 * 10^{-29}$	$2.29 * 10^{59}$
5	(f-f)-transitions	Schwartz (1975)	$2.00 * 10^{56}$
6	Observations on IUE	Cram et al. (1980)	$7.22 * 10^{54}$

SLITLESS DIGITAL TV SPECTROPHOTOMETER OF THE CRIMEAN ASTROPHYSICAL OBSERVATORY

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ABSTRACT. The original slitless spectrograph are created in the Crimean Astrophysical Observatory for 0.5-m meniscus telescope. It has three replaceable transparent diffraction gratings with the distance control. The highsensitive TV tube intensified isocon is used as detector. The digital videodata are collected in the memory of the computer PC AT 286. The spectrophotometric observations may be done in wave range of 3700-7400Å with spectral resolution 80Å, 60Å, 30Å. Exposure time for stars $10-12^m$ is 2-5 minutes. The relative photometric accuracy of one such record is about 3-5 %. Absolute photometric accuracy is comparable with it because the artificial photometric standard used for absolute calibration of records.

Key words: spectrophotometry, spectrograph.

Introduction

The spectrophotometrical observations of different astronomical objects are significantly more important then the photometric investigation. Spectrophotometry of faint sources get real when highsensitive detector is employed. On the base of digital TV complex of 0.5-m meniscus telescope of the Crimean Astrophysical Observatory (Abramenko et al. 1982, 1988) the modern afocal slitless spectrophotometer was developed.

The goal of this development was creation apparatus on small telescope for routine observation of different peculiar objects that need many hours monitoring. The cheap telescope and apparatus allow such investigations.

Spectrograph

Slitless afocal spectrograph contains plan-concave negative and plan-convex positive lenses, diffraction grating put between them and prism having small refracting angle. The prism permits to eliminate aberration from inclined beams. Spectrograph is displaced in the convergence beam before the focal plane of the telescope. Collimator lens and prism are made from the single whole block of the glass. Transparent diffraction grating is placed over the flat surface of the positive lens (Pronik, Sharipova 1993). Three grating are employed having 50, 100 and 150 grooves per mm. Their replacement has distantional control.

TV and record devices

The detector of light is an Isocon image tube with one-stage intensifier. Its temperature is held within the range $0-5°$ C during observation by cold dry air. The stellar spectrum is projected on the photocathode perpendicular to the TV line direction. TV analog videosignal is sent to special interface where it is digitized. The digital information of many (50 - 100) TV scans is integrated in the memory of the computer (PC AT 286).

The spectral resolution depend not only from apparatus but from atmospheric seeing also. Under condition of good seeing we have spectral resolution of 80Å, 60Å or 30Å using different gratings.

Observation method

The spectrophotometrical standards having well known distribution of energy may be observed for the absolute calibration of the ordinary spectrophotometrical observations. The differential method is applied. Using the artificial standard calibrated by special observations we can estimate absolute spectral distribution of investigated objects when atmospheric extinction is known.

Reduction method

Reduction of spectrophotometrical data consist of two stage. At the first stage all spectral data are calculated in the common scale of artificial standard. At the second stage the absolute distributions of energy of the investigated objects are calculated. The value of extinction for observational nights may be estimated using data of standard stars. Synthetic stellar magnitudes in passband V and colour indices $B-V$ may be calculated also.

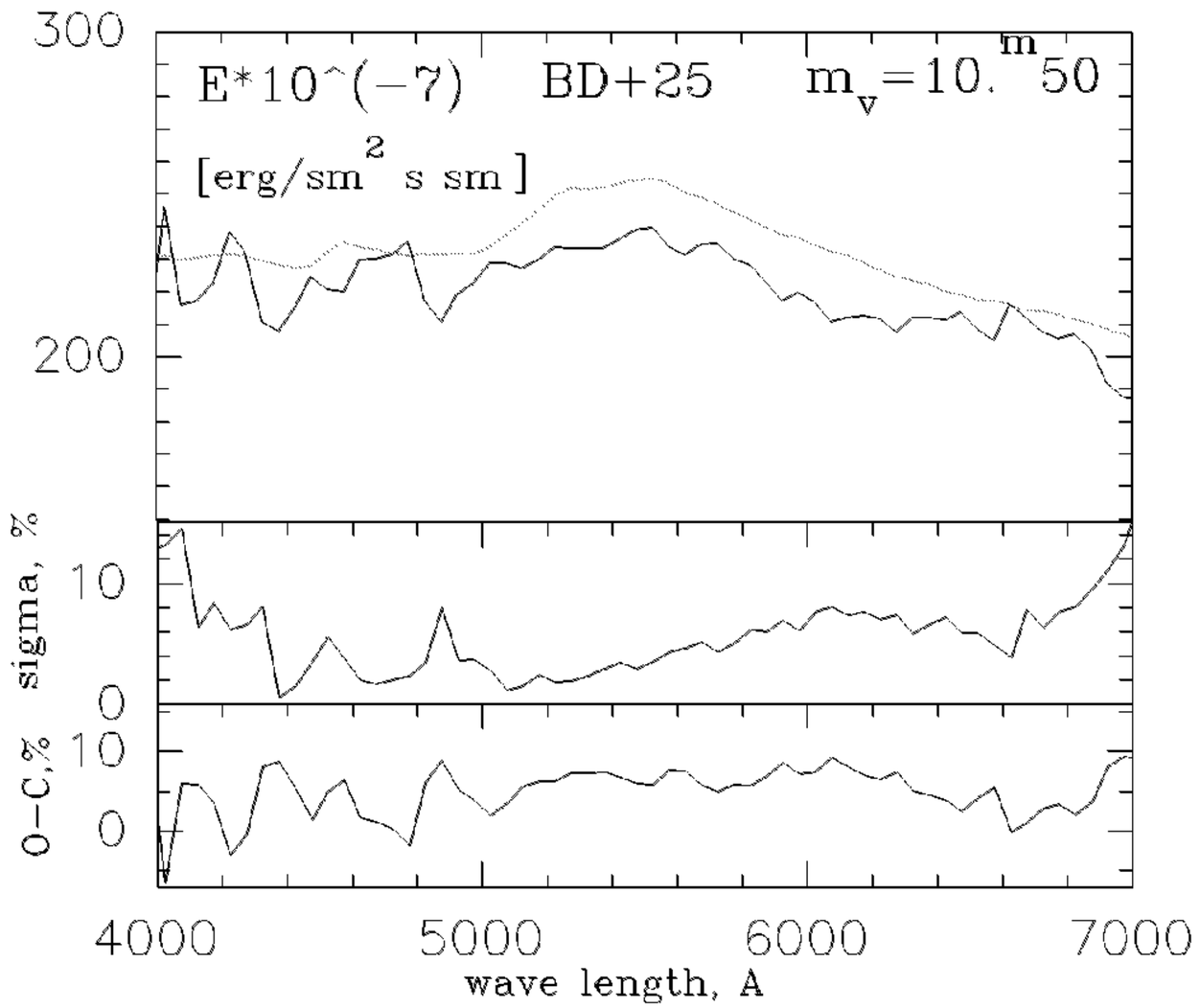


Figure 1:

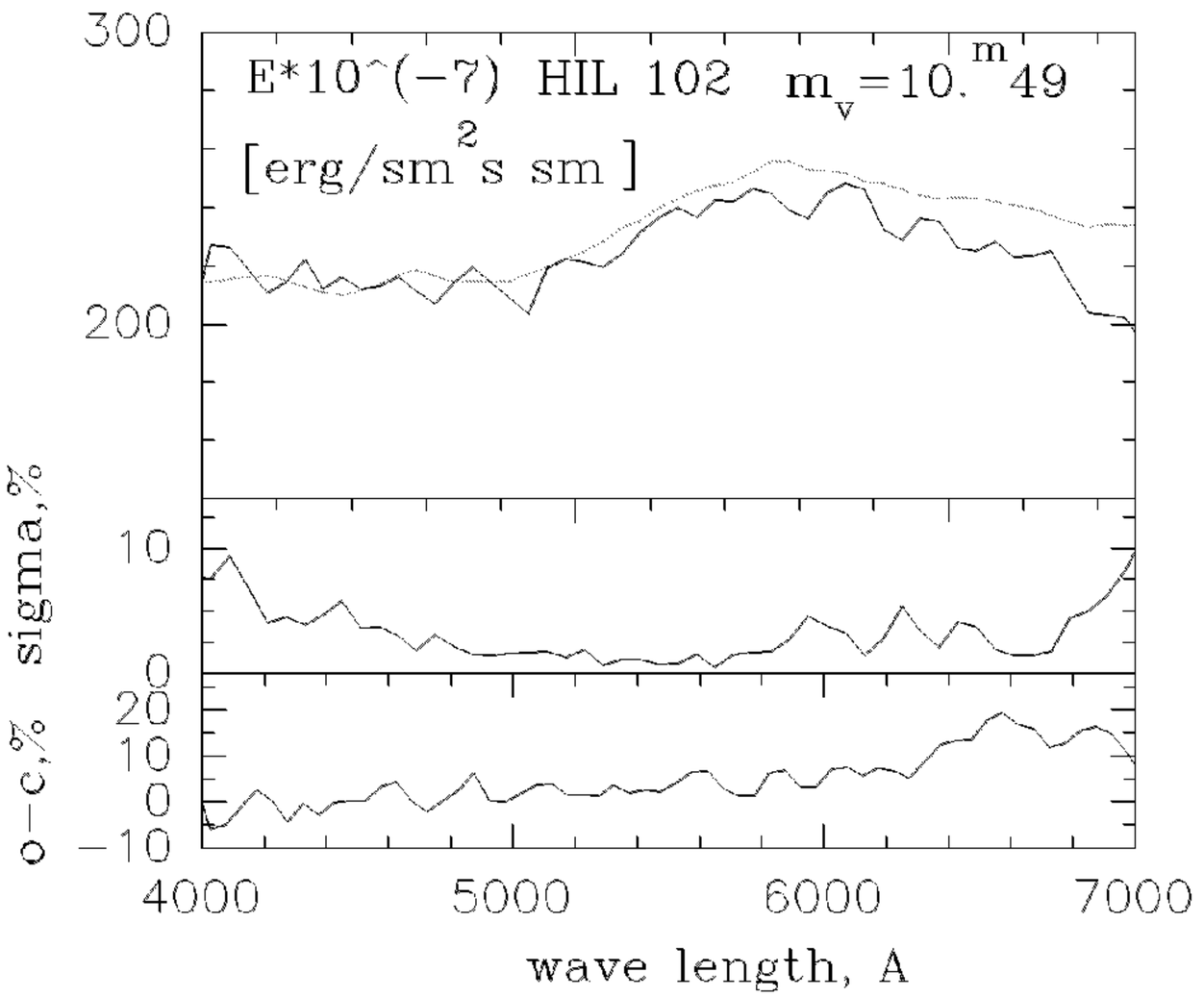


Figure 2:

Precision of the TV spectrophometrical observations

The examples of our spectrophotometric data in comparing with catalog data are given on the Fig. 1, 2. Absolute distributions of energy in the spectra of the stars with brightness about $10^m.5$ BD+25 and HIL 102 are shown on the Fig. 1a, 2a by solid lines for our observations and by dashed lines for the the Kitt-Pick observatory data (Barnes, Hayes 1984). Spectral dependencies of the internal and external accuracy are presented on the Fig. 1b, 1c, 2b, 2c accordingly. The absolute energy distributions with our apparatus were obtained for twelve stars near the North Pole. The standard deviations of distribution data energy were estimated as 2-3 % for stars of $9 - 10^m$. and 3-4 % for stars of $11 - 12^m$.

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A LAZER STAR AS A REFERENCE RADIATION SOURCE IN FORMING NONDISTORTED AES IMAGES

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ABSTRACT. In the work, a possibility is shown of using an artificial laser source (a laser star) as a reference one to obtain an undistorted image of artificial Earth's satellites.

Key words: laser, image of AES, atmospheric turbulence.

Atmospheric turbulence and distortions, caused by it, of artificial cosmic objects' images, in particular, of artificial Earth's satellites (AES) as well as compensation methods of these distortions have been studied thoroughly and for a long time (Tatarsky, 1967; Bacoot, et al., 1977). One of compensation methods consists in obtaining images of a point source located within an isoplanatism angle Θ_0 in wich the observed object is olso found, in subsequent assessment of the wave front distortion, and then in compensations of these distortions in the obtained image of the object of interest. However, during AES observations it is intricate to find such a source (and even if it is found) its use is rather problematic. The possibility has been lately studied to use an artificial laser star (Bacoot, et al., 1995) as a reference source. The report deals with the investigation of this problem. The following questions are considered: energetics, the star's size, focal nonisoplanatism, nonpoint possible compensation methods, analysis of efficiency of using an artificial laser star (ALS) as a reference source.

Let us consider ALS as being formed due to the resonance scattering effect in a sodium mesospheric layer. At a height of 90 kms above the earth's surface the sodium atom number density is maximum and amounts to 10^3 - 10^4 cm. The resonance scattering section is - 8 10^{-12} cm^2. A relatively high sodium atom number density in the mesosphere and a large effective cross section of the back scattering make the sodium layer most suitable for forming artificial reference radiation sources.

The calculation of mean energy should be carried out in several steps. First, it is necessary to calculate the reaction of one unlabile atom per laser radiation. Then, the broadening of atomic scattering lines due to different reasons should be assessed: Doppler broadening due to atomic motion, broadening due to pulse character and partial coherence of laser radiation, broadening due to finite time of atomic passing by the laser ray. Taking account of all these factors permitted to derive a formula for energy signal received from an artificial star.

$$E = E_{rad} K \frac{N A \sigma_\rho h}{8\pi R^2} \int_0^\infty \frac{\exp(-x - \alpha^2 x^2)}{1 + \beta^2 x^2} dx \qquad (1)$$

where
K is the coefficient taking into account absorption, reaction and a detector;
E is the energy received;
E_{rad} is the radiated energy;
σ_ρ is the cross section of resonance scattering $[m^2]$, $\sigma_\rho = \frac{\lambda_{nm}}{4\pi}$,
λ is the wavelength of atomic transition, λ=589 nm,
A is the area of aperture $[m^2]$,
N is the mean sodium atomic number density in a layer $[m^{-3}]$,
h is the thickness of the layer [m],
R is the distance to the layer [m]

$$\alpha^2 = \frac{1}{2\gamma^2}\left(\frac{1}{4\tau_i^2} + \frac{1}{\tau_{corr}^2} + \sigma_v^2 k^2\right), \qquad (2)$$

$$\beta^2 = \frac{1}{\gamma^2}\left(\frac{\sigma_v^2}{4\sigma^2} + \frac{\sigma_v^2}{\sigma_A^2} + \frac{k^2 \sigma_v^2 \sigma^2}{f^2}\right), \qquad (3)$$

τ_{corr} is the root-mean-square extension of a radiated signal correlation interval [c],
τ_i is the pulse duration [c],
γ is the natural bandwidth of atomic transition, γ=10 MHz,
σ_v is the mean-root-square scatter of velocities of atomic thermal motion (of one component), σ_v=278 m s^{-1},
$k = \frac{2pi}{\lambda_{nm}}$ is the wave number,
σ is the area of radiating aperture $[m^2]$,
f is the focal length [m]
σ_A is the root-mean-square extension of atmospheric fluctuations [m].

According to the formula obtained, calculations were made which showed that in the existing elemental fase (Zollars, 1992), and moreover in the promising one,

the registering, and therefore assessment of distortions may be possible.

Calculation of geometrical dimentions of LAS under the following assumptions: - the function of a pupil $A(\vec{\rho})$ is

$$A(\vec{\rho}) = \exp^{-\frac{\vec{\rho}^2}{2\tilde{\alpha}^2}}, \qquad (4)$$

where $\vec{\rho}$ - is the lateral radius-vector [m] $\tilde{\alpha}$ is the equvalent cross-section of a laser bunch at the opering [m], The function of coherence $\Gamma(\vec{\rho})$ is

$$\Gamma(\vec{\rho}) = \exp\left(-\frac{\vec{\rho}^2}{2\tilde{\beta}^2}\right), \qquad (5)$$

where $\tilde{\beta}$ - the root-mean-square extention of atmospheric fluctuations [m], gives the following sizes of laser bunch cross-section at a distance z[m] over the Earth's surface d_{nn} [m]:

$$d_{LL} = \sqrt{z^2 \frac{1 + 2\left(\frac{\tilde{\alpha}}{\tilde{\beta}}\right)^2}{\left(k\tilde{\alpha}^2\right)^2} + \left(1 - \frac{z}{f}\right)^2}. \qquad (6)$$

Calculations yield a result from several to tens of centimeters.

The analysis (of physico-chemical problems: nonpoints of a reference object, focal non-isoplanatism) has shown that a method of using a laser star for AES-observations can be realized. All the necessary calculations have been made at the theoretical department of Prof.P.A.Bacoot and they are to be put into practice at the Department headed by Yu.A.Medvedev in Odessa astronomical Observatory.

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THE EIGHT–CHANNEL PHOTOMETER–POLARIMETER 1. THE SELECTION AND REGISTRATION SYSTEM

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ABSTRACT. This paper presents the selection and registration system of the eightchannels photometer-polarimeter,which was developed at the Lviv Astronomical observatory for observations of the artificial satellite of the Earth. As feeding optics are two Cassegren system telescopes with diameter 3500 mm and equivalent focus 3.5 m installed at the four-axes guide-mounting. The device allowed to produce the measurements in UBV system to measure the degree of linear polarization and location of oscillations plane simultaneously in eight spatial-timing divided channels with automatically subtraction of background. The lights fluxes of each channels were registrated by four photomultipliers.The selection and registration system is the separated block, which allowes to carry out primary working up the signals and to enter the resulting signals to the computer at the real time.

Key words: photometric observations; polarimetric observation

For solution of problems connected with studying of the surface of artificial space objects (ASO) especially value presents colorimetric polarimetric observations. At present there are great number of different photometric and polarimetric equipment. At the same time, the problem of observations ASO with rapid variations and impossibility of repeating obtained information is very actually. Because unique of analogous observations there is the problem of getting more information about given object. Therefore, it is very important to have synchronous observations in several photometric bars in wide spectrum diapazon and polarimetric parameters.

For this purpose at Astronomical Observatory of Lviv State university is developed multichannel electrophotometer - polarimeter. This instrument consists of optical-mechanical part, which is strengthening on guide-mounting and system of selection and registration of signal.

Feeding optics consist of two Cassegren telescope systems .The main mirror of both telescopes have diameter 350 mm,the focus distance of this system - 3500mm. Optical details of this system were produced in the optical workshop at Crimea Astrophysical Observatory. The telescopes were installed on the four-axes guide-mounting from laser range-finger (type LD -2). Each optical channel is eguiped by segments with set of double diaphragms, which mechanical sector modulator coveres in turn for automatically subtraction of background. The modulators of both channels formes united system, strictly connected with gear and are rotating by one synchronous engine. Feeding of electro-engine is realized by quartz generator. The modulators are connected in one system with the blocks of polaroids, which are rotating twice as quickly as modulators. This gives a possibility during one circle of modulator to measure the polarization and photometric parameters signal+background and background apart, what allowes to give data about polarization quasisimultaneously with photometry of signal+background and background. The modulators were installed and adjusted in such manner,that by one optical system we can measure (signal+background),at the same time,that we have take data about background from other system. The realization of this scheme allowes not to lose useful signal in semi-period of measuring of background.

After polaroids in optical channel of each telescopes were set the filters under angle 45 degrees to optical axis. That divides each channel on two spectral parts according to blue or red regions of spectrum. The light from each of four created channels are registered by photomultipliers .Each photomultiplier have pulse amplifier - discriminator,which input pulses are send in the selection system and registration system of signals.The system is the separated on electronic block allowed to carry out primary working up the signals and to enter the resulting signals from each channel to the computer . All operation and synchronization systems are on modulator"s disk and consist of thick openings and optic pairs. At present time the possibility to change synchronic engine to step engine is developed.

As been mentioned above, the polarization parameters are taken by rapidly rotating polarizational analyzers. Registration of measurements is conducted by accumulation of pulses from photomultipliers in four counters at the each of 8 channels switching synchronously with rotation of analyzers. The first counter countes the pulses from photomultiplier in angle intervals of turning analyzer from 315 to 45 degrees and

from 135 to 225 degrees,secound counter - from 45 to 135 degrees and from 225 to 315 degrees , third counter - from 0 to 90 degrees and from 180 to 270 degrees, fourth counter - from 90 to 180 degrees and from 270 to 360 degrees . Then for few turns of analyzers having the total number of pulses from four counters, we have got an opportunity to count the degree of linear polarization and location of plane primary oscillations.

All instrument is composed in the block system allowed father modernization and changes of separate nodes for most wide use of this device.There was predicted the possibility of hand output polaroidal filter from optical channel. Therefore, having two independent optical channels we can give simultaneously and polarization and photometric measurements in the same or different spectral ranges.

At present are finished the stand investigations of this device and the stage assembling at the observational base of the Lviv Astronomical Observatory.

THE MOUNTING OF THE NEW 2-M RCC TELESCOPE AT TERSKOL IN 1994-1996

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ABSTRACT. In 1996 "Carl Zeiss Jena" and Centre of Astronomical and Medico-Ecological Investigations had mounted new 2-m RCC telescope, named as ZTT (Zerkalny Telescop v Terskole). The general review of the telescopes and buildings on the hiltop Terskol (3100m) are given. The basic design of ZTT are described. The results of first engineering tests of the new 2-m RCC telescope have been discussed.

Key words: Astronomical instruments.

RECORDING THE CALCIUM SPECTRUM IN CAPILLARY LAMP

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ABSTRACT. Considered possibility of fabrication in laboratory conditions of special tubes with metals vapours of increased brightness. Shown possibility of their use for astronomical instruments.

Key words: Instruments: artificial standards

Calcium is an element of the II Group of the Periodic System. It is an alkaline-earth metal possessing the considerable vapor pressure only at hundreds degrees above zero and very high affinity for oxygen. The same properties are shown by other alkaline-earth metals, such as magnesium and lithium. So, everything mentioned below as characteristic for calcium is also actual for these elements.

All of them interact with glass and quartz showing the flash, and their vapors also destroy these materials making them opaque. Thus, it is really difficult to make the spectral lamps with these elements. However, it is possible to avoid the undesirable chemical reactions in the lamps, for example by introducing the metals as iodides (Yushkov, 1984) or by spraying them within the hollow cathode (Moskalenko, 1969). The former method was tested using the "beads" with the high frequency excitation and it did not show any good results. Quartz was readily crystallized and the lamp flask was destroyed, as even the micro traces of CaO catalyze quartz crystallization. The discharge with the filled cathode is not always acceptable, since too many lines in it are excited (Moskalenko, 1969) which is generally undesirable.

Taking into consideration the inertness of Ca for the transition metals, it seems advisable to use the accessories made of these metals (Brauer, 1985) for the evaporation of Ca.

The lamp we have developed can be considered "capillary", as in spite of the presence of the hollow cathode it is used only as the source of electrons and as the "stove" for evaporation of Ca. The evaporated atoms due to diffusion enter the discharge where they are excited and emit the "arc" lines.

The design of the device is as follows: The cylindrical flask of molybdenum glass contains the hollow cathode of iron or molybdenum which is located on the long holder. Within it, behind the perforated diaphragm, the alloy Ca-Al with the content of Ca 50%, stable on air, is placed. The cavity of the cathode, in the simplest case, is closed by the iron diaphragm with the hole 0.7-1.5 mm in diameter. In general, both cathode and diaphragm should be made of molybdenum, due to its high conductivity, however, it is hardly accessible and poorly processed. Near the hole on the diaphragm the anode of the titanium plate of rather large surface (1-2 cm) is located. It also serves as a getter, and at the work of the lamp it must not be heated too much in order to avoid the back hydrogen release. At the end face of the cylinder the plane glass window or collecting lens is welded in which brings into focus the image of the discharge capillary tube on the end face of the light guide. Due to the fact that the discharge shows sometimes the trend to burn on the external surface of the cathode, the latter is sealed from the outside by the sleeve made of Polycor or Alundum. Quartz does not suit for this purpose, as it is destroyed by the Ca vapors and splitted at the cathode heating. The lamp is filled with He or Ar at the pressure 50 mm Hg. The pressure of the gas is not very critical, however, it influence the lifetime, as it sharply decreases the diffusion of Ca vapors from the cathode. At too high pressure the discharge transforms into the arc form with the cathode spot more readily which will cause the unstable work of the lamp. The helium inflation results in less quantity of the extra lines, since the light He atoms spray the cathode and discharge cathode walls, however He possess extremely high thermal conductivity, so higher current is needed for heating cathode in it. It should be noted that the similar (though not soldered off) source was manufactured by Paschen (Moskalenko, 1969), however, in this source gas filling was not used. In addition, this source acted as HCL (Moskalenko, 1969). The buffer gas in our lamp accomplishes several functions: it provides the initiation of the cold lamp, prevents both the drift of the metal on the walls and its spraying onto the outlet window. As both He and Ar posses much higher ionization potential than Ca, the atoms of the latter, being ionized within the discharge are transported back into the cathode. This phenomenon is called cataphoresis. And since it is in proportion

to the square of the number of the current density, it is obvious that in order to increase the lifetime the capillar diameter should be minimal. In this case the surface brightness of the discharge would also increase. Using cataphoresis for the absolute suppression of the metal vapor diffusion from the cathode, thus creating the "perpetual lamp", demands the accurate calculation of the mode of operation, in particular, strict observance of the heat condition of the cathode, as the pressure of the vapors significantly (exponential curve!) depends on temperature. This phenomenon has not been investigated in our work for the different reasons. At the combustion of the discharge in the iron capillary tube the spectrum is contaminated by its lines. In order to increase its purity we have made two samples of lamps with the porcelain capillary tube which prevented the undesirable lines of iron.

The operating current of the lamp which influences the cathode temperature, thus influencing the pressure of the metal vapors was chosen so that the irradiation of the inert gas was suppressed almost completely. Here, the metal lines are narrow and bright enough.

We have manufactured the lamps of this type with Ca, Mg, Li, and Tl. Then we have investigated the spectral lines of Ca and Tl. The coherence value for Tl was 80 mm (l/Dl = 16000). At the lamp lighting the evaporated metal was sprayed on the flask walls near the cathode, the outlet window being clean.

Tha similar construction of the lamps can be used for the work with the active metals with the temperature of the visible evaporation less than 1000 C in the case when the increased brightness of the source is needed. The lamp with Tl was used at the work with the double frequency Fabry-Perot interferometer for observing the planetarium nebulae.

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COMPUTER PROGRAM FOR TIME SERIES REDUCTION AND ANALYSIS

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ABSTRACT. The program package is elaborated which allows to view the whole data set and its parts, to scale, edit and partially reduce. The external programs are connected which allow to compute "running parabolae" fit (Andronov, 1990) and determine the individual extrema. Contrary to majority of similar programs, all determined characteristics are followed by corresponding accuracy estimates. The program is much more faster than the existing more complicated graphic editors.

Key words: Methods – statistical, data reduction

Although exist some scientific graphical programs likewise Sigma Plot, Origin, Grapher and others, for our specific problems often we need rather simple programs for visualization and data reduction. Besides correct mathematical algorithm, the contemporary programming style requests the user–friendly interface either for DOS or for Windows. The demands of fast computing and comfortable interface are satisfied by the programming languages such as Borland Pascal, C++ and Delphi.

Pascal and C++ for DOS simplify the manipulation with memory and other personal computer resources, but have less beautiful interface.

Here we introduce the program, written in the Borland Pascal 7.0 language with using the object–oriented library Turbo Vision 2.0.

The package "Remove&Reduce" is a simple program for time series analysis. Here we can scale and scroll time series image along abscissa or ordinate axes. Also used "cutting of image" options for quick zooming of curves (F3, Alt-F3 keys) for both axes. Zooming by the time axis allows us to see shorter timescale variations, and zooming by Y axis allows us to hide bad points (for which the absolute values of deviations from the "mean" curve are much larger than the values for other points). Such keys as "arrow left" and "arrow right" allow to show the properties of the individual points and to remove the points or reduce them. The interpolating formula to reduce the points is the following:

$$S_{\rm I} = (4 * (S_{\rm I-1} + S_{\rm I+1}) - S_{\rm I-2} - S_{\rm I+2})/6 \qquad (1)$$

which corresponds to a 3–rd order interpolating polynomial.

Also we can smooth the data by using the "running parabolae" fit (Andronov, 1990), and to save results to a file. The "Space" bar calls a "smoothing parameters" dialog, from which we can change the filter half–width and the number of steps of trial times for approximation. After this we fix the changes by pressing "Enter". The example of the results of smoothing are shown in Fig.1 ("F5" key).

For the objects with variations at short time scales (from seconds to minutes) we use the correction of times not to the center of the Sun, but to the barycenter of the Solar system. For computation of the value of correction we have use the spherical trigonometry formulae and the barycentric position expressions for the Earth in the Cartesian coordinates (Soma et al., 1988).

The last requirement which should be satisfied by our program, is the storing to the file the results of processing in an easily readable form. Also the package should support an opportunity of reading any file of results for their visualization and, if it is necessary, must contain some service – transforming work, for example, "cuttings" of parts of a file on time, calculation of various statistical characteristics etc. Now this program is used as a basic one for making other packages for other types of observations.

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Appendix

Operating procedure with the program for processing the ZTSh observations

Part 1. "Simple calculations"

After the loading "ZTSH.EXE" one should choose "Simple calculations".

- Choose the time correction from the current time to U.T.

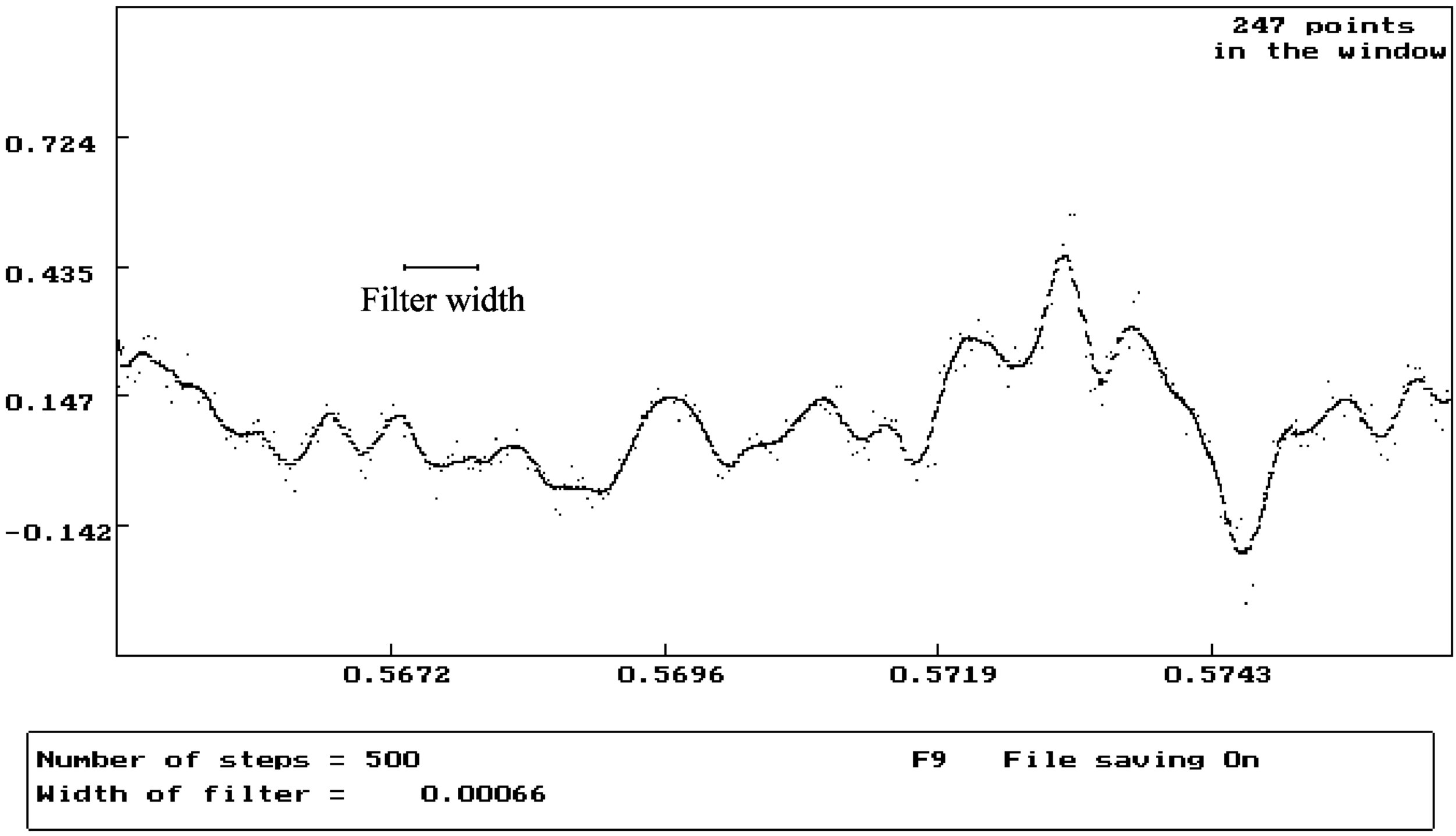


Figure 1: The light curve of AM Herculis obtained on 20.10.1993 by N.M.Shakhovskoy and S.V.Kolesnikov (1993) at the 2.6 Shain telescope at the Crimean Astrophysical Observatory fitted by the "running parabolae" in "Remove & Reduce" package. The abscissa is t=HJD-2449281, the ordinate is $\Delta m = m_{var} - m_{comp}$

- Load files: $(F3)$
- Enter types of objects (background, comparison star, variable star, standard star)
- Bad points:
- Removing of bad points: $(F8)$
- Reduction of a dropping out point \ groups of points: (Insert), then: $(Alt) + (R) \backslash (Alt) + (E)$
  Cancel marking of points: "+" on grey keyboard
- Reduce a background: $(F9)$
- Interpolate a background:
  $("blank"), (F1) \backslash (F2), (Enter), (Alt) + (-)$
- Interpolate a comparison star – " –
- Interpolate calibration – " –
- *Repeat* for the second pair of channels, starting with *reduction* of a *background*.

! Degrees of polynomial are desirable to be the SAME as in the first pair.

- Save the file of the results *.k*: $(F2), (F2)$

Part 2. "Calculations of mean polarization and viewer"

- Establish mode of operations
- Load beforehand calculated files of the standards *.S*: $(F3)$
- For the *linear polarization* indicate "Zero–polarized standard" or "Large–polarized standard" for each of entered standards
- Calculate the corrections P_x, P_y: $(F5)$
- Enter a name of object and it's coordinates from the list: $(F7)$
- Load *.K*: $(F3)$
- Delete superfluous points $(F8)$, so that the number of points in each series was divisible to number of points, on which will be calculated average.
- Calculate the individual mean value:
  $("blank"), (F1) \backslash (F2), (Enter)$
- Determination of the slope of the P_x, P_y diagram: $(F9)$
- Calculate values of polarization: $(F10), (Enter)$
- Recording file *.Z*: $(F2), (F2)$
- Recording file *.P*: $(Alt) + (F2)$

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LOCAL FITS OF SIGNALS WITH ASYMPTOTIC BRANCHES

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ABSTRACT. The method of "asymptotic parabola" fit is described, its analytical properties are discussed in comparison with other types of fits. The method is effective for the (possibly highly asymmetric) signals with practically linear ascending and descending branches connected by relatively short transitions at maximum or minimum, e.g. for the brightness variations of pulsating or eclipsing variables or for the phase variations in stars with abrupt period changes. The method is illustrated by an application to the Mira–type star U Her.

Key words: Data Reduction – Variables: Pulsating: U Her

Introduction

The individual cycles of variability of many stars show phase intervals of abrupt changes and/or undergo significant changes of the shape (e.g. Kholopov et al. 1985). To study these objects, several methods are usually applied - the fitting by ordinary and trigonometric polynomials, splines, (multi–) Gaussian functions etc. A number of "running" approximations may also be applied, the statistical properties of which for arbitrary basic functions and additional weight functions were recently discussed by Andronov (1997).

Andronov (1994) described some algorithms used in his programs for time series analysis. In this paper we describe a supplementary method of smoothing which we call the method of "asymptotic parabolae" (AP). Its error estimates are sometimes better than the polynomial or "running parabola" fits. The main idea is to split the observational interval near extremum into the parts with linear ("asymptotic") branches which are connected by a transition curve. This also will allow to determine the characteristic time of a transition from one linear branch to another.

To study abrupt "switches" of the outburst cycle length of some dwarf novae between two preferred values, Andronov and Shakun (1990) have used hyperbolic functions. However, Andronov (1995) noted that more simple parabolic connection between the lines takes less computational time and often corresponds to better accuracy estimate of the position of the extremum. A corresponding program was developed with an algorithm described below in detail.

The "Asymptotic Parabola" Fit

Assuming the signal is represented by the observational values y_k obtained at times t_k, $k = 1...n$, one may obtain the coefficients of the fit

$$y_c(t) = \sum_{\alpha=1}^{m} C_\alpha f_\alpha(t) \qquad (1)$$

from the system of normal equations

$$\sum_{\alpha=1}^{m} A_{\alpha\beta} C_\alpha = \sum_{k=1}^{n} y_k \, f_\beta(t_k). \qquad (2)$$

Here $y_c(t)$ is a value of the smoothing function at argument t, $f_\alpha(t)$ are basic functions ($\alpha = 1...m$), and

$$A_{\alpha\beta} = \sum_{k=1}^{n} f_\alpha(t_k) \, f_\beta(t_k) \qquad (3)$$

is the matrix of normal equations (e.g. Whittaker and Robinson, 1926). We repeat these well–known expressions to apply them to the proposed basic functions.

Among the infinite number of functions $f_\alpha(t)$ we have chosen the basic functions which may be written in a form:

$$f_1(t) = 1, \quad f_2(t) = F(z), f_3(t) = -F(z). \qquad (4)$$

Here we used the transformation $z = (t - t_0)/\Delta t$, where t_0 is some characteristic value of the argument t, and Δt is a characteristic scale of the argument (or $2\Delta t$ is the "effective duration" of the transition).

The smoothing function remains the same, if one will choose the a new set of basic functions which are *linear* combinations of the initial ones. This is the case e.g. for the ordinary polynomial $f_\alpha(t) = t^{\alpha-1}$ or trigonometric polynomial fits which are not dependent on t_0. Moreover, the ordinary polynomial fit does not depend also on Δt, contrary to a trigonometric polynomial.

In the case of non–linear transformation of the basic functions one may also include the corresponding "non–linear" parameters to the list of unknowns and make the optimization according to these parameters.

As an additional assumption, we introduce the function $F(z)$ with asymptotes for large positive z : $F(-z) = 0$, $F(+z) = z$, with corresponding asymptotic

expressions for $x_c(t) = C_3F(-z)$ and $C_2F(+z)$. Obviously, such fits with asymptotes depend both on t_0 and Δt which must be determined as the values minimizing the r.m.s. deviation from the fit. The algorithm is the usual one: the preliminary values are determined by choosing the minimum value at a grid of trial values and then corrected by using some iterations.

The asymptotic functions $F(z) = 0$ $(z \leq -1)$ and $F(z) = z$ $(z \geq +1)$ may be connected by a parabola $F(z) = (1+z)^2/4$ $(-1 \leq z \leq +1)$ which satisfies the conditions of continuity of the smoothing function and its first derivative at all arguments (including the border points).

For illustration, the fits are computed for one interval of observations of the Mira–type star U Her from the AFOEV database (Schweitzer 1996).

For this "asymptotic parabola" (AP) fit one may choose the borders in such a way that they will be equal to $t_{*1} = t_0 - \Delta t$ and $t_{*2} = t_0 + \Delta t$. This will correspond to the border values $z_1 = -1$ and $z_2 = +1$.

One may note that the AP fit may be represented by more usual functions. For example, if $t_{*1} \leq t_1$ and $t_{*2} \geq t_n$ (where t_1 and t_n are the smallest and largest arguments of the signal), than the data will be fitted by an ordinary parabola. If $t_{*1} = t_{*2} = t_0$, then the duration $2\Delta t$ of transition is equal to zero, and the fit is an "angle–like" broken line. If $t_{*1} \geq t_n$ or $t_{*2} \leq t_1$, one will obtain a single line without any transition to another asymptote. "One–line" + parabola fits correspond to $t_{*1} \leq t_1$ and $t_1 < t_{*2} < t_n$ or to $t_1 < t_{*1} < t_n$ and $t_{*2} \geq t_n$. Only the case $t_1 < t_{*1} < t_{*2} < t_n$ corresponds to the AP with two asymptotes. These remarks are obvious but all these cases are to be taken into account in the algorithm while computing the differential corrections.

In the computer program we have checked also the condition $t_{*1} < t_{*2}$. If needed, these values were swapped to obtain the ascending order.

If $t_{*1} = t_{*2} = t_0$, then we decreased the number of unknowns leaving only t_0. In this case the parabolic connection of the asymptotes is equal to zero, and one should use the modified function $F(z) = 0$, if $z \leq 0$ and $F(z) = z$, if $z \geq 0$, where in this case $z = t - t_0$ without dividing by Δt.

Determination of the "Non–Linear" Parameters

The root mean squared error $\sigma[y_c^{[s]}(t)]$ of the smoothing function $(s = 0)$ and its derivatives of the s^{th} order in respect to the parameter t

$$\sigma^2[y_c^{[s]}(t)] = \sigma_0^2 \sum_{\alpha\beta=1}^{m} A^{-1}_{\alpha\beta} f_\alpha^{[s]}(t) f_\beta^{[s]}(t), \qquad (5)$$

where σ_0 is the error estimate corresponding to an "unit weight" (e.g. Whittaker and Robinson 1926) and may be computed according to the equation

$$\sigma_0^2 = \frac{1}{n-m} \sum_{k=1}^{n} (y_k - y_c(t_k))^2, \qquad (6)$$

where $A^{-1}_{\alpha\beta}-$ is the matrix, inverse to $A_{\alpha\beta}$.

The values of σ_0 are dependent on the 'non–linear' parameters – the pairs t_0 and Δt or t_{*1} and t_{*2}. From the computational point of view, the grid should be computed for different data sets on similar number of points. Thus one may recommend to use the scaled arguments, e.g. $x = (t-t_1)/(t_n-t_1)$. In our program, the function $\sigma(x_1, x_2)$ is computed for $0 \leq x_1 \leq x_2 - s_x$, $s_x \leq x_2 \leq 1$ with an adopted step $s_x = 0.05$. Here x_1 and x_2 correspond to the times t equal to t_{*1} and t_{*2}. This dependence is shown in Fig.1. To compute the surface, we have used also the values $x_1 \geq x_2$ swapping them for computation. Thus, in our definition, $\sigma(x_2, x_1) = \sigma(x_1, x_2)$ and the surface is symmetrical in respect to the line $x_1 = x_2$. One may see a wide "valley" with a single minimum in a region $x_1 \leq x_2$. The contour map of the smaller region near the minimum $0 \leq x_1 \leq 0.4$ and $0 \leq x_2 \leq 0.4$ computed with a smaller step $s_x = 0.01$ is shown in Fig.2.

The lines of constant σ are elliptic only in the vicinities of the minimum with a major semi-axis directed nearly along the line t_0 =const and a minor semi–axis along the line Δt =const. With increasing σ, the lines $\sigma(x_1, x_2)$ =const are strongly deformed having a joint point at $x_1 = x_2 = x_{m0}$. However, this value corresponds to the minimum of $\sigma(x_0 - \Delta t, x_0 + \Delta t)$ for the fixed value of $\Delta t = 0$, but the true minimum may be found by determination of the optimal value of Δt.

For symmetrical input signal (same observational values for x and $1-x$), one may expect that the function $\sigma(x_1, x_2)$ will be symmetrical not only in respect to the line $x_1 - x_2 = 0$, but in respect to the line $x_1 + x_2 = 1$ as well. In this case $x_0 = x_{m0} = 0.5$ and one has to find Δt only, i.e. the minimum will occur on the line $x_1 + x_2 = 1$. For asymmetric signals the function $\sigma(x_0 - \Delta t, x_0 + \Delta t)$ will reach its minimum along the line Δt =const at the values of x_0 being dependent on Δt. The possible consequence of this curvature is that the minimization of $\sigma(x_0 - \Delta t, x_0 + \Delta t)$ may be obtained by preliminary determination of x_{m0} for $\Delta t = 0$, then minimization in respect to Δt for the fixed x_{m0}, then for the fixed Δt in respect to x_0 etc. This method of "cyclic" optimization was described e.g. by Korn and Korn (1970, p. 576).

Differential Corrections

The differential corrections δC_α, $\delta\nu$, δz_0, at each iteration may be determined by using the system of "conditional" equations

$$\sum_{\alpha=1}^{m} f_\alpha(t_k)\,\delta C_\alpha + \frac{\partial x_c}{\partial \nu}\,\delta\nu + \frac{\partial x_c}{\partial z_0}\,\delta z_0 = x_k - x_c(t_k). \qquad (7)$$

Here we introduced new variables $\nu = \Delta t^{-1}$ and $z_0 = \nu t_0$, thus $z = \nu t - z_0$. One may note that the partial derivative of the smoothing function in respect to the "non–linear" parameter μ is

$$\frac{\partial x_c(t)}{\partial \mu} = \sum_{\alpha=1}^{m} C_\alpha \frac{\partial f_\alpha(t)}{\partial \mu} = \sum_{\alpha=1}^{m} C_\alpha \frac{\partial f_\alpha(t)}{\partial t} \frac{\partial t}{\partial \mu} \quad (8)$$

After some iterations one may determine $m+2$ parameters C_α, ν, δz_0 and corresponding error estimates.

Andronov and Shakun (1990) have used an analytic function

$$F(z) = \frac{1}{2}(z + \ln(e^z + e^{-z})) = z + \frac{1}{2}\ln(1 + e^{-2z}) \quad (9)$$

which is differentiable infinite number of times. The corresponding derivative of the smoothing function is generally equal to

$$\frac{\partial x_c(t)}{\partial t} = \sum_{\alpha=1}^{m} C_\alpha \frac{\partial f_\alpha(t)}{\partial t} \quad (10)$$

and in our case

$$\frac{\partial x_c(t)}{\partial t} = \left(C_2 \frac{dF(z)}{dz} - C_3 \frac{dF(-z)}{d(-z)} \right) \nu. \quad (11)$$

For the "asymptotic" fits, $dF(z)/dz \to 0$ for large negative z and $\to 1$ for large positive z, thus $\partial x_c(t)/\partial t \to -C_3$ and $\to C_2$. For the function (9) $dF(z)/dz = \frac{1}{2}(1 + \tanh z) = 1/(1 + e^{-2z})$, and the fit may be called a "hyperbolic tangent" (HT) one. For practical purposes one may not compute the fit precisely for very large positive or negative z making simplification by neglecting the term $e^{-|z|}$ when compared with unity. Thus one may conclude that the whole interval of arguments is splitted into three parts - large negative, intermediate and large positive values. However, the borders are not single functions on Δt and t_0.

The first derivative (which is needed for differential corrections) is also very simple:

$$\frac{dF(z)}{dz} = \begin{cases} 0 & \text{if } z \le -1 \\ (1+z)/2 & \text{if } -1 \le z \le +1 \\ 1 & \text{if } +1 \le z \end{cases} \quad (12)$$

However, the apparent simplicity of this derivative does not cause very simple computation of the differential corrections, and there are some problems which have been taken into account in the algorithm for application of this method for the time series analysis.

At first, we have introduced the independent variables t_0 (i.e. the argument, at which the asymptotic lines cross each other) and Δt (the complete duration of the transition between the asymptotes). The corresponding derivatives $\partial z/\partial t_0 = \Delta t^{-1}$ and $\partial z/\partial \Delta t = -(t - t_0)\Delta t^{-2}$ are dependent on Δt and tend to infinity while $\Delta t \to 0$. However, one may not expect any singularity when choosing the fits with $\Delta t \to 0$, thus this problem may be solved. Slightly better solution is to use the variables ν instead of Δt, thus $z = \nu(t - t_0)$ and the derivatives are equal to $\partial z/\partial t_0 = -\nu$ and $\partial z/\partial \nu = t - t_0$. Introducing the parameter z_0, i.e. $z = \nu t - z_0$ one may simplify the derivatives.

Moreover, the matrix of normal equations may be degenerate because for the "bad" location of x_1 and x_2, the values of the fit at arguments of data may not depend on x_1 and/or x_2 (e.g. when no data are present in the interval of transition). Thus practically there must be an automatic checking the degeneracy of the matrix of normal equations the number of parameters being determined. If needed, they must be changed, e.g. from x_1 and x_2 to single x_0; from two borders to one border, if another one coincides with a data limit.

Because the intersections of the surface $\sigma_O(x_1, x_2)$ by the plane $x_1 = const$ or $x_2 = const$ are parabolic only in small vicinities of the minimum (Fig. 3), sometimes the differential corrections may not converge. In this case we use the values of δx_1 and δx_1 multiplied by a parameter $\alpha \ll 1$ increase the number of iterations.

Comparison with Other Methods

Generally, the AP fit corresponds to 5 unknowns (including x_1 and x_2). Thus one has to compute the error estimates by using the matrix $A^{-1}_{\alpha\beta}$ of order 5. The corresponding dependence on t of the accuracy of the smoothing function $\sigma_c(t)$ is shown in Fig 4 and is marked as AP 5. However, the accuracy estimate of the same fit when using the matrix $3\times$ (assuming x_1 and x_2 are fixed and have the best fit values; marked as AP 3) is much smaller than for AP 5. The corresponding error estimates $\sigma[t_e]$ of the moment of extremum differ by a factor of 3! This difference is natural taking into account a high degree of degeneracy of the matrix $A_{\alpha\beta}$. Even more drastic difference is between the AP fits with $\Delta t = 0$ which are marked as BL (broken line) with 3 and 4 parameters. For BL 3 $\sigma[t_e] = 0$, because $t_{*1} \le t_e \le t_{*2}$, and only use of the BL 4 fit allows to make an accuracy estimate.

For comparison, we have also computed the polynomial fits (P) with 3, 4 and 5 parameters (i.e. of the orders 2,3,4). The P 3 fit coincides with the AP fit with $t_{*1} = t_1$ and $t_{*2} = t_n$ which is the worst in our sample. The fit P 5 with the same number of parameters as AP 5 has similar $\sigma[m_e]$, but 2 times larger $\sigma[t_e]$. The best order of the polynomial is 3 (AP 4). The running parabola (RP) fit (Andronov, 1990) with $\Delta t = 89^{\rm d}$ has very good value σ_0, which is close to that of AP, but large $\sigma[t_e]$. The cubic parabola P 4 has the best value of $\sigma[t_e]$ which is slightly larger than that for AP, but much larger systematic deviations from the fit. The BL 4 fit is better than P 3 arguing for the "asymptotes". Similar results were obtained for other data. Thus the AP fit is optimal and may be recommended for use.

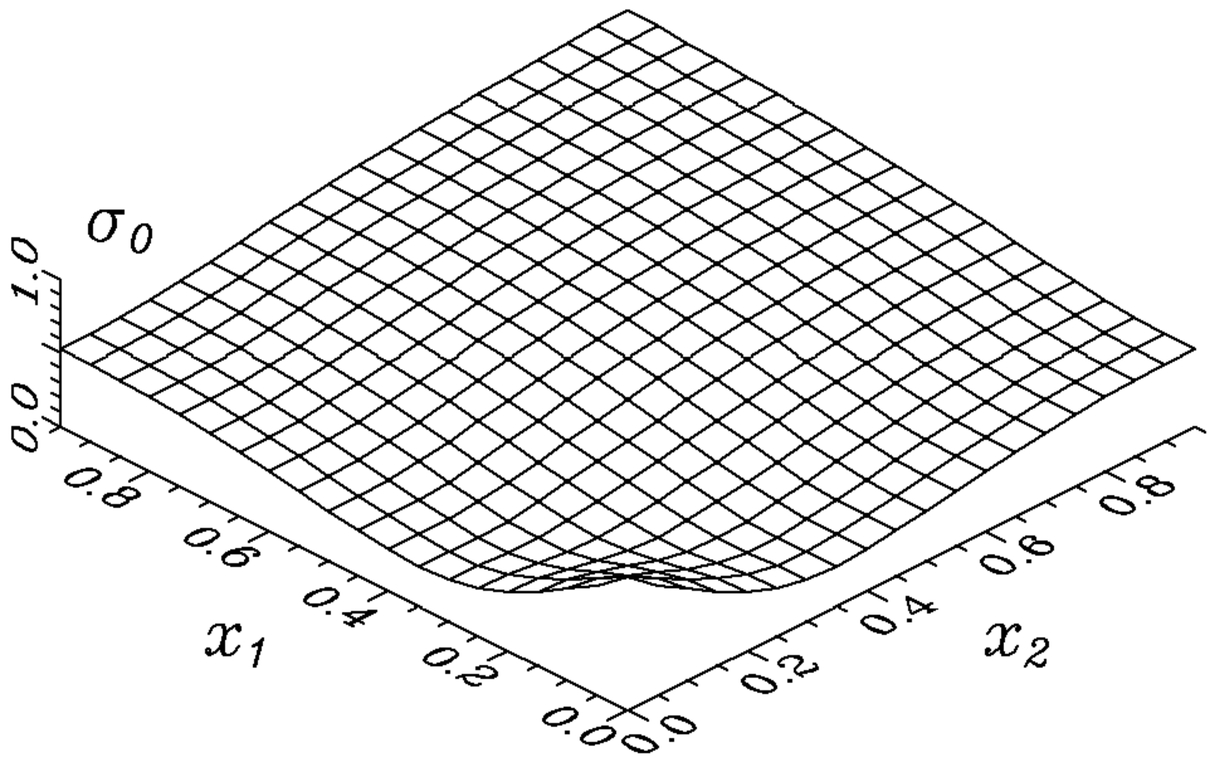


Figure 1. The dependence $\sigma(x_1, x_2)$ of the unbiased r.m.s. deviation of the observations from the AP fit with the borders $x_1 = (t_{*1} - t_1)/(t_n - t_1)$ and $x_2 = (t_{*2} - t_1)/(t_n - t_1)$.

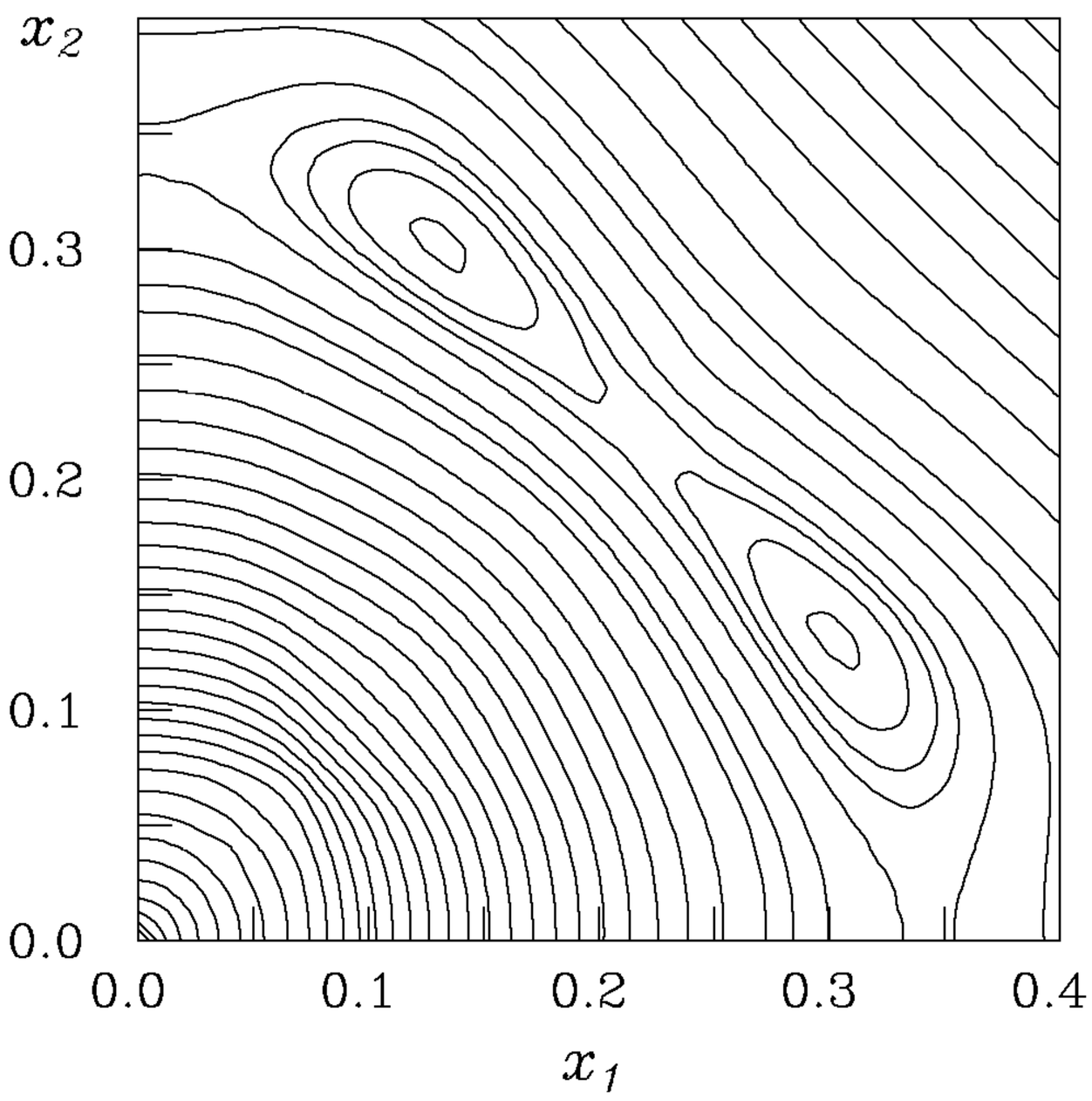


Figure 2. The lines of equal $\sigma(x_1, x_2)$ near the minima of this function.

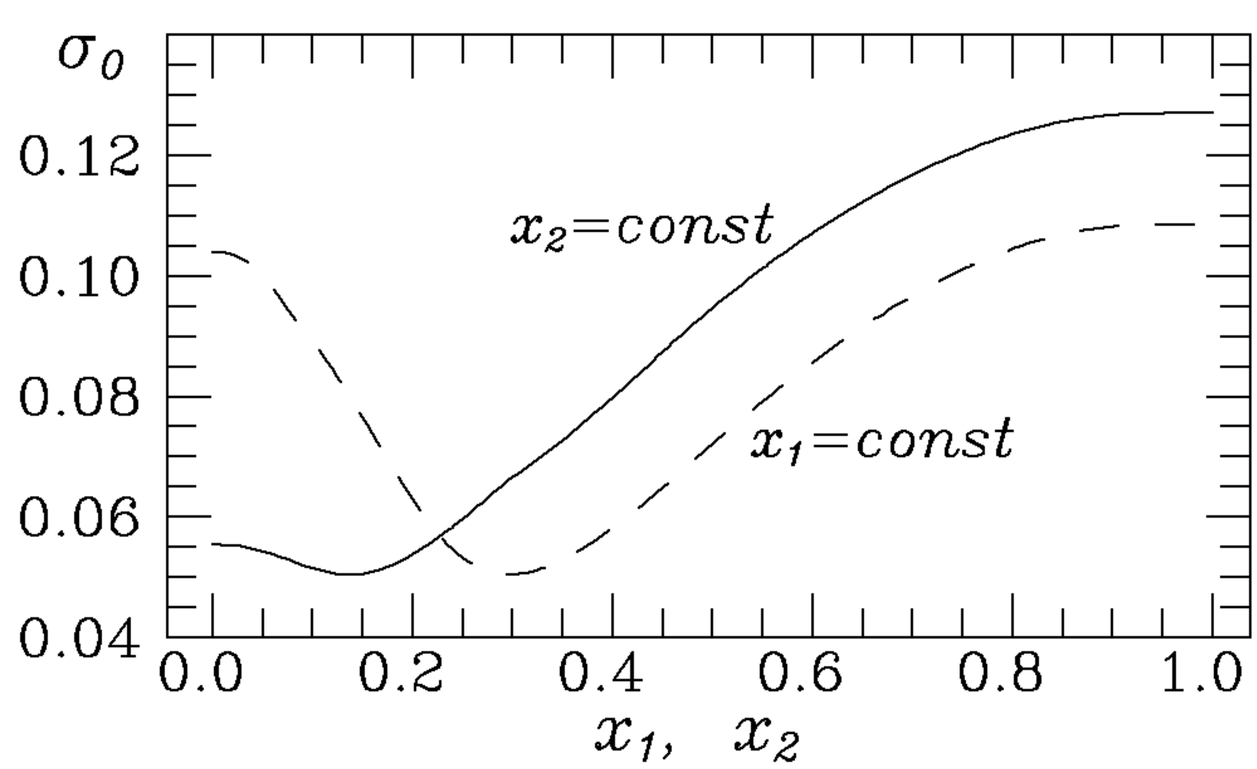


Figure 3. The dependence $\sigma(x_1, x_2)$ of the unbiased r.m.s. deviation of the observations from the AP fit with the borders x_1 and x_2.

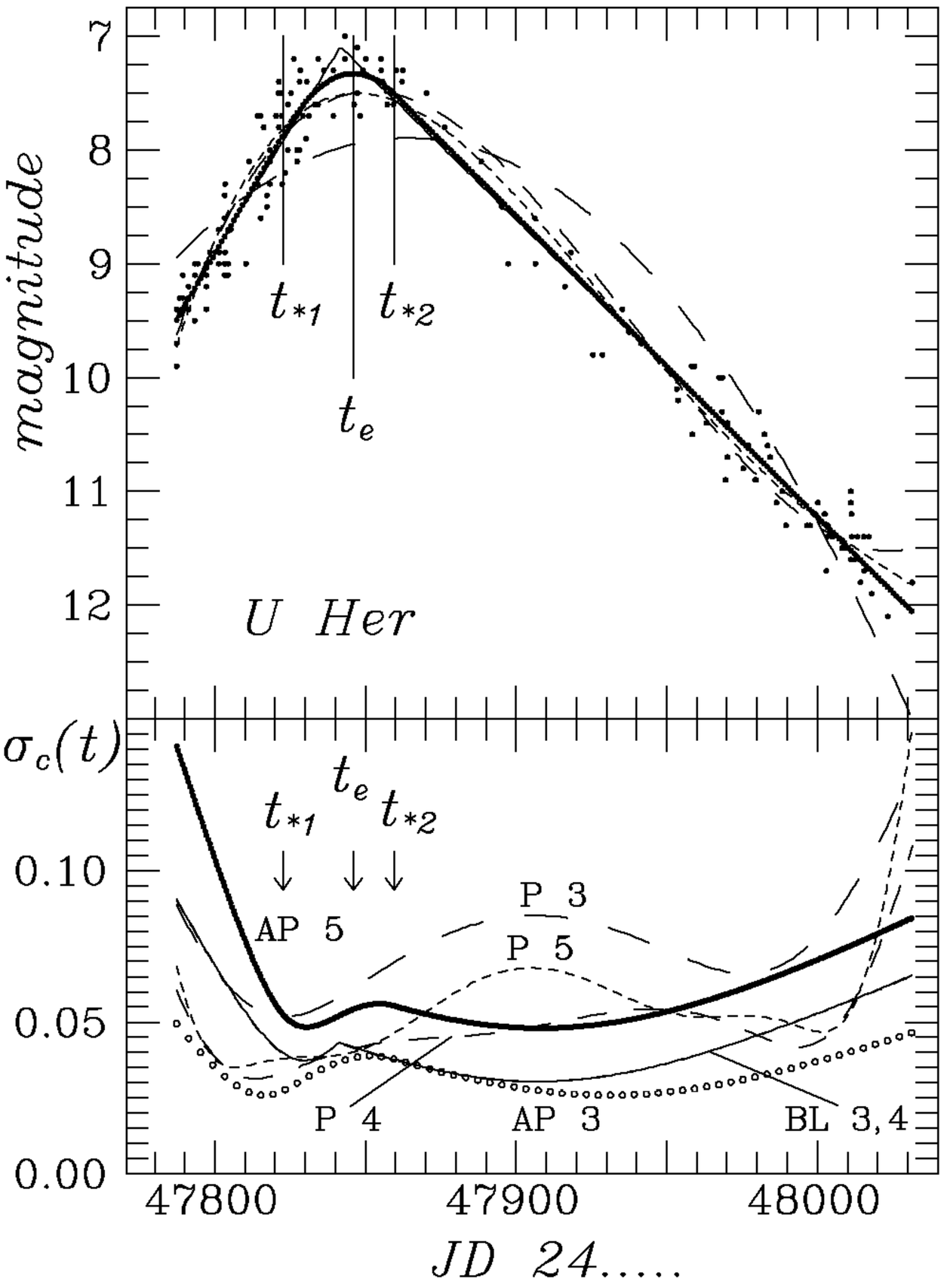


Figure 4. The fits of the data obtained by using different methods (up) and the error estimate of the smoothing function $\sigma_c(t) = \sigma[y_c(t)]$ (bottom).

Table 1. Characteristics of the extremum.

method	t_e	$\sigma[t_e]$	m_e	$\sigma[m_e]$	σ_0
AP 5	47845.68	0.65	7.338	0.054	0.257
AP 3	47845.68	0.21	7.338	0.038	0.257
BL 4	47841.02	1.24	7.095	0.057	0.263
BL 3	47841.02	0.00	7.095	0.043	0.263
P 3	47863.53	2.60	7.895	0.072	0.529
P 4	47851.93	0.83	7.489	0.043	0.291
P 5	47847.22	1.60	7.505	0.041	0.283
RP	47853.12	2.48	7.366	0.045	0.258

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ENGINEERING DEVELOPMENT OF TELESCOPE CONTROL SYSTEMS

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ABSTRACT. Advantages are presented in the use of stepping motors with electron drives, developments and investigations of them at the Observatory throughout recent years.

Key words: Telescope control systems.

For the first time the urgency of producing new telescope control systems in Odessa arose due to the problem of changing outdated, worn–out by long–term exploitation, counter–weight driven clock mechanisms equipped with centrifugal stabilizers of rotation frequency. These gradually went out of service and their replacement was wanted. Instruments synchronously motor operated owing to a small rate adjustment range in using frequency stabilization circuit designs were not efficient enough.

The development of modern control systems for telescopes manufactured at common tendency of enhanced requirements to stability and precision in rates of wide range led to the development of drives with stepping execution motors [SH] in Odessa.

Many years' use of step drives has shown their high reliability and good exploitation parameters. The elaborated circuit designs and designs have found a wide use not only as clock guiding systems for telescopes but also in other information–measuring devices where precision displacements by rotating are wanted.

The stepping drive as an executive element involved in modern automatic systems is most successfully combined with a control computer.

These properties of the stepping electrodrive have caused its wide application in telescope control systems in astroinstrument making. Moreover, SM are distinguished with steady work, though at different disturbing factors affecting, and with wide frequency range without any power or synchronism loss. By its nature, SM are multiphase synchronous motors retaining synchronism both at the start, reversal, braking and at the zero frequency of rotation permitting lengthy fixed rotor outage. Most adequate in their parameters, which we could afford to purchase were the motors of the types: SM–4M, SM–300/300, SM–200, SM–5 and SM–88.

For selecting optimum designs in the Odessa observatory were developed and investigated drives with all the above types of motors for telescopes at different mountings. To increase the electromagnetic moment at the high frequency motor work the circuit designs were elaborated cutting the duration of transitional processes in control winding, circuits of forcing, circuits of splitting the main rotor step of the motor into several tacts (A.V.Ryabov, O.Sh.Shakhrukhanov).

In developments depending upon the customer's requirements the functional parameters of control systems were set. Small telescopes with mirrors up to 400 mm in diameter were equipped with drives which provided only clock guiding from the right ascension with correcting rates frequency.

For larger telescopes control system functions were broadened. The control from two coordinates with preset rates and fast readjustment to the set angles relative to the observed object was designated. One of the telescopes was equipped with a tracking synchro system.

The development of new methods of telescope control with the help of step electrodrives led to the necessity of producing new original structural and principal circuit designs to realize these methods. Stabilized frequency oscillators, digital dividers of pulse of program control and communication with the computer have been developed (V.N.Ivanov, A.V.Ryabov, O.Sh.Shakhrukhanov). The circuit designs of controllers for direct electrodrive control with the personal computer have been elaborated (A.V.Ryabov). A digital automatic telescope control system with pulse sensors of angular displacements is produced (V.N.Ivanov).

One of designs was awarded a Golden Medal of VDNKH (All–Union Achievements of National Economy) of the USSR in 1985. In the designing of new control systems participated Observatory collaborators, and namely: M.G.Arkhipov, V.N.Ivanov, L.I.Keir, A.F.Pereversentsev, A.V.Ryabov, O.Sh.Shakhrukhanov and others. In manufacturing the drives, the Experimental Enterprise of the Main Astronomical Observatory of the Ukraine took part (I.I.Krishchuk, V.V.Kulibaba, R.A.Chaichuk).

THE INFLUENCE OF ATMOSPHERE INTO RADIORANGEFINDER OBSERVATION OF ARTIFICIAL EARTH SATELLITES (A E S)

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ABSTRACT. The atmospheric refraction causes changes in the velosity retardation and in the direction of electromagnetic waves (bending) along the propagation path and introduces a delay in the time of arrival of transatmospheric signals.In the results of location of atmosphere in fine days during the year on five stations of Ukraine it is investigated the influense of wet component on to the size of atmosphere error by measusuring of distance to satellites in radiorange. Radiosonde data are used to examine the accuracy of several models for wet component of tropospheric delay prediction on the base of surfase meteorological measurements.

Key words: artificial satellites.

The given paper is devoted to the investigation of the wet component influence of atmosphere on radiorangefinder observation of AES. In the passing of radiosignal through the atmosphere its delay is arised, that's why the atmosphere error to the measured distance to the AES should be put in. It is known that in a common case the error is:

$$dR = dR_1 + dR_2 \tag{1}$$

where dR_1 is the range error at the expense of dry air, and dR_2 is the range error at the expense of water vapor. For being in a place dR it is necessary to know the physical parameters of atmosphere along the path of radio-signal spreading. The operative information about real profiles of meteoparameters is given by the sondation of the atmosphere, what it is not always possible pass during the observation of AES. Therefore, more often the meteoparameters are measured on the surface@Earth at the settlement of observation and are designed its changes by the atmosphere altitude. However the modelling dR_2 is compound from behing the great spatial and temporal variations of water vapor content in the atmosphere.

We determined dR by the results of location of atmospherein five settlementes of Ukrain (Kiev, Uzhorod, L'viv, Shepetivka) during the year (215 sondes), - 3 - and on the basis of the surface measuring of meteoparameters according to the thermodynamic model and according to Hopfield's model. Thermodynamic model in brief, considers a moist atmosphere obeying perfect gas law under adiabatic regime. The humidity is given by specific humidity, S, which is the ratio of mass of water vapor to total mass of the moist air in a small volume.

The differences between the errors for the region of Ukraine which are computed according to the aerological data and the thermodynamic model

$$dR_a - dR_t \tag{2}$$

and according to the aerological data and Hopfield's model

$$dR_a - dR_h \tag{3}$$

are given on figure 1.

Considerable differences between dRa and model's presentations are conditioned by such reasons:

1. in the thermodynamic model the content of water vapor in the tropospheric is given as

$$S = S_0 \exp(-A * h) \tag{4}$$

Where S_0 is content of water vapor on the Earth surface, h is the altitude of troposphere under the surface of the Earth, $A = 0.4(1/km)$.

On the basis of real condition of atmosphere we defined A in every settlement for various spheres of atmosphere, whence it appears A is changed within the limits of $(0.2-0.6)1/km$ and sometimes $(0.8-1.0)1/km$;

2. in given models the altitude of atmosphere, over which the content of water vapor may be neglected, is assumed to be $h = (10 - 11)km$.

It is established from the real investigations that height may be changed within the limits of $(8 - 15)km$.

Becides, it is investigated presence of inversions of water vapor content in the low spheres of atmosphere which have an influence on the meaning A and correspondingly on the meaning dR_2.

In order to receive the most exact meaning dR_2, it is necessary take into account local and reginal peculiarities of given settlement of observation which also includes the determination the most probabls meaning A and h.

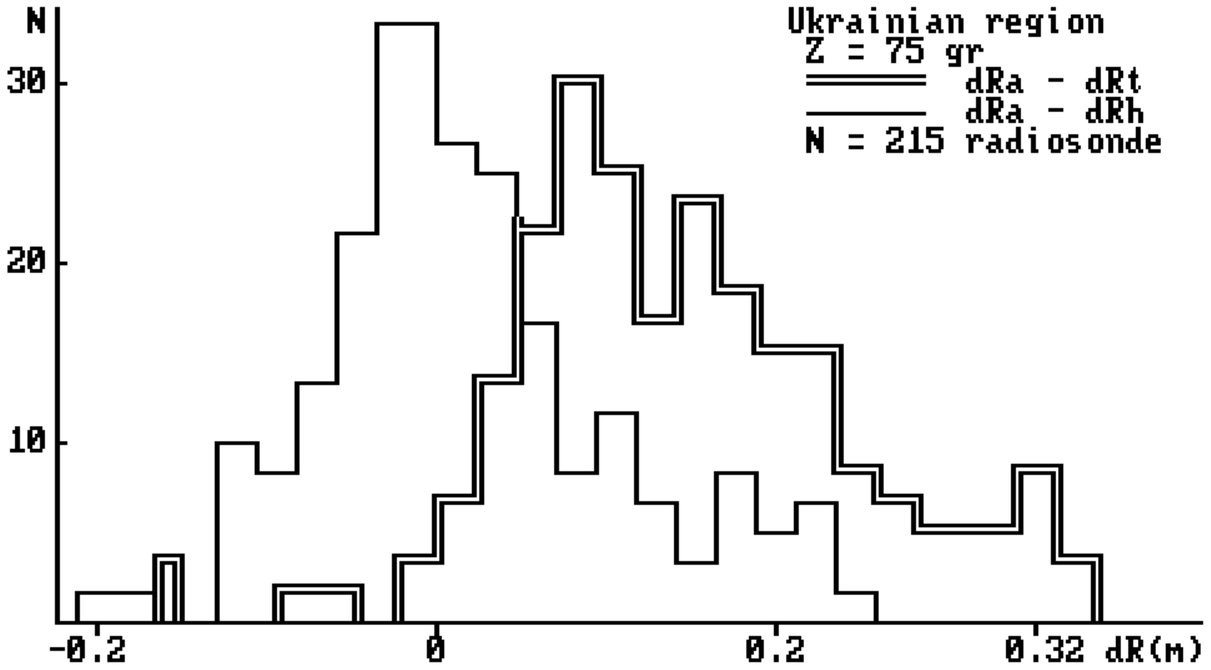


Figure 1: Figure 1. The histogram of the differences between the wet component tropospheric delay obtained accoring to the radiosonde data and the thermodynamic model(double line). The solid line - according to the radiosonde data and Hopfield's model.

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ON THE PROBLEM OF IMPROVING LASER DISTANCE MEASURER LD-2

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ABSTRACT. The question of creation of the mathematical model laser-location station (LLS), which shouldbe take into account of the basic counstituents of the instrumental error of the LLS LD-2 are given. By mean packets of programs "CHECK-GRAFH" we carried out analyse qualitatively seperate bloks and parts of station in the regime of the static distance measurement to a calibre target.

After modernization LD-2, performed together with State Interinstitutional Centre "Orion", the square error measurement of one satellite passage are reduce from $2.5m$ to $0.7 - 0.8m$; mean square error the normal satellite position is of $0.25 - 0.30m$ at then.

Key words: Artificial Satellites.

The first laser observation of satellites in Ukraine occured in 1972 in Uzhgorod (Bratiychuk M.V., 1994). At present on the territory of Ukraine with the participation of several ministries and organizations are working for creating a network of laser - location stations (LLS) in the composition of which there will be two types of stations:

- navigational for the location of low-orbital artificial satellites of the type "Ajisai", "Ers", "Topex";

- geodesic for the location of high-orbital artificial satellites of the type "Lageos", "Etalon". Laser Distance measurer-2 have been used as navigational LLS at the present stage as the most spread on the territory of Ukraine. That is why, the problem of increasing technical characteristics of the given LLS is actual. Exactness of measurements, extreme distance and exploitation indices are to be improved.

At Uzhgorod State University a large experience of the exploitation of the given LLS has been obtained. LD-2 has been used to locate "Ajisai", "Ers", "Topex", "Geos-C", "Geos-A", "Bulgaria 1300", more than 6000 measurements have been carried out.

During the whole period of LLS exploitation work to improve technical characteristics of the given LLS has been carried out at first independently, and then with the State Interinstitutional Centre "Orion" in the town Alchevsk. A number of factors of the permanent and occasional character influence exactness of LD-2 measurements; and eliminating or reducing some of them demanded considerable material and time expenditures, and there was no guarantee of the LLS parametres considerable improvement. That is why we have chose three direction of the work:

- to improve the apparatnes of the receiver-transmitter part of the LD-2;

- to study the experience of the exploitation and improvement of the distance measurers of the first-second generation in the home and foreign publications;

- to create a mathematical model of the LLS, taking into account the basic constitunts of the instrumental error of the LD-2 that would enable to define the the degree of efficienly of the improvement and the choice of directions in these improvements.

When modelling the measurement system of the LD-2 we have use a probability approach to the evaluation of errors. A relativ error E of the N variables function is equal to square root of the squares sums of the partial differentials of the function natural logarithma (Chepurenko V.G. et al. 1978). The limit of the credible interval dY one can define as multiplication of the given limit relatively to error E on arithmetical mean of set of equal point measurements:

$$dY = E * Ya.m. \text{ or } dY = t * G, \qquad (1)$$

where G - is mean square error of a series measurements,

t - coefficient, dependant on the number of observations and trustful variatibility.

For the accepted trustful variatibility at technical measurements $P = 0.9$ this coefficient according to (Novitskij P.V. et al. 1985) is equal to 1.9. All the given results are just for the normal distribution of the system casual errors.

Taking into account this for more graphicality, and for grounding proportions expenses and efforts for improving the apparatus of the receiver-transmitter part of the LD-2 we have chasen an additive manifactoral mathematical model of LLS (Novitskij P.V. et al. 1985) the equation of which has the following form:

$$dY = A_1 * dX_1 + A_2 * dX_2 + ... + A_n * dX_n, \qquad (2)$$

where $dX_1 - dX_n$ - are the reduce errors stipulated by a number of factors influencing exactness of the measuring complex.

$A_1 - A_n$ - are coefficients, taking into account the level of influence of seperate errors upon the error of

the whole measurement ($A_1 - A_n$ may be whole or fractional, positiv or negativ). The model allows to analyse the influenc of errors, provided by seperate parts of LLS upon exactness of distans measuring before and after the modernization. Analysing the equation of the additive model, we come to the conclution that when reducing a seperate error brought by one of the parts of the LD-2, the degree of influence of the other constituents upon the general exactness of measurement will increase. Some factors which provide errors of measurements might be obscure and might be discovered only after long frials or work of LLS. The additive model is very conviment. Computation of the additive model comes to the selection of the most significant factors by defining its most important terms.

On the ground of these exposition, directed by methods of computation, give in (Chepurenko V.G. et al. 1978, Novitskij P.V. et al. 1985) we have worked out algarythms and a packets of programs "CHECK-GRAPH" with the help of a compiler TURBO-BASIC, and it allows to analyze qualitatively seperate bloks and parts of LLS LD-2 in the regime of the static distance measurement to a calibre target. The quality of the given packet is the presence in it the program of support of the very LLS registration system with the computer. The "CHECK-GRAPH" program packet allows:

- to define a mean square error of a series of measuremenst;
- to make direct and indirect computation coefficients of the importance and errors in the equation of the additive model;
- to build histograms of the distribution of the distance measurements results to the target;
- to analyse correlational connection between the results of measurement and definite parametres of seperate blocs of LLS. The packet "CHECK-GRAPH" allowed to work more efficiently upon improving the apparatus part of LLS LD-2. The results of work performed together with "Orion" centre are:

- increase of laser impulse energy of the optical quantum generator LD-2 from $0.3J$ (certificat meaning) to $0.7J$;
- reducing duration of the laser imruls from 50-$70nsec$ (at half attitude) to $20nsec$;
- reducing of mean square error of measurement of one satellite passage from $2.5m$ (sertificate meaning) to $0.7 - 0.8m$; mean square error of the normal satellite position is of $0.25 - 0.30m$ at that. Besides, we have defined further priority ways of improving LLS LD-2. They are:
- choice and optimization of the regimes of photoreseivers of reseiving-optical apparatus of the LD-2;
- time grounding of the distance measurer to the energy centres of reflecting and reflected impulses;
- selection of reflected impulses from "noise" ones by optical and electronic ways.

Preliminary results allow us to hope that in the nearest future we shall increase exactness of distance measurements with the LD-2 for one satellite passage approximately to $0.5m$.

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ANALOG IR–PHOTOMETER

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ABSTRACT. The circuit design is described of a photometer functioning in the analog regime with the signal accumulation and conversion and its input into the computer.

Key words: Photometers

Interest taken in investigations of cosmic object radiations in the IR–range has not faded away. That is why complicated IR–systems are produced (Kriksunova, 1980). However, at times for observing cosmic objects such photometers with removable IR–detectors can be used which are simple in maintenance and adjustment.

One of such systems has been produced in the Odessa Observatory and for a number of years it has been updated. Simultaneously with carrying out the works planned the system elements and units were being elaborated, refined and subsequently used in the IR–photometer. These are amplifiers of direct current, integrators, cooling systems, analog–digital converters, control units, optical–mechanical designs, interfaces with computers.

The functional scheme of photometer is given in the Figure.

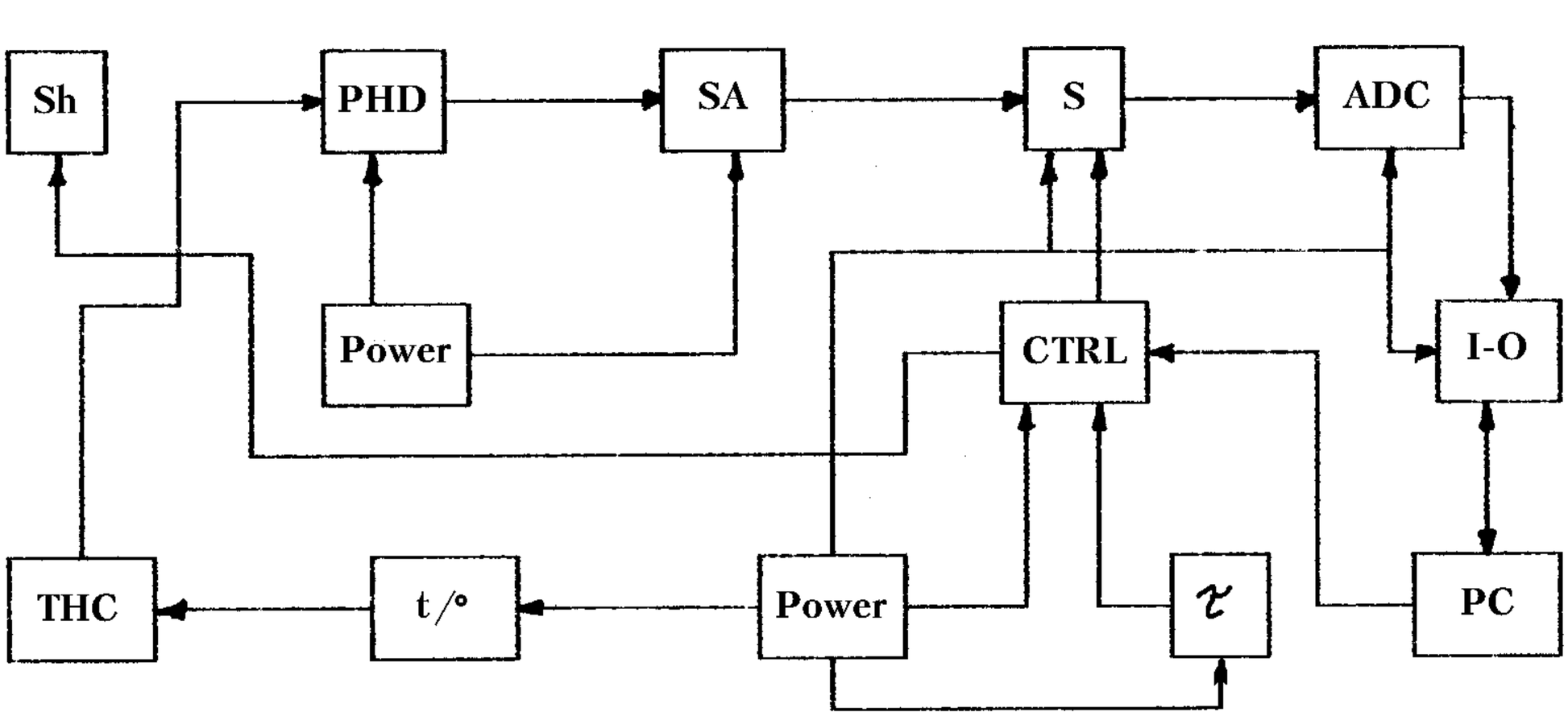
As photodetectors (PHD) both photodiodes of different types and photoresistors were used not larger than 10 mm in size. This is due to the fact that the cooled volume is limited by technical conditions of thermocoolers (THC).

To cool PHD standard semiresistor thermocoolers (one–cascade) TEB–04 and two–cascade coolers (TEB–023) are used which provide temperature difference in 25 – 30 K and 90 – 95 K respectively, and fit power. The cooler design makes it possible to cool the photodetector as low as –45 C (228 K) and stabilize the temperature t/ on this level.

This is a temperature of one of stability areas in the dark current determined from the work with oxygen photocopies which has not been explained yet. We have decided to stick to this temperature for PHD and stabilize it.

It is impossible to directly register a radiation flux emitted from stellar objects, and therefore the signal amplification (SA) is needed.

For amplifying the photocurrent, high sensitive IMS in the regime of direct current amplification (DCA) has been used. Based upon the experience of the work with DCA it has been found that the sensitivity 10 A is sufficient for a great number of stars and cosmic objects. The housing of IMS contains two amplifiers that permits to linearize the amplifier characteristic (Gutnikov, 1988).



The use of the integrator (S) designed in the same series of IMS incorporating polystyrene capacitors distinguished by small current losses enables to accumulate the signal in the analog form with a sufficient precision.

The quartz works for a timer that provides high time interval stability. The accumulation of time present by the timer ranges from 0.1 to 10 seconds.

The signal stored by the integrator (I) enters the analog–digital converter (ADC) (Fedorkov, Telets, 1990) where it is converted into a three–bit digital code. During the process of converting the PHD entry is closed by a shutter (SH) but as soon as at the circuit entry of the input–output (I–O) there appears a digital code, the hermetically sealed reed relay of the integrator zeroing is switched on and the shutter opens.

As the shutter is electromechanic, this link is the most sluggish in all the circuit and it determines the speed of response.

The circuit design of control gives signals and matches the work of the whole photometer as well as matches the information input and output to the computer and switches on the integrator following the computer command.

The photometer is designated to work at an off–line regime with an analog signal carried in the needle indicator when the photometer adjustment and PHD replacement are wanted.

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PECULIARITIES OF THE USE OF PHOTOELECTRON MULTIPLIERS (PHEM)

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ABSTRACT. Particular recommendations are given on the use of PHEM in the photon count regime.

The use of photoelectron multipliers (PHEM) in many fields of science and engineering has led to their wide promulgation. In the meanwhile their use in passport regimes is nearly always connected with a number of peculiarities and limitations which are rather wholly described in the handbook (Larionova, 1985).

The investigations of PHEM carried out for the determinations of their characteristics and limiting capacities resulted in using them in the regime of photon count (PHC) or one electron regime. This regime permitted to study radiation sources with energy flux amounting to 10(-17) walt at the PHEM input window.

The use of PHEM in the PHC regime required supplementary investigations on the stability response, spectral sensitivity, multiplication factor, dark current, radiation resistance, temperature stability and on a number of other parameters (Berkovsky et al. 1976, Gulakov et al. 1989, Vetokhin et al. 1979).

In the present work we have made an attempt of giving common recommendations on the use of PHEM with multialkali and oxygen photocathodes.

PHEM power supplies should be of high stability, have the voltage up to 2.5 kilovolts with the possible discrete voltage switching to 10 – 20 volts within all the range of PHEM supply. This is urgent for selecting a working point in the plateau of phem count characteristics.

The voltage divider in supplying the PHEM diode system at the work in the PHC regime should not be uniform to provide the decay of volume changes which are formed in the photocathode and anode area.

Resistances R in the voltage divider are commonly chosen from 100 to 200 kOm and distributed as follows:

photocathode – modulator – 1.5 R, modulator – the first dynode – 0.5 R, up to the last dynode – R, the last dynode – unified bus – 0.1 R.

The case when the work is carried out with the earthed cathode is more efficient since the photocathode proves to be at the same potential as the ambient cooling elements. This brings about the decrease in dark current fluctuations but it is connected with the use of high voltage interstage capacitor for picking up the signal from the PHEM.

The PHEM balloon screening with magnet soft materials permits to remove the Earth's magnetic field influence, whereas the bifiling arrangement of thermoelectrocoolers (THEC) and the wires feeding them saves PHEM from the influence of magnetic and electric fields of THEC.

It is also necessary to supply a safe shielding from the outer exposures to light, radiation fluxes and atmospheric heavy showers, due to high energy particles present in the upper atmospheric layers. These fluxes and showers can give rise to fluorescence of materials being near PHEM.

Main contribution to the PHEM dark current is made by thermoelectron emission of a photocathode and dynodes. One can get rid of greater part of thermoelectron dynode noises by means of the amplifier–discriminator.

One electron pulses from the photocathode of PHEM conditioned by thermoelectron emission principally are not distinct from photoelectron pulses. Therefore, the most efficient procedure of decreasing the dark current is the photocathode thermoemission suppression by means of cooling. According to our data the cooling, for example, of PHEM–83 down to 248 K enables to decrease the dark current by the order of 4 whereas that of PHEM–79 by 30–fold.

It is stated that in the oxygen photocathodes the dark current drops by one order in cooling the photocathode by 14–15 K, whereas it's no use cooling multialkali ones lower than 273 K, it is important to keep temperature on one stable level as precise as 0.5 K. The use of semiconductor thermoelectron coolants permits to attain the task set with the greatest simplicity and economy (Pereversentsev et al. 1989). It tares two–three hours for such systems to start functioning under certain regime. During exploitation there arise unforeseen complications as well, you should know about them beforehand.

So, in particular, it is necessary to get rid of freezing moisture (hoar–frost) sticking to the photocathode in deep cooling.

This phenomenon control is simple enough: dessication of the air in the volume near–by the photocathode

with the help of silica gel or this volume hermitization with simultaneous dessication.

One should bear in mind about non–uniform photocathode sensitivity that is of importance during astronomical observations of small angular objects.

The use of fluorine stratum as one of the materials for producing a small panel of the voltage divider provides particularly small current losses but there is some doubt pertaining its luminescence durability.

Taking into account all these measures, nevertheless, a constant control of PHEM condition in sensitivity is needed. For the control it is worth while using light diodes, inexpensive and rather stable in sensitivity, which are fed from current stabilizers.

Taking all these measures against interferences, the following regulations of work with PHEM should be observed.

Before starting the work, wash PHEM and the small panel of the voltage divider by the method of dipping. Let the PHEM stand all day long in full darkness at the voltage by about 100 volts higher than the working one.

It is preferable to switch on PHEM and the system in which it is functioning two–three hours before the outset of the work.

For you own feeling well, it is necessary to provide the safe earthing of the system.

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INCREASE IN SENSITIVITY OF PHOTOELECTRON MULTIPLIER (PHEM)

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ABSTRACT. Plots of spectral sensitivity as a function of voltage are obtained. A conclusion can be made on the spectral sensitivity shift with voltage increase towards longwave spectrum region.

Key words: Instrumental: multipliers.

Astronomical investigations in the fields of photometry (PHM) and spectrophotometry (SPHM) are carried out by using different photodetectors (PHD) including photoelectron multipliers (PHEM).

Photodetectors differ in spectral sensitivity, range and other parameters, and for each task it is necessary to select its own PHS. It should fit the best characteristics simultaneously in several regions, frequently incompatible ones. So, for SPHM and PHM, photoelectron multipliers are needed with a large spectral range, uniform sensitivity over the spectrum, a good signal–noise relation, small overall dimensions, not high supply voltages, slight sensitivity to the parameters of power supply, coolproof etc. It's no use enumerating all of them.

Our work deals with one verify PHEM pertaining spectral sensitivity. Light–emitting diodes with maximum radiation in points 560 nm, 660 nm and 700 nm have been chosen as radiation sources in three points over the spectrum.

In checking up some specimens of multislit PHEM it has been found that with the PHEM supply voltage change the maximum spectral sensitivity is shifted.

More particular results have been obtained in carrying out investigations with six specimens of PHEM by using with a wide spectral range. We have plotted spectral sensitivity as a function of wavelength (fig.1). The sensitivity is expressed in relative units whereas spectral characteristics in nanometres. In the plots are given serial Nos. of particular PHEM and supply voltages in volts.

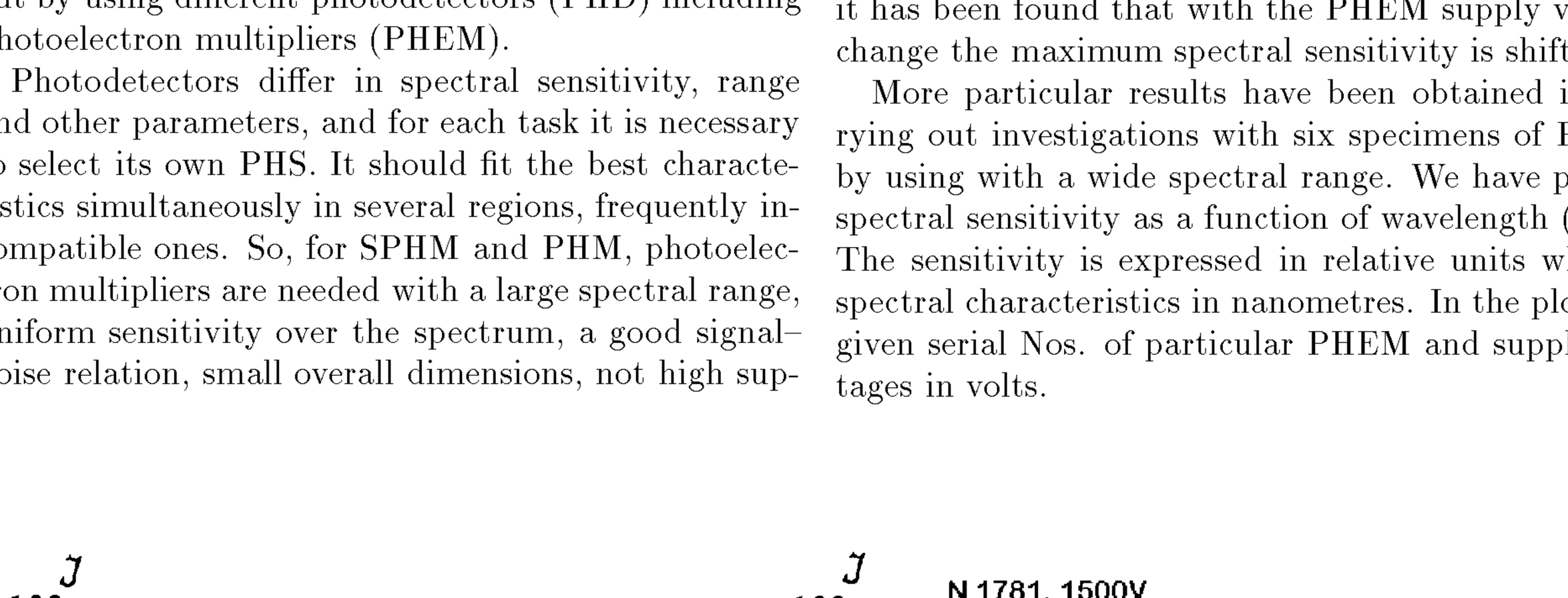


Figure 1(a,b): Variations of spectral sensitivity as a function of wavelength.

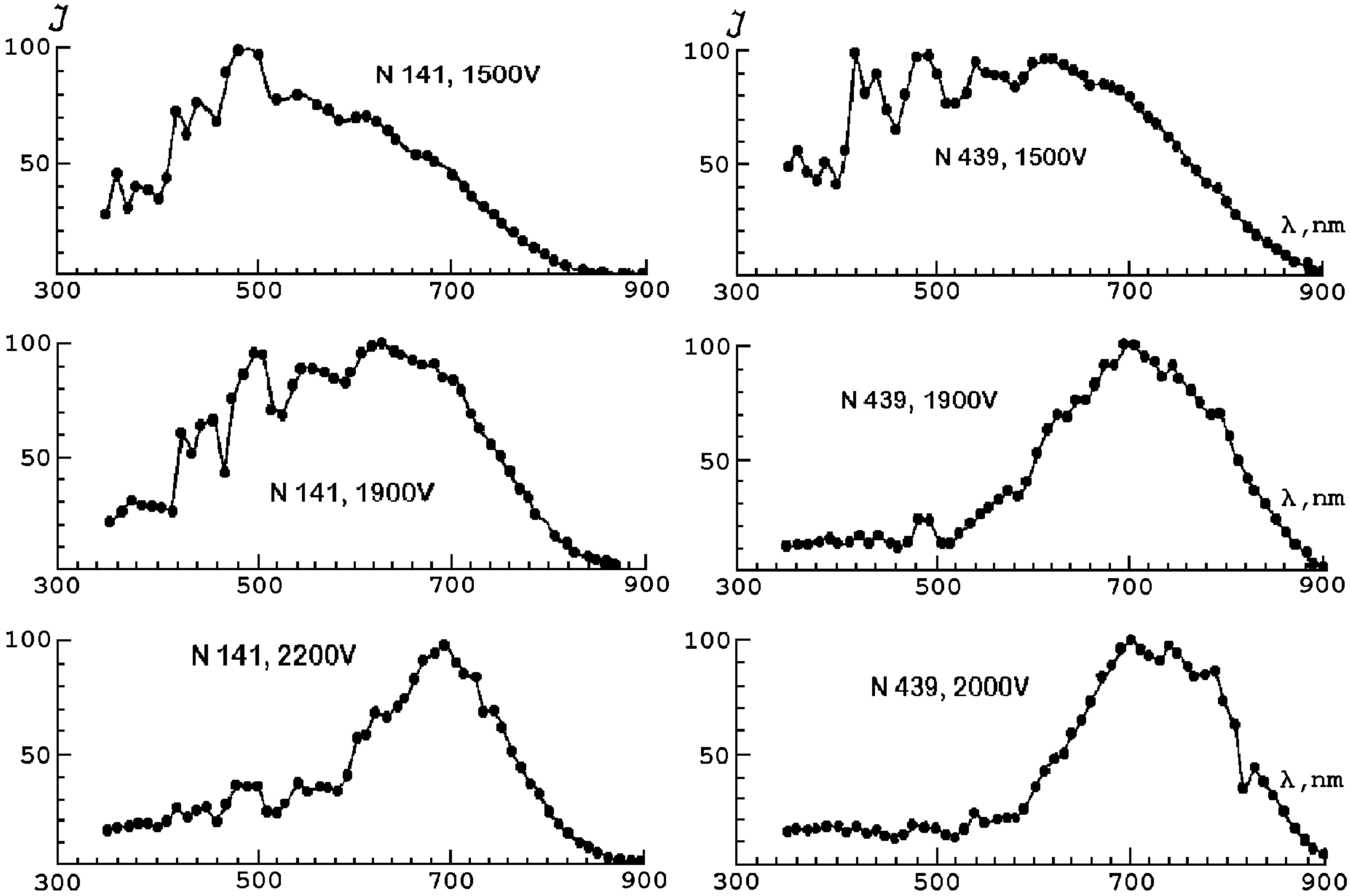


Figure 1(c,d): Variations of spectral sensitivity as a function of wavelength.

The following conclusions can be made:

— in stepping up the supply voltage, maximum spectral sensitivity of the PHEM is displaced towards a longwave range of the spectrum;

— the curve of spectral characteristics of PHEM changes rather spontaneously;

— for observations, it is necessary to choose PHEM according to spectral characteristics strictly keeping to the supply voltage chosen;

– there is a possibility of the PHEM spectral sensitivity variation control.

The last inference item implies the supply voltage control by the computer, i.e. in every part of the spectrum there should be the most efficient voltage for obtaining high signal–noise relation.

PARALLEL COMMUNICATION INTERFACE

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ABSTRACT. Structural circuit design of an interface working in the line as long as 30 m is developed and given.

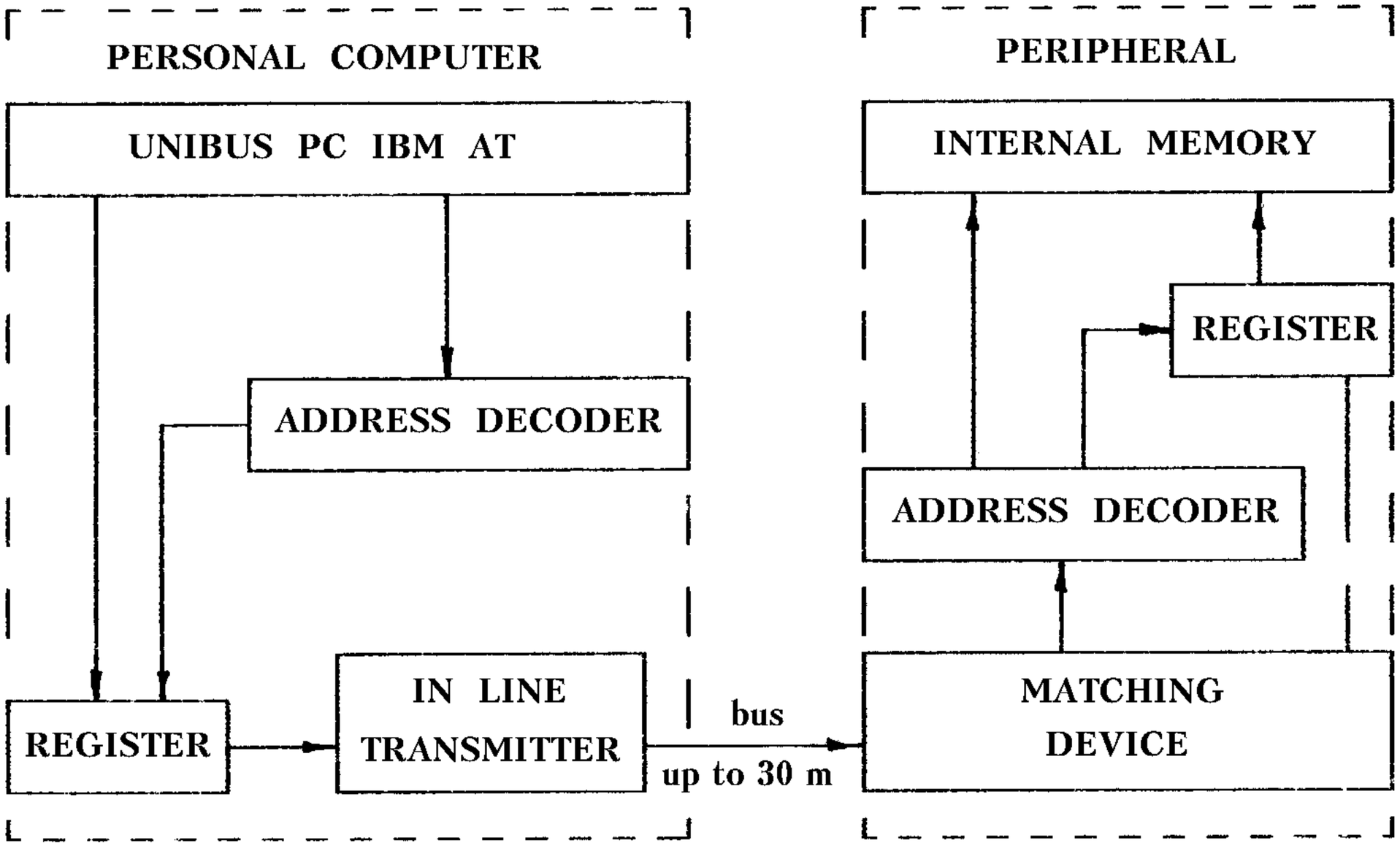
In working with computerized control systems data transmission from the central computer to peripherals and vice versa is needed. We have developed a parallel communication interface which permits to transmit an eight–bit signal in TTL–levels from the unibus of the PC–type IBM AT at a distance up to 30 meters, at a velocity up to 400 kilobyte/sec.

Structural scheme of the device is given in the Figure below.

Similarly is arranged the information reception in PC. A computer part of the interface is executed in the form of a circuit–board inserted into a unibus of PC. A real product of this type provides stable work of the information device as distant from the control computer as 32 meters.

This system is supposed to be used in the automatic observational devices of the meridian circle.

Key words: Astronomical instruments.



THE POINT OBJECT'S IMAGE FORMING RAY MODEL

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ABSTRACT. Light wave front's distortions are commonly explained by atmosphere turbulence. But Anler equation solution's analysis shows that distributed homogeneous medium even in the absence of turbulence makes nonlinear transformation of coordinates as well as ray's entry angles to the telescope's optical system (rays' trajectory is a screw-like line).

Key words: Atmosphere, model, parameters.

The atmosphere light propagation in distributed inhomogeneous optical medium is distribed by Auler's differential equations (Mikaeljian, 1990).The rays trajectories depened upon medium perts' types when going through them on the way to telescope's image plane.Optical mediums are subdivided on the type of refraction coefficient's $(RC)N[X,Y,Z]$ symmetry into:

1. homogeneous (classical optics) - $N[X,Y,Z] = \text{const}$;

2. distributed isotropic - $N[X,Y,Z] = N[Z]$. In such atmosphere RC increases in ray's direction according to density growing.

3. Anisotropic- $N[X,Y,Z] = N[X,Y]$. Anisotropy is a consequence of local RC disturbances along axes X,Y. Suppose that the telescope axis is Z one; the plane XY coincides with the moving image plane. Auler's equation for distributed isotropic medium describes the ray trajectory projection to XZ or YZ plane. For the first case:

$$(X\text{“}/1+(X\text{‘}))+(1/N[Z])\cdot(dN[Z]/dZ)\cdot X\text{‘}=0; \quad (1).$$

Substitute to (1) function defining $N[Z]$ dependence on medium parameters. Designate angle formed by the telescope axis and the zenith as F and power function M as $M\{s\}$. It is known (Zverev, 1975), that

$$N[Z]=(1+C\cdot P[H])\{-1/2\}=P\cdot(kT/gm)\{-gm/kC\}\cdot e\{(-gm/Bk)\cdot H\}; \quad (2).$$

where C=const; $P[H]$-medium density; $B = dP[H]/dH$; P,h,T-medium density, height and temperature recordingly at the layer's border. Formula (2) was obtained under assumption that $T[H]=T+B\cdot H$. Taking into account that $H = Z\cdot\cos F$, substitute RC and its derivative to (1),and separating variables,integrate result:

$$dX/dZ=-tg[(\pi/r[F,x])[Z+(g\cos F)(1-e\{-h+S[n]\cos F\}\cdot e\{az\cos F\})]-Q(x)]; \quad (3).$$

Here $a=gm/kT; A=(1/a)\{-gm/kC\}$; $r[F,x]$ - ray's oscillation period in XZ plane; $Q(x)$ - ray's entry angle; $q=C\cdot P\cdot A/a; S[n]$ - ray's trajectory length along Z for n previous periods while.

In order to express depedence dY/dZ upon medium parameters designate in (3)

$$dX/dZ=-\text{tg}[(\pi/r[F,x])Fi(x,z)-Q(x)]; \quad (3a).$$

$$dY/dZ=-\text{tg}[(\pi/r[F,y])Fi(y,z)-Q(y)]$$

and taking into account, that $Q(y)=(\pi/2)-Q(x)$, receive:

$$dY/dZ=\text{ctg}[(\pi/r[F,y])\cdot Fi(F,y]+Q(x)]; \quad (3b).$$

Oscillation periods $r[F,x], r[F,y]$ at XZ and YZ planes correspondingly are found from:

$$(\pi/r[F,x])Fi(x,z)-Q(x)=\pi; \quad (4).$$

$$(\pi/r[F,y])Fi(y,z)+Q(x)=\pi; \quad (4a).$$

$$1+r[F,x]+(q/\cos F)(1-e\{-h+S(n0\cos F\}\cdot e\{ar[F,x]\cos F\})+(Q(x)r[F,x])/\pi=0; \quad (5).$$

Expression (5) represents (4) in detailed form. Let's formulate atmosphere optical characteristics followed from (3), (4) and (4a):

1. Ray's propagation vector rotates when coordinate Z changing and makes one spiral spire for two $r[F,x]$ periods;
2. At the end of every period ray's propagation angle equales to the angle of its entry to the medium.The ray is parallel to Z axis in trajectory points, where phase equals to $\pi/2$;
3. The oscillation frequency increases in successive periods,when decreasing temperature factor $B, Q(x)$ and $Q(y)$ absolute values;
4. Ray's parallelism maintains at the every trajectory point;
5. Medium entry angles equality for axis Z points' rays causes the angles equality when propagating within the medium;
6. Two axis Z points' rays with entry angles $Q(x)$ and $\pi/2+Q(x)$ correspondingly have equal frequencies and $\pi/2$ phase shift when propagating wilhin the

medium.Rays are meeting or diverging ones subject to phase;
7. Rays cutting image plane along the circle with $(0, 0, Z)$ center are homocentric ones, that is tangents to their trajectories cut one point at Z axis.

The above permits to assert that atmosphere possesses plate characteristics (*it*.4) as well as convex or concave sphere ones (*it*.6).To the specific opti- cal characteristics concern: spiral-like trajectory; conservation of the entry angle's value in whole number of periods; homocentricity of one radius's rays family (*it*.2). Any distortion may be realised as simulation model if angles and rays' entry coordinates to the telescope's objective are known. The entry angles to the objective are determined by residual values of variable Z (deduction by whole values of periods) and expressions (3), (3b). While $z < r[F, x]$ ray's entry coordinates $X[Z], Y[Z]$ are determined by formulas:

$$X[z] = X[0] + U \cdot ln(\cos Q(x)/\cos[(\pi/r[F,x])[z+$$

$$+q/\cos F(1 - B \cdot e\{az\cos F\})] - Q(x)]); \qquad (6a)$$

.

$$Y[z] = Y[0] + U \cdot \ln(\sin Q(x)/\sin[(\pi/r[F,y])[z+$$

$$+q/\cos F(1 - B \cdot e\{az\cos F\})] + Q(x)]); \qquad (6b).$$

Here $U = r[F, x] \cdot a \cdot \cos F/\pi(a\cos F - qB); B = e\{-h + S[n]a\cos F\}$. It is evident that ray's entry to objective coordinates depends on periods' number in trajectory. In every period ray performs straight and reverse motions in axes X and Y, which amplitudes don't coincide with each other becanse of oscillations' frequency increasing in the following semicycle. That is the reason of coordinate's shift accumulating in periods.

Conclusions

1. Atmosphere in simulation model may be represented by optical system consisting of a number of 'plate-sphere' conjunctions.
2. Whole 'plate-sphere' conjuctions (its thickness equals to period) transform the going ray's parameters and remain entry angles' values.
3. Fractional 'plate-sphere' conjuctions transform parameters and going out rays.
4. The proposed model of the light propagation permits to realize atmospheric image's transformations in the level of phisical laws and take into account variate RC disturbances and variations of medium's parameter's (the stratum's thickness, molecules' mass, temperature factor).

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THE AUTOMATIC MEASURING MACHINES AND GROUND-BASED ASTROMETRY

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ABSTRACT. The introduction of the automatic measuring machines into the astronomical investigations a little more then a quarter of the century ago has increased essentially the range and the scale of projects which the astronomers could capable to realize since then. During that time, there have been dozens photographic sky surveys, which have covered all of the sky more then once. Due to high accuracy and speed of automatic measuring machines the photographic astrometry has obtained the opportunity to create the high precision catalogs such as CpC2. Investigations of the structure and kinematics of the stellar components of our Galaxy has been revolutionized in the last decade by the advent of automated plate measuring machines. But in an age of rapidly evolving electronic detectors and space-based catalogs, expected soon, one could think that the twilight hours of astronomical photography have become. On opposite of that point of view such astronomers as D.Monet (U.S.N.O.), L.G.Taff (STScI), M.K.Tsvetkov (IA BAS) and some other have contended the several ways of the photographic astronomy evolution. One of them sounds as: "...special efforts must be taken to extract useful information from the photographic archives before the plates degrade and the technology required to measure them disappears". Another is the minimization of the systematic errors of ground-based star catalogs by employment of certain reduction technology and a dense enough and precise space-based star reference catalogs. In addition to that the using of the higher resolution and quantum efficiency emulsions such as Tech Pan and some of the new methods of processing of the digitized information hold great promise for future deep ($B < 25$) surveys (Bland-Hawthorn et al. 1993, AJ, 106, 2154). Thus not only the hard working of all existing automatic measuring machines is apparently needed but the designing, development and employment of a new generation of portable, mobile scanners is very necessary. The classification, main parameters of some modern automatic measuring machines, developed with them scientific researches and some of the used methods of high accuracy, reliability and certainly ensuring are reported in that paper. This work are supported by Grant N U4I000 from International Science Foundation.

Key words: Astronomical instruments.

THE VERIFICATION OF DATA OF MEASUREMENTS AT THE CREATION OF SKY SURVEY CATALOGUES WITH AUTOMATIC MEASURING MACHINES PARSEC

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ABSTRACT. The system of an automatic control and the data verification in real time at the measurements with the automatic measuring machines PARSEC, had been developed to obtain the best accuracy, reliability and certainty of the results of the measurements and the high productivity in the same time. The principles and methods which had been used as a base of the developed system are presented in this paper.

Key words: Astronomical instruments and techniques - astronomical instruments: measuring machines - Astronomical instruments and techniques - data processing

The problem of the data verification at the measuremens with semi-automated measuring machine such as Ascorecord had being decided by the operator in accodance with his experience directly during the process of measuring. The reliability and certanty of obtained data had been based on operator's level of proficiency. The using of automatic measuring machines PARSEC, which provide at present the rate of coordinate and diameter measurements in real time of 500-800 images per hour, make it impossible for any man to make an estimation ofthe reliability and certanty of output infomation flows. As a matter of fact, the operator of PARSEC is separated from the control of the reliability of obtained data of measurements. Therefore the system of information technology with an automatic control and data verification in real time is urgently need. Such system had been developed and successfully used for the measurements of the sky survey plates with PARSEC in the Main Astronomical Observatory of the Academy of Science of Ukraine (MAO ACU) and the State Astronomical Institute of Shternberg, Moscow. The principles and methods which had been used as a base of the developed information technology are present in this paper.

There are many reasons which could cause the uncertainties, unreliability and mistacency of the measurement's data with an automatic measuring machines PARSEC. In the first place, there are problems associated with the quality of plates (transparency, contrast, blurs, ghosts, background unhomogeneity, wide variety of shapes of images, such as ellipticity, spikes, "tails", and so on, some kinds of defects, such as scratches, dark and light spots, proximity of bright stars images with large halo to the measured images, etc.). Secondly, there are some problems associated with pecularities of the measuring algorithm of PARSEC. They depend in some sort on above-mentioned quality of plates and on the third group of complicative factors associated with human activities: nonoptimal organization of all measuring procedures (from quality and accuracy of the input data to the methods of the control and verification of the output data) and variety of blunders, misses and mistakes of operator. Summarizing, the reasons which could interrupt the measuring process of PARSEC or cause the uncertainties of data (so called "unregular situations") and which have been in need of automatic control may be defined as:
- the mistakes of input data (wrong values of preliminary coodinates);
- the dimensions of the measured image exceeding the permitted extreme ones;
- the considerable gradient of density of the image or large unhomogeneity of near-by background;
- the mergered images;
- the noncircular shape of measured image, especially a high ellipticity;
- nearly all kind of blunders, misses and mistakes of operator;
- any kind of malfunctions, faults or failures of hardware.

In order to obtain the best accuracy, reliability and certanty of data with high productivity in the same time in the measurements of the sky survey plates, the system information technology had been developed on the next principles:
- maximum automatization of all stages of the measuring procedure;
- minimization of human-made operations;

- support of stable and stopless procedure of automated measurements;
- optimal organization of input and output data structure;
- supporting of the effective intraction of measuring and computing systems, the hardware and software;
- using the verification software for the check of data reliability at the each stage of the information technology;
- operative processing and the estimation of the quality of measurements in real time during the measurings;
- using the methods of optimal duplication, parallelizm and surplusity for data protection;
- providing the homogeneity of measurements by means of the metrological assessment of PARSEC.

The realization of that principles allow to avoid some of mentioned unregular situations. Other have been analysed and controled by all stage of information technology.

As a part of developed information technology - unregular situation analysing software (USAS) realises the automatic control of some of above-described unregular situation in real time during measurements and ensure in this way the verification of the measured data. The situations being analysed by it are:

1 - the preliminary coodinates values exceed the permitted extreme ones;
2 - the image in the area of view is absent;
3 - impossibility to estimate the image centre for a certain time;
4 - large unhomogeneity of near-by background;
5 - the dimension of the measured image exceeds the permitted maximum value;
6 - the dimension of the measured image is less then the permitted minimum value;
7 - moving of cariage during the scaning of image;
8 - mulfunctions of scaning hardware;
9 - mulfunction of coordinate reading hardware;
10 - fatal errors.

If for measured image the situations 1 - 6 have happened the USAS stops the measurement of that image, makes the message to operator, puts the corresponding marks to the flag field of that image record in output file, then the measurement of next image have begun. In the case of situations 7 - 9 USAS regists them, makes the message to operator, puts the corresponding marks to the flag field, and the measurement of the same image have repeated. So the appearance of marks of situations 1 - 6 in output file means the uncertainties and unreliability of the data for corresponding image. The mark of situations 10 in output file means full uncorrection of the data.

To control the operation of PARSEC hardware in total and to provide the homogeneity of measurements the metrological assessment have been carried out regularly. In order to control the quality of data of the measured plate and the operation of PARSEC hardware during measurements the statistical assessment of data have been accomplised. It presents the estimation of:
- standard deviation of the every control plate mark in the block of measurements;
- mean standard deviation of the marks in the block of measurements;
- mean standard deviation of the marks in the whole file of measurements;
- evaluation of unhomogeneity of a background density on the plate;
- trend of marks during the time of measuring.

(The programm of the statistical assessment was written in TURBO PASCAL by L.K.Pakulyak.)

As a result of above mentioned attempts to control measuring process we have obtained the software, which optimizes the measuring process perfectly well, verificates the data and reduces a possible operator mistakes.

This work is suppoted by Grant N U4I000 from International Science Foundation.

THE ESTIMATION OF THE HEIGHT AND HALF-WIDTH OF THE TWILIGHT BEAM IN EARTH ATMOSPHERE

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ABSTRACT. New program models the scattering of the sun light in Earth atmosphere. The program is not in the strict relation with the model of light scattering and atmosphere structure. This fact permits to use the program for different atmosphere models. The way of determination of the twilight beam characteristics is discussed in detail. The article presents the results of the model for average atmosphere. They may be used for determine of the direction scattering coefficient and execute iterations. The given is model similar to the average model used in N.B. Divari' articles. This fact caused the similarity of the obtained results.

Key words: twilight, atmosphere, twilight sound, twilight beam, optic depth of the atmosphere.

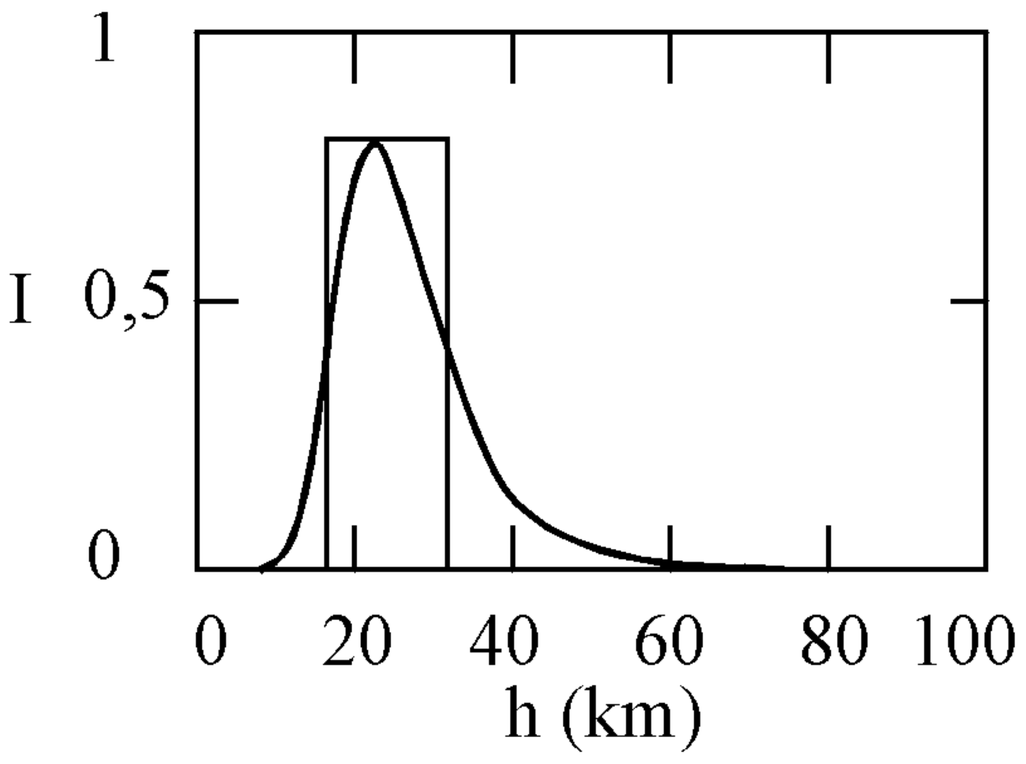


Figure 1:

One of the methods to determine Earth atmosphere dust is the method of twilight sounding, which it basic on solving of the inverse problem of the light scattering in the atmosphere. The result of solving the inverse problem is the directed scattering coefficient which is determined out of the visible brightness of the twilight sky.

Primary twilight brightness may be present as

$$B_1 = B_m + B_d + B_o, \qquad (1)$$

where B_m - the brightness of primary twilight, caused by molecular component,
B_d - the brightness of primary twilight, caused by dust component,
B_o - the brightness of primary twilight, caused by ozone component.

Each component causes brightness, which may be obtained after the formula

$$B = \beta\psi(\theta)\int_0^\infty I_0 n(h) e^{-\tau} e^{-\tau'} dh, \qquad (2)$$

where B - the brightness, caused by one of the components,
$e^{-\tau}$ - decreasing of a light flaw up to a scattering point,
$e^{-\tau'}$ - decreasing of a light flaw from a scattering point up to observer,
β - the scattering coefficient of an appropriate component,
I_0 - the intensity of solar radiation outside the atmosphere at the distance of the Earth orbit,
$n(h)$ - the concentration of particles of appropriate component at the height h,
$\psi(\theta)$ - the indicatrix function of appropriate component.

N.B. Divari (Divari 1972,1973,1974) offers to substitute profile of the twilight beam by rectangular (fig. 1),

where I_h - solar radiation intensity at height h,
h - scattering point height.

The height of the rectangle equals the maximum of the integrand (2) and its width is difference of heights, where the value of integrand is two times less than maximum value (5).

$$\frac{dB}{dh} = \beta\psi(\theta) I_0 n(h) e^{-\tau} e^{-\tau'}, \qquad (3)$$

$$\frac{dB}{dh}(h') = max\left(\frac{dB}{dh}(h)\right), \qquad (4)$$

$$\Delta h = h_2 - h_1, \qquad (5)$$

where h'- the height of the twilight beam,
Δh - the half-width of the twilight beam,
$h_{1,2}$ - the height, where brightness of the scattering light is two times less than maximum brightness of the scattering light (6).

$$\frac{dB}{dh}(h_{1,2}) = \frac{1}{2} max\left(\frac{dB}{dh}(h)\right). \qquad (6)$$

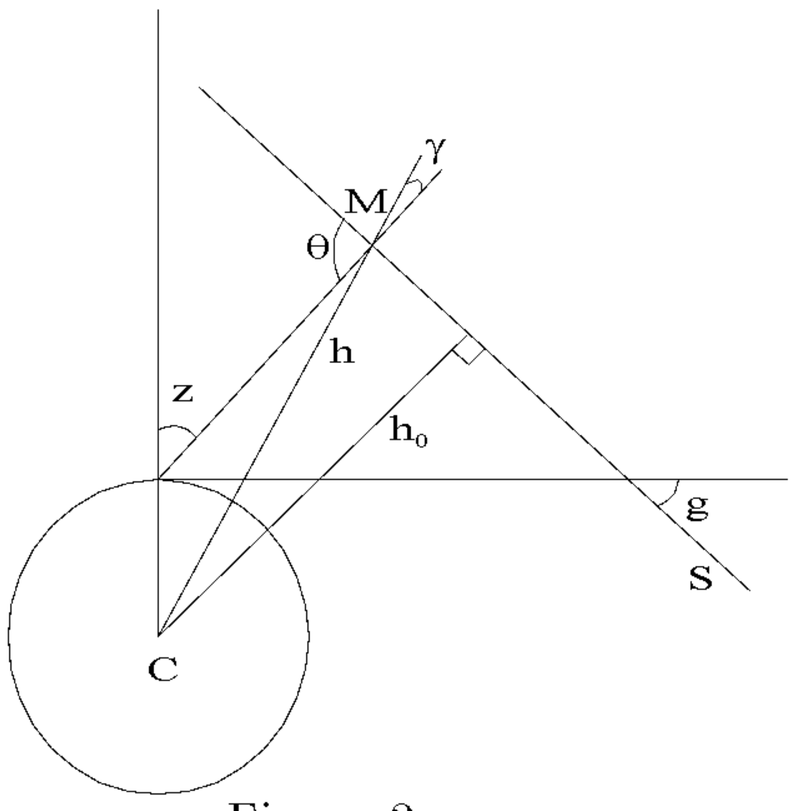


Figure 2:

As a result this substitution transforms integrate equation (2) in algebraic equation (7).

$$B = I_0 \sigma(\theta, h') e^{-(\tau+\tau')} sec(\gamma) \Delta h, \qquad (7)$$

where $\sigma(\theta, h')$ - the directed scattering coefficient.

Thus, the solving of the inverse problem needs to knowing angels and , height of the twilight beam, its half-width and optic depth along twilight beam. Angels and may be easily determined out of geometrical ideas (fig. 2). The height of the twilight beam, its half-width and optic depth may be determined only using the results of modelling the light scattering in atmosphere. As follows, the result of solving the inverse problem will depended from the choice of the prior atmosphere model. It may be assumed, that solving the inverse problem will produce the atmosphere model more similar to reality than prior model. Lets use iteration method.

The task was formulated to obtain the height, half-width of the beam and optic depth along the twilight beam for every observing day by iteration. Within the discussed problem we made program which calculates the profile of the twilight beam for any prior atmosphere. To determine the twilight beam profile. Its needed to calculate optic depth along any trajectory. Optic depth in atmosphere may be present as

$$\tau = \tau_m + \tau_d + \tau_o, \qquad (8)$$

where τ_m - the optical depth of the atmosphere molecular component,
τ_d - the optical depth of the atmosphere dust component,
τ_o - the optical depth of the atmosphere ozone component.

The optic depth of any component may be calculated after the formula (9) (Divari and Plotnicova 1965; Lebedinech 1981)

$$\tau = \int_{h_0}^{\infty} \alpha n(h) \frac{R+h}{\sqrt{(R+h)^2 - (R+h_0)^2}} dh, \qquad (9)$$

where R - the Earth radius,
h_0 - the minimum distance of the beam from the Earth surface,
α - the extinction factor.

Though the given formula is simple enough for analytic it is principal unsuitable for calculation near $h = h_0$. When $h = h_0$ the integrand becomes to infinite. This may be avoided by integration along the trajectory. The transformation Jacobean excluded from formula (9).

$$\frac{\partial S}{\partial h} = \frac{R+h}{\sqrt{(R+h)^2 - (R+h_0)^2}} \qquad (10)$$

and we get the formula, where optic depth is

$$\tau = \alpha \int_0^{\infty} n(h) ds, \qquad (11)$$

where α- the factor of absorption for molecules and ozone and the dispersion factor for dust,
$n(h)$ - the concentration of particles of appropriate component at height h,
ds - the beam trajectory element.

To estimate the quality of the integration we may use a value estimation of the remainder. For quadrature integrate formulas the remainder member may be presented as follows (12) (Demidovich and Maron 1963)

$$R = A l^n f^{(n)}(\xi), \qquad (12)$$

where $f^{(n)}(\xi)$ - n rank derivative from integrate function at point the , that belong to the interval of integration,
l - step of integration,
A - constant.

The calculation offer formula (11) is more effective, because the $n-$ rank derivative of integrand function from formula (11) near $h = h_0$ is less than integrand from formula (9).

Knowing optic depth along the trajectory of the beam, we can determinate the profile of the twilight beam (3). Using the profile of the twilight beam we can determinate the height of the beam h and it half-width h in above-mentioned way.

In formula (1) we assumed that model of atmosphere includes molecular, ozone and dust components. The absorption and scattering by molecular and ozone components can be determined if absorption and scattering coefficients of those two components is known and the dependence of molecular concentration from height and molecular indicatrix. The question which concerns the dust component is more complicated because it consists from the particles of different size, that scatter radiation indifferent way evidently. The scattering coefficient cant be equivalent for all particles. Therefore to simplify we refused from atmosphere model that contains particles different size. We suppose that instead the atmosphere has "effective" particles with identical

Table 1:

λ (nm)	$\beta_m(\mathrm{cm}^{-1})$	$\beta_d(\mathrm{cm}^{-1})$	$\beta_o(\mathrm{cm}^2)$	$\alpha_m(\mathrm{cm}^{-1})$	$\alpha_o(\mathrm{cm}^2)$
371	$4.83 \cdot 10^{-8}$	$0.13 \cdot 10^{-8}$	0	$0.607 \cdot 10^{-6}$	0
575	$7.80 \cdot 10^{-9}$	$0.13 \cdot 10^{-8}$	$0.0382 \cdot 10^{-25}$	$0.955 \cdot 10^{-7}$	$0.0471 \cdot 10^{-19}$

Table 2:

h(km)	lgN (cm^{-3})	h	lgN	h	lgN
0	19.41	20	18.27	120	11.69
1	19.36	30	17.58	150	10.66
2	19.31	40	16.92	200	9.86
3	19.28	50	16.34	250	9.3
4	19.23	60	15.82	300	8.9
5	19.19	70	15.26	400	8.1
6	19.14	80	14.60	500	7.4
8	19.04	90	13.80	700	6.4
10	18.98	100	12.98	1000	5.2
15	18.61	110	12.29		

Table 3:

h(km)	n(cm^{-3})	h(km)	n(cm^{-3})
10	$1.0 \cdot 10^{12}$	60	$1.0 \cdot 10^{10}$
15	$1.1 \cdot 10^{12}$	65	$3.2 \cdot 10^{9}$
20	$2.9 \cdot 10^{12}$	70	$1.0 \cdot 10^{9}$
25	$3.2 \cdot 10^{12}$	75	$3.2 \cdot 10^{8}$
35	$2.0 \cdot 10^{12}$	80	$1.4 \cdot 10^{8}$
40	$1.0 \cdot 10^{12}$	85	$1.0 \cdot 10^{8}$
45	$3.2 \cdot 10^{11}$	90	$1.1 \cdot 10^{8}$
50	$1.0 \cdot 10^{11}$	95	$1.3 \cdot 10^{7}$
55	$3.2 \cdot 10^{10}$	100	$1.7 \cdot 10^{6}$

scattering coefficient and indicatrix. The concentration of these particles is such, that they scatter light equally to its scattering by all particles, of atmosphere. Then dust component of the atmosphere can be set by the scattering coefficient of the "effective" particles and they distribution by height.

$$n(h) = \begin{cases} 7.1e^{-0.1h}, & h \leq 40km \\ 4.8 \cdot 10^{10} h^{-7.2}, & h > 40km \end{cases} \qquad (13)$$

Factors of scattering and absorption a presented in table 1 (Divari and Plotnicova 1965; Sedunov 1991), the concentration of a molecular in table 2 (Allen 1977), concentration of ozone in table 3 (Sedunov 1991).

The column herders used in the table 1 are
β - scattering factors,
α - absorption factors.

For molecular and dust component the factors are the decrising of light flux per length unit at sea level and for ozone the decrising at crossing volume unit.

Scattering indicatrix of molecular and dust according to (Divari and Plotnicova 1965) a represented by formulas (14,15).

$$\psi(\theta) = 3.046 \cdot 10^{-4} \frac{3}{16\pi}(1 + cos^2\theta) \qquad (14)$$

$$\psi(\theta) = \frac{1}{18.28}[1 + 11.1(e^{-3\theta} - 0.009)] \qquad (15)$$

Using the given atmospheric model we obtained heights and half- widths twilight beams as well optic depths along them (tab. 4,5). Calculating the characteristics of twilight beam we supposed, that beams in atmosphere have linear of trajectories and Sun is a point source. Thus we neglect with effects of refraction, refraction divergence and limited size of the Sun. These effects change a little bit the numeric values of twilight beam characteristics but dont change qualitative dependence of the twilight beam the height and its half-width on direction of the observation and sun immersion.

The designations used in table 4, 5 are
g - Sun immersion under horizon,
z - zenith distance of observation point. The negative values of z are zenith distances merged from zenith point in the direction to the opposite Sun. τ - optic depth from Sun to observer,
h' - twilight beam height,
Δh - its half-width,
λ - wave length.

On the basis of date given in table 4, 5 and formula (2) we may obtaining the scattering direction factor if the brightness of primary twilight is known. The scattering direction factor may be used for repeated obtain of the twilight beam characteristics. In order to do this atmosphere is to be interpreted as consisting of the only component and scattering direction factor as a product of concentration of particles of mentioned component and indicatrix same component.

As all absorption and scattering factors, molecular and dust indicatrix and concentration of the "effective" particles were got from N.B. Divari works we compared heights of twilight beams obtaining by us and by N.B. Divari (fig. 3).

On figure 3 we put regular bias in 5km for heights obtained by N.B. Divari in order to make curves not to coincide.
hm - twilight beam heights obtained by us,

Table 4:

λ =371(nm) gas,dust				
g	z	lg($e^{-\tau}$)	h' (km)	Δ h (km)
2	80	-1,594	24,65	14,77
4	80	-1,612	32,03	14,65
6	80	-1,548	43,56	14,00
10	80	-1,512	74,05	15,38
14	80	-1,400	117,24	22,35
2	70	-1,057	25,84	16,19
4	70	-0,978	36,51	15,96
6	70	-0,947	50,49	16,41
10	70	-0,909	90,37	18,86
14	70	-0,762	148,06	28,41
2	60	-0,813	27,42	16,28
4	60	-0,777	38,36	15,15
6	60	-0,742	54,18	16,26
10	60	-0,667	100,88	22,64
14	60	-0,556	167,39	31,75
2	50	-0,723	27,83	16,39
4	50	-0,678	39,52	15,88
6	50	-0,690	55,65	15,48
10	50	-0,538	108,49	24,97
14	50	-0,457	181,61	34,91
2	40	-0,675	28,12	16,41
4	40	-0,625	40,35	16,70
6	40	-0,633	57,38	16,19
10	40	-0,482	113,73	25,54
14	40	-0,400	193,09	36,48
2	30	-0,645	28,35	16,44
4	30	-0,647	40,05	15,42
14	30	-0,366	203,06	38,15
2	20	-0,629	28,54	16,42
4	20	-0,627	40,60	15,66
6	20	-0,579	59,99	19,24
10	20	-0,402	123,04	27,13
14	20	-0,344	212,34	39,81
2	10	-0,621	28,72	16,46
4	10	-0,681	40,13	15,98
6	10	-0,568	61,12	17,78
10	10	-0,391	126,87	27,95
14	10	-0,320	222,48	41,28
2	-80	-1,711	39,29	16,90
4	-80	-1,889	74,22	26,82
6	-80	-1,732	203,73	81,08
2	-70	-1,022	33,72	18,30
4	-70	-1,191	50,45	18,64
6	-70	-1,053	90,43	29,75
10	-70	-0,869	285,18	72,65
2	-60	-0,807	32,06	18,36
4	-60	-0,906	46,72	18,71

Table 4 (Continue)

λ =371(nm) gas,dust				
g	z	lg($e^{-\tau}$)	h' (km)	Δ h (km)
6	-60	-0,847	76,17	20,80
10	-60	-0,613	196,38	46,23
2	-50	-0,702	31,31	17,47
4	-50	-0,804	44,53	17,76
6	-50	-0,746	70,55	19,81
10	-50	-0,513	168,55	38,15
2	-40	-0,700	29,82	19,11
4	-40	-0,750	43,25	17,17
6	-40	-0,691	67,41	18,63
10	-40	-0,459	154,76	34,26
2	-30	-0,661	29,52	18,84
4	-30	-0,715	42,37	16,80
6	-30	-0,651	65,30	18,07
10	-30	-0,423	146,14	32,19
2	-20	-0,639	29,28	18,56
4	-20	-0,693	41,70	16,57
6	-20	-0,580	64,76	19,38
10	-20	-0,402	139,94	30,73
2	-10	-0,626	29,08	18,35
4	-10	-0,683	41,13	16,35
6	-10	-0,569	63,43	18,78
10	-10	-0,391	135,02	29,73

Table 5:

λ =575(nm) gas,dust,ozone				
g	z	lg($e^{-\tau}$)	h' (km)	Δ h (km)
2	80	-0,887	14,60	16,39
4	80	-1,043	22,32	19,31
6	80	-1,158	33,92	21,44
10	80	-1,213	64,81	30,07
14	80	-0,387	122,28	28,41
2	70	-0,774	16,48	16,97
4	70	-0,977	25,19	21,76
6	70	-0,986	39,01	11,38
10	70	-1,071	79,89	39,53
14	70	-0,229	153,02	32,48
2	60	-0,807	15,99	17,35
4	60	-0,954	26,56	21,93
6	60	-1,009	41,14	10,36
10	60	-0,990	89,52	44,51
14	60	-0,166	173,57	36,45
2	50	-0,799	16,25	17,54
4	50	-0,945	27,40	21,34
6	50	-1,068	42,10	12,75

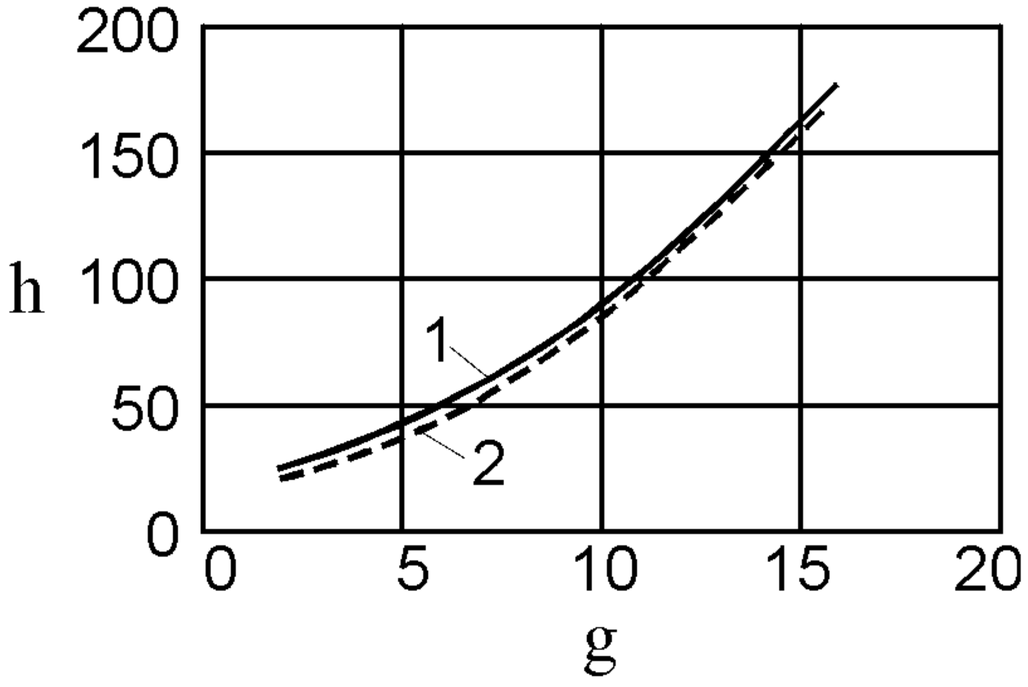


Figure 3:

hd - twilight beam heights after by N.B. Divari,
g - Sun immersion under horizon.

You can easily notice that our results are very similar to those obtained by N.B. Divari through all the heights range.

Thus as a result we have obtained program that models twilight scattering for any atmosphere if supposition of linear spreading of sunbeams and neglecting limited size Solar dimensions. The values that characteristics the twilight beams for prior given atmosphere are obtained. The comparison of twilight beam heights shows they identity, that witness the correctness of program running and although the absence of strong correlation of twilight beam height with the prior selected molecular component.

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Table 5 (Continue)

λ =575(nm) gas,dust,ozone				
g	z	lg($e^{-\tau}$)	h' (km)	Δ h (km)
10	50	-0,993	94,77	49,35
14	50	-0,142	188,21	38,58
2	40	-0,742	17,40	17,68
4	40	-0,937	27,99	20,46
6	40	-1,029	45,30	21,53
10	40	-0,894	102,10	50,88
14	40	-0,128	200,04	40,50
2	30	-0,739	17,55	17,74
4	30	-0,937	28,46	21,12
14	30	-0,120	210,35	42,31
2	20	-0,740	17,67	17,74
4	20	-0,936	28,87	21,79
6	20	-1,017	47,38	22,22
10	20	-0,183	129,74	45,13
14	20	-0,115	219,93	45,94
2	10	-0,741	17,78	19,76
4	10	-0,938	29,23	20,43
6	10	-1,016	48,28	22,62
10	10	-0,179	133,77	46,59
14	10	-0,112	229,40	47,83
2	-80	-1,163	20,80	20,97
4	-80	-1,989	40,92	23,50
6	-80	-1,329	154,38	62,21
2	-70	-0,923	18,89	19,59
4	-70	-0,930	38,71	12,23
6	-70	-1,187	70,41	28,40
10	-70	-1,039	250,34	127,91
2	-60	-0,866	18,05	19,49
4	-60	-1,027	33,94	20,40
6	-60	-1,071	60,96	26,86
10	-60	-0,961	172,70	89,76
2	-50	-0,838	17,66	19,19
4	-50	-0,992	32,40	20,03
6	-50	-1,040	56,56	24,56
10	-50	-0,937	148,62	76,10
2	-40	-0,770	18,45	18,76
4	-40	-0,973	31,49	20,54
6	-40	-1,032	54,09	24,56
10	-40	-0,197	163,24	57,30
2	-30	-0,765	17,25	16,90
4	-30	-0,960	30,86	19,36
6	-30	-1,024	52,42	23,31
10	-30	-0,915	129,07	66,44
14	-30	-0,120	281,56	56,71
2	-20	-0,749	18,13	18,41
4	-20	-0,952	30,37	20,56
6	-20	-1,019	51,15	24,44
10	-20	-0,184	147,56	51,33
2	-10	-0,745	18,00	18,14
4	-10	-0,945	29,96	19,80
6	-10	-1,017	50,10	23,66
10	-10	-0,181	142,36	49,47

A PART OF THE STARRY SKY DESCRITION FORMIG WHEN TV OBSERVATION

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ABSTRACT. The observing part of the starring $j = 1, k$, k - number of observation circles, and measured when setting up TPPF' nonstationary elements identity and determining their parameters difference. sky is represented by two-dimentional pulse parametric field$M, M = [(S, B, (X_o, Y_o))i, i = 1, n$. Where (X_o, Y_o) - optical radiation centroid's coordinates, B - Summary radiation (brightness), S - the qbject's area Compact object's isolation and their parameters $S, B, (X_o, Y_o)$ determination real time algoritm is developed. The method may be realised by a middle class computer vision system (CVS). The CVS computing system may be realised by convejor inhomogeneous structure "base computer + functional oriented processor" (BC + FOP). Some FOp's units are developed. The method's efficiency was carried out when imitation testing of binary image models.

Key words: Picels', measured, images, algoritm.

Automatization of the Starry sky (SS) observation presupposes the SS part model forming at the computing system's (CS) memory. The SS image appertains to the local information class, that is, in accordance with the task semantics the objects of interest may be separated from the background in it (Val'teris, 1983).

The natural SS model therefore would be two-dimensional pulse parametric field (TDPPF), where every cosmic object (CO) is represented by numerical characteristics - area S, optical radiation B, radiation centroid coordinates (X_0, Y_0). A part of SS representation M forms joint of CO characteristics: $M = [(S, B, (X_0, Y_0)_j], j = 1, n$. Situation changes at the observing part of SS may be find out when setting up correspondence of the current frame TPPF' (M_j) elements to the previous frame $(M_j - 1)$ ones,

Pixels' signals of scanning aperture size $A \times B$ histogram forming algorithm is developed (Strygin, 1985). This histogram is necessary when defining adaptive threshold for detecting compact small sized and point objects located on the complex background. Real time (RT) object detecting and TPPF forming algorithms are developed. They work at multiplied objects' images, correcting CO parameters when pointing over their "holes". M-forming method may be realized by computer vision system (CVS); it may be rated as a middle class one by the complexity. Such CVS are developed as specialized ones.

The CVS's CS may be realized by inhomogeneous pipeline structure "Base computer plus functional - oriented processor (BC+FOP)".

A number of FOP' units is developed:picels' signals of scanning aperture forming. measured (for example, optical radiation B) and computed (for example, frequency of code in series) sign sorting, and some others. The method's program realization was examined when testing model binary images. As a computer was used IBM 386/DX-40 and C++ was used as a programming language.

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INTERFACE AND SOFTWARE FOR OSCILLOSCOPE COMPARATOR

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ABSTRACT. For measurement of photographic spectrograms on the comparator with the oscilloscopic guidance on line are used photoelectric moire measuring detector of linear movement of carriage with measuring plate and reversible binary-decade digit counters, which interfaced with the personal computer IBM PC. Automatic input of the current comparator count and control of cutting slits motion are carried out by means of a parallel interface board. The comparator software works is designated to make reduction of ordinary and zeeman photospectrograms.

Key words: spectrograms, oscilloscope comparator.

To determine Doppler and Zeeman shifts of spectral lines in spectrograms, a precise determination of spectral stellar line position and their reference to the comparison spectrum are needed. A method of prospect for this purpose is the use of solid-state panoramic light detectors with respective computer hardware. However, formerly accumulated photographic spectrograms can be effectively processed on the comparator with automatic input of counts for linear displacement of the carriage with a plate measured into the personal computer with a successive complete mathematical reduction of measurements.

The comparator work principle is based on constructing an optical image of a photospectrogram part in the dissector photocathode, its scanning in two directions and obtaining two mirror-symmetrical profiles of the scanned part in the electron-beam tube screen for an oscilloscopic guidance. The current position of a linear coordinate of the carriage is read out by scanning moire sensors, is digitized by reversible binary-decade counters and enters the IBM PC personal computer parallel port, by means of an elaborated computer interface. According to the command of the computer control program the output code is latched and can be stored for an unlimited long time until the next latching command follows. Then by means of the comparator output bytes the twenty bit code is divided by three bytes with eight bits for an alternate input into the computer. The selection and input of a low, mid and high byte of the count is carried out by fixing respective addresses. The complete count restoring takes place in the computer memory by mids of a bit shifting of a mid and a high bytes to the respective number of bits or by multiplying by the constant. From commands of control program a slit displacement motor control permits to display a stellar spectrum or a comparison spectrum for measurements. For this purpose are executed commands of motor switching on and slit displacements, switching off and displacement halting, reversal. The data input and output are carried out from signals I0R and IOW formed by a processor computer. But in the computer these signals can be formed not only by a processor but also by a controller of direct access to the memory (DAM). To exclude failures, the signal AEN is transmitted to the decipherer of address access with blocks it at the work of the computer in the DAM regime.

The software is functioning under the MS-DOS operational system control. The control program has a block structure consisting of controller and execution parts. The controller program part contains subprograms of the number input and slit displacement motor control. To avoid the input of false numbers at accidental failures of the device or at the voltage jumps of the line supply, the simultaneous input of twenty values of the number is carried out, then the analyses of number values is made – in the case of considerable deviations of numbers from the average (rough undershoots), the input process is repeated anew on attaining the wanted precision set. Subprograms of slit displacement control comprise commands of setting the address of switching on or switching off the motor in the address buses of a parallel port and time delay for executing these commands.

The execution part of the program incorporates a block of initial settings and the main menu. Initial settings are needed for the selection of a comparator working regime, the kind of measurements and peripherals. In the main menu, options are selected by the operator for identification and measurement a comparison spectrum, a stellar spectrum, approximations of a dispersion curve from the linear measured, line deleting, computations of radial velocities and magnetic field, calculations of corrections and errors. For the work of

the program, catalogs are needed of spectral lines for the stellar spectrum and comparison spectrum produced adequately in the form of separate files. Approximation of dispersion dependence and computations of reference line wavelengths of comparison spectrum are carried out by virtue of n-degree of polynomial (the degree is chosen from minimum deviations, commonly, a polynomial from a square to the fifth power is used). Calculation of Zeeman and Doppler stellar line shifts is carried out by using a dispersion curve constructed. The computations of corrections and errors in measurements is made according to the standard procedure of spectrogram reduction.

LOW ENERGY TIMER

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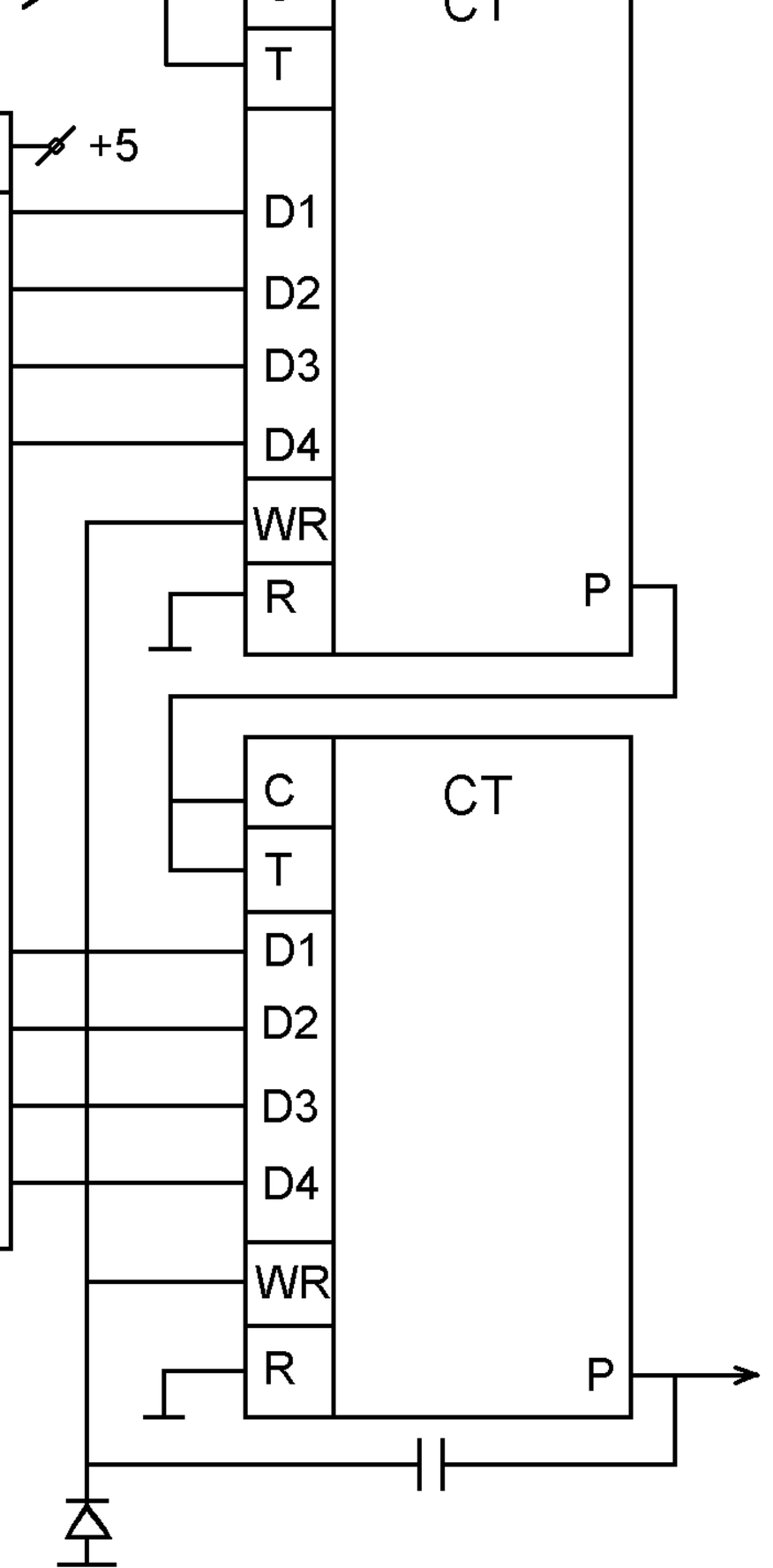
ABSTRACT. It was describe the simplest scheme of low energy timer for founding of the CCD-matrix storage time.

Key words: timer, CCD-matrix.

For realising a lot of different astrophysical tasks with high resolution measurements some problems a rise, that connected with additional heat radiation in the measurement technics.

This timer has been designed as the devise for founding of the CCD-matrix storage time.

The scheme of this device is shown on the Fig.1. The device has been assemblyed on the base of two reversing counters CMOS series. The carrient at use $R_z - 7A472$ is $5mA$ at supply voltage is near $5V$ (the analog, that assembled on the found of TTL, has the dissipated power more then factor by 10). The timer generates low-level impulses in the output, and they are equal by the duration ones of input signals. Then the system works in the TV standart. It is simpliest regime for storaging drive. This scheme gives the possibility to drive the storage time to 256 TV frames. The storage time is istablished by the micro-connector (MC). Moreover, the timer may be used to telescop driving.



SOME WAYS OF IMPROVEMENT THE ELECTROPHOTOMETRIC INSTRUMENTS

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ABSTRACT. In the paper some ways of the improvement (changes in the optical-mechanical part and improvement in the electronical part) the electrophotometric instruments are described. The apparatus which were constracted at Lviv astronomical observatory were taken as the examples.

Key words: electrophotometric observations; artificial celestial bodies (ACB)

The electrophotometric observations are the most popular method of getting information about stellar objects. Many years ago electrophotometric observations achieved popularity thanks to their simplicity and effectivenes of collection data. In spite of that at present there are no generally accepted type of instruments and methods for observations. It can be explanated so that every experiment nead special instrument and methodik. Especially it concerns the artificial celestial bodies (ACB). Besides that the aspiration to get information more accurate, in different spectral diapason, and from weaker and weaker ACB explains the wish to have better instruments. And that leads to modernisation and improvement of the electrophotometric apparatus.

For demonstration the ways of improvement the instruments one may take as the example the electrophotometers which were constructed at Lviv astronomical observatory. There were two ways of improvement: modernization of the optical-mechanical part and improvement of the electronical part.

One may begin the modernization of the optical-mechanical part with the prototype i.e. the electrophotometer with one objective without filters and without subtraction of the background. Than one constructes some examples of instruments which differ one from another in the number of objectives, spectral filters and as the consequence in the number of channels in which the ACB could be observated. There were constructed three examples of instrument:

first - with one objective and with automatical subtraction of sky background. As the result it has two channels for observations in integral light;

second - with two objectives, with different spectral filters in each channel, and automatical subtraction of sky background. It means that this instrument has four channels;

the third - with four objectives, with three different filters, and automatical subtraction of sky background. It means eight channels for observations in three colors and integral light.

And so on: one can add some more objectives and get more channels. It is evidently that such way could be realised only for instruments with small objectives. But just such instruments are needed for the ACB which are very special object for observations. They have very fast velocity of motion on the sky and fast change of brightness.

The improvement of the electronical part concerns to all electrophotometric instrument not only to specialized for observations the ACB. And could be fulfilled in two directions: the improvement of the selection system and the improvement of the recording system. In the selection system one can researche good results if a matematical model of inputing sygnal adequate to the experiment is chosen. Father on the base of this model one worked on the constructive algorithme of processing the signal and realised it in the specialised electronical scheme. It gave one the opportunity to make the most effective selection system with minimum errors.

In the registration system the improvement must go on the way of using the more accurate registration instrument. This way of improvement also concern to all the instruments. On the very beggining of the electrophotometric era all astronomers used the analog instruments (selfrecording apparatus), then - digital selfrecording instruments, and now - computers. Computer can be used in real time or with buffer. It depends on the main task of the observations. It is just the way we made during the improving the recording system. Our peculiarity is that we send the output signals of all channels of the electronical part of the electrophotometer to the computer in parallel regim. That gives us opportunity to save time and to make minimum errors during the registration the signal. In the future one would use still more powerfull computers and the question of improving would be in composing the better program service. And that we are doing now.

THE COSMOLOGICAL TEST "MAGNITUDE-REDSHIFT" FOR SOME MODELS OF GRAVITATIONAL END PHYSICAL VACUUM

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ABSTRACT. The cosmological test $m(z)$ has been calculated condition equation of state $p = -\varepsilon/3$ and $p = \varepsilon$. A case $p = \varepsilon$ doesn't contradict observational values of $m(z)$ for quasars.

Key words: equation of state, cosmological test, quasars

As far as we know (Veinberg, 1972) two independent Einshtein's equation contain three functions in standard cosmological model of homogeneous isotropic world : $a(t)$ - scaled factor, $\varepsilon(t)$ - power density and $p(t)$ - pressure:

$$\dot{a}^2 = \frac{8\pi G}{3c^2}a^2\varepsilon - kc^2 \qquad (1)$$

$$\ddot{a} = -\frac{4\pi G}{c^2}a(\varepsilon + 3p). \qquad (2)$$

For system (1),(2) decision a matter state equation which looks like $p = \mu\varepsilon$ for ideal fluid is used and powerdominational condition (Stanyoukovich, 1972) asks for: $\mid \mu \mid \leq 1$. Most commonly the cases $\mu = 0$ and $1/3$ describing the matter era and the radiation era in the evolution of our Universe are discussed. The value $\mu = -1$, describing hight - energy vacuum, makes a foundation of inflational models of early Universe. It should be noted that the value $\mu = 2/3$ has the classical ideal gas. It should be concentrated upon that all specified values of μ are the private cases of the equation $p = M\varepsilon/3$, where M is integer. Thou it is normaly to discuss the cases where $M = -1$ $(p = -\varepsilon/3)$ and $M = 3$ $(p = \varepsilon)$. The first case is discussed in (Kolb, 1989) where the suitable matter state is called K-matter. In (Stanyoukovich, 1972) equation of state appears under consideration of gravitational vacuum which is a medium consisting sting of supermassive particles -plankeons. The second case describes the limit stiff matter state when the sound velocity is equal to the light velocity. Such equation of state may have low-enegry vacuum [1].Under the hight density and pressure interaction between nucleons can also lead to the equation $p = \varepsilon$ (Zel'dovich, 1961).

When solving the system (1),(2) in conjunction with equation of state we receive the relation $a(t)$. After that from the interval equality 0 for photon it's non - dimensional rang can be find: $r = c\int_{a_0}^{a} dt/a(t)$. If we pass from time t to redshift z now (using the proportion $1 + z = a/a_0$),we shall receive (Gudmundsson and Rognvaldsson, 1990):

$$r = \frac{1}{\sqrt{\Omega - 1}} sin\left(\frac{2}{1+M}\left(arcsinA - arcsinB\right)\right), \qquad (3)$$

where

$$A = \sqrt{\frac{\Omega - 1}{\Omega}}, \quad B = \sqrt{\frac{\Omega - 1}{\Omega(1+z)^{1+M}}},$$

Ω is the relative density.

It is an interesting fact that (3) is formaly actually under any values of M and Ω. But when $M = -1$ or $\Omega = 1$ it is neccessary to make the proper limit passage in (3) and when $\Omega < 1$ it should be noted that trigonometric functions of imaginary argument pass to the proper hyperbolic functions of real argument.

Finalli, the fotometric distance to the square which is inversely proportional to the of radiation flow from object being located on cosmological distance is $d = (1 + z)r$. The magnitude of object is

$$m = M_0 + 5lg((1 + z)r) + const, \qquad (4)$$

accordingly,where M_0 is it's absolute magnitude. Some calculation results using the formulas (1),(2) and (3) are repsented on fig.1. The area which occupies by quasars on $m - z$ diagrame is shown schematically by a multangular (Khodjachikh, 1983).

One cen see thet the test $m(z)$ for K-matter and "dust" don't correlate with observations at least when $\Omega \simeq 1$ (the possible evolution effects for quazars don't take into account). The functions $m(z)$ for "stiff" matter $(p = \varepsilon)$ occur into occupied quasars when densities are hight $(\Omega > 10)$.

The metrical evolution velocity of the Universe increases with the growth of density Ω. When $\Omega > 1$ such dependences of value Ω on evolution parameter η (defining by the proportion $cdt = ad\eta$) (Monin et al.,

1989) take place:

$$\Omega_1 = \frac{1}{\cos^2(2\eta)}; M = 3 \qquad (5)$$

Taking into account that $\Omega_1 = 30$, we shall receive that $\Omega_0 = 1.13$ i.e. near to 1. The suitable estimations of evolution time will give us: $t_1 = 0.7c/a_0$ and $t_0 = 0.03c/a$. Though, evolution velocity increase by means of hight values Ω_1 is compensated,when order of value is considered, by arrest of evolution development under the passage from "dust" world to "limit stiff". Under the passage to K-matter the evolution rate rises and this rules out the possibility of great values Ω in that case.

So assumption that quasars can contain matter with limit stiff equation of state is not contrary to visible for them values $m(z)$ and can be the object of next treatment.

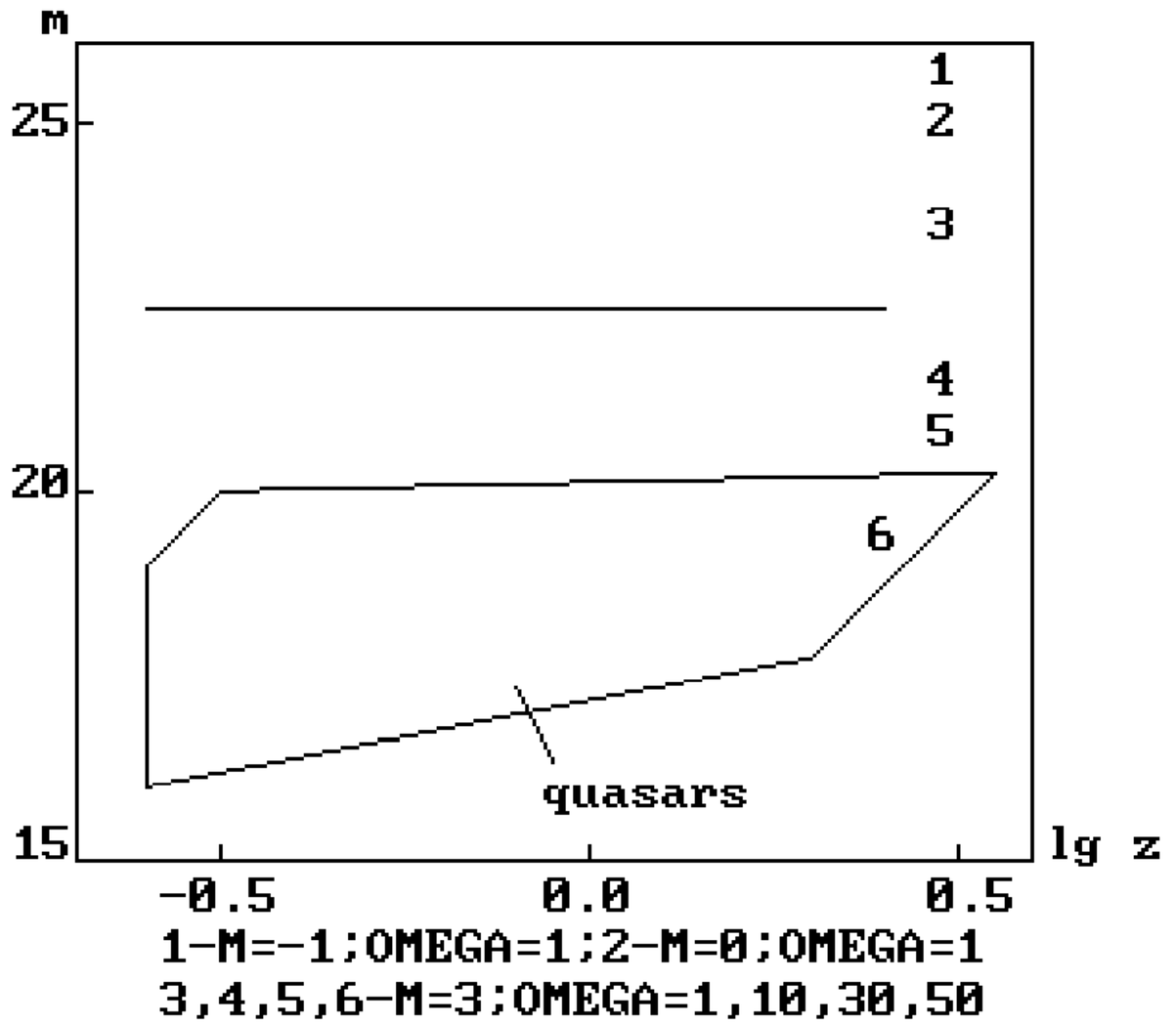


Figure 1. The dependence $m(z)$ for $p = -\varepsilon/3$, $p = \varepsilon$ and quasars.

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METRICAL EVOLUTION OF MULTIDIMENSIONAL UNIVERSES

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ABSTRACT. Fridman's cosmological equations generalisation have been received for arbitrary number of N-dimension space and their decision in ideal fluid model. The analise of values N influence on the type of universe's evolution have been shown from the point of antropic principle view in particular.

Key words: dimensional of space, evolution of universe, antropic principle.

Events development,which joints the early Universe cosmology with elementary particle physics, have led to appearance of ideas about great number of universes with different fundamental properties, with different number of space dimension in particular (Linde, 1990). Much attention is paed to idea how the manifestation of compressed into point space dimensionalities existing over ordinary three can explaine the visible fundamental interactions. The present paper concerns the next postquantum evolution of Universe with arbitrary number of space dimension from the point of view connecting the type of that evolution with antropic principle in particular.

Calculation of Kristophel's symbols and curvature tensor in Robertson's - Woker's metric at N-dimentional space leads to the next equation generalising Fridman's equation of standard cosmological model :

$$\dot{a}^2 = \frac{S_N G}{(N-1)c^2}\left(\frac{N+1}{N}\varepsilon - (N-3)p\right)a^2 - kc^2, \quad (1)$$

where a-scale factor, S_N-surface area of N-dimensional unit sphere [2], ε-energy density, p-pressure, k-curvature sign, c-light velocity. Once more equation (low of energy conservation) follows from the condition that energy - momentum tensor divergence is equal to 0. Calculation of the $T^{t\nu}_{;\nu}$ value gives us after the passage frome time t to variable a:

$$\frac{d}{da}(a^N\varepsilon) = -Na^{N-1}p, \quad (2)$$

The third equation allowing to found function $a(t), \varepsilon(t)$ and $p(t)$ is equation of matter state which look like: $p = \mu\varepsilon$ in the model of ideal fluid , where $\mid \mu \mid \leq 1$ by powerdominational condition. Payng attention to the fact that considered ussualy in cosmology equation of state $p = -\varepsilon$, $p = \varepsilon/3$ and $p = 0$ are the private cases of equation $p = M\varepsilon/3$ where M integer let's write the equation of state in our case as:

$$p = \frac{M}{N}\varepsilon; \quad \mid M \mid \leq N. \quad (3)$$

Excluding from (1), (2) and (3) the values ε and p we shell receive after separating of variables:

$$\int_{a_1}^{a} \frac{da}{\sqrt{\pm\left(\frac{a}{a_0}\right)^{2-(N+M)} - k}} = ct, \quad (4)$$

where

$$a_0^2 = \frac{c^4 N(N-1)}{S_N G\varepsilon_0 \mid (N+1-M(N-3)) \mid}, \quad (5)$$

ε_0-meaning ε when $a = a_0$, $a_1 = 0$ or a_0. The sign "-" accords to the values of M and N locating highter than the hyperbola $M - 1 = 4/(N-3)$ where the expression under the modulus sign is negative. First of all let's pay attention to the fact that underintegral expression in (4) depends symmetrically on parameters N and M by ful correspondence with ideas of modern common field theory about the connection of prysical matter properties with space dimension, but (4) is the consequence of GRT. It should be noted also that (4) is integrated in elementary functions only when $N+M = 0, 1, 2, 3, 4$ by Chebishev's theorem about differential binom and in hypergeometrical functions in common case.

Possible integral results (4) and their analyse, from the point of view eigther the appropriate cosmological model is closed or opened, are represented on fig.1 shematicalli.

It is visible fact that all typical for evolution of our Universe occasions can be realised with any N: $M = -N$ (the inflational stage), $M = 1$ (the radiation stage) and $M = 0$ (the matter stage). This allowes to assume the existance of some common nature of the Universe's with arbitrary number of dimension evolution. The idea about the definite relativity of antropic principle can follow from that. It consists in that the qualitative matter evolution may take place in universes with $N \neq$

3 but in types which are different from the existance of electrostatically (atoms) and gravitationally (multiple stars and planets system) connected system. The last, as it is known, is the consequence of special properties of the task with two bodies in three-dimensional space decision.

Also the question about the studing of another Universes possibility appears in the case of their existance idea confirmation. But in such case will the abstract about the experience (experiment) as the source of know ledge acquiring be true. Such studing will be possible only on the base of controling appropriate theory about observing in our Universe, e.g. basically the nature of knowledge acquiring process will not change. But again manifestation measure of this process through another phenomena will essentially grow. As it have taken place when passing from macrocosm studing to microcosm and megacosm studing.

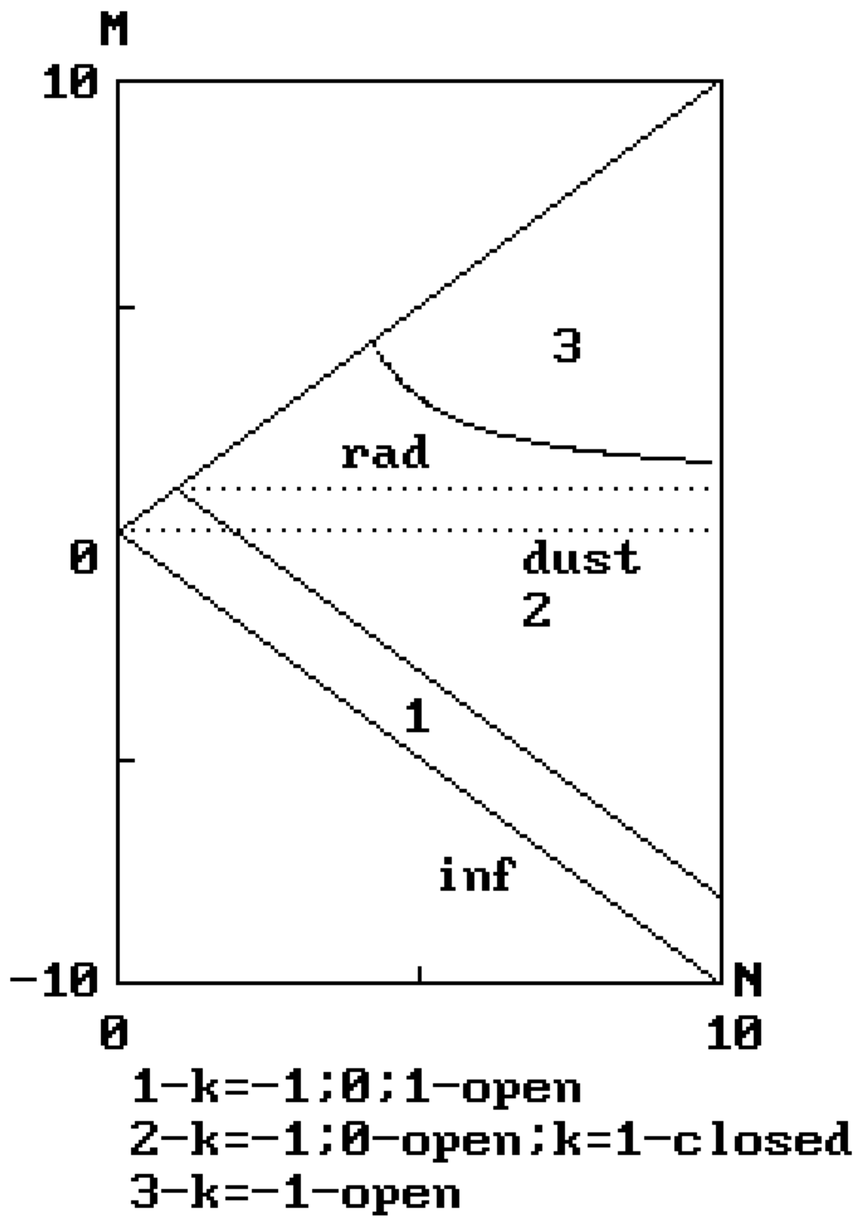


Figure 1. The dependence of cosmological models from parameters N and M.

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2D CALCULATIONS OF COLLAPSE OF ROTATING MAGNETIZED BODIES

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ABSTRACT. 2D numerical simulation of the collapse of rotating magnetized cloud has been made as preliminary investigation of magnetorotational mechanism of supernova explosion. The part of envelope of the cloud is throwing out when magnetic pressure becomes comparable with gas pressure. The amount of mass of the envelope thrown out and the energy it carries away are estimated.

Key words: stellar dynamics, magnetohydrodynamics, numerical methods

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THE INVARIANT SPLITTING FORMALISM IN GENERAL RELATIVITY

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ABSTRACT. The invariant splitting method of a pseudo-Riemanian manifold on arbitrary number of sections has been constructed in the present work.

Key words: general relativity, splitting, tangent bundle, the Gauss-Codacci-Ricci's equations.

Our technique is based on introduction of projection operators $\{H^\alpha\}$, inducing splitting of the bundle $T(M)$ and geometrical objects defined on it. The linear operators $\{H^\alpha\}$ (the tensors of (1,1) type) are given by:

$$\begin{aligned} H^\alpha \cdot H^\beta &= \delta^{\alpha\beta} \\ \sum_\alpha H^\alpha &= I \end{aligned} \qquad (1)$$

where $\alpha,\ \beta = 1, 2, ...k$ are indeces of sections and I is the unit operator. Any vector $\vec{X}$ and one-form ω are projected into corresponding sections of the tangent and cotangent bundles by these projection operators $\{H^\alpha\}$

$$\begin{gathered} H^\alpha \cdot \vec{X}^\alpha \equiv H^\alpha(\vec{X}) = \vec{X}^\alpha, \vec{X}^\alpha \in \Sigma^\alpha \\ H^\alpha \cdot \omega \equiv H^\alpha(\omega) = \omega^\alpha, \omega^\alpha \in \Sigma^{*\alpha} \\ T(M) = \Sigma^1 \oplus \Sigma^2 \oplus ... \oplus \Sigma^k \\ \dim T(M) = \sum_{i=1}^k \dim \Sigma^i, \\ \vec{X} = \sum_{\alpha=1}^k \vec{X}^\alpha, \\ \Sigma^\alpha \equiv Im H^\alpha \end{gathered} \qquad (2)$$

so that for any metric g we have

$$g = \sum_{\alpha=1}^{k} g^\alpha \qquad (3)$$

where g^α is the metric induced on the section Σ^α. Due to conditions $H^\alpha \cdot H^\beta = 0$ and $g(H^\alpha \cdot \vec{X}, \vec{Y}) = g(\vec{X} \cdot H^\alpha, \vec{Y})$ it follows that

$$\vec{X}^\alpha \cdot \vec{Y}^\beta = 0, g^\alpha(\vec{X}^\beta, \cdot) = 0 \qquad (4)$$

The Levi-Civita connection ∇ is splitted on k^3 components

$$\nabla_{\vec{X}} \vec{Y} = \sum_{\alpha,\beta,\gamma} \nabla^\gamma_{\vec{X}^\alpha} \vec{Y}^\beta, \quad \alpha, \beta, \gamma = 1, 2, ...k \qquad (5)$$

and the components

$$\nabla^\alpha_{\vec{X}^\beta} \vec{Y}^\beta = H^\alpha(\nabla_{\vec{X}^\beta} \vec{Y}^\beta) \equiv -B(\vec{X}^\beta, \vec{Y}^\beta)$$

determine the exterior unholonomisity tensor of the section Σ^β, while the components

$$\nabla^\alpha_{\vec{X}^\beta} \vec{Y}^\beta = H^\alpha(\nabla_{\vec{X}^\beta} \vec{Y}^\gamma) \equiv -Q^\alpha(\vec{X}^\beta, \vec{Y}^\gamma)$$

determine the generalized Ricci's coefficients of rotation.

Substituting all the connections in the invariant definition of the curvature tensor

$$R(\vec{X}, \vec{Y})\vec{Z} \cdot \vec{V} = (\nabla_{\vec{X}} \nabla_{\vec{Y}} - \nabla_{\vec{Y}} \nabla_{\vec{X}} - \nabla_{[\vec{X},\vec{Y}]})\vec{Z} \cdot \vec{V} \qquad (6)$$

by their "splitted representatives" (**??**), we have obtained the invariant generalizations of the Gauss-Codacci-Ricci's equations:

$$\begin{gathered} R(\vec{X}^\alpha, \vec{Y}^\alpha)\vec{Z}^\alpha \cdot \vec{V}^\alpha = R^\alpha(\vec{X}^\alpha, \vec{Y}^\alpha)\vec{Z}^\alpha \cdot \vec{V}^\alpha + \\ + \sum_{\gamma \neq \alpha} \{2A^\gamma(\vec{X}^\alpha, \vec{Y}^\alpha) \cdot B^\gamma(\vec{Z}^\alpha, \vec{V}^\alpha) + \\ + B^\gamma(\vec{Y}^\alpha, \vec{V}^\alpha) \cdot B^\gamma(\vec{X}^\alpha, \vec{Z}^\alpha) - \\ - B^\gamma(\vec{X}^\alpha, \vec{Y}^\alpha) \cdot B^\gamma(\vec{Y}^\alpha, \vec{Z}^\alpha)\}, \end{gathered} \qquad (7)$$

where $R^\alpha(\vec{X}^\alpha, \vec{Y}^\alpha)\vec{Z}^\alpha \cdot \vec{V}^\alpha$ is the curvature tensor on the section Σ^α.

$$\begin{gathered} R(\vec{X}^\alpha, \vec{Y}^\alpha)\vec{Z}^\alpha \cdot \vec{V}^\beta = \vec{V}^\beta \cdot \{(\nabla^\beta_{\vec{Y}^\alpha} \vec{B}^\beta)(\vec{X}^\alpha, \vec{Z}^\alpha) - \\ - (\nabla^\beta_{\vec{X}^\alpha} \vec{B}^\beta)(\vec{Y}^\alpha, \vec{Z}^\alpha)\} - \\ - \sum_{j \neq \alpha,\beta} Q^j(\vec{X}^\alpha, \vec{V}^\beta) \cdot B^j(\vec{Y}^\alpha, \vec{Z}^\alpha) + \\ + \sum_{j \neq \alpha,\beta} Q^j(\vec{Y}^\alpha, \vec{V}^\beta) \cdot B^j(\vec{X}^\alpha, \vec{Z}^\alpha) + \\ + \sum_{j \neq \alpha,\beta} 2\vec{Z}^\alpha \cdot Q^\alpha(\vec{A}^j(\vec{X}^\alpha, \vec{Y}^\alpha), \vec{V}^\beta) + \\ + 2\vec{Z}^\alpha \cdot B^\alpha(\vec{A}^\beta(\vec{X}^\alpha, \vec{Y}^\alpha), \vec{V}^\beta) \end{gathered} \qquad (8)$$

$$\begin{gathered} R(\vec{X}^\alpha, \vec{Y}^\beta)\vec{Z}^\alpha \cdot \vec{V}^\beta = (\vec{Z}^\alpha \cdot (\nabla^\alpha_{\vec{X}^\alpha} \vec{B}^\alpha) + \\ + (\vec{X}^\alpha \cdot \vec{B}^\alpha, \vec{Z}^\alpha \cdot \vec{B}^\alpha))(\vec{Y}^\beta, \vec{V}^\beta) + \\ + (\vec{V}^\beta \cdot (\nabla^\beta_{\vec{Y}^\beta} \vec{B}^\beta) + (\vec{Y}^\beta \cdot \vec{B}^\beta, \vec{V}^\beta \cdot \vec{B}^\beta))(\vec{X}^\alpha, \vec{Z}^\alpha) + \end{gathered}$$

$$+\sum_{\gamma\neq\alpha,\beta}\{B^\gamma(\vec{X}^\alpha,\vec{Z}^\alpha)\cdot B^\gamma(\vec{Y}^\beta,\vec{V}^\beta)-$$
$$-Q^\gamma(\vec{X}^\alpha,\vec{V}^\beta)\cdot Q^\gamma(\vec{Y}^\beta,\vec{Z}^\alpha)+$$
$$+\vec{V}^\beta\cdot Q^\beta(\vec{\Lambda}^\gamma(\vec{X}^\alpha,\vec{Y}^\beta),\vec{Z}^\alpha)\} \quad (9)$$

$$R(\vec{X}^\alpha,\vec{Y}^\beta)\vec{Z}^\alpha\cdot\vec{V}^\delta=\vec{V}^\delta\cdot\{(\nabla^\delta_{\vec{Y}^\beta}\vec{B}^\delta)(\vec{X}^\alpha,\vec{Z}^\alpha)-$$
$$-(\nabla^\delta_{\vec{X}^\alpha}\vec{Q}^\delta)(\vec{Y}^\beta,\vec{Z}^\alpha)\}+$$
$$+\vec{Z}^\alpha\cdot B^\alpha(\vec{Y}^\beta,\vec{Q}^\beta(\vec{X}^\alpha,\vec{V}^\delta))-$$
$$-\vec{V}^\delta\cdot B^\delta(\vec{Y}^\beta,\vec{B}^\beta(\vec{X}^\alpha,\vec{Z}^\alpha))-$$
$$-\vec{Z}^\alpha\cdot B^\alpha(\vec{\Lambda}^\alpha(\vec{X}^\alpha,\vec{Y}^\beta),\vec{V}^\delta)+$$
$$+(\vec{Y}^\beta\cdot\vec{B}^\beta,\vec{V}^\delta\cdot\vec{B}^\delta)(\vec{X}^\alpha,\vec{Z}^\alpha)-$$
$$-(\vec{X}^\alpha\cdot\vec{B}^\alpha,\vec{V}^\delta\cdot\vec{Q}^\delta)(\vec{Y}^\beta,\vec{Z}^\alpha)-$$
$$-\sum_{\gamma\neq\alpha,\beta,\delta}\{\vec{Z}^\alpha\cdot Q^\alpha(\vec{\Lambda}^\gamma(\vec{X}^\alpha,\vec{Y}^\beta),\vec{V}^\delta)+$$
$$+B^\gamma(\vec{X}^\alpha,\vec{Z}^\alpha)\cdot Q^\gamma(\vec{Y}^\beta,\vec{V}^\delta)+$$
$$+Q^\gamma(\vec{X}^\alpha,\vec{V}^\delta)\cdot Q^\gamma(\vec{Y}^\beta,\vec{Z}^\alpha\} \quad (10)$$

$$R(\vec{X}^\alpha,\vec{Y}^\beta)\vec{Z}^\gamma\cdot\vec{V}^\delta=\vec{V}^\delta\cdot\{(\nabla^\delta_{\vec{Y}^\beta}\vec{Q}^\delta)(\vec{X}^\alpha,\vec{Z}^\gamma)-$$
$$-(\nabla^\delta_{\vec{X}^\alpha}\vec{Q}^\delta)(\vec{Y}^\beta,\vec{Z}^\gamma)\}+\vec{V}^\delta\{\cdot B^\delta(\vec{X}^\alpha,\vec{Q}^\alpha(\vec{Y}^\beta,\vec{Z}^\gamma))-$$
$$-B^\delta(\vec{Y}^\beta,\vec{Q}^\beta(\vec{X}^\alpha,\vec{Z}^\gamma))-B^\delta(\vec{\Lambda}^\gamma(\vec{X}^\alpha,\vec{Y}^\beta),\vec{Z}^\gamma)\}+$$
$$+\vec{Z}^\gamma\cdot\{B^\gamma(\vec{Y}^\beta,\vec{Q}^\beta(\vec{X}^\alpha,\vec{V}^\delta))-$$
$$-B^\gamma(\vec{X}^\alpha,\vec{Q}^\alpha(\vec{Y}^\beta,\vec{V}^\delta))-B^\gamma(\vec{\Lambda}^\gamma(\vec{X}^\alpha,\vec{Y}^\beta),\vec{V}^\delta)\}+$$
$$+(\vec{Y}^\beta\cdot\vec{B}^\beta,\vec{V}^\delta\cdot\vec{Q}^\delta)(\vec{X}^\alpha,\vec{Z}^\gamma)-$$
$$-(\vec{X}^\alpha\cdot\vec{B}^\alpha,\vec{V}^\delta\cdot\vec{Q}^\delta)(\vec{Y}^\beta,\vec{Z}^\gamma)+$$
$$+\sum_{\gamma\neq\alpha,\beta,\gamma,\delta}\{Q^j(\vec{Y}^\beta,\vec{V}^\delta)\cdot Q^j(\vec{X}^\alpha,\vec{Z}^\gamma)-$$
$$-Q^j(\vec{Y}^\beta,\vec{Z}^\gamma)\cdot Q^j(\vec{X}^\alpha,\vec{V}^\delta+$$
$$+\vec{V}^\delta\cdot Q^\delta(\vec{\Lambda}^j(\vec{X}^\alpha,\vec{Y}^\beta),\vec{Z}^\gamma)\} \quad (11)$$

Here we use the following definitions:

$$\Lambda^j(\vec{X}^\alpha,\vec{Y}^\beta)\equiv H^j([\vec{X}^\alpha,\vec{Y}^\beta])$$
$$(\vec{Y}^\beta\cdot\vec{B}^\beta,\vec{V}^\delta\cdot\vec{Q}^\delta)(\vec{X}^\alpha,\vec{Z}^\gamma)\equiv$$
$$\equiv g^{ab\alpha}[\vec{V}^\delta\cdot Q^\delta(\vec{Z}^\gamma,\vec{e}^\alpha_a)\vec{X}^\beta)\cdot B^\beta(\vec{X}^\alpha,\vec{e}^\alpha_b)] \quad (12)$$
$$(\nabla^\alpha_{\vec{X}^\beta}\vec{Q}^\alpha)(\vec{Y}^\gamma,\vec{V}^\delta)\equiv\nabla^\alpha_{\vec{X}^\beta}\vec{Q}^\alpha(\vec{Y}^\gamma,\vec{V}^\delta)-$$
$$-\vec{Q}^\alpha(\nabla^\gamma_{\vec{X}^\beta}\vec{Y}^\gamma,\vec{V}^\delta)-\vec{Q}^\alpha(\vec{Y}^\alpha,\nabla^\delta_{\vec{X}^\beta}\vec{V}^\delta)$$

Objects S and A are the symmetric and antisymmetric parts of B respectively. All popular splitting methods (such as the monad method Antonov V.I., et.al., 1978, the Newman-Penrose's formalism Newman E.T. and Penrose R., 1962, the Geroch's formalism Geroch R., 1971) and many others can be obtained as a special cases of this approach when we choose concrete basis of splitting.

For example, the Newman-Penrose's method corresponds to the following projection operators:

$$H'=E_a\otimes\theta^a, H''=I-E_a\otimes\theta^a,$$
$$g=g'+g'' \quad (13)$$

$$g'=2(\theta^{\{1}\otimes\theta^{2\}}+\theta^{\{3}\otimes\theta^{3\}})+...$$
$$+\theta^{\{n-1}\otimes\theta^{n\}}) \quad (14)$$

The basis of one-forms $\{\theta^a\}, a=1,2,...n$ is a complex one in general case.

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A POSSIBLE REASON OF FORMING THE VARIOUS TYPE OF SPECTRA IN EXTRAGALACTIC OBJECTS

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ABSTRACT. An analysis of multifrequency observations of 1,300 instantaneous spectra at cantimeter–decimeter waves during 7 sets for a sample of up to 200 VLBI–compact objects gives a strong experimental evidence to an old hypothesis, that a VLBI–compact jet of relativistic particles from an object's nucleus is a main reason of forming the various type of spectra in extragalactic objects. It is enough to explain all main known spectra types (steep, flattened, inverted) by *two spectra components only* - of a quasi stationary jet in a longitudinal magnetic field and an optically thin cloud or envelope, resulted by the jet. A combination of these two components gives also complex shapes in a case of a nonstationary phase of the jet.

Key words: galaxies: compact — galaxies: active — quasars: general.

Introduction

An idea that a typical extragalactic radio source consists on 2–3 main components (a nucleus, a compact jet and/or a cloud) had been discussed during last 20 years on various initial bases by many authors (see, an example, Kellermann and Pauliny-Toth, 1981; Kovalev, 1983; Amirkhanyan, 1985). Nevertheless, a typical situation was also, when many separate components was suggested to explain complex spectra and VLBI–structure of extragalactic sources. In opposite to the majority of discussions, we use practically instantaneous 1–22 GHz spectra, measured during several minutes of the each. It is important because the sources are *variable*, as a rule.

Observations and Analysis

The preliminary results of instantaneous multi frequency spectra observations at the wavelengths of 31, 13, 7.6, 3.9, 2.7 and 1.4 cm, carried out at the RATAN–600 during last 7 sets in July, August, October, December of 1995 and March, June, July of 1996, are used. As an example, about 500 spectra, including 400 last spectra, have been presented in Appendix to the poster. All data are planned to be published by Kovalev et al., 1997. Main observed types of these spectra are summarized on the Figure 1. They cover known spectra types.

It had been studied about 1,300 instantaneous spectra for a sample of up to 200 sources with declination $-30° \div +43°$. 146 of these objects form the full sample with correlated flux density more than 0.5 Jy at 2.3 GHz in the VLBI–servey by Preston et al. (1985).

The main our aim here is to answer on the question, is it possible to explain the presented main types of spectra as a combination of two components only? The answer is positive. The analysis includes a model analysis like in Nesterov et al. (1994).

Results and Discussion

1. We did not obtain any exotic or too complex spectra type, and belive that this is a positive result of using the practically instantaneous spectra measurements.

2. *Only two main components are enough* to explain all spectra types on the Figure 1: a quasi stationary continuos flow of relativistic plasma from a nucleus (as a source of relativistic matter) and an optically thin cloud (as "a receiver" of the matter flow).

3. We think, that the main variability of spectra may fully depends on a temporal variability of the matter flow from the object's nucleus in a longitudinal magnetic field. The jet may be unvisible on scales of more than milli–arcsecond scale, because of a known effect of an evolution of electron pitch–angles along the magnetic field, until a strong curvature of magnetic field lines is absent.

4. A theoretical synchrotron spectrum of a such *stationary* jet has a flattened part, the slope of which depends on a power γ in an electron energy distribution, and the width of which depends on the

angle ϑ between the jet and the direction to an observer. The spectra maximum and the frequency of it depend on physical conditions in a jet.

5. Observations are in agreement with a morfology of an object like a nucleus–jet–cloud (or envelope as a result of a temporal evolution of the cloud). As a rule, the radio emission of the nucleus can be neglected, and the envelope is optically thin in the 1–22 GHz band. Varying a relative contribution of the emission from the jet and the envelope to the integral spectrum, we can simulate all observed types of instantaneous spectra. Such formal varying is equal to varying the above physical conditions in jets — first of all, ϑ, γ, the magnetic field and the age of an object. The age can also influence on forming the envelope from "a jung cloud" by the continious pumping the matter from the jet. So, the older an object the more a contribution of the envelope to the integral spectrum.

6. From this point of view, several observed bright VLBI–components, have to be "hot spots" of a continious nonstationary jet, as a matter of fact, rather than separate independent components or the nucleus of an object. This conclusion is supported by a simulation of VLBI–maps of various such jets in Kovalev (1995).

7. These results explain also a known observational fact that sources with flat spectra are variable, as a rule. Really, flat spectrum is a sign of a such jet. Any jet is potencially nonstationary. So, a variability in the flow of relativistic plasma gives the observed spectra variability (see details of this effect in Kovalev and Larionov, 1994). Moreover, because the used sample of compact objects is complete, *any extragalactic object with VLBI–compact components* can show a spectra variability, if our conclusions are true.

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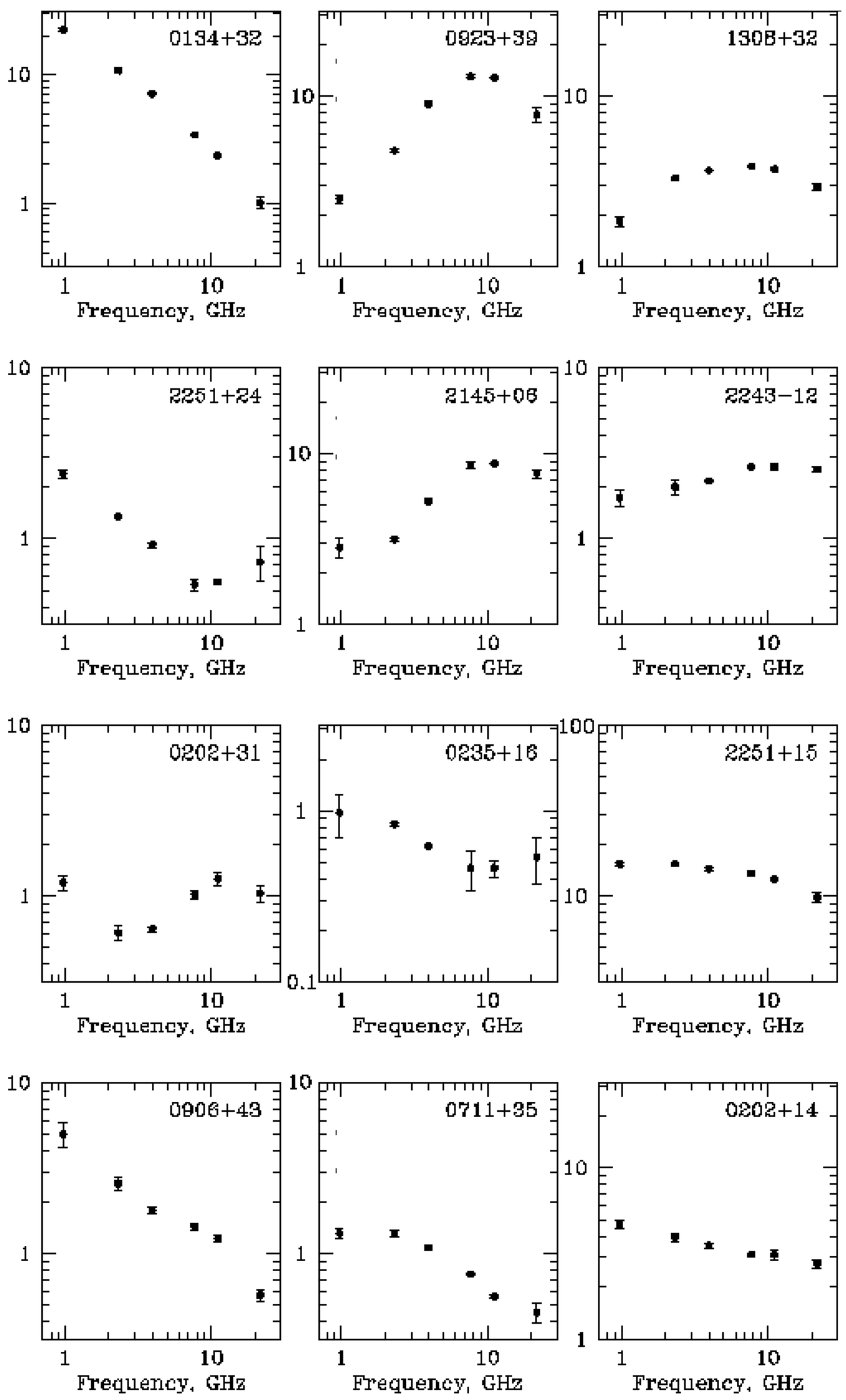


Figure 1. Main spectra types and their combinations on the examples, extracted from 1,300 instantaneous spectra, measured during 7 sets from June, 1995, to July, 1996, for a sample of 200 compact objects: steep (left column), inverted (middle column), and flattened (right column). The ordinate is the flux density in Jy.

ANALYSIS OF 6-FREQUENCY SIMULTANEOUS OBSERVATIONS OF 170 COMPACT EXTRAGALACTIC OBJECTS IN 1995–1996: A STATISTICS OF MAIN SPECTRA PARAMETERS

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ABSTRACT. Results of instantaneous spectra observations, carred out at the RATAN–600 during six sets in 1995–1996, are used. We analyse a behaviour of an effective width of spectra, turnover frequency and maximal flux density.

Key words: radio continuum: galaxies — galaxies: compact — quasars: general — BL Lacertae objects: general

Introduction

The question on the common and differencies in the nature of quasars an BL Lacs is studied by many authors during many years. In some papers the authors find such differencies (Valtaoja et al., 1988), in the others — not. It is important that analysed multifrequency spectra was not simultaneous, as a rule. As a result, some main conclusions may be not correct, because the sources are *variable*.

On this reason, it is interesting to do analysis, using do simultaneous observations on many frequencies for many sources. First such analysis in Kovalev (1996) had been done for instantaneous 7-frequency observations in a set of 1989 for 113 objects.

Observations

The preliminary results of instantaneous multifrequency spectra observations at the wavelengths of 31, 13, 7.6, 3.9, 2.7 and 1.4 cm, carried out at the RATAN–600 during six sets in Juli, August, October, December of 1995 and March, Juni of 1996, are used (spectra have been presented in Kovalev et al., 1997).

It is studied a sample of about 170 sources with declination $-30^\circ \div +43^\circ$, 146 of which are the full sample with correlated flux density more than 0.5 Jy at the frequency 2.3 GHz in the VLBI–servey by Preston et al. (1985).

Procedure of Calculations

Using Landau et al. (1996), all spectra before calculations had been transformed to the rest frame of the sources, and then they had been approximated by

$$\log F_\nu = C + (\log \nu - B)^2/2A\,,$$

where F_ν is the flux density, ν — frequency, recalculated to the rest frame of a source. Details on the parameters A, B, C see on the figure 1. There are not used the parameters with great errors, for calibration sources and if $A > 0$, because they have not a sence in the last case. For the each source, the parameters are calculated for the each set and then are averaged with their weights.

Results and Discussion

The strong differences in distribution of parameters A, B, C are absent for 3 studied subgroups of objects (see figure 1). Subgroups for quasars, BL Lacs and other sources have one approximately common peak in the each distribution. Average values of A, B, C are nearly the same for different types of objects. Kolmogorov–Smirnov test on the 5% significance level supports a hypothesis on the identical distribution of different types of objects on the parameters A, B, C.

A comparizon of figures 1 here with the figure 2 from the paper by Landau et al. (1986) gives, that the peak values of parameters B and C are similar. I'd like to emphasize, that similarity of peaks for parameter B has a principial importance. It can be made a conclusion, that high frequency limiting at 22 GHz in presented work did not influence on true deriving a turnover frequency, because the highest frequency, used in Landau et al. (1986) paper, is much higher than 22 GHz.

A tendence for quasars and BL Lac's to be located in different regions of $C - B$ space, as in Valtaoja et al. (1988), is absent.

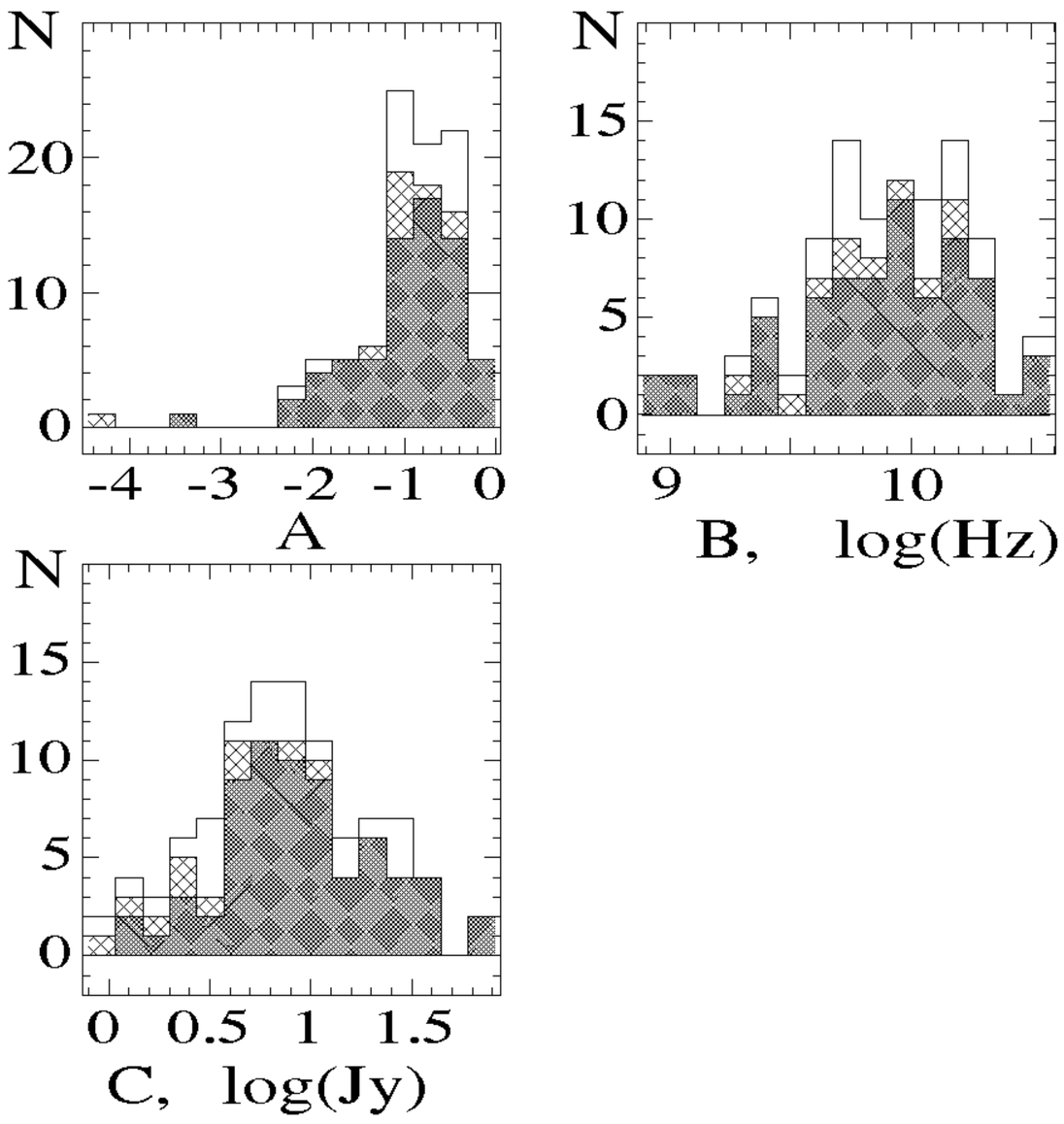


Figure 1. Histogram of the spectral parameters A (a), B (b), C (c) for sources in the sample (A is an effective width of spectra, B is a logarithm of the turnover frequency, C is a logarithm of the maximal flux density). It is blacked for quasars, shaded — for BL Lacs, open — for other sources.

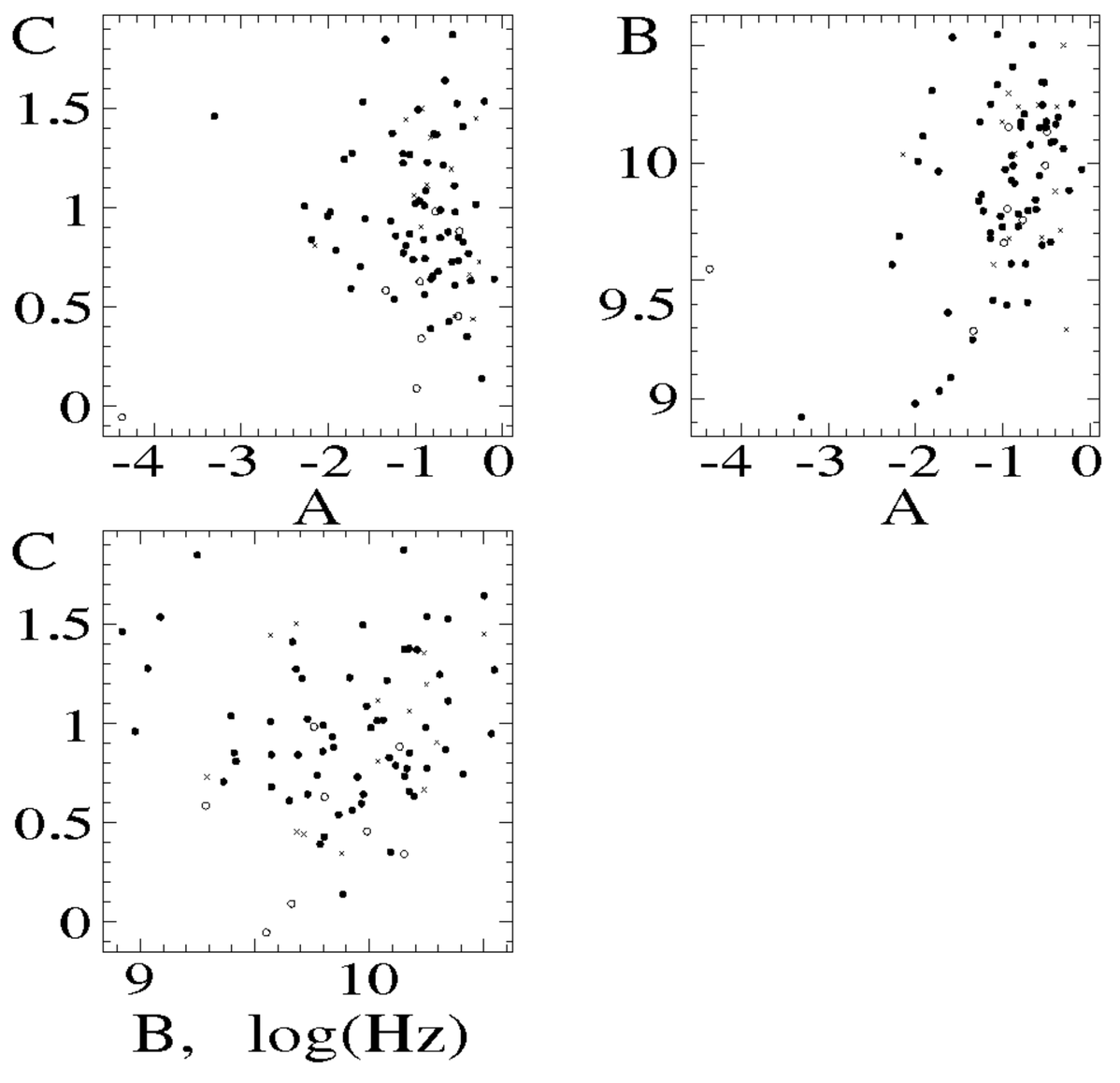


Figure 2. Dependences for C versus B (a), C versus A (b) and B versus A (c): filled circles — for quasars, open circles — for BL Lac's, cross – for the other sources. The ordinate is marked in log(Jy).

Table 1. Correlation of the spectral parameters.

Optical ID	Number of objects	Correlation Coefficients (Probabilities)		
		(A, B)	(A, C)	(B, C)
Quasars	67	0.448 ($> 99.9\%$)	0.204 (90.1%)	0.002 ($< 10.\%$)
BL Lac objects	10	0.479 (83.8%)	0.588 (92.9%)	0.206 (43.4%)
Other	22	0.125 (42.0%)	0.323 (85.2%)	0.266 (76.7%)
All sample	99	0.378 ($> 99.9\%$)	0.070 (50.5%)	0.088 (61.4%)

Unfortunately (or fortunately) we did not obtain *again any* correlation between maximal flux and its turn over frequency (see figure 2 and table 1). Correlation between (A, B) parameters has been found (see table 1). This result may shown a decreasing a number of independent parameters, by which the spectra are characterized. This conclusion is in agreement with the results by Landau et al. (1986), Valtaoja et al. (1988). General results are in agreement with Kovalev (1996).

Summary

1. Obtained distribution testify in the favour to common physical nature of quasars and BL Lacs.
2. Correlation between the peak flux density and its frequency is absent.
3. The peak histogram value of the turnover frequency is about 10 GHz in the local frame of the source.

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BRIEF DESCRIPTION OF THE RESTORATION METHOD OF A VECTOR VELOCITY FIELD IN GASEOUS DISKS OF SPIRAL GALAXIES

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ABSTRACT. This work is the brief description of the restoration method of a vector velocity field in gaseous disks of spiral galaxies from observed line-of-sight velocities (more detailed description see Lyakhovich et al., Astron.Zn. 1997).

Key words: Spiral galaxies, corotation radius, line-of-sight velocity field

From observations only line-of-sight velocities in gaseous disks of galaxies (only one component of velocities) can be obtain. Therefore for reconstruction of a complete vector velocity field it is necessary to use some model of the vector velocities. The most simple model is a model of pure circular motions. The line-of-sight velocities in a galactic gaseous disk in the framework of such model have the form

$$V_{obs}(R,\,\varphi) = V_s + V_{rot}(R)\cos\varphi\sin i,$$

where V_s is the systematic line-of-sight velocity of the galaxy, V_{rot} is the rotational velocity in the galactic plane, which depends only on, R, galactocentric radius, φ is the galactocentric azimuthal angle (equations of link between coordinates observed in the sky plane and galactocentric coordinates in the galactic plane see Lyakhovich et al., 1997), i is the inclination angle of the galaxy (angle of rotation from the sky plane to the galactic plane). However, there are the observational data (see, for example, Fridman and Polyachenko, 1984), which indicate to the existence of non-circular motions in gaseous disks of galaxies. It is natural to assume that these non-circular motions in spiral galaxies are connected to motions in spiral density waves.

The line-of-sight velocities accoding to the density wave theory have the form

$$\begin{aligned} V_{obs}(R,\,\varphi) &= V_s + V_r(R,\,\varphi)\sin\varphi\sin i + \\ &+ V_\varphi(R,\,\varphi)\cos\varphi\sin i. \end{aligned} \qquad (1)$$

where

$$\begin{aligned} V_r(R,\,\varphi) &= \tilde{V}_r(R,\,\varphi)\,, \\ V_\varphi(R,\,\varphi) &= V_{rot}(R) + \tilde{V}_\varphi(R,\,\varphi)\,. \end{aligned} \qquad (2)$$

Here V_r, V_φ are the radial and azimuthal galactocentric velocities in the gaseous disk, $\tilde{V}_r$ and $\tilde{V}_\varphi$ are the velocities caused by a density wave; for two-armed spiral galaxies they have the form:

$$\begin{aligned} \tilde{V}_r(R,\,\varphi) &= C_r(R)\,\cos(2\varphi - F_r(R))\,, \\ \tilde{V}_\varphi(R,\,\varphi) &= C_\varphi(R)\,\cos(2\varphi - F_\varphi(R))\,, \end{aligned} \qquad (3)$$

where C_r and C_φ are the radial and azimuthal amplitudes in spiral arms ($C_r \geq 0$, $C_\varphi \geq 0$), F_r and F_φ are the radial and azimuthal phases of velocity in spiral arms. Substituting (2) - (3) in (1), we obtain, that the observed velocities, in the framework of the model, should have the form

$$\begin{aligned} V_{obs}(R,\,\varphi) &= V_s + \sin i[a_1(R)\cos\varphi + b_1(R)\,\sin\varphi + \\ &+ a_3(R)\,\cos 3\varphi + b_3(R)\,\sin 3\varphi\,], \end{aligned} \qquad (4)$$

where the coefficients a_1, b_1, a_3, b_3 are equal

$$\begin{aligned} a_1 &= +(C_r\sin F_r + C_\varphi\cos F_\varphi)/2 + V_{rot}, \\ b_1 &= -(C_r\cos F_r - C_\varphi\sin F_\varphi)/2, \\ a_3 &= -(C_r\sin F_r - C_\varphi\cos F_\varphi)/2, \\ b_3 &= +(C_r\cos F_r + C_\varphi\sin F_\varphi)/2\,. \end{aligned} \qquad (5)$$

Coefficients $a_1(R)$, $b_1(R)$, $a_3(R)$, $b_3(R)$ can be determined from observations of line-of-sight velocity field of the galaxy using the least-squares method (Lyakhovich et al., 1997).

System of the equations (5) consists of four equations with five unknown parameters $C_r(R)$, $C_\varphi(R)$, $F_r(R)$, $F_\varphi(R)$, $V_{rot}(R)$. Thus, one more equation is needed to make the system (5) complete. Such equation can be obtained from a density wave theory.

Variant 1. For galaxies with a small pitch angle of spiral arms, we have in WKB approximation (see Lyakhovich et al., 1997)

$$\begin{aligned} F_\varphi(R) &= F_r(R) - \pi/2, \quad \text{for} \quad R < R_c, \\ F_\varphi(R) &= F_r(R) + \pi/2, \quad \text{for} \quad R > R_c, \end{aligned} \qquad (6)$$

where R_c is the corotation radius of spiral arms. From (5) and (6) we obtain

$$C_r \cos F_r = b_3 - b_1, \qquad C_r \sin F_r = b_1 a_3/b_3 - a_3,$$
$$C_\varphi \cos F_\varphi = a_3 + b_1 a_3/b_3, \qquad C_\varphi \sin F_\varphi = b_1 + b_3,$$
$$V_{rot} = a_1 - a_3 b_1/b_3. \tag{7}$$

Thus, determining from observations $a_1(R)$, $a_3(R)$, $b_1(R)$, $b_3(R)$ and solving (7) we determine all required parameters.

Variant 2. For galaxies with a small pitch angle of spiral arms, we have in WKB approximation (see Lyakhovich et al., 1997)

$$\begin{aligned} F_r(R) &= F_\sigma(R) + \pi, \text{ for } R < R_c, \\ F_r(R) &= F_\sigma(R), \qquad \text{for } R > R_c. \end{aligned} \tag{8}$$

where F_σ is the density phase in spiral arms. From (5) and (8) we obtain

$$\begin{aligned} C_r \cos F_r &= b_3 - b_1\,, \\ C_r \sin F_r &= (b_3 - b_1)\tan F_\sigma\,, \\ C_\varphi \cos F_\varphi &= 2a_3 + (b_3 - b_1)\tan F_\sigma, \\ C_\varphi \sin F_\varphi &= b_1 + b_3\,, \\ V_{rot} &= a_1 - a_3 - (b_3 - b_1)\tan F_\sigma. \end{aligned} \tag{9}$$

The quantitative agreement between the first and second variants is the proof of correctness of the method.

Determination of a corotation radius R_c. Using (5), (6), (8) we can determine a corotation radius. Really, using (5), (6), and the fact, that $C_r > 0$ and $C_\varphi > 0$ we obtain

$$\begin{aligned} |b_3(R)| - |b_1(R)| &\le 0, \quad \text{for} \quad R < R_c, \\ |b_3(R)| - |b_1(R)| &\ge 0, \quad \text{for} \quad R > R_c. \end{aligned} \tag{10}$$

Thus, a corotation radius should be located in a region, where $|b_3(R)| - |b_1(R)|$ changes the sign.

Using (5), (8), and the fact, that $C_r > 0$ and $C_\varphi > 0$ we obtain

$$\begin{aligned} (b_3(R) - b_1(R))\cos F_\sigma(R) &\le 0, \quad \text{for } R < R_c, \\ (b_3(R) - b_1(R))\cos F_\sigma(R) &\ge 0, \quad \text{for } R > R_c. \end{aligned} \tag{11}$$

Thus, a corotation radius should be located in a region, where $(b_3(R) - b_1(R))\cos F_\sigma(R)$ changes the sign.

The quantitative agreement between the first (10) and second (11) variants can be considered as a proof of correctness of this procedure.

Observed criterion for using of the method. From comparison between phases of the third harmonic of an observed velocity field and density phases in spiral arms we can determine region, where in galaxies equations (6) and (8) are fulfilled. Really, assuming, that the equations (6) and (8) are fulfilled, we obtain, that the third harmonic should have the form

$$H_3 = 1/2(C_\varphi(R) \mp C_r(R))\cos(3\varphi - F_\sigma(R) - \pi/2). \tag{12}$$

Here "$-$" for $R < R_c$, "$+$" for $R > R_c$.

Knowing from observations a_3 and b_3 we can represent the third harmonic as $H_3 = C_3 \cos(3\varphi - F_3)$ ($C_3 \ge 0$). We obtain then

$$\begin{aligned} F_3 &= F_\sigma - \pi/2\,, \quad \text{for } R < R_c \text{ and } C_\varphi < C_r\,, \\ F_3 &= F_\sigma + \pi/2\,, \quad \text{for } R < R_c \text{ and } C_\varphi > C_r\,, \\ F_3 &= F_\sigma + \pi/2\,, \quad \text{for } R > R_c\,. \end{aligned} \tag{13}$$

This link between $F_3(R)$ and $F_\sigma(R)$ is the test for using of the method. This method was successfully used for restorations of the velociy fields of the galaxies NGC 157, NGC 3893, NGC 6181 (Fridman et al., 1997).

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CONTRIBUTION OF TOPOLOGICAL DEFECTS TO THE VARIABILITY AND STRUCTURE OF EXTRAGALACTIC SOURCES OF LIGHT

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ABSTRACT. We discuss the mechanism of the fast extrinsic variability of the compact extragalactic sources of electromagnetic radiation due to the diffraction on cosmic strings. The multiple string intervention could give rise both to observable variability and considerable increase in observable luminosity of quasars. The light curves due to the intervention of strings are obtained.

Key words: dark matter, gravitational lensing.

The existence of cosmological strings with a mass per unit length about 10^{23} g/cm was suggested more than 15 years ago (Zel'dovich 1980). Now there are indications that intermediate cosmic strings, associated with cosmological phase transitions taken place after the 'Grand unification' symmetry breaking and before the electroweak symmetry breaking, possibly exist at our days (Ossipov 1995).

The clouds of the strings of different mass densities, maybe associated with ordinary matter, can lens the light of quasars and galactic nuclei. When the sizes of closed string loops are sufficiently large (Ossipov 1996)

$$R \gg \sqrt{\frac{D_{LS} \cdot D_{OS}}{(D_{LS} + D_{OS})} \cdot \lambda \cdot \frac{1}{\sin^2 \varphi}}. \qquad (1)$$

the gravitational microlensing (lensing without resolution of images) by strings can be easily distinguished from the microlensing by ordinary matter.

The strings split the light geodesic producing a number of unresolved images. It is necessary to calculate the luminosity curves of the total observable intensity of quasars in wave optics approximation despite the fact that at cosmological distances the 'zone excess number' (Ossipov 1995)

$$N = \frac{1}{2}\delta^2 \frac{D_{OS} \cdot D_{LS}}{D_{OS} + D_{LS}} \cdot \frac{1}{\lambda} \sin^2 \varphi \qquad (2)$$

is considerably bigger than 1. (For notation see Fig. 1. φ is the angle between the string and the line-of-sight.)

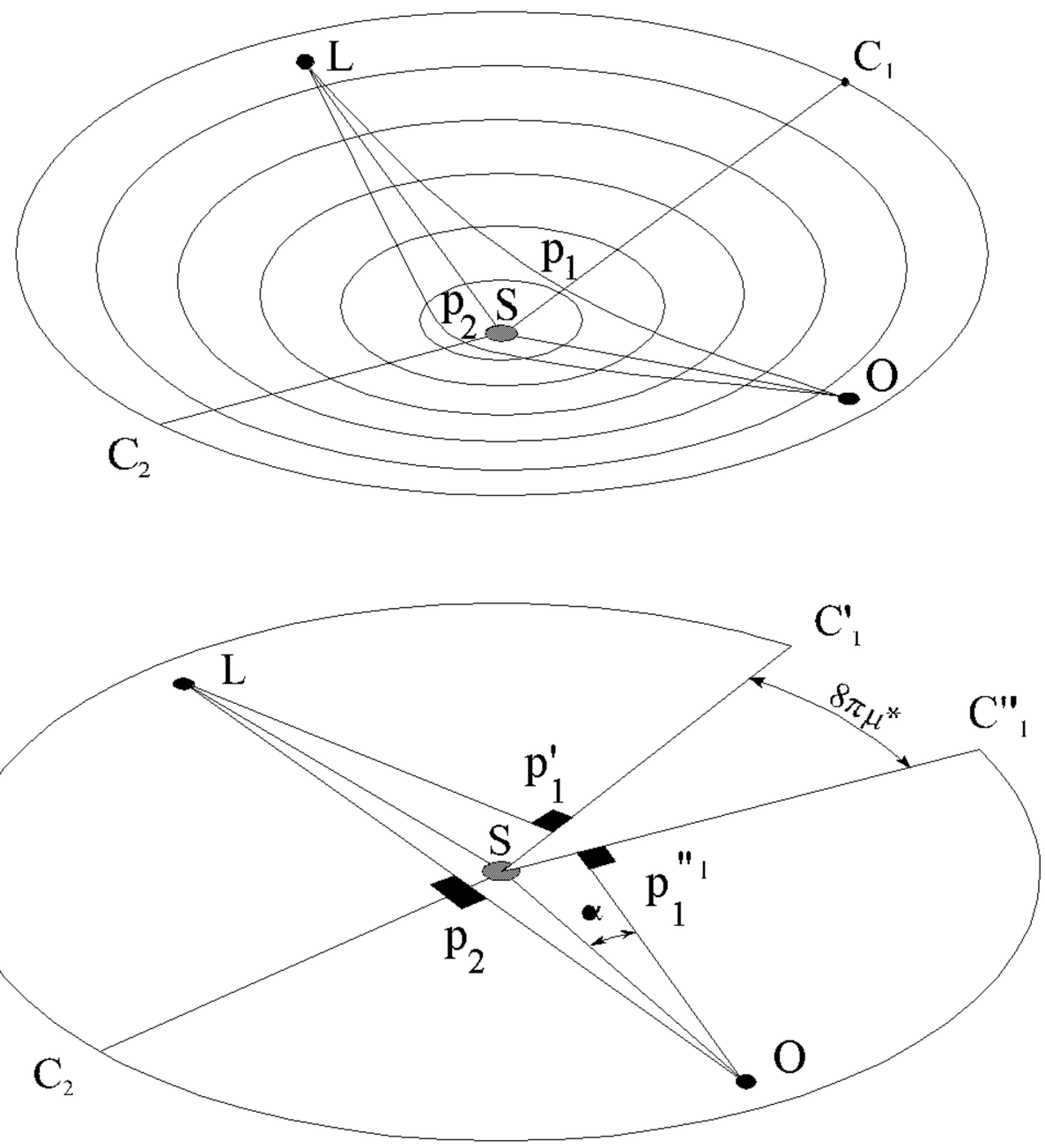


Figure 1. Embedding of a two-dimensional projection of the space around a string — surface perpendicular to the string — in a three-dimensional flat space, together with a planar unfolding of this projection. The section for the unfolding is made along the straight line SC, perpendicular to the straight (geodesic) line Lp_1O. When the string (S) lies near the line of sight, the star (L) and the observer (O) are connected by 2 minimum geodesics: Lp_1O and Lp_2O. These geodesics give two images of the lensed star which are formed by electromagnetic waves.

When $N \gg 1$ the partial intensities of the images, connected with each geodesic, are almost equal and constant. However the appearance (disappearance) of images should be described in the framework of the Fresnel diffraction problem.

When there are N strings near the line of sight from the observer to the point-like source of light, we can see M images ($N + 1 \leq M \leq 2N$) randomly distributed over some solid angle. The motion of strings perpendicular to the line of sight changes the number of images giving rise to the variability of the observable luminosity of the intrinsically stable light source. We may distinguish two mechanisms of variability events with different variability curves.

First type mechanism . The variability caused by the appearance or disappearance of a geodesic. The corresponding variability curve are shown in Fig. 2a,b. The monochromatic curve is the same as in the Fresnel diffraction problem for the half-plane absorbing screen.

Second type mechanism (Fig. 2c,d). Interference caused by 'coincidental' proximity of lengths of two geodesics. We observe it when the difference between two geodesic lengths is of the size of the wave packet. The curve is well known in radio interferometer techniques. The finite angular size of the light source diminishes the amplitude of oscillations.

It is quite evident that the individual variability events may overlap. The typical time scales of variability events can be found in the article by Ossipov (1996).

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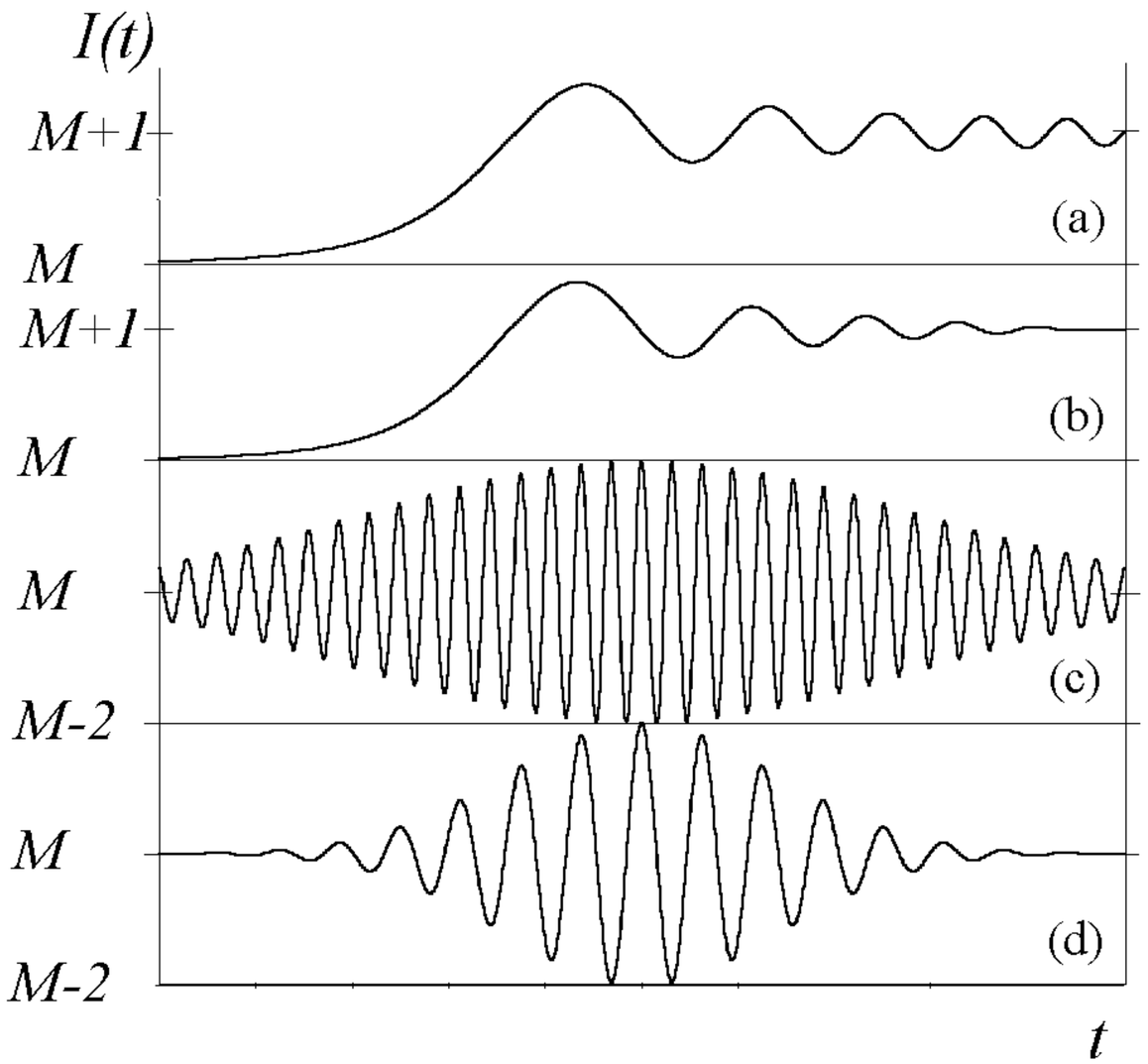


Figure 2. Two types of the luminosity variability curves for a point like source. (a) first type monochromatic curve. (b) first type curve for the spectrometric band of 20%. (c) second type curve for the spectrometric band of 5%. (d) second type curve for the spectrometric band of 20%.

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SIMULATIONS OF LARGE-SCALE GASEOUS STRUCTURES WITH SPH

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ABSTRACT. A computer programme based on the 3D SPH approach is described. Some numerical results are presented: the formation of gaseous ring around an S0 galaxy due to the stripping of a gas-rich donor system. It is found that the ring structure strongly depends on the detailed structure of the recipient object. With the same impact parameters, rings forming around galaxies with a strong concentration of mass to the center should be less extended (on the average) than that around galaxies with a more gently sloping density profile. This inference explains in a quite natural manner the absence of extended polar rings around elliptical galaxies.

Key words: galaxies: general, interactions, kinematics and dynamics, peculiar

Method.

Many stellar systems contain a substantial amount of gas and gas dynamical processes play an important role in the evolution of these systems. Studying interacting galaxies we come across nonaxisymmetric and nonlinear phenomena and need to use complicated 3D gas dynamics models. One of the most fit tools to construct such models is the numerical technique. There are two main numerical approaches to solve the hydrodynamical equations. The first is based on finite-difference methods and uses a rigid grid. There is an alternate scheme, smoothed particle hydrodynamics (SPH), which has been introduced to avoid the limitations of grid-based codes. Originally proposed in (Lucy, 1977) and (Gingold and Monaghan, 1977), it has been considerably developed in the late eighties (e.g. (Hernquist and Katz, 1989), see also (Monaghan, 1992; Steinmetz and Muller, 1993).

The SPH algorithm is fully three-dimensional, flexible regarding the geometry of the gas distribution and consequently well-suited to modelling both the interacting galaxies and the empty extended space between them. It is based on an interpolation method which allows any gas dynamical value, $f(\vec{r})$, to be substituted for its smoothed value, $< f(\vec{r}) >$, which is expressed as

$$\langle f(\vec{r})\rangle = \int f(\vec{x}) W(\vec{r}-\vec{x};h) d\vec{x}\,. \qquad (1)$$

The smoothing kernel, $W(\vec{r})$, is normalized to 1, is sharply peaked about $\vec{r}=0$ in order to resemble a delta-function as $h \to 0$ and has a spherical geometry. The smoothing length, h, specifies the extent of the averaging volume.

The next step is the evaluation of the integral (1) by the Monte-Carlo method. If the values of $f(\vec{r})$ are known for N discrete points, distributed with number density $n(\vec{r})$, then $< f >$ for $\vec{r}_i$ can be evaluated as

$$\langle f(\vec{r}_i)\rangle = \sum_{j=1}^{N} \frac{f(\vec{r}_j)}{< n(\vec{r}_j) >} W(\vec{r}_i - \vec{r}_j; h)\,. \qquad (2)$$

The SPH method is a particle method. Nevertheless it treats the gas as a continuous medium. This medium is modeled as an ensemble of fluid elements - particles of the finite size. Each particle moves according the momentum equation, its velocity is the local fluid velocity and the particle mass density is proportional to the mass density of the fluid. Then, keeping in mind the properties of function $W(\vec{r})$, one can treated the procedure (2) as a local average of $f(\vec{r})$ performed over particle ensemble in the volume of $2h$ extent and h can be attributed as the particle size.

The smoothing formalism leads to the estimation of gradients of the local fluid properties by means of integral interpolant of $f(\vec{r})$ with the kernel $\nabla W(\vec{r}-\vec{x};h)$. Thus the equations of momentum and energy become sets of ordinary differential equations which are easy to solve.

There are some variants of SPH-equations. Our computer code is rather standard and is based on the numerical algorithm described in (Sotnikova, 1996). The motion of N particles, which represent elements of the continous gaseous medium, can be traced by means of the following equations

$$\rho_i = m \sum_j W(\vec{r}_i - \vec{r}_j; h)\,, \qquad (3)$$

$$\frac{d\vec{r}_i}{dt} = \vec{v}_i\,, \qquad (4)$$

$$\frac{d\vec{v}_i}{dt} = -m \sum_j \left(\frac{2\,c^2}{\sqrt{\rho_i \rho_j}} + Q_{ij} \right) \nabla_i W(\vec{r}_i - \vec{r}_j; h) - \nabla\Phi(\vec{r}_i)\,, \qquad (5)$$

where ρ_i is the local gas density, $\vec{r}_i$ and $\vec{v}_i$ are the spatial coordinate and velocity of i-th particle, m is the particle mass, $c = const$ is the isothermal speed of sound (we assume an isothermal equation of state) and Φ is the gravitational potential. The term Q_{ij} is the viscous contribution to the pressure gradient depending on the velocity field. For more detailed description of the adopted numerical scheme see (Sotnikova, 1996). The code was tested by applying to the shock and rarefaction wave propagation problem (for the case of the adiabatic gas). The test runs have satisfactory reproduced the exact solutions.

Numerical example. Polar ring formation.

Many S0 galaxies possess rings of gas-rich material that appear to be kinematically distinct from the galaxy properties. In these galaxies the material is located in a plane perpendicular to the main disk in a polar configuration (Whitemore et.al., 1990). It is generally assumed that they are of external origin. Two possible scenarios for such an acquisition process are: capture of gas-rich dwarfs and accretion of material during an encounter with a neighbouring galaxy (Schweizer et.al., 1983).

We have considered a distant parabolic encounter of equal-mass galaxies ($10^{11} M_\odot$), one of which is rich of gas. In the case of a distant encounter the effect of self-gravity may be ignored.

For simplicity the potential of the gas-rich galaxy was taken as that of a softened point mass with the softening scale length, a_1, to be equal to 1.5 kpc. $N = 10\,000$ particles are used to represent the gaseous medium. They are initially gathered in a thin disk with a $1/r$ distribution from a center of the donor galaxy up to outward radius 15 kpc and are placed in dynamically cold circular orbits. The total gas mass is $10^{10} M_\odot$. The used value of the gaseous particle size, h, which determines a numerical spatial resolution, is 300 pc.

The host-ring galaxy was represented by a second softened point mass. We have considered 2 models of a galaxy - with the softening scale length, a_2, 1.5 kpc and 3 kpc. So the first model imitates rather E galaxy with a strong mass concentration.

Two interacting galaxies are initially separated by a rather large distance (75 kpc) for tidal effects to be negligible. The host-ring galaxy passes in a zero-inclination (regarding the plane of a gaseous disk of the donor galaxy), prograde orbit (that is, the orbital angular momentum is parallel to the spin of the donor galaxy) with a pericenter distance 24 kpc.

During the encounter the galaxy strips the outskirts of the donor object and a narrow ring, rotating in the direction of the orbital motion, eventually forms around the galaxy in the encounter plane. The timescale of the ring formation is a few 10^8 years. The marked difference in the ring structure for two used models is the difference in the ring size which ranges from 6 kpc in diameter for $a_2 = 1.5$ kpc to 10 kpc for $a_2 = 3$ kpc.

This implies that under the same conditions rings forming around elliptical galaxies with a strong concentration of mass to the center should be less extended (on the average) – rather internal – than that around galaxies with a more gently sloping density profile. This inference explains in a quite natural manner the absence of extended polar rings around elliptical galaxies.

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ON THE PROBLEM OF THE NUMERICAL MODEL CONSTRUCTION OF ZERO-AGE SUBSTARS

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ABSTRACT. The numerical modelling of substars inner structure is analysed and main definitions are suggested. Here we present results of calculation of degeneracy parameter ψ, permitting to make calculate the dependence of number of free electrons on function temperature and density typical interior of zero-age substars (ZAS).

Key words: substar: brown dwarfs: degeneracy parameter

Astronomical objects with masses smaller than the minimum stellar value are generally referred to as brown dwarfs (see, e. g., Tarter, 1975). Thermonuclear reactions of truncated $p-p$ chain in the interiors of the brown dwarfs occur, that is objects more massive than $0.07M_{\odot}$ can burn hydrogen, objects with masses more than $0.015M_{\odot}$ burn deuterium, combustion process of ^3He is unavailable due to the low core temperature (Burrows and Libert, 1993; Grossman, 1970; Grossman, 1974).

At about the same time Alexandrov and Zakhozhaj (1980) when characterising internal structure of stars and giant planets proposed a whole new class of low-mass objects containing matter with degenerate electron gas in their interior. It was suggested to call these objects substars taking into account that their maximum mass is coincident with lower stellar mass limit and their lower limit depends on central density that is equal to critical density of degenerate electrons ρ_{cr}.

Because central density of brown dwarfs with minimum mass is larger than ρ_{cr}, the definition of substar introduced above includes greater range of objects and is more general compared with the masses range of brown dwarfs. The first estimates of the minimal substars masses obtained from mass dependence of central density and mean density dependence of critical density yielded that values of minimum substar mass M_{SSmin} is equal to $0.005M_{\odot}$ (Alexandrov and Zakhozhaj, 1980; Landau and Lifshitz, 1976). As numerical simulations of their structure along the whole range of mass were not carried out, the value M_{SSmin} is not conclusively established.

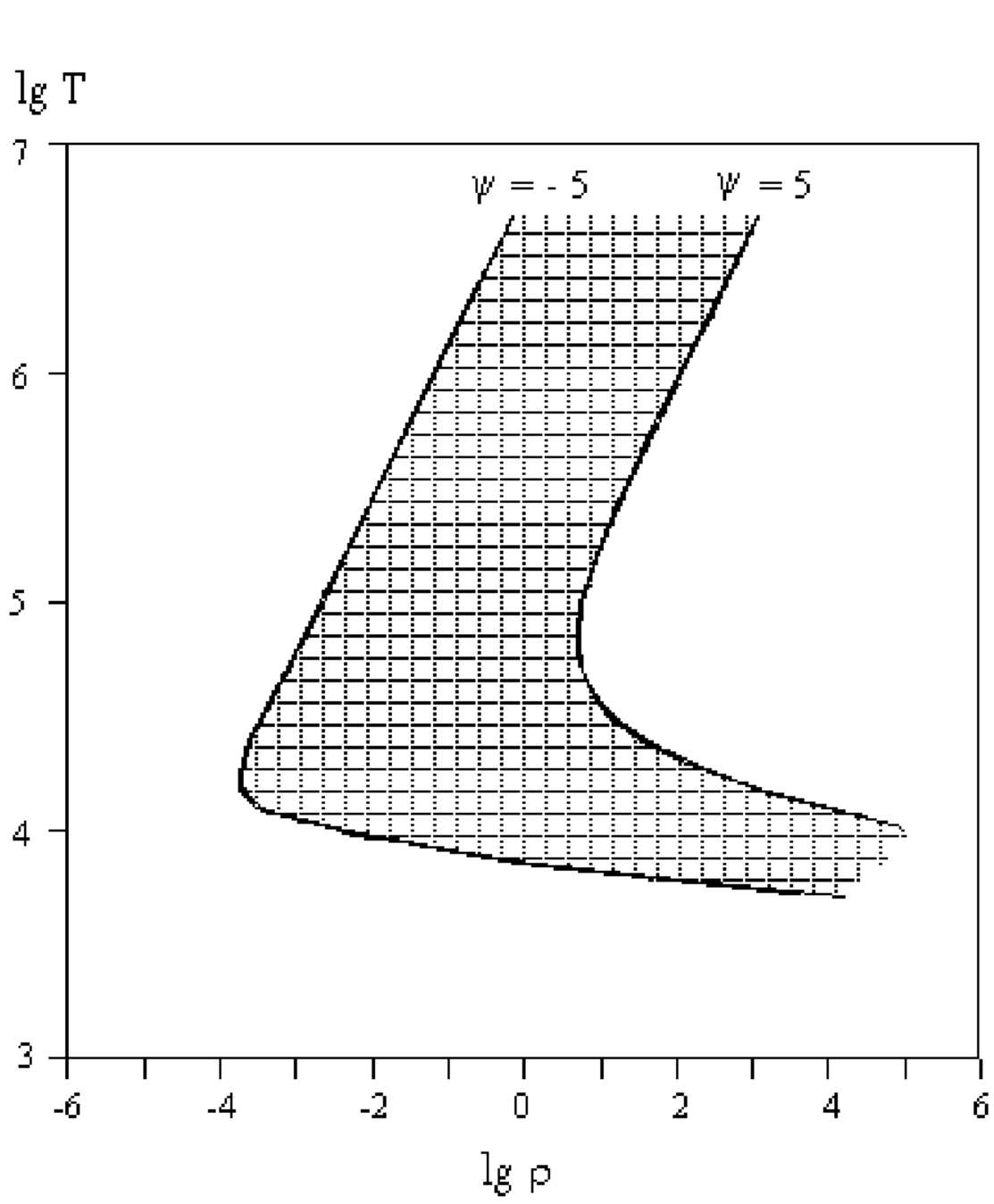


Figure 1: Dependence of degeneracy parameter ψ on temperature T and density ρ for mixture of gases H and He ($X = 0.75, Y = 0.25$). The electron configuration in the section on the left of the curve $\psi = -5$ is described by classic partition function; on the right of curve $\psi = 5$ lies the region of strongly degenerate electron gas; the hatched section represents schematically the realm of the partially degenerate electron gas.

The active phase duration of radiation and luminosity of brown dwarfs are connected with the burning process of hydrogen, deuterium and lithium. Massive brown dwarfs with mass above $0.07M_{\odot}$ can sustain hydrogen-burning during the time interval of about 10^9 years until nuclear reactions cut off (Burrows and Libert, 1993). In the interior of brown dwarfs with mass larger than $0.015M_{\odot}$ primordial deuterium burns within first ten million years (Grossman, 1970; Grossman, 1974). For mass down to $0.06M_{\odot}$, primordial lithium is used up, though the process takes more time.

Further radiation on passive phase of brown dwarfs evolution, as in the case of low-mass substars with

masses up to $0.015M_\odot$, is defined by reserves of thermal energy. Thus, for substars of the same age with the masses $\sim 0.015M_\odot$ on the H-R diagram, the first-order discontinuity should be observed, because of start cooling time shift of substars with different masses. It is useful to introduce the definition of zero-age substars (ZAS) by which we mean the age when a substar starts cooling. We also find it useful to categorise substars into two classes, those of low masses $M \sim [M_{ss\,min}, 0.015M_\odot]$, and brown dwarfs $M \sim [0.015M_\odot, M_{*\,min}]$. M_{*min} — minimal star mass, which is now considered $\approx 0.08M_\odot$ with small variations depending on a chemical composition (Bisnovatyi-Kogan, 1989).

Chandrasekhar (1932), Landau and Lifshitz (1976) constructed theoretical models for stable configurations of astronomical objects with the polytropic parameter $n = 3/2$ corresponding to the case of fully degenerate electron gas. Similar modelling was carried out by Kumar (1963) for fully convective substars with masses $0.04M_\odot$ and more. Further advancement of these ideas was continued by Grossman (Grossman, 1970; Grossman et al., 1970), Graboske (Graboske et al., 1973), Nelson (Nelson et al., 1986; Dorman et al., 1989), D'Antona and Mazzitelli (1985, 1986), Stevenson (1991) and other (Burrows and Libert, 1993; Burrows et al., 1989; Liebert and Probst, 1987). On the other hand, all these papers cover modern conceptions of electron screening effects, which influences the nuclear reaction rate. Also they used the results of calculation of opacity in the matter similar to that of substar interiors. However, their polytropic models provide rather a simplified idea about the substars internal structure.

In the absence of external energy sources, ZAS structure may be described by the system of differential equations: two standard equations of hydrostatic equilibrium and equation of adiabatic equilibrium. The system of equations has solution in the case when the equations of state of matter are specified. State of matter, by definition, is bound to vary from fully degenerate electron gas in the center of brown dwarf, to classic electron gas in the ZAS atmosphere, passing the partially degenerate region (see the hatched section on the Figure 1), which is specified by degeneracy parameter ψ. Atoms of matter across the whole width of ZAS interiors are described by equation of state for perfect gas.

All the recited equations have been investigated except the dependence degeneracy parameter ψ on temperature and density. In order to gain insight into dependence $\psi = \psi(T, \rho)$ we evolved a theory, which makes possible calculate number of free electrons as function of T and ρ typical for ZAS interiors, where Saha type equation takes into account the degree of electron gas degeneracy. Hence, our consideration goes far beyond the scope of the polytropic models.

In the nearest future we intend to publish the results of ZAS inner structure calculations taking into account the dependence $\psi = \psi(T, \rho)$.

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SMALL VELOCITIES OF METEOROIDS: INTERRELATION OF SOLAR SYSTEM SMALL BODIES

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ABSTRACT. Reality and dynamical connection of meteoroids with small velocities are discussed.

Key words: asteroids, comets, meteoroids

Introduction

Meteoroids with velocities less than 20 km/s are practical absent in most statistical reliable radar meteor orbit catalogs. Owing to it meteoroids with radiants in antapex, geocentric elongations more than 130^0, also absent. Thus the question of reality and origin meteoroids with small masses is arises.

Reality of meteoroids with small velocities are confirmed by radiants of radar meteors in antapex derived from azimuthal observations. In these observations meteor velocity do not determined and because it selectivity of method is minimal. We have meteors with small velocities in catalogs of photographic observations also.

In the paper Andreev et al. (1993) had been demonstrated that absence of radar meteors with small velocities is connected with selectivity of radar observation method with determination of velocity.

Discussion

Thus the problem is the determination of the dynamical evolution path and parent bodies of meteoroids with small velocities.

Let us define domain in space of orbital elements a, e and i of parent bodies from which will be have meteoroids with velocities less than 23 km/s during collisions with the Earth.

From the integral of squares of the two body problem and vector adding of the Earth orbital and particle heliocentric velocities we can obtain relation for relative (geocentric) velocity of particle (Opik 1951):

$$V_g^2 = 3 - T, \tag{1}$$

where

$$T = 1/a + 2\sqrt{a(1-e^2)}\cos i. \tag{2}$$

The Earth orbital velocity is unit for all velocities.



Fig. 1. Velocity domain for inclination 0°.

The appearance of T coincides with the Tisserand invariant which is approximation of Jacobi integral of three body problem.

If we define the upper limit of observational velocity of meteoroids equal to 23 km/s then value of T will be varies from 2.72 to 3.0.

L. Kresak in paper of 1967 (Kresak 1967) had suggested to use for analysis of small bodies dynamical evolution, in particular meteoroids, system of coordinates with axes eccentricity - semimajor axis. In this coordinate system we can define for different of inclination angles domain of orbital elements a and e in which we will be get meteoroids with observed velocity less than 23 km/s. This domain is show on Fig. 1 by open circles. This domain decreases with increasing of inclination of meteoroid orbit.

The distributions of a and e of asteroids and periodic comets were derived for all inclinations for velocities less than 23 km/s. For comparison the same distributions were derived for photographic meteoroids (McCrosky and Posen 1961). Very important is that what these distributions for meteoroids were derived with taking into account influence of motion and attraction of the Earth on flux of the sporadic meteoroids (Andreev and Belkovich 1975; Andreev et al. 1993) and selectivity of observation method (Andreev et al. 1983).

As follows from comparison of distributions $N(a)$ and $N(e)$ for asteroids and comets and ones for me-

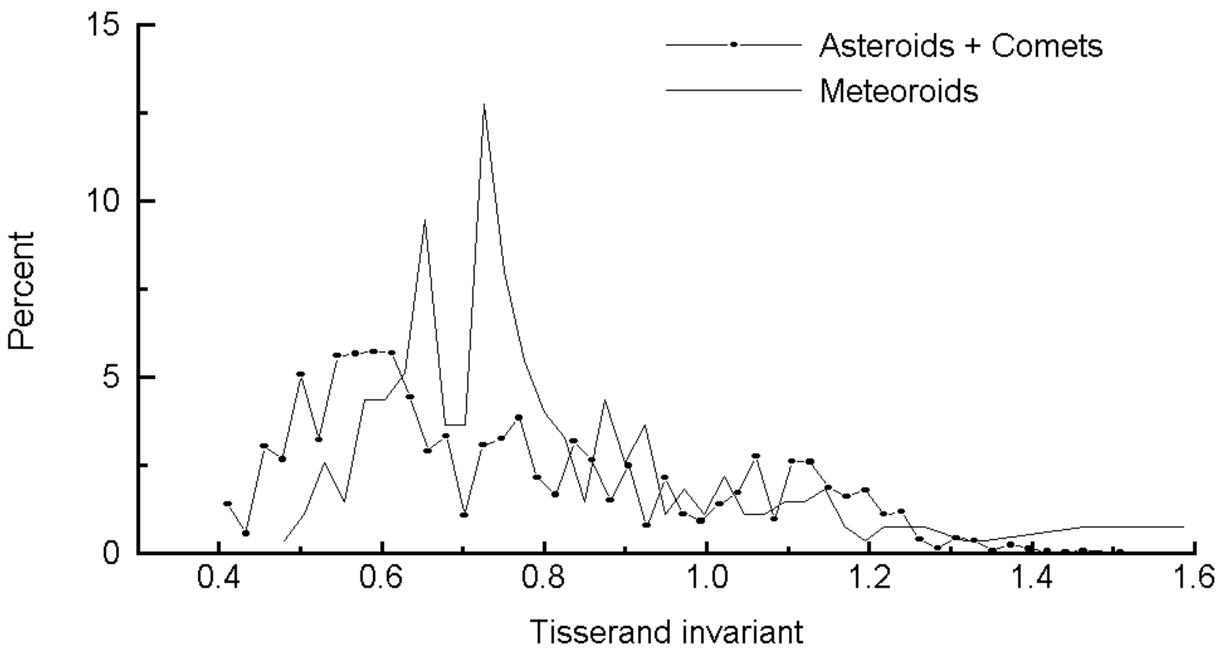


Figure 2. Distribution of Tisserand invariant.

teoroids they do not coincidence. This is a consequence of fact that from present population of asteroids and periodic short–periodic comets only small part has $q < 1AU$.

Thus question arises on dynamical way which could provide redistribution of orbital elements meteoroids.

The difference of distributions $N(a)$ and $N(e)$ is that what meteoroids with large a and e have large weight. From it follows that Poynting - Robertson effect, resulting in decreasing of a and e, do not play role and we must consider perturbations of Jupiter. As result of Jovian perturbations meteoroids from asteroids and comets do not crossing of the Earth orbit, will be collided with the Earth. Evolutionary path of these particles follows to curves having in coordinate system of Fig. 1 appearance of inner border of velocity domain drawing in Jovian domain of influence only. For this evolutionary motion Tisserand invariant relative of Jupiter

$$T_J = 1/a + 2A_J^{-1.5}\sqrt{a(1-e^2)}\cos i \qquad (3)$$

remains constant.

The distribution of T_J for meteoroids with velocities under consideration (548 meteors) and cumulative distribution for comets (14) and asteroids (288) are showed on Fig. 2. We can note nearly coincidence of main maximum of meteoroid distribution. Displacement of this maximum can be explain by large statistics of asteroids and that what productivity of comet and asteroids had been taken the same.

Conclusion

Thus it was show that we can point out evolutionary path large meteoroids. For more precise determination of distribution of large meteoroids on T_J we must have information on relative productivity of dust by comets and asteroids. As result we get information on distribution of meteoroids in the interval of velocities which do not observed owing to observational selectivity especially for radar observations.

Acknowledgements. For determination of distribution of small bodies electronic catalogs of comets and asteroids were used. These catalogs were received from Dr. B. Marsden (Harvard- Smithsonian Center for Astrophysics, Cambridge, MA, USA) and Drs. E. Bowell and B. Kohen (Flagstaff, LPI, Arizona, USA). The author acknowledges with thanks to them.

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SPACE DENSITY DISTRIBUTION OF METEOROIDS OVER THE SPHERE WITH RADIUS 1 A.U.

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ABSTRACT. Space density distributions of meteoroids over the sphere with radius 1 AU and the centre in the Sun were found for meteoroid masses greater than 10^{-3} g, 10^{-2} g and 1 g. Meteoroids with greater masses concentrate to the ecliptic plane

Key words: meteoroid, Solar system

Introduction

Ground-based radar observations of meteors are the most numerous and therefore the most reliable now. All ground-based observations are related to the small part of the Solar system, i.e. to the vicinity of the Earth's orbit. But we have to know meteoroid distributions in a more volume of the cosmic space to study their origin and evolution.

Observational data

The four dimentional distribution of the flux density of sporadic meteors over the celectial sphere $QP(\varepsilon, \psi, v, m)$ has been found as a product of the radiant distribution $P(\varepsilon, \psi)$, the conditional distribution of velocities $P_\varepsilon(v)$ and conditional cumulative mass distribution $F_\varepsilon(m) = (m/m_0)^{1-s}$ (Andreev *et al.* 1994):

$$QP(\varepsilon, \psi, v, m) = QP(\varepsilon, \psi) P_\varepsilon(v) F_\varepsilon(m), \qquad (1)$$

where ε is the meteor radiant elongation from the Earth's apex, ψ is the azimuth angle measured between the ecliptic plane and plane crossing through apex, radiant and antapex, v is the meteoroid velocity, m the mass of a meteoroid, m_0 is the minimum mass and s is the distribution parameter. Here Q is the total flux of meteoroids with masses greater than m_0 over the complete range of velocities and from the whole celestial sphere.

Distributioins of meteoroid radiants and masses were obtained from radar observations in Kazan, Russia, for the last several years (Andreev *et al.* 1994). All observations have been avereged over a year. Velocity distributions have been taken from the Lund set of meteor orbit catalogues (Lindblad, 1992). Selectivity of observations have been taken into account.

Solution of the problem

The meteoroid flux density distribution over the celestial sphere (1) have been calculated for the three minimum masses: 10^{-3} g, 10^{-2} g and 1 g and then transformed to the heliocentric frame of references (Andreev *et al*, 1993). The space density ρ of meteoroids can be obtained as a function of the only variable β i.e. the ecliptic latitude because of the data averaging for a year:

$$\rho_\beta = Q_\beta \int\int\int \frac{P_\beta(\varepsilon, \psi, v)}{v} \sin\varepsilon \;\; d\varepsilon \;\; d\psi \;\; dv, \qquad (2)$$

where the flux density distribution relates to the same latitude β as the ρ.

As was shown by Andreev *et al.* 1993, perihelion arguments of sporadic meteoroid orbits with given values of orbit elements a, e, i have the uniform distribution. So, it can used the same method as one given in the paper by Belkovich, 1983 for taking into account the astronomical selectivity. In this case the relation between flux density distributions in the ecliptic plane ($\beta = 0$) and in the point at the sphere with given β is:

$$Q_\beta P_\beta(\varepsilon, \psi, v) = Q_{\beta=0} P_{\beta=0}(\varepsilon, \psi, v) \cos\gamma^{-1}. \qquad (3)$$

Here γ is the angle in the orbit plane between the node and the point with the coordinate β. Finaly, from (2) and (3)

$$\rho_\beta = Q_{\beta=0} \int\int\int \frac{P_{\beta=0}(\varepsilon, \psi, v)}{v \;\; \cos\gamma} \sin\varepsilon \;\; d\varepsilon \;\; d\psi \;\; dv, \qquad (4)$$

The variation of the space density as a function of the ecliptic latitude β is shown in Fig.1 in the relative units, in the ecliptic plane $\rho_{\beta=0} = 1$.

Conclusion

As one can see in Fig.1 the space density of meteoroids near the pole of the eclipic is very low. It can be explained by the fact that meteoroid orbits with inclinations about 90° are very unstable. Meteoroids with greater masses concentrate to the ecliptic plane. Some

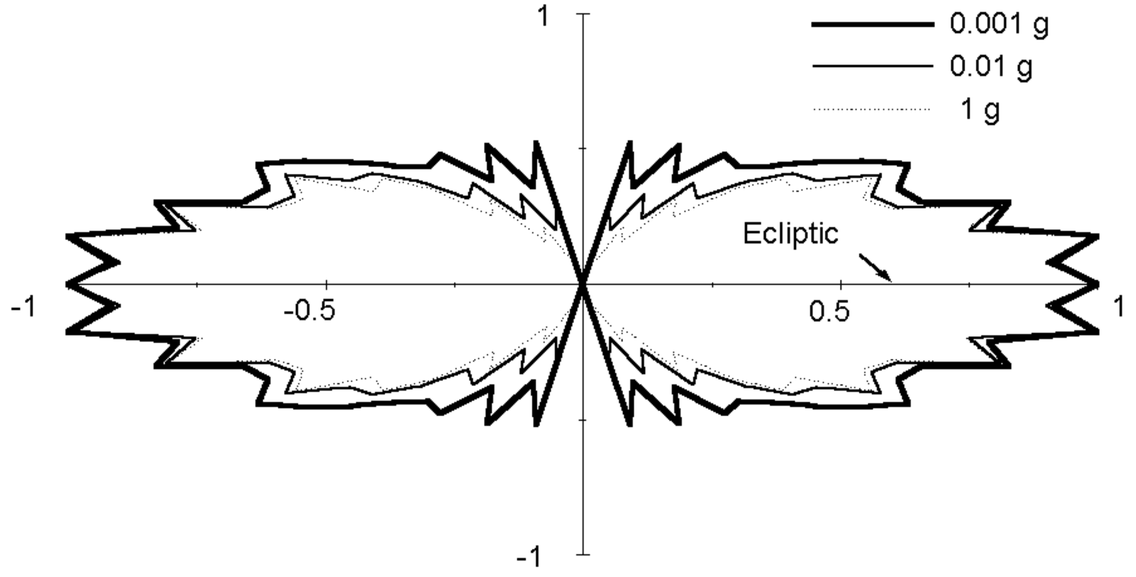


Figure 1. Space density of meteoroids (in relative units) at the distance 1 AU off the Sun as a function of the ecliptic latitude.

pikes at the diagram are not reliable and can be considered as artifacts.

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THE LIGHT CURVES OF THEORETICAL ASTEROIDS' MODELS

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ABSTRACT. On the basis of modeling of asteroids form is calculate the set of light curves for five laws of reflection.

Key words: Asteroid model, Light curve

In the problem of determining parameters of asteroids' rotation from photometric data, a necessity arises to interpret the observed asteroids' light curve variation in form, the extrema light "shift" relative to a linear ephemeris and other similar phenomena taking place due to geometric observational conditions, the phase angle etc.

In the given work we shall consider some ellipsoids light curve characteristics obtained by dividing surfaces into element ones (N=1200) with the known area and orientation.

As a law of model surface light reflection the law of Lommel-Seeliger (LS) has been used:

$$dI = \frac{\cos i \cos \varepsilon}{\cos i + \cos \varepsilon} dS ;$$

as well as that of Lambert (L):

$$dI = \cos i \cos \varepsilon dS;$$

theoretical Akimov's law (AT) (Akimov at al.,1992):

$$dI = \cos(\frac{\pi}{\pi - \alpha}) \cos[\frac{\pi}{\pi - \alpha}(\lambda - \frac{\alpha}{2})];$$

empiric Akimov's law:

$$dI = \cos^P \varphi \, [\cos^P(\lambda - \frac{\alpha}{2}) - \sin^P \frac{\alpha}{2}]$$

at two values of the parameter P=1.1 (A1) and P=1.3 (A2).

To simplify the examination of the geometry influence of both the illumination and observation on the light curve form we restrict ourselves to a model – a rotational ellipsoid in form – with axes 1:2 in a ratio. Let us consider a system of coordinates related to the model centre (Fig.1).

The light curves are nearly always asymmetric except for the cases when $d_E = \pm d_S$ or a = 0. At

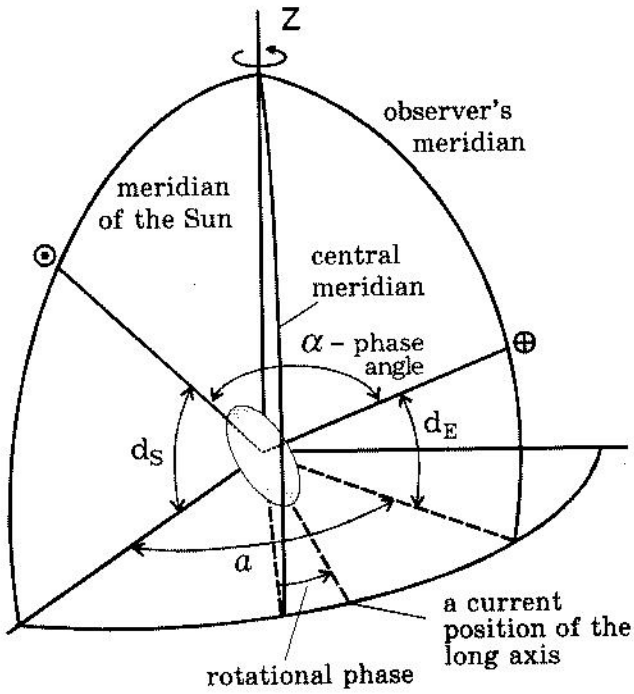


Figure 1: Geometry of the illumination and observation of asteroid model.

$d_S > 0$ for any law of reflection, minimum light is observed at phase of rotation equal to $-a/2$, that is when longitudinal ellipsoid axis crosses the illuminant meridian.

In Fig.2 is shown a course of the minimum light shift from the central meridian for five laws of reflection. When the Sun and the observer are on opposite sides from the rotation equator of model, the light is mainly determined by the body form.

At $d_S < 30^o$ maximum difference in the minimum state is observed in the region of $40^o \le d_E \le 80^o$ and amounts to 10^o in phase whereas at $d_E = \pm\pi/2$ the phase of minimum is equal to $-a/2$ for all the laws considered. At $d_S > 30^o$ such a minimum state is always observed only for the Lambert's law. The laws LS, A1 and with some reserves A2 and AT in case $d_E = \pi/2$ result in the minimum phase equal to $\pi/2 - a/2$

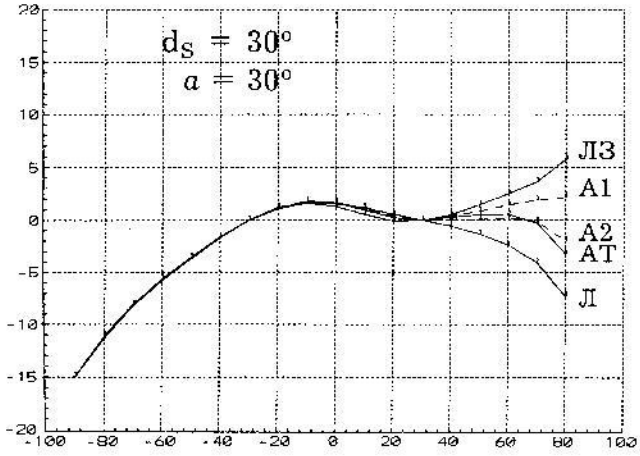


Figure 2: Shifts of the light minimum phase for five reflection laws.

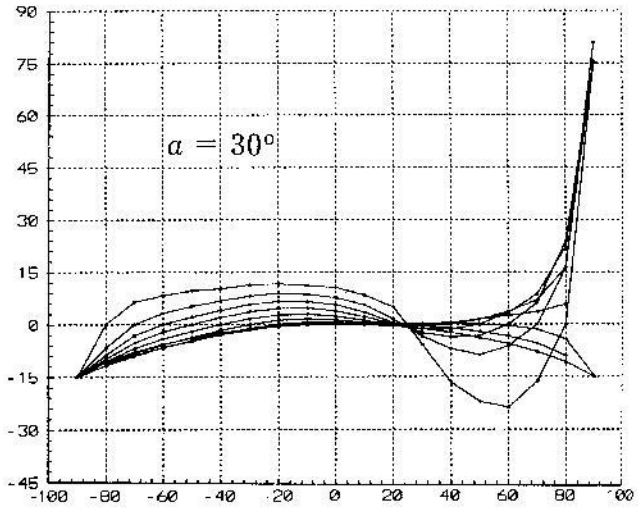
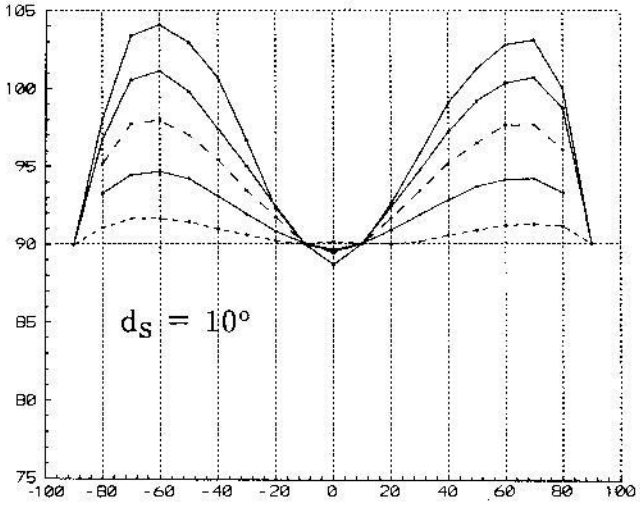


Figure 3: Shifts of the light minimum phase for LS-ellipsoid for set of Sun's aspect.



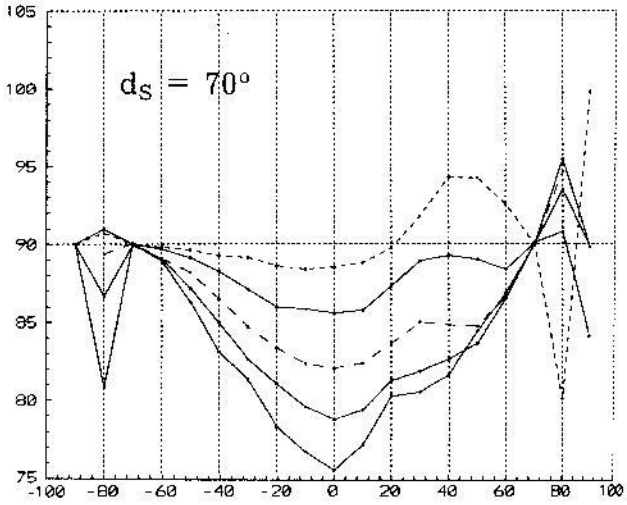


Figure 4: Asymmetry of light curves for LS-ellipsoid for set of Sun's aspect.

that is their light curves are in antiphase with Lambert's light curves and the minimum light phase is far from the region embraced between the Sun's and the observer's meridians.

In Fig.3 are presented shifts of the minimum light phase for the Lommel-Seeliger ellipsoid depending upon the observer's aspect for a = 30° at different aspects of the Sun.

In Fig.4 are given differences in the minimum and maximum shifts for the LS model. As is seen, a common character of the maximum phase shift is the same as that of the minimum. But the magnitude may differ, and as a result of this in the considered range of geometric conditions the assymetry of light curves (deviations of phases for maximum and minimum light from $\pi/2$) can be equal to $\pm 15°$.

It should be noted that a varying sign of the light curve asymmetry is ignored in methods based upon phase angle bisectrix that may lead to essential problems in determining asteroids' rotation parameters. As to the choice of the most suitable light reflection law for asteroids' surface, the problem is likely to be solved in comparing light curves of models with circumpolar observations of asteroids or their rigowns physical analogues.

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THE ASTEROIDS' ROTATION PARAMETERS DETERMINATION USING PHOTOMETRICAL DATA

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ABSTRACT. Presented a new method of determination of the asteroid rotation parameters.
Key words: Asteroids, Photometry, Light curve, Modeling

There are a few methods of determining the period and orientation of the asteroids' rotational axis by using their light curves obtained in several oppositions. These methods have a number of drawbacks: the use of a "geometrical" reflection law and that of a vector-bisectrix phase for approximating the variation of maximum phase in light curves.

We have used the asteroid model in the ellipsoid form (or some other more intricate body) with the most adequate law of its surface light reflection to calculate theoretical light curves and compare these with the observed moments of the asteroids' light extrema.

In changing the position of a test pole of rotation, for one time interval between extrema moments ΔT_κ we get different values of f_K which are used for the sidereal period determination.

The period determination procedure is based upon the testing of a series of test periods. To optimize a search algorythm both the determination of test periods and their refinement is devided into three stages.

In the first stage are set limits of the period search P_{max} and P_{min}. A series of intervals $\Delta T_\kappa = T_i - T_j$ is formed and their values are limited to one opposition. As the main interval ΔT_o the minimum one is chosed from of the series.

Let us calculate values $N_{max} = [\Delta T_o / P_{min}]$ and $N_{min} = [\Delta T_o / P_{max}]$. This is an uppon and a lower limits for the quantity of cycles N. The brackets designate the nearest integer. When choosing N_l from the interval $N_{min} \le N_l \le N_{max}$, we get $(N_{max} - N_{min} + 1)$ of the test periods:

$$P_l = \Delta T_o / (N_l \pm f_o).$$

In this case the sign "+" is used for a prograde rotation whereas that of "−" for the retrograde one.

Further on all the test periods are tested for all the series ΔT_K. Determine

$$N_k = [\Delta T_k / P_l \pm f_k].$$

N_k obtained are used to calculate average test period $\overline{P}_l$ and $\sigma_{\overline{P}_l}$.

$$\overline{P}_l = \frac{1}{m}\sum_{k=0}^{m-1}\frac{\Delta T_k}{N_k \pm f_k}$$

For each period found in this way we determine extrema phases from the observations

$$\varphi_k^l = \frac{\Delta T_k}{P_l} - N_k$$

and set up differences $(O-C)_k^l = \varphi_k^l \pm f_k$ and calculate mean square deviation for a prograde and retrograde rotation

$$\overline{(O-C)}_l = \frac{1}{m}\sum_{k=0}^{m-1}(\varphi_l^k \pm f_k)^2 .$$

The test period $\overline{P}_l$ respective minimum of $\overline{(O-C)}_l$ is chosen to be refined in the second stage. New values for the limits are determined by the formulas

$$P_{max} = \overline{P}_l + 3\sigma_{\overline{P}_l}; \quad P_{min} = \overline{P}_l - 3\sigma_{\overline{P}_l}.$$

In the second stage, moments T_i for the formation of intervals ΔT_κ are chosen from different oppositions. As the main interval ΔT_o the maximum one is chosen from the series available and the prosedure is repeated.

We calculate ephemeris moments T_{calc} with the period value obtained in the second stage

$$T_{calc} = T_o + P(N \pm f).$$

Differences $T_{obs} - T_{calc}$ for respective values N and f enable us to write a system of conventional equations

$$(O\text{-}C) = \Delta T_o + \Delta P(N \pm f).$$

This system of equations is solved by the least squared method, then convections ΔT_o and ΔP are calculate. Allowing for these correcttions, as

a finite result we get new ephemeris moments and new deviations values (O-C) and determine mean square deviations

$$\overline{(O-C)} = \frac{1}{m}\sum_{k=0}^{m-1}(T_k - T_O - P(N_k \pm f_k))^2,$$

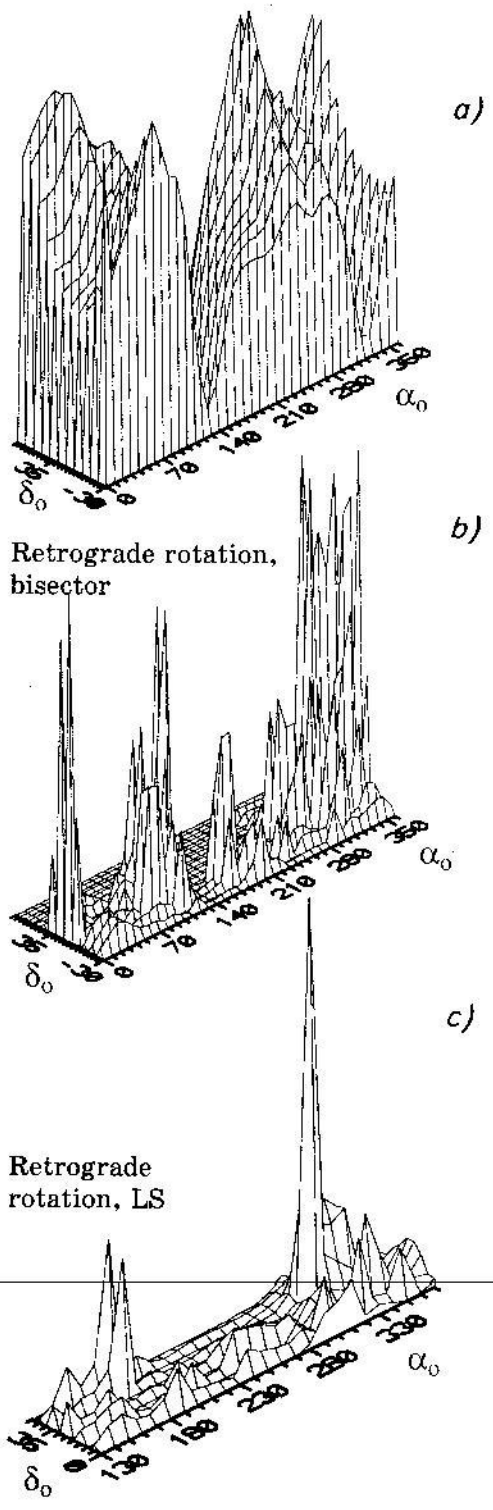


Figure 1: The deviations of amplitude and $\overline{(O-C)}$ value for asteroid 79 Eurinome.

where T_o, P and N determined separately for a prograde and retrograde ratation.

Now varying the position of a test rotational pole we calculate respective values of $\overline{(O-C)}_{pro}$ and $\overline{(O-C)}_{retr}$. The minimum value $\overline{(O-C)}$ determines a solution for the pole position, direction and rotational period.

Application. The asteroid 79 Eurinome was observed during three oppositions. We have used 11 moments of maximum light by Michalowski and Velichko (1990). In Fig. 1a is shown a deviation course of the observed amplitude from the calculated one for the "geometric" law of reflection. In Fig. 1b are presented mean deviation $\overline{(O-C)}$ for the retrograde rotation obtained by using the bisectrix. And in Fig. 1c are illustrated mean deviations $\overline{(O-C)}$ for the retrograde rotation obtained for Lommel-Seeliger model. The best solution in this case agrees with α_o =310° and δ_o =30° and P_{sid} = 0^d.24918182.

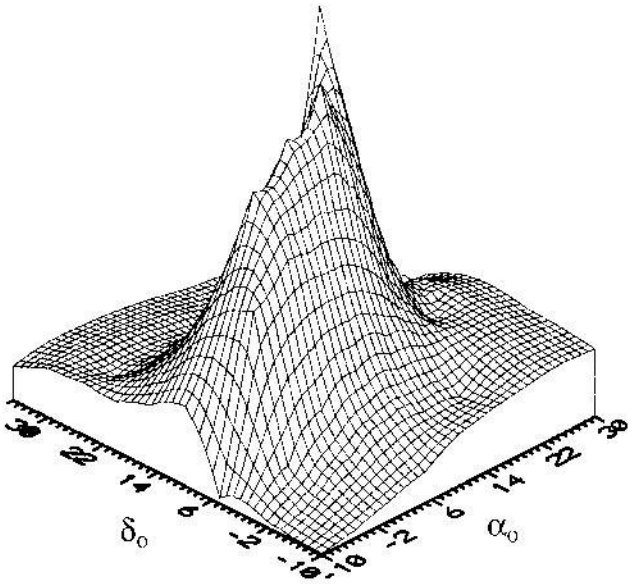


Figure 2: The deviations of $\overline{(O-C)}$ value for asteroid 433 Eros.

In Fig. 2 are shown mean deviations $\overline{(O-C)}$ for the asteroid 433 Eros. This asteroid has been observed in five oppositions since 1901. For the given solution, 35 moments of minimum light are used. The best solution corresponds to α_o =15° and δ_o =15° and P_{sid} = 0^d.21959392.

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OBSERVATIONAL RESULT ON COSMIC OBJECTS: "Okean 7" (94-08-1), "Sich-1" (95-132-1)

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ABSTRACT: The results are represented of photometric observations of cosmic objects "Okean-7", "Sich-1", obtained at the Odessa Astronomical Observatory in September-October 1995.

Key words: cosmic object, photometry, light curve.

The given results resperent observations of 12 transits of CO "Okean-7" and 22 transits of CO "Sich-1": In other dates of observations measurments were not carried out due to unfavourable weather conditions.

Observations were made in September-October 1995 and in June-August 1996 at the apparatus complex of photomrtric and coordinate observations of CO of space reseach department of Odessa Astronomical Observatory (KOD-1) certified by NPO "Astrofizika" in 1988 in process of joint work.

As a base traking system, the cinetheodolite KT-50 is used - an azimutal system of dueding fast mooving objects. In mechanical part the following changes are made: sensor of turn units are built in, a platform of optico-mechanical photometer block etc is introduced. To register CO light a one-channel photometer at the photons'count with spring diafragm is used. Electron parts of the fotometric channel consists of a frequency meter, control unit,register device and a high-voltage power supply, all connected logically, algorithmically and constructively.

For automatic obtaining coorginate information on CO, an angle measuring device is developed and manufactured; it permist to yield coordinate information from KT-50 in real time scale and suitable for the input in the computer.

A list of objects observed is given in Table 1. For all the objects light curves are obtained in direct intensities in the instrumental system.

Besides CO observations, every night observations were made of calibration stars and stars for atmospheric extinction determination. By using the developed algorithms of the analysis of malfunctions and rejection data and algorithm of CO light curve formation in the instrumental system, the redaction of the data

Table 1: Observed object

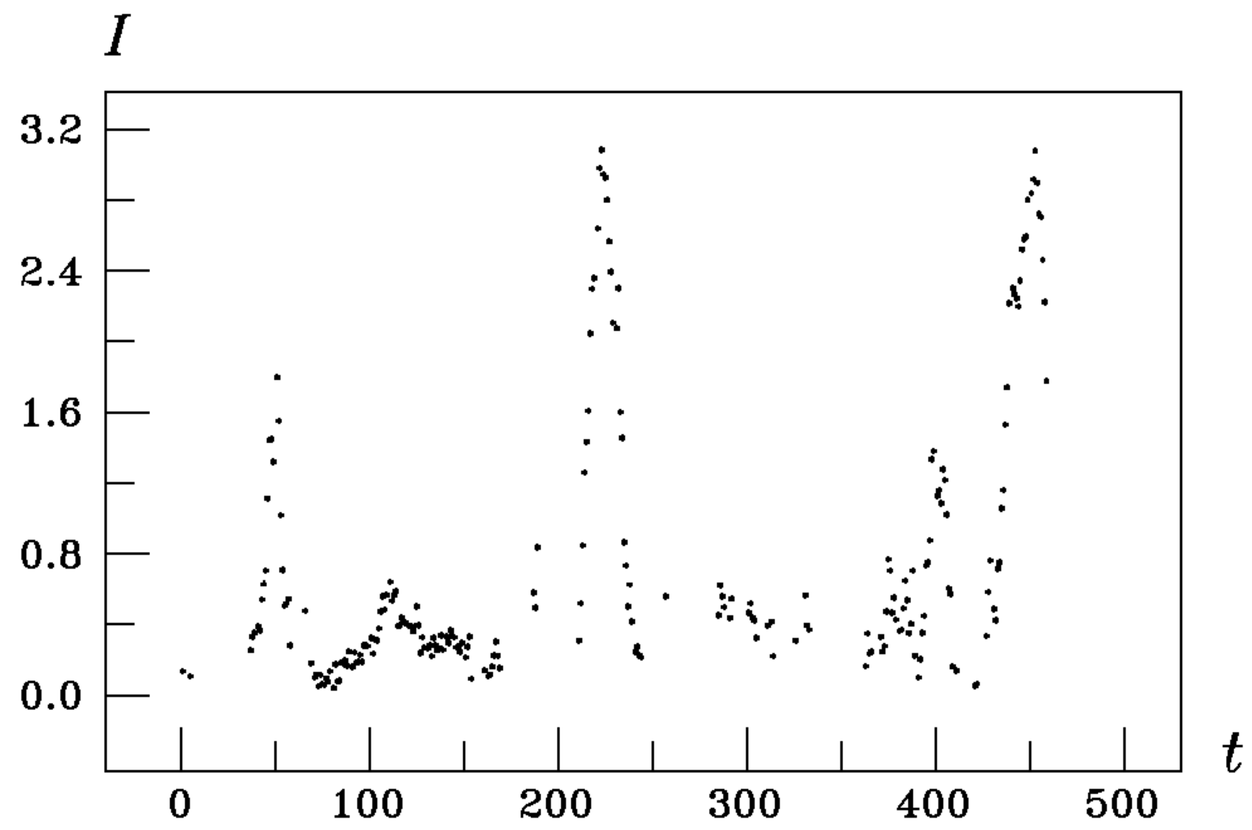
Name of CO	Date of obs.	Time of outset	stell. mag.	Ext. coef.
94-08-01	25.09.95	17 28 00	8	0.5
94-08-01	28.09.95	14 43 23	3	0.7
94-08-01	02.10.95	17 50 32	3	0.5
94-08-01	03.10.95	18 18 53	5	0.6
94-08-01	04.10.95	17 05 00	3	0.5
94-08-01	05.10.95	17 31 50	3	0.6
94-08-01	06.10.95	18 00 00	4	0.4
94-08-01	14.10.95	16 36 13	6	0.6
94-08-01	15.10.95	17 35 10	6	0.6
94-08-01	16.10.95	03 12 38	3	0.4
94-08-01	18.10.95	02 26 32	4	0.5
94-08-01	19.10.95	02 53 23	3	0.4
95-132-1	29.09.95	17 14 27	5	0.7
95-132-1	17.10.95	03 23 33	7	0.4
95-132-1	18.10.95	02 13 09	7	0.4
95-132-1	06.06.96	19 37 31	4	0.4
95-132-1	08.06.96	18 52 50	4	0.4
95-132-1	09.06.96	19 19 32	5	0.5
95-132-1	10.06.96	19 48 21	6	0.3
95-132-1	14.07.96	01 09 02	5	0.4
95-132-1	18.07.96	01 17 01	5	0.3
95-132-1	21.07.96	01 00 00	3	0.5
95-132-1	22.07.96	01 58 33	4	0.5
95-132-1	23.07.96	00 15 40	4	0.4
95-132-1	27.07.96	00 25 35	4	0.4
95-132-1	30.07.96	22 56 48	4	0.7
95-132-1	31.07.96	23 23 32	4	0.8
95-132-1	11.08.96	21 45 40	4	0.4
95-132-1	15.08.96	21 56 30	5	0.6
95-132-1	26.08.96	20 20 20	5	0.7
95-132-1	29.08.96	20 02 00	5	0.5

obtained is carried out. All the light curves are reffered to the brightness standart. Coordinate information and tabulated light curves are in the CO data bank of Space Reseach Department of AO.

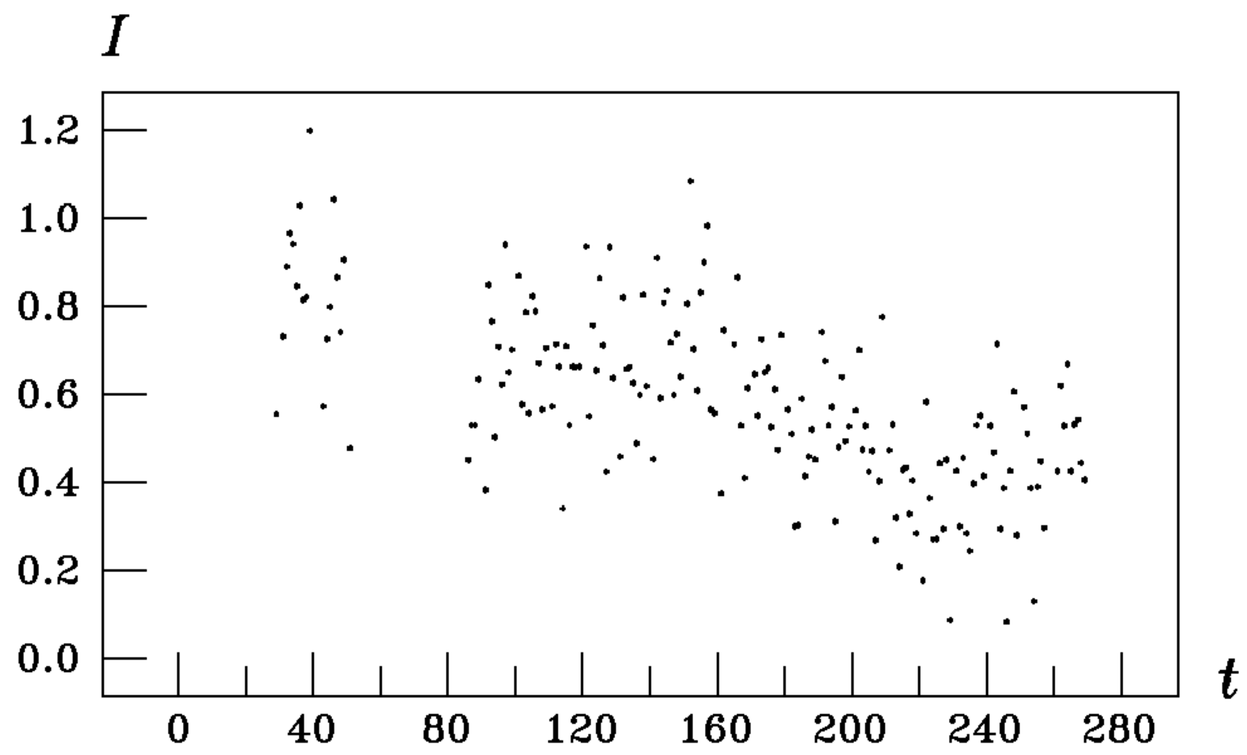
Analysis of coordinate and photometric information of CO data has shown stability of object's orbits as well as stabylity of their beheviour in orbit (i.e. that is, constancy of a light curve, color and other photometric characteristics.

In observing CO "Sich-1" on August 13th 1996 two objects were discovered. The given fact was confirmed by observations made on August 14th 1996 and August 15th 1996.

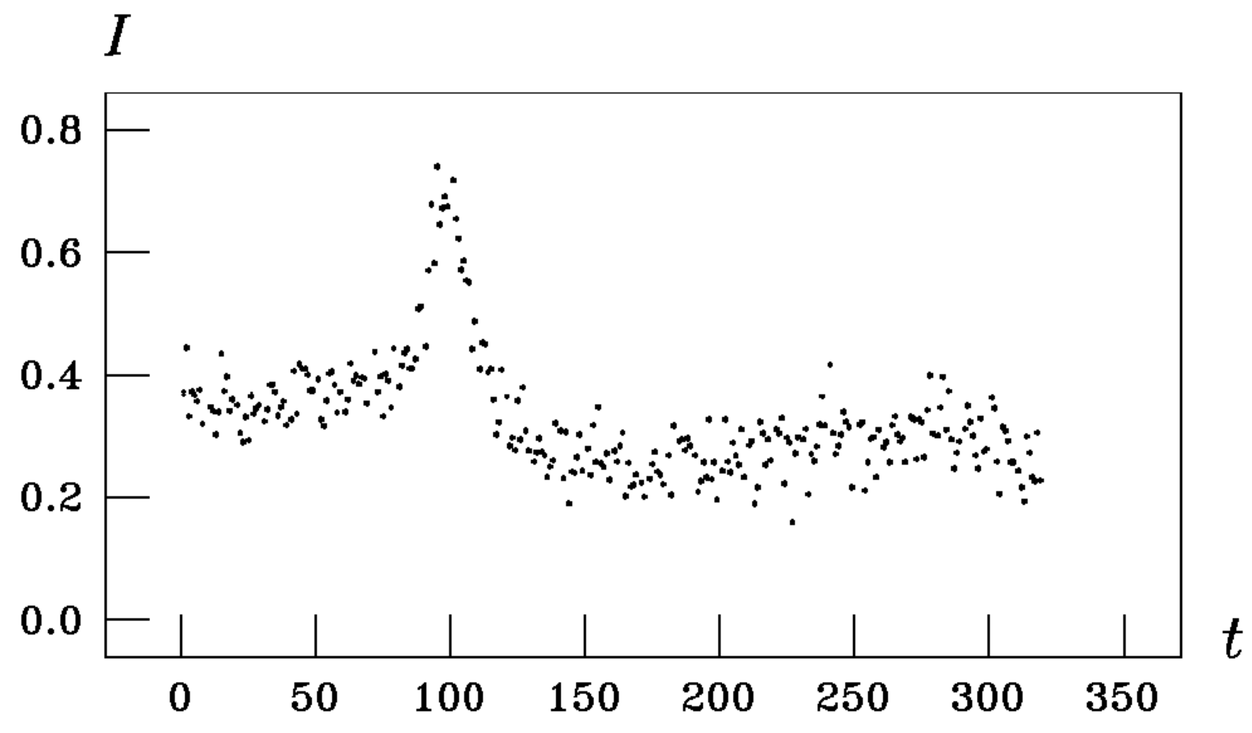
The observations carried out are of impotent informational value for functioning the system of control of CO behaviour in orbit and systems of cosmic space control.



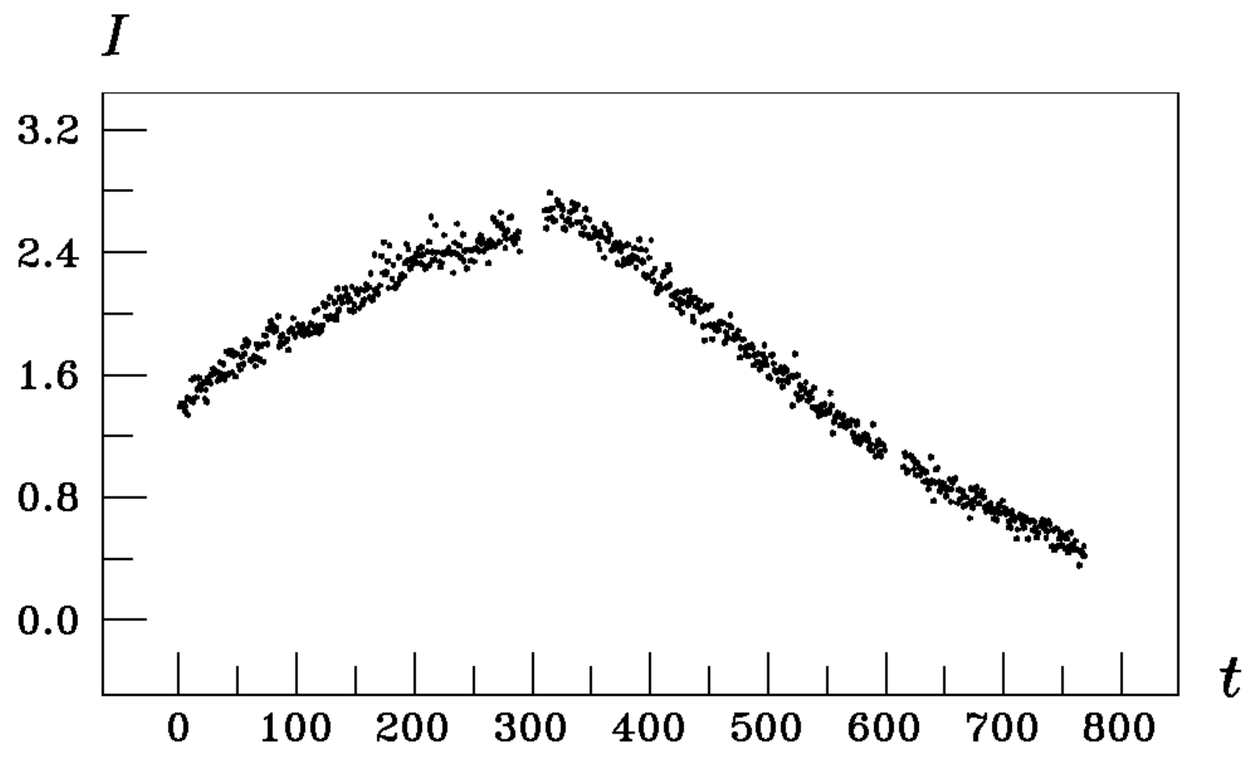
95−132−1, 28.09.95 UT=17^{h}15^{m}785, σt=0^{s}349, et.=1500



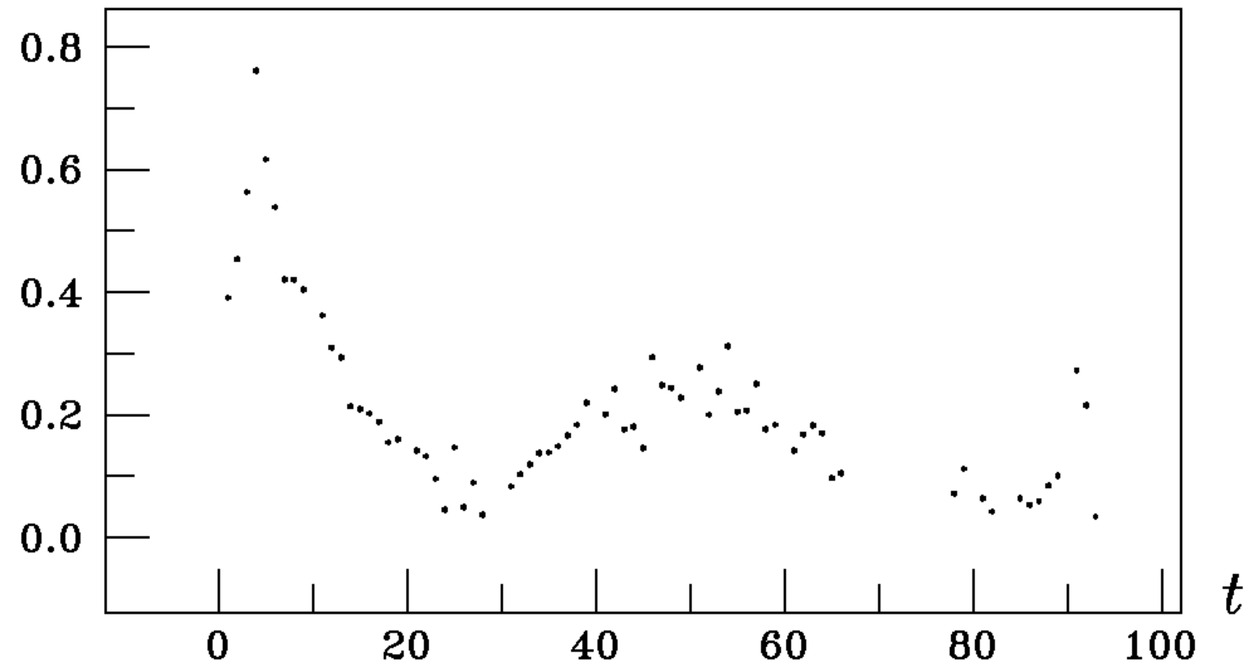
95−132−1, 22.07.96 UT=01^{h}28^{m}586, σt=0^{s}349, et.=149



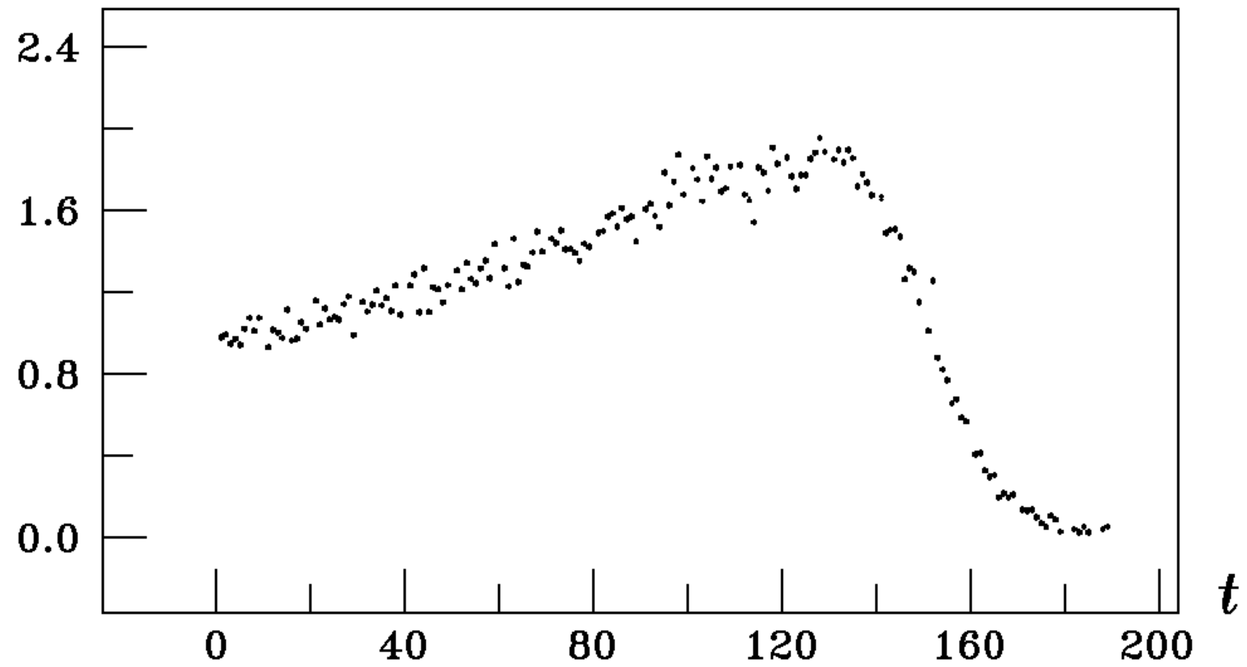
95−132−1, 10.06.96 UT=19^{h}48^{m}324, σt=0^{s}350, et.=1580



95−132−1, 23.07.96, UT=00^{h}15^{m}638, σt=0^{s}350, et.=1490



95−132−1, 21.07.96 UT=23^{h}53^{m}317, σt=0^{s}350, et.=1410



95−132−1, 11.08.96 UT=21^{h}45^{m}695, σt=0^{s}349, et.=140

Figure 1. Finding charts for V Sge

ABOUT THE DYNAMICS AND ROTATION OF THE ARTIFICIAL SATELLITES

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ABSTRACT. In the present work the results of the investigation of the unguided artificial objects which belong nowadays to Space Debris, have been considered.

The experience of the analysis of these results has proved that such objects may serve indicators in basic perturbating moment study. One of the methods of perturbation reveling is investigation of the objects orientation changes in space.

Key words: Artificial satellites

The analysis of the prolonged observations showed that the uncontrolled artificial satellites which are distinguished by their mass, size and shape can be a good indicator of different processes in the circumterrestrial cosmic space. Any such satellite "tries to please" disturbing moments. The latter are born by the asymmetry of the Earth's and the Moon's gravitational fields, the aerodynamic processes, the Earth's magnetic field, the pressure of the Solar radiation, the reaction of the inner mobile parts of the satellite. The difficulty in the solution of this problem is connected with the separation of these moments into individual components of the resultant interaction. Researches of the changing of the satellite rotation period around its own center of mass, and the Earth in the present case are insufficient.

The definition of the orientation character of one of main object's axes, and its changing are an important step to success. These affirmations are caused by our experiment. We determined the secular precession period, and the sector of the ging character. According to the theory, the triaxial satellite will be regularly precesses around the direction of the vector of the angular momentum in the gravitational field which acting with another field in resonance. The vector of the angular moment precesses around the perpendicular to the orbital plane.

The obtained data concerning the character of the secular precession allowed us to conclude about the mechanism of the influence of the main disturbings moments in their interaction to the satellite. For example, the Moon's effect is clearly displaying on the rotation of the heavy satellites with the single stereometric shape. During the year seasonal changing of the rotation period has been noticed in light satellites especially of large diameters. The analysis of the orientation character of the satellite "Pageos" ($m = 56\,\mathrm{kg}$, $d = 32\,\mathrm{m}$, $H \approx 4000\,\mathrm{km}$), and the theoretical calculations of the action of the all possible disturbing moments concerning it have been carried out. The obtained data displayed that the interaction of two disturbings moments such as the magnetic moment, and the solar radiation pressure have been the cause of the seasonal changing of the rotation period of the present satellite. This interaction has a resonance character.

"Midas-4". From the results of the observations of the satellite "Midas-4" the orientation of this object was determined. It was found, that the rotation object is realired around lengthwise axis, which is directed to the center of the Earth. This axis carried out the forced nutation with angle $9° - 12°$. Period of the nutation vibrations with the period of proper rotation 1:3. During some years the period of the rotation changed from 105 sec to 135 sec. These results were compared with the Wolf numbers of the Solar activity. The period is increased with the Solar activity.

Rocket-bearer of "Cosmos-546". During one year the orientation of the object was investigated. Examination of the results showed that the body turned somersault.

Somersault axis penetrates the body at the angle 53° to the lengthwise axis and it is directed to the centre of the Earth's. As a results of the secular precession of the vector of angular momentum this axis is vibrating as to orbital plane with the $P \approx 28$ days and the angle $\approx 27°$.

The method of the orientation definition of the uncontrolled satellites have been carried out at the Uzhgorod University. Results of the photometric, and positional observations for the Earth's artificial satellites are the base of the abovementioned methods. All the experimental data have been obtained at the Uzhgorod University.

EXPERIMENTAL CONFIRMATION OF THE EXACTNESS OF ORBITAL ARTIFICIAL NEAR–EARTH OBJECTS "SICH–1" MEASURINGS WITH OPTICAL INSTRUMENTS BY ASTRONOMICAL OBSERVATORIES OF UKRAINE

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ABSTRACT. In the article it is shown, that by photographic cameras AUF-75 with a consequent astrometric reduction of images artificial celestial bodies it is possible to make on observations from one item to calculate orbit of the satellite "Sich–1". A method to receive some orbit elements during the short time interval is present. Observations from three items will enable to update elements of orbit. The accuracy of calculation of orbits of the satellite makes up 10–20 meters.

Key words: artificial space objects, photographic camera, astrometric processing, orbit.

The artificial space objects differ from traditional objects in astronomy, therefore special equipment, and also special methods of astrometric processing are necessary for their observations.

The observations artificial celestial bodies (ACB) at different heights above the Earth's surface are necessary for a solution of many practical problems, and it means necessity of observation of the satellites of various visible stellar magnitudes. Photos of the weaker satellites will receive applying a method of compensation of a velocity of transition of its image on photoemulsion.

Universal semi-automatic camera of the AUF-75 type on the four-axial mounting is such an instrument Camera is devoted to the photographic observations of the active, passive, bright and weak satellites. Camera has the seven-lenses objective of the URAN–16 type with D=210mm, F=735mm. Width of film is 190 mm, rewinding of the film is automatic. The size of photos is 140×200 mm ($10° \times 15°$.). Camera permits object's photographing with the brightness up to 10–11 magnitude in the interval $0.02 - 1°$ per second of the topocentric angular speed.

Main difficulties of photographic observations of artifical Near–Earth objects 500 km/s $< H <$ 5000 km/s (Kirichenko, 1970) are:

1. Complexity of simultaneous registration of an exact time and deriving of exact coordinates.

2. For majority of the existing satellites the effective exposure time for fixed camera lies within the limits of the 100-th parts of a second and results that the trace of the weak satellite is impossible on photoemulsion

$$t_{ef.} = d/F \times m,$$

where d – object's image diameter in mm, m – angular velocity concerning a photomaterial in rad/sec, F – focal length of the camera in mm.

The sources of errors, which influence the accuracy of definition of a position ACB, are learned and investigated (Kirichenko, 1970).

The astrometric reduction of negatives with ACB is made by Turner's method making allowances for all features and single-error corrections in a system of the catalogue SAO on epoch 1950.0, i.e. if the photographic observations are obtained, the positions of the satellite on epoch 1950.0 with an accuracy 3" on coordinates and 0.001 seconds of time. For calculation of orbit parameters it is necessary:

1. To reduce the moments of observations in a system of standard time UT1 (using the Report of world time) making allowance for single-error corrections for delay of signals of time in camera and equipment of a service of time. For the radioreceiver "Wolna" is recommended to accept the following significance of single–error corrections:

Band	Correction
0.5 kHz	0.001 sec,
1.5 kHz	0.0006 sec

It is necessary to enter into instants in a system UT1 a single-error correction for berration time – space of time, for which light passes a distance from the observer up to the camera: $t = 0.0213 \times R$, where R – distance from the observer up to the satellite.

2. It is necessary to reduce topocentric coordinates obtained on epoch 1950.0 (in systems of the catalogue SAO), on moment of observations (Kirichenko and Klimik, 1985). The program takes into account not only the precession and nutation, but also the daily aberration. The year's aberration is entered by coordinate's

calculation by Turner's method. The accuracy of coordinate's reduction on other epoch makes about 0.001 seconds.

The program allows to enter a single-error correction for a daily aberration for many items, only it is necessary to enter coordinates ϕ and λ for the given item. The items, such as Uzhgorod and Kiev are entered in the program. It is possible to enter lot of items.

If the observations are made in such a manner that the coordinates of the satellite in a horizontal system are obtained, for deriving elements of orbits it is necessary to transfer then in to equatorial coordinates. We compose the program on computer with this purpose. The program works under the following scheme: $A, h \longrightarrow \alpha, \delta \longrightarrow x, y, z, vx, vy, vz \longrightarrow$ elements of orbit.

In this case we have a,d already will be in a system of observations. By results of observations we define space coordinates of the satellite and their modification, i.e. x, y, z, vx, vy, vz , where the coordinate x is directed exactly of vernal equinox, and coordinate z – on the north celestial pole.

$$x = X_0 + R \times \cos\delta \times \cos(\alpha - S),$$

$$y = Y_0 + R \times \cos\delta \times \sin(\alpha - S),$$

$$z = Z_0 + R \times \sin\delta$$

Where X_0, Y_0, Z_0 – are coordinates of items in a system of the Standard Earth III (Lunquist and Weiss, 1969), R – topocentric distance, S – local stellar time.

As it is visible from the formula, it is necessary to know a distance, which can be obtained by laser or photographic observations. The coordinate x can be directed to a Greenwich meridian, then it is necessary to replace S on $s = S - \lambda$ (λ – longitude of item of observations).

According to observations from other items of Ukraine, where there are photographic cameras "AUF-75" or other equipment, which gives the accuracy of a Near–Earth object position up to 5", it is possible to update the calculated elements of orbit and ephemerides.

Thus, using the above-stated programs, and also actual observation's results, it is possible to improve elements of orbit for the object "Sich–1" upto $10 - 20m$ even on observations from one station.

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THE PRECESSION OF ASTEROID 1620 GEOGRAPHOS

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ABSTRACT. The frequency analysis of the fine photometric effects in the photometric observation obtained during asteroid 1620 Geographos approaching to Earth in 1994 allowed to derive the precession of asteroid spin axis. The periods of $0^d.8$ and $2^d.8$ or multiple to them were revealed. The magnitude of precession angle was estimated to be near 3°. The nature of the precession discussed. The emergence of the free precession may be supported at time of the formation of the asteroid or by the collision with another body. The forced precession does not contradict to the Geographos connection with meteor streams and the assumption that Geographos may have small satellites.

Key words: asteroids: rotation, precession, satellites

Introduction

Asteroid 1620 Geographos belongs to the group of Apollo S-type. The silhouette of asteroid has the dimension of 5.11x1.85 km accordingly to the radar data. The three-dimensional ellipsoid model of asteroid has the axis-ratio $a/b = 2.8$ and $b/c = 1.1$ (Magnusson et al. 1996; Michalowski et al. 1994). The sidereal period is P=0.2176386 days and maximum amplitude of light variations about 2^m. The light curves have fine photometric effects: time displacements of extrema, irregular brightness and amplitude changes and other.

The rotation motion of an irregular body can be described in common case by a solution of Euler equations. There are two stable solutions: the rotation around the largest or smallest axis of the momentum of inertia. For the three-dimensional ellipsoid these axes coincide with the longest and shortest axes. In the common case asteroids have rotation, precession and nutation motions. Sher (1971) was the first who noted that the changes of light curve forms may be caused by the precession.

External force excites the forced precession. In such case the changes of asteroid mean brightness occurs with the precession period. Asteroid 1220 Crocus showed such effect and Binzel (1985) pointed out on existence of an satellite.

In the case of free rotation the angular momentum vector is constant and the instant axis of rotation is precessing around the main axis. As a result the amplitudes of light curves change. But the asteroid mean brightness remains constant.

The goal of this paper is the investigation of the fine effects in rotation motion of Geographos by means of care frequency analysis of photometric data.

The frequency analysis

Selected for analysis observations contained 25 light curves of V-magnitudes from August 28 to September 14 1994 (Magnusson et al. 1996). All data were corrected for phase function and reduced to unit geo- and heliocentric distances. Two partly overlapping in time sets were created for analysis from 1322 brightness measurements. Each set was whitened by the frequency of asteroid rotation. As the result the obtained data contained only precession light variations. For comprehensive analysis seven additional sets were formed also: asteroid brightness at maxima and minima of light curves, the amplitudes of light curves, mean brightness, time displacements of observed light curves extrema moments relatively calculated moments.

Three different methods of frequency analysis were used for search of unknown periods (Prokof'eva et al. 1995). They are assumed to be real if they are presented in all methods and sets.

The rotation of rigid body was confirmed. Two sets of multiple periods $2^d.8, 5^d.6, 11^d.2$ and $0^d.8, 1^d.7, 2^d.4$ with probability 98 % were found. The periods with smaller significance are not involved.

The evaluation of precession angle

The results obtained for light curve maxima (period $2^d.8$ with amplitude $0^m.05$) were used for the evaluation of the precession angle. At this moments the largest asteroid axis lays in picture plane and the dimension of asteroid shape projection on this plane is the largest. The change of brightness in light curve maxima is possible only when axis b projection on picture plane varies periodically. Using relation $b/c = 1.1$ and mean value of aspect angle 98° we estimated the angle of pre-

cession as 3°.

The evaluation of precession period

According to Kopal (1970) periods of free precession P_f and rotation P_r in the case of three-dimensional rotation in space are connected with rough relation

$$(P_r/P_f)^2 = (C - B)/A$$

where A, B, C denotes the moments of inertia of the body about axes x, y, z. We used known half-axes of Geographos $a = 2.55$ km, $b = 1.02$ km, $c = 0.92$ km calculated A, B, C and evaluated free precession period as $P_f = 0.7^d$. This value is very close to the period $0^d.8$ that was found by our analysis. This fact confirms our assumption that we found the free precession of Geographos with period $0^d.8$ or multiple of it $1^d.7$ or $2^d.4$.

On Geographos precession nature

We have found two sets of multiple periods. One period from each set is real, but we don't know what. It is impossible also to make right conclusion what kind of precession was recorded.

The physical conditions of formation of free or forced asteroid precession has different nature. Both kind of precession may exist.

The free precession has relict nature. There are two reasons of initiation of it. Firstly, the small asteroid have time scale of damping to steady rotation around the shortest axis comparable to the Solar system age. Secondary it was possible that free precession had catastrophic cause that was pointed by Rozaev and Tomanov (1996).

The forced precession arises under the action of external force. Such force may be created by satellite. Facts revealed the Geographos connection with meteor streams: Virgo (Kres'ak, Stohl 1990) and possible 9 small streams (Ryabova 1986). Geographos may be surrounded by a cloud of dust and other fragments of different sizes. In such conditions our suppose about satellites of Geographos may be real.

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OBSERVATIONAL RESULTS OF CALIBRATION AND NAVIGATION COSMIC APPARATUS (CA)

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ABSTRACT. Results are represented of photometric observation of nine calibration and navigation cosmic apparatus obtained at the Odessa Astronomical Observatory in September-October 1995.
Key words: cosmic apparatus, photometry.

According to the contract on collaboration with MPO "Astrophyzika" from the given elemental orbits, ephemerides are calculated and observations are carried out of cosmic objects numbered KA-077, -081, -090, -091, - 098, -150, -804,-805, ERIDAN, GEOS IK.

The given results represent observations of 37 transits of 9 cosmic objects. In process of 16 transits, coordinate and photometric information on 5 CA is obtained. In the rest transits the information was not registered due to faint objects' light and unfavorable observational conditions. The observations were made from September 25th to October 25th 1995, and since August 12th 1996 at the apparatus complex of photometric and coordinate observations of CA department of space research, Odessa Astronomical Observatory (KOD-1) certified by MPO 'Astrophyzika" in 1988 and process of joint work.

Cinetheodolite KT-50 - the azimuthal system of guiding fast moving objects - is used as a base tracking system. Mechanical part of the system has been modified: turn units' sensor are set in, a platform of optic-mechanical photometer block is introduced etc. To record the CA light, a one channel photometer at the photons' count with a spring-diaphragm is used. Electron part of the photometric channel consists of a frequency meter, control unit, record center and a high-voltage power supply, all connected logically, algorithmically and constructively.

For automatic obtaining the coordinate information on CA, an angle–measuring device is developed and manufactured permitting to yield coordinate information from KT-50 in real time scale suitable for the input in the computer.

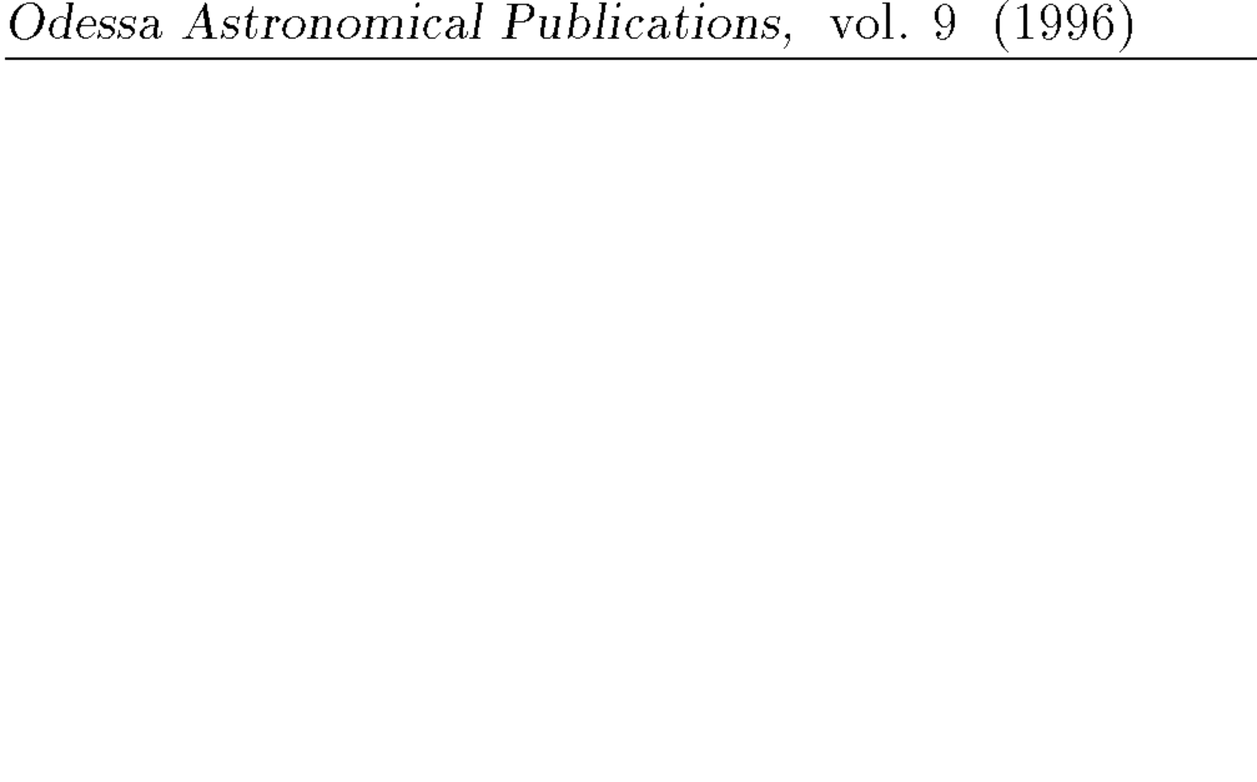
The list of objects observed is summarized in Table 1. For all the objects, light curves in direct intensities in the instrumental system are obtained. Apart from the CA observations every night, the observations of calibration stars and stars for atmospheric extinction determination were carried out. By using developed algorithms of malfunction, failure analysis and rejection data and algorithm of CA light curve formation in the instrumental system, the reduction of the data obtained is carried out. All the light curves are reduced to the brightness standard. Coordinate information and tabulated light curves are stored in the CA data bank of AO Space Researches department.

Table 1: Program stars

Name of CO	Date of obs.	Time of outset	stell. mag.	Ext. coef.
CA-081	25.09.95	22 48 00	7	0.5
CA-081	28.09.95	21 33 00	8	0.7
CA-081	05.10.95	19 55 00	9	0.6
CA-081	06.10.95	19 31 16	8	0.5
CA-081	14.10.95	18 11 00	9	0.6
CA-081	15.10.95	19 36 15	8	0.5
CA-081	16.10.95	21 02 34	5	0.4
CA-081	17.10.95	18 48 13	9	0.4
CA-081	17.10.95	20 37 10	3	0.4
CA-081	18.10.95	18 24 27	10	0.5
CA-081	23.10.95	18 12 24	9	0.5
CA-081	24.10.95	17 48 05	9	0.4
CA-090	07.10.95	03 03 40	2	0.6
CA-091	24.10.95	02 28 31	4	0.5
CA-091	25.10.95	02 05 05	4	0.4
CA-098	05.10.95	01 06 04	10	0.4
CA-098	05.10.95	22 43 00	9	0.5
CA-098	06.10.95	22 09 00	10	0.7
CA-098	15.10.95	20 36 00	10	0.4
CA-098	16.10.95	21 49 54	10	0.4
CA-150	05.10.95	01 58 11	9	0.4
CA-150	06.10.95	01 42 38	10	0.5
CA-150	16.10.95	02 26 00	8	0.4
CA-150	17.10.95	02 05 55	7	0.4
CA-150	18.10.95	01 49 21	7	0.4
CA-150	24.10.95	00 08 00	9	0.5
CA-150	24.10.96	01 57 25	8	0.5
CA-150	25.10.95	01 40 22	8	0.5
CA-804	03.10.95	02 17 50	7	0.4
CA-804	05.10.95	00 35 11	7	0.4
CA-804	05.10.95	02 21 04	7	0.4
CA-804	06.10.95	00 35 34	7	0.5
CA-804	06.10.95	02 16 57	7	0.4
CA-804	07.10.95	00 36 27	7	0.7
CA-804	07.10.95	02 18 00	7	0.6
ERIDAN	25.10.95	02 17 03	4	0.4

As is seen from appearances of light curves observed by CA, the given objects can be discriminated, and their behavior can be traced in orbit that is of important informational value for functioning circumterrestrial space control systems.

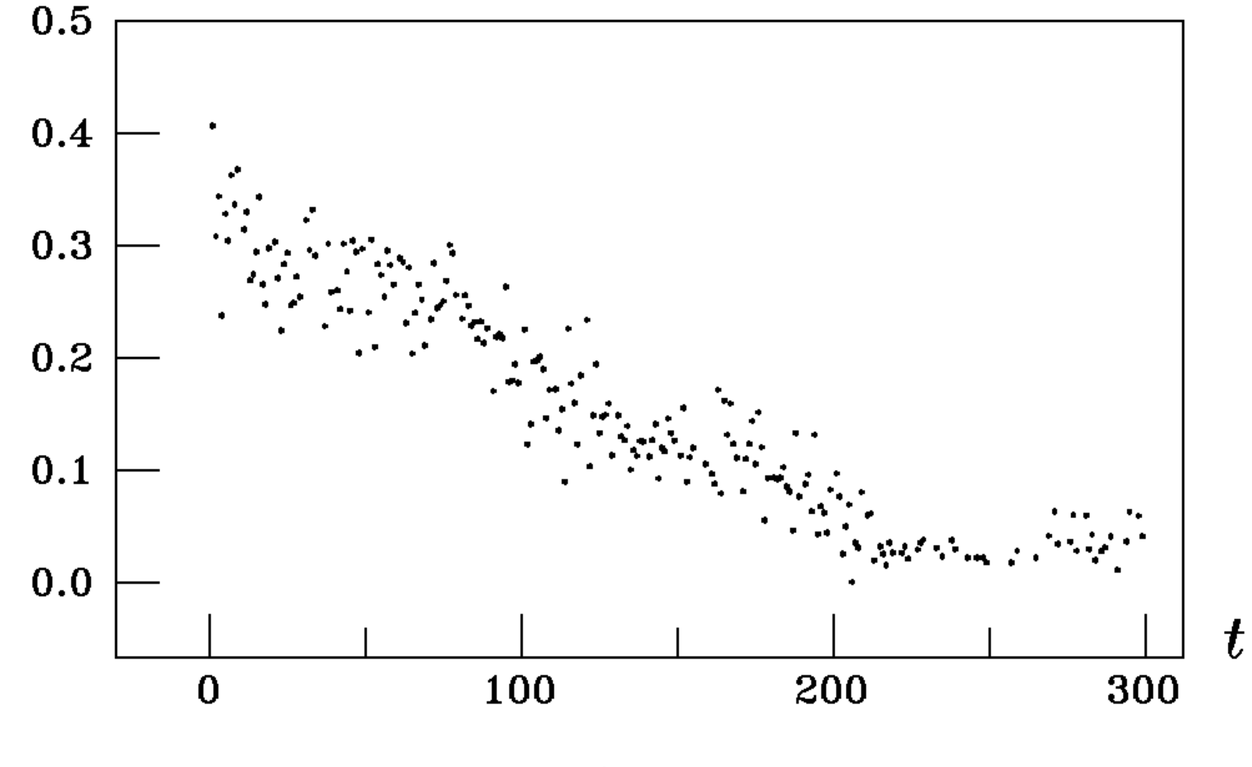
In 1996 due to unfavorable weather conditions (Moon, clouds etc) the objects were not found so far.



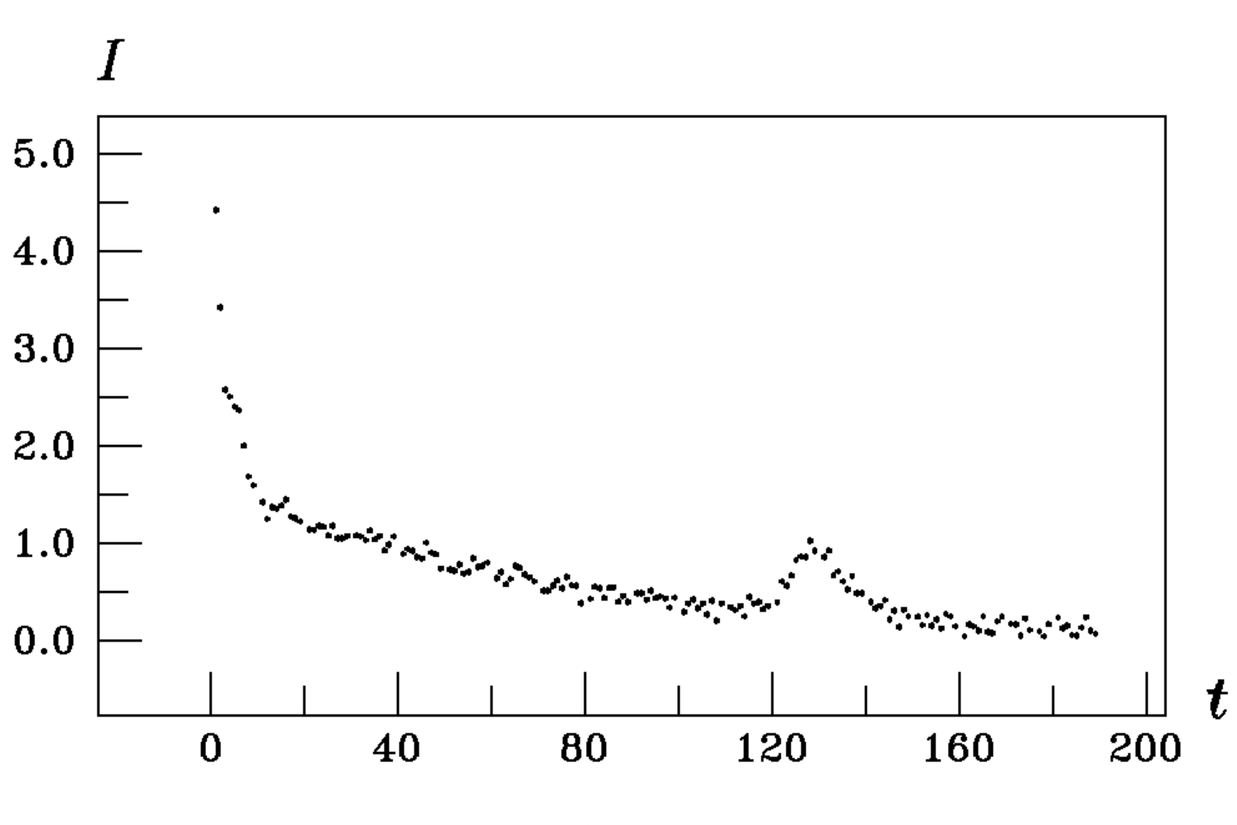
KO−081, 25.09.95 UT=22^h51^m278, $\sigma t=0^s348$, et.=1360



KO−090, 07.10.95 UT=03^h03^m402, $\sigma t=0^s349$, et.=1330



KO−081, 24.10.95, UT=17^h49^m254, $\sigma t=0^s348$, et.=1170



KO−091, 25.10.95 UT=02^h05^m482, $\sigma t=0^s348$, et.=1080

Figure 1. Finding charts for V Sge

PROBLEM OF LATENT MASS UNDER RADIATION OF METEORS

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ABSTRACT. The date on absolute spectrophotometry of meteor spectrograms permit to estimate the number of radiating particles for different brightness of meteor.Methods of nonradiation meteor mass estimation are given. Comparison of observed numbers of radiating concentration with know data of artificial cosmic sample will allow to get the coefficients for calculation the nonradiating meteor mass.

Key words: Meteors: spectrofotometry, the latent mass.

The physical theory of meteor radiation is know to be founded upon equation:

$$J = \tau(-\mathrm{d}m/\mathrm{d}t)V^2/2, \qquad (1)$$

τ - coefficient of radiation efficiency which can be determined quantitatively from special experiments. Only velocity V is the most beliable value obtained. τ and mass m, relation $m(t)$ are unknown magnitudes. It is possible to examine two methods possibility calculation of nonradiating meteor mass. First is the spectral intensity expression introduction a corrector factor $q_n = (A_{nl} + D_n)/A_{nl}$. In this expression A_{nl} is the calculated probability of spontaneous transmission from the level n to that l below per unit of time. The introduced magnitude D_n characterized frequency of inelastic collisions of the second art between particles of meteor plasma.

Formula for spontaneous radiation intensity from the level n to level l is of the form:

$$J_{nl} = N_n^T A_{nl} h\nu_{nl} q_n. \qquad (2)$$

Here N_n^T - theoretical population of level n corresponding to the thermodiynamic equlibrium condition. The theoretical radiation intensity arising at the spontaneous transition from the level n to l is designated with i_{nl} and defined by the formula

$$i_{nl} = N_n^T A_{nl} h\nu_{nl}. \qquad (3)$$

Let us assume the frequency of inelastic collisions of the second kind for levels n and k to be the same that is $Dn = Dk = D$. The nagnitude D can be derived which characterizes the degree of meteor plasma radiation departure from the equilibrium state

$$D = \frac{\frac{i_n}{i_k} - \frac{I_n}{I_k}}{A_n \frac{I_n}{I_k} - A_k \frac{i_n}{i_k}} A_n A_k, \qquad (4)$$

that is possible to determine. However, to determine real theoretical values N of atom number density the real theoretical intensities for the model corresponding to a radiative object are needed which cannot be done practically.

Second method of calculating nonradiating meteor mass based on comparising the number for selected radiating atoms from observation and theoretical values of particle number densities received from decision of kinetics equation. Application of kinetics equations makes it possible to calculate changes in particle number densities in time (Smirnov, 1995). Comparing observed and theoretical number densities for the meteor we can get radiation efficiency.

Numerical calculations according to both methods contains in the book "Spectra of trancient atmospheric light phenomena: meteors" (Smirnov V.A., 1994).

So, to yield real elemental abundance in meteor spectra, artificial standards are needed the radiation of which occurs under the conditions similar to the meteor ones. The project "Fire I" is an illustration of such a standard object investigation (Millman, 1964). Comparison of spectra of such artificial objects with meteor plasma might help to determine meteor radiation efficiency and find real chemical composition of radiating matter.

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ORIGINS OF COMETS: THE HYPOTHESIS OF RELICT RESERVOIR OF COMETARY BODIES (CB) AS UNITARY STORE OF COMETS OF THE SOLAR SYSTEM

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ABSTRACT. Solar system comets come from a relict reservoir of cometary bodies (CB). The reservoir consists of two components of common origin, but highly different spatial, dynamical and kinematical characteristics:
1. Dynamically stable on cosmogonic time-scale component formed by Kazimirchak-Polonskaya (K.-P.) belts laying between giant planets (GP) and beyond Neptune (including the Kuiper Belt). The component extends up to the unknown boundaries of the zone of primordial planetesimals formation and (thanks to CB collisions pushing the CB away from the zone of stability) provides us with periodic comets (with the exception of almost all the parabolic ones).
2. Swarm of dissipantes moving on Brown-type trajectories; at present the swarm may be of a size of no more than 100 ps, but expand diffusing "into the Galaxy", and provide, thanks to statistically inevitable returns of part of the CB to the Sun, "quasiparabolic" comets, including: a) elliptic quasiparabolic; b) nondistinguishable from parabolic; c) slightly hyperbolic comets. The CB that populate the nearest belt (the one between the orbits of Jupiter and Saturn) must be as bright as 23 - 24th magnitude and consequently, in principle, observable.
Key Words: cosmogony; comets; cometary relict reservoir.

Cosmogonic premises

1. It had been Schmidt's cosmogonic theory that had first considered the formation of cometary bodies (CB) as part of general process of planetogenesis - the CB had originated in the ample cool outer regions of primordial planetesimal disc. Still, in the frame of the same theory the following concept was developed: the zones of instability between the orbits of the giant planets (GP) not only amplified but merged as the planets grew; consequently, practically all the CB were driven away from the GP zone "out into the Galaxy"; only about 1of CB remained, because of stellar perturbations, and formed the Oort cometary cloud (OC) - the present comets supplier.

2. The statement of "general ejection", however, has not been proved as yet. Even its author (B.Yu Levin, 1949, 1976) did allow for the existence of certain number of "non-observable" asteroid-like bodies (e.g. cometary bodies) in the GP zone. Similar assumptions were made by several other authorities in asteroid-cometary problematic (D.Ya.Martynov, A.Delsemm, A.N.Simonenko, K.I.Churyumov, etc.). At the beginning of 1980th L.Kresak has shown from a theoretical standpoint that ring-shaped zones of dynamically stable minor bodies motion exist in front of, between and beyond the GP zones. As early as 1970th E.I. Kazimirchak-Polonskaya has proved that short-period comets drift to their observed orbits precisely from the belts laying between the GP (N.A.Beljaev has named those stores of comets "K.-P. Belts"). K.-P. herself had assumed that comets find their way to the belts through "gradual diffusion" from the Oort Cloud.

3. However, this method of replenishing the K.-P. belts with comets meets grave theoretical difficulties. The same is true in respect to practically all the other hypothesis for the origins of the CB that evolve to short-period orbits from the K-P Belt. (These are as a rule, alternative in respect to each other: comets capture from the OC and giant molecular clouds, ejection by volcanos on GP satellites or by explosions of the satellites frozen hydrospheres, etc.) Sagdeev has thus summarized the situation: "The problem of comets origins remains unsolved. ... To solve it, we must, in the first place, bring comet substance down to the Earth" (Sagdeev, 1989). Here is a clear recognition of the fact that the theory for comets origins has come to a dead end.

4. We arrive to the conclusion that the difficulties of cometary cosmogony developed in the frame of Schmidt's general cosmogony that has so successfully worked out a huge number of CB at the planetesimal disc, originate out of the statement, erroneous in principle, of the "total ejection" of CB out of the GP zone by

gravitational perturbations from GP. What does the cometary cosmogony gain by dropping that arbitrary statement?

Periodic Comets.

1. The K-P Belts obtain their cosmogonic base. All the other explanations of the existence of the Belts (as well as the short-period comets origins) become superfluous.

2. The CB remaining on stable orbits since the Solar System was formed, were affected by Solar radiation, Solar and stellar wind, cosmic radiation, etc., lost volatile elements from their thick (but later thinned) outer layers and formed a very dark silicon-metal crust with certain organic admixture. Parts of the crust are stricken away through statistically inevitable collision between CB. CB "shacking" (up to complete destruction) and shock perturbations of CB orbits also take place. A CB may jump all of a sudden on a "cometary" orbit of short perihelion distance or be thrown on a non-cometary-type orbit traversing one of the zones of strong perturbations near a GP orbit. Further dynamical evolution of such CB orbits is evident.

3. Similar phenomena take place, in particular, at the area extended from beyond Neptune through all the zone of dynamically stable relict CB reservoir up to the borders, unknown to us, of the zone of planetesimals formation.

So then, by dropping the "total ejection" statement, we gain an explanation, free from usual difficulties and paradoxes, of periodic comets origins (with the exception, at present, of the quasiparabolic ones). Yet, our approach is valid for the quasiparabolic comets as well.

Quasiparabolic comets.

1. The statement of general (not total!) ejection of CB from the GP zone (up to 10 exp 30 g, 10 exp 14 - 10 exp 15 CB) at the time of GP formation is one of the fundamental deductions of Schmidt's cosmogonic theory. The mechanism of the ejection permits to assume an extremely small value of the energy excess of an average ejected CB (the velocity at infinity v 0.1 km/s). The full energy h of such a CB may undergo brusque changes through stellar perturbations, up to changing the sign. The CB that would get an h¡0, return to elliptical heliocentric orbits (no matter the heliocentric distance of the CB), and, if perturbed no more, reach into the vicinity of the Sun.

The motion of the CB through perturbing media must have, under the exposed condition, a Brown-like character. The swarm of CB as a whole would expend, diffuse, and decelerate with time in right proportion with the square root from t (t being the time of ejection, e.g. the age of the Solar System).(But: see (Radzievskij, 1954)).

2. In accordance with the Polya theorem (Feller, 1967) separate members of such a swarm are to return to "the source" (e.g. the Sun) with an asymptotic probability of 0.35. Such a CB moving along the cometary orbit would be interpreted as a slightly hyperbolic (h¿0) or near-parabolic (h¡0) elliptic comet. (All the CB of sufficiently small module h wood be described as non-distinguished from parabolic comets).

So, both the types of quasiparabolic comets (including those non-distinguished from parabolic) may be explained on the base of the practically established "theoretical fact" of general ejection of CB from the GP zone at the epoch of Solar System formation.

Summing up: All the assemble of the observed Solar System comets may easily be explained qualitatively if we assume the existence of a relict CB reservoir consisting of two spatial-dynamic components of the same age, but of different character: 1. Dynamically stable component extended from the zone of PG on to the limits of the region of planetesimals formation; 2. Cloud of ejected CB that diffuses "into the Galaxy" (kinematically analogous to the Schiaparelli Swarm).

Observational aspects of the problem

1. The galactic cometary cloud is composed of repeatedly overlapped diffuse cometary clouds of separate stars. The average fraction of "native comets" in a local Opic cometary cloud - in the neighborhood of any given star, the Sun, for example, is very small. Still, we know of no "alien" comet as yet, may be, because the "native comets", having extremely small energy (velocities) in respect to the Sun are strongly focused by its gravitational field.

2. The "observational proves of the existence of the OC are just a misinterpretation: OC is thought to be the home place of all the observed objects belonging really to the "Schiaparelli Swarm"). In fact, there is no further need in the existence of OC.

3. The short-period comets we observe come from Solar System relict cometary reservoirs (in all probability, mostly from the Jupiter-Saturn belt). Consequently, we can ascribe certain characteristic parameters to the CB: a size d of 1 - 3 km (Churyumov, 1996), and an albedo A, probably not exceeding 0.04. It follows, that the CB of the middle of the belt (the expected CB highest abundance zone) should be as bright as 23 - 24th magnitude, that is, in principle, accessible to observations. The relict reservoirs of the Solar System CB may be discovered...

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TWENTY YEARS OF THE ODESSA CORRESPONDENCE ASTRONOMICAL COURSES

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ABSTRACT. The work of the Odessa Correspondence Courses is briefly described.

Key words: Astronomical education, amateur astronomy

The Odessa Correspondence Courses were initiated by Prof. V.P.Tsessevich, the famous scientist and popularizer of science, whose books and popular lectures attracted to science few generations of young people. These courses were initially based on the replies to the letters of the amateurs and schoolars who often ask for a various astronomical information. However, in addition to the consultations, V.P.Tsessevich proposed to send also home tasks on astronomy, mathematics and physics, and the work started. For each class at the school, five parts of samples from 10 home tasks were elaborated. The solutions by the schoolars were checked, their errors marked and correct solutions and answers sent back.

This work started when the number of pupils of this correspondense school was about a dozen or two. However, it's popularity growed within the whole Soviet Union and even other countries. The peak of activity occured in mid-80-ies, when the annual number of letters exceeds 3200! One may note, however, that these courses were not a separate official structure inside the University and had no special funding for salary, thus it was something like a public organization for introducing astronomical knowledge to the schoolars. However, the postal expenses were covered, as well as the publication of the booklets for amateur astronomers and students, and we succeeded to publish a series of booklets on instructions for observers, theoretical reviews and sample computer programs. These materials have been published by the Odessa State University, Odessa Institute for the Extended Teaching of Pedagogs and the Ochakov Lyceum. The teachers of these courses are listed as co-authors in the alphabetical order. Some part of work (about 10 per cent) was done by students.

This work was made in close collaboration with the groups teaching the pupils in the Planetarium and the Region Station for Young Technicians (OblSUT). Moreover, during 2 years (1994–95) the courses were supported financially by OblSUT in addition to the existing section of astronomy of the "Small Academy of Sciences" "Prometheus". Now the courses still exist again as a public organization, tha aim of which is to help young people to "find their own star".

Brief list of popular articles and booklets by the members of this group.

Andronov I.L.: 1987, Polars.- *Priroda* (Nature, Moscow), N 5, p. 26-35.

Andronov I.L., Kudashkina L.S.: 1988, *The instruction for visual observations of variable stars.* - Odessa University Press, 8pp.

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Andronov I.L., Chinarova L.L.: 1991, *Structure and Evolution of Variable Stars. Part 2.* Textbook for the school astronomical groups.- Odessa Inst. for the Extended Teaching of Pedagogs, 48pp.

Andronov I.L.: 1992, *Preparation of Data at Personal Computers.* - Odessa University Press, 48pp.

Andronov I.L.: 1993, *Classification of Variable Stars and their Visual* Observations. - Ochakov Lyceum, 52pp.

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Kudashkina L.S.: 1990-96, *The Atlas of Amateur Astronomer, parts 1–5.*

Kudashkina L.S., Rudnitskij G.M.: 1988a, Long-periodic variable stars, *Zemlya i Vselennaya* (Earth and Universe), N 2, 17-24.

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NSV 05513 = 69 (Δ) UMA – A LONG–PERIODIC ECLIPSING VARIABLE?

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ABSTRACT. The star NSV 05513 is suggested to be an eclipsing variable with a period of $1030^{\rm m}$ – $1180^{\rm m}$ ($1115^{\rm m}$) and a range $3^{\rm m}.3$-$4^{\rm m}.3$ V.

Key words: Stars: eclipsing: NSV 05513

According to the "New Catalogue of Suspected Variable Stars" (NCSVS, Kholopov et al., 1981), 69 UMa is NSV 05513 with a spectrum A3V and a range 3.27-3.34(V). The variability type was not recognized. Its variability was suspected by Zinner (1929). In the "Catalogue of the WBVR–magnitudes of the bright northern stars" (Kornilov et al., 1991), the object NSV 05513 (69 UMa) is marked as HD 106591 A (p.171), and also BD+57°1363 - ZI 919 with a spectrum A3V, V=$3^{\rm m}.308$, W–B=$0^{\rm m}.099$, B–V=$0^{\rm m}.082$ V–R=$0^{\rm m}.050$. In the remarks to the Catalogue it was noted that 69 Uma = IDC 12105+5735 A, where $\rho_{AB} = 189$", $\rho_{AC} = 186$" (p. 355).

In May and June 1995 the weakening down to $4^{\rm m}.0$–$4^{\rm m}.3$ mag was observed by the authors. Such type of event was not mentioned neither in the "General Catalogue of Variable Stars" (Kholopov et al., 1987), neither in NCSVS. The regular visual observations started in the end of July, 1995. The comparison stars were HD 103287, HD 95418, HD 81937 A, HD 71369 AB, HD 84999 AB, HD 123299, HD 126660 A, HD 125162. Their V magnitudes were used for our photovisual systems. From 28.07.95 to 17.08.95, the brightness of 69 UMa was about $4^{\rm m}.0$; from 18.08.95 the star began to brighten.

I.S.B. used the negatives of the new "SPEZ" collection (panchrom film with a GOST 250 sensitivity, the yellow–green filter ZhZ-2*, the photocamera "Zenith–ET" with an objective "Helios–44–7", limiting magnitude $8^{\rm m}.5$). On 24 negatives the star is faint being at $4^{\rm m}.2$–$4^{\rm m}.3$ V in June and brightens up to $3^{\rm m}.3$-$3^{\rm m}.4$ V in September.

V.M.A. measured 13 negatives (panchrom GOST 130, the yellow–blue filter ZhS-18, the photocamera "Zenith–ET" with an objective "Helios–44–7", and on the film A500 at the same camera without filters (experimental photothek, 1991–92). One may note that a white star (Sp A3) seems to be more bright $3^{\rm m}.0$–$3^{\rm m}.3$ on the panchrom negatives rather than on A500 ($3^{\rm m}.6$–$3^{\rm m}.7$). This argues for a systematic difference between the two instrumental systems.



Figure 1. The phase curve of NSV 05513 corresponding to a period $P = 1115^{\rm m}$.

Based on our photographic data an on the information by Goranskij (private communication) that 69 UMa was suspected to be variable by E.Zinner in 1928 and L.Campbell in 1946, we suggest that the star 69 UMa = NSV 05513 is an eclipsing variable with a period of $1030^{\rm m}$ – $1180^{\rm m}$ ($1115^{\rm m}$) and a range $3^{\rm m}.3$-$4^{\rm m}.3$.

Our observations were confirmed by L.N.Champion (England), Yu.Strigelskij, D.Babinovich and Yu.Beletskij (Belorussia).

Acknowledgements. The authors are thankful for attention and help to I.L.Andronov and V.P.Goranskij.

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RESULTS OF OBSERVATIONS OF V 1081 TAU AND A NEW EA–TYPE VARIABLE STAR BD+23°770 IN THE TAURUS

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ABSTRACT. The stars V 1081 Tau = NSV 1702 and BD+23°440 (GSC 1832.1631) are found to be EA–type eclipsing variables with the elements 2449215.51+1.0078·E and 2448597.342+1.95558·E based on 142 Ipv negatives of the "Betelgeuse" collection.

Key words: Stars: eclipsing: V 1081 Tau, BD+23°440.

History of Study of V 1081 Tau

The information on the variability of NSV 1702 (=V 1081 Tau = BD+22°743, $6\overset{m}{.}6 - 8\overset{m}{.}0$ V, Sp B9) was published in the Binoc. Sky Soc.Rep. (1967/68) where slow brigtness variations were mentioned. Chinarova and Andronov (1993) have measured the star on 125 negatives of the Odessa plate collection and pointed out that the histogram of brightness is characteristic for an eclipsing binary.

We have measured the star according to the call for observations by I.L.Andronov.

The Observations

V 1081 Tau was measured on 144 negatives of the amateur Sky patrol collection (the photographic camera "Zenith-3", the objective "Helios-44", the "yellow-blue" filter ZhS-17, the photo film RF-3) in the interval J.D. 2448509-2449763. The finding chart and the brightness of the comparison stars were published by Chinarova and Andronov (1993).

Description of the light curve of NSV 01702 = V 1081 Tau

During each observational night the object was slightly variable in a range $6\overset{m}{.}5 - 6\overset{m}{.}9$, but no periodicity was found. However, at the negatives obtained at J.D. 2449073.377, 2449215.5076, 2449221.55: and 2449597.454 we have found at the image and at the secondary image the Algol–like weakenings downto $7\overset{m}{.}2 - 7\overset{m}{.}4$.

The time series analysis was carried out by using the program by D.Kolpakov (SAI) realizing the method by Lafler and Kinman (1965). It was found that the star is an eclipsing variable with the ephemeris

$$J.D.min = 2449215.51 + 1.0078 \cdot E, \qquad (1)$$

duration of the eclipse $D = 0.13$, and the range of brightness variations $6\overset{m}{.}5 - 7\overset{m}{.}3$. The phase light curve is shown in Fig.1.

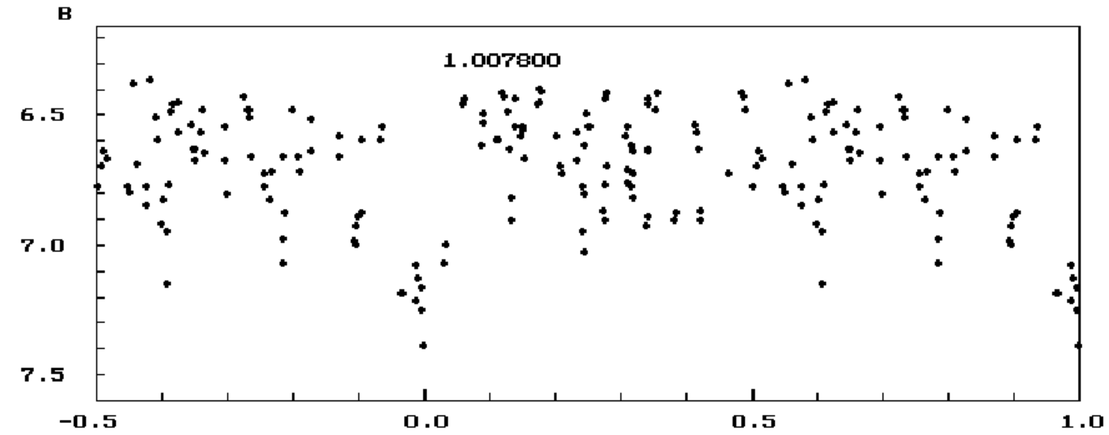


Figure 1. The phase curve of V 1081 Tau according to the elements (1).

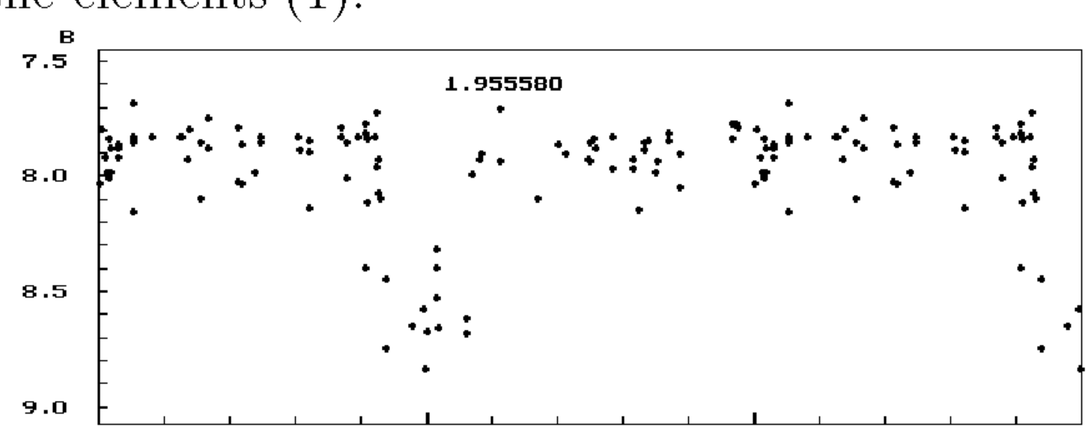


Figure 2. The phase curve of BD+23°770 according to the elements (2).

BD+23°770

While measuring the star V 1081 Tau, we have found on the same negatives another variable star BD+23o770 (HD 31353, Sp B9). The similar time series analysis have shown that the suspected variable is an EA–type eclipsing star with the elements

$$J.D.min = 2448597.342 + 1.95558 \cdot E, \qquad (2)$$

$D = 0.2$, range $7\overset{m}{.}8 - 8\overset{m}{.}7$. The phase light curve

stars is shown in Fig. 2. We have used the comparison GSC 1832.0923, GSC 1832.0809, GSC 1832.0849 and GSC 1832.1874.

Acknowledgements. The authors are thankful to N.N.Samus' for his attention to the work and to I.L.Andronov for initiating this work and for its preparation for publication.

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NEW EA–TYPE VARIABLE STAR IN THE FIELD OF NGC 2174 AND NGC 2175

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ABSTRACT. New Algol–type star is found with $\alpha = 06^h09^m16^s.9$, $\delta = +20°25'06''$ (2000.0), JD Min= 2449311.467 + 2.210345·E, range $13^m.9 - 15^m.3$, duration of eclipse $D = 0.07$.

Key words: Stars: eclipsing

The variability of the star in the field of NGC 2174 and NGC2175 was discovered by the author. The brightness was measured on 46 negatives of the Moscow (Sternberg Astronomical Institute) plate collection which were obtained in J.D. 2429362 - 2449359 and on 84 negatives of the Odessa plate collection (Astronomical Observatory, Odessa State University) in J.D. 2436252 - 2448919. The finding chart is shown in Fig. 1. The brightness of the comparison stars was determined by linking to the photometric standard SA 74 in the photometric system .

The data were analyzed by using the computer code by Yu.K.Kolpakov based on the method by Lafler and Kinman (1965). The star was found to be eclipsing with the parameters of the light curve (Fig. 2) listed in the Abstract. At the Palomar Atlas the star is not coloured, possibly its spectral class is A or F.

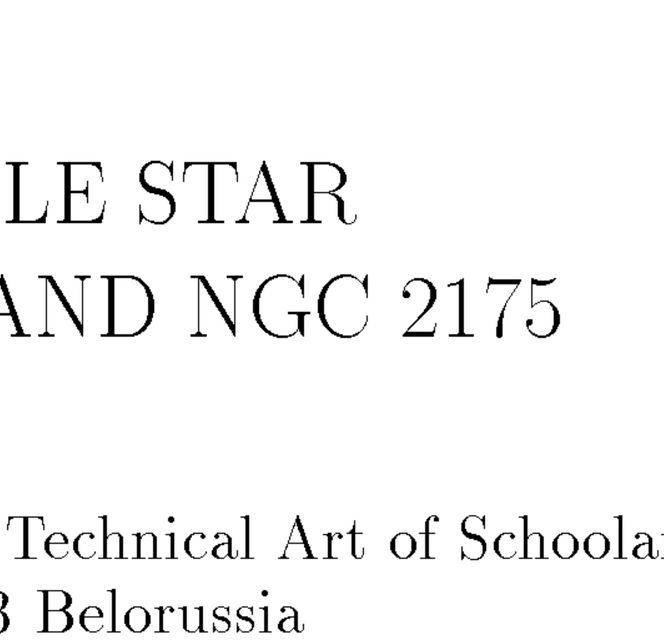


Figure 1. The finding chart for the new variable. The nearby star N1 = GSC 1322.0029, the brightness of the comparison stars = $13^m.91$, $b = 14^m.72$, $c = 15^m.43$.

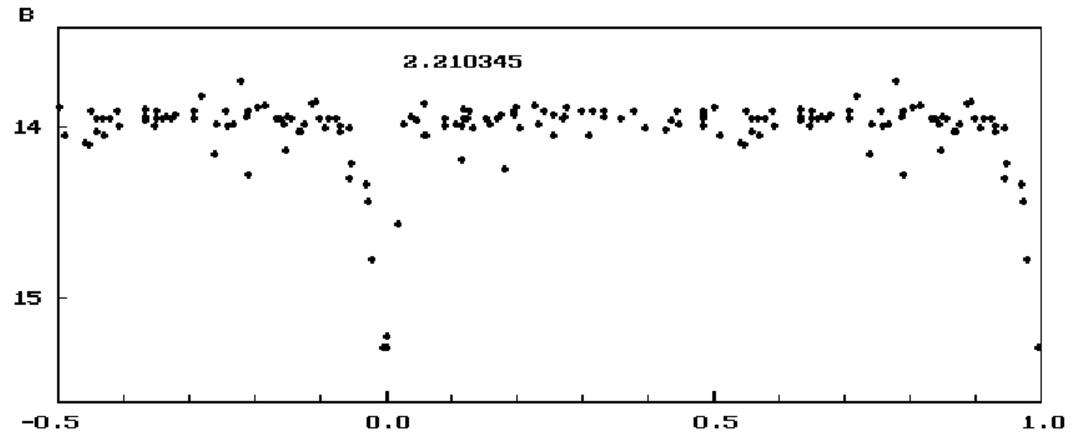


Figure 2. The phase curve.

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UKRAINIAN SCIENTISTS AND THE BEGINNING OF THE NATIVE METEORITICS

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ABSTRACT. The oldest known meteorite on the Ukraine territory fallen in 1787y. played essential part on the first stage of the native meteoritics development. The Kharkov university professors were ones of the first who investigated this meteorite in the beginning of XIX c. Prof. A.I.Stoikovich was the first author of the fundamental book on the aerolithes problem in Russia. P.Ya.Gamaleya (from Poltava province) was the first in Russia who believed the asteroid nature for the aerolithes and the shooting stars.

Key words: meteoritics, asteroid, minor planet , the history of natural science, personalia - Chladni, Stoikovich, Gamaleya.

The Chladni's first fundamental united cosmic theory of the aerolithes, bolides and strange pure iron blocks that was founded in the different regions of the Earth to this time (1794) has excited the first serious interest to this semi-legendary subject. The famous meteoritic stone rain that took place near Aigle in Normandia (France) at 1803 year proved the reality of the phenomenon itself. But its origin was enigmatic still during a third of the XIX c. (Eremeeva, 1982). In this time two hypothesis were competing with each other: (1) the aerolithes are the bombs from the Moon volcanoes (Olbers, 1795; Laplace, 1802) and (2) they are a product of our atmosphere (Isarn, 1803).

The first papers in Russia discussed this subject appeared at the beginning of XIX c. as a few short articles translated and original in some popular and scientific journals in Moscow, Kaluga and St.Petersburg.

On this stage of the native meteoritics development the meteorite fallen in October 1 1787 y. near Kharkov (the oldest of the ones was known in the Ukraine territory -"Jigailovka" (Kulik, 1935)) played the essential part for the process of beginning of this new science in Russia . One of its fragments was received in St.Petersburg academy of sciences in 1804 y. and researched first by acad. T.Lowitz which discovered in it the new chemical sign of meteoritic matter - the availability of chrom.

The other fragment of this meteorite was received soon after by the professor (last - the rector) of the Kharkov university the physicist A.I.Stoikovich. He first described this aerolith and its history in detail and described any other known aerolithes also in his papers (Stoikovich, 1807a) and in his fundamental, the first in Russia book about aerolithes (Stoikovich, 1807b). E.Klinger, adjunct of the Kharkov university, investigated of the mineralogical composition and the structure of this meteorite, and the professors of the same university L.Schnaubert and I.E.F.Giese investigated its chemical composition (Stoikovich, 1809).

Thanks to Stoikovich papers and his book essentially the cosmic Chladni's theory became first known in Russia. But Stoikovich himself has not understood these new ideas and believed that aerolithes were a product by the Earth atmosphere similar the hail.

The other ukraine scientist P.Ya.Gamaleya (1766 - 1817) had more progressive point of view on this subject. He was the astronomer and the seaman (the captain-commandor [-p]) and the professor of the St.Petersburg Nautical academy (Zapiski..., 1848). In his paper (Gamaleya, 1809) he also discussed the surprising similar composition and structure of the all known in that time aerolithes and admitted their cosmic nature as very small planets that are meeting on the our Earth way sometimes. Gamaleya believed the chief argument in this idea's favour - the fact of discovery of new heavenly bodies - the minor planets Cerera, Pallada and Yunona (1801 -1804). Gamaleya was the first in Russia who admitted the similar nature of the shooting stars.

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SOME EUROPEAN VARIABLE STAR OBSERVERS ORGANIZATIONS

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ABSTRACT. A subjective description and comparison of four groups of variable stars observers.

Key words: amateur astronomy, variable stars

This is the written version of a short talk held at the conference in Odessa in begin of September 1996 and it presents and compares organizations where I am member. The description is subjective, activities of minor interest to me are omitted, even if they may be important to others. In the following I shall mention four organizations (in alphabetical order)

BAV = Bundesdeutsche Arbeitsgemeinschaft fuer Veraenderliche Sterne e.V.
BBSAG = Bedeckungs-veraenderlichen Beobachter (der) Schweizerischen Astronomischen Gesellschaft
BRNO = Brno Regional Network (of) Observers
GEOS = Groupe Europeane d'Observation Stellaire

AFOEV, the Association Francesse d'Observation d'Etoiles Variables is different from GEOS, mainly interested in Mira type stars, and shall not be described here.

This four organizations are very different from each other. BBSAG is the smallest, has 6 active observers and the editor of the BBSAG bulletin. The other groups are large, have more then 100 members, but many of them are inactive. BRNO was long time specialized on eclipsing binaries too, just in the last years there was founded a subgroup (called Medusa) of people observing semiregular variables. BAV has several subgroups, according the types of variable stars (eclipsing, pulsating, Mira, novae). But in fact the work is concentrated on eclipsing and Mira stars. GEOS is mainly interested in short period variables, but semiregular stars are observed too.

BAV was originally a small organization of citizens from West Berlin, but it expanded and about 1990 it included the AKV organized in the German Democratic Republic around the Hartha observatory by Helmuth Busch. Several foreign members join BAV for many years, from all countries around. Denmark, Austria, Switzerland, Belgium, Italy and others. BBSAG contains only Swiss and amateurs, but many others use to publish results here. Some of them did, as long as they have been students, some still do even as professional astronomers. BRNO was initiated by prof Oburka and Kordylewski from Krakow in 1964. It did contain only Czechoslovakians and became international by the division of the Republic. By now there are a few foreign members, German, Austrian and Italian (and me!). GEOS was from the begin on international, at present the most active observers are Belgians (observing in Switzerland), people interested in computation are grouped around Dr Gaspani in Milano (Italy), the center of the organization is Paris and the current president, Juan Fabregat, lives in Spain. People from western or southern Switzerland, Geneva, Ticino speaking french or italian join GEOS and even do not know BBSAG.

BAV and BRNO do have a headquarter, GEOS only formally (in Paris), BBSAG does not. Most of BRNO observers used to be young people, the central takes some responsibility on data quality. Similar, but less surveillance is done in Berlin. BBSAG assumes, that every observer is responsible for himself. In GEOS usually one member suggest a certain star and all others do observe to help him. The "owner" of the star is responsible about the results.

All the groups try to attract young people. Most systematically it was done in BRNO, more individually in BBSAG (most BBSAG members are teachers by profession). Unknown to me is this aspect in GEOS. Indeed, we are all becoming older and the small BBSAG suffers from this aspect more then others. One member, Robert Germann, died and left a gap. We have never more observed so many minima as before. All organizations are presently in some crisis - a few members did buy ccd cameras and got into closer cooperation to professional astronomers while the majority of visual observers got the feeling of being obsolete. Under this circumstance it is more difficult to tell young people, that some work with their cheap equipment will be useful. The international contacts increased in the last years with the consequence that even small, "national" meetings are held at least partially in english. People not speaking english fluently feel themselves excluded.

Older Germans, young Czechs and Italians generally.

Even if most of the organization have professional astronomers as members in financial respect we are amateurs, everybody paying his activities from his own pocket. Cases where people use existing instruments of a university or public observatory are abundant. But the possibility to obtain some funds to organize conferences or to buy new instruments are exceptions.

BAV issues several periodical publications, but only two of them are of interest outside: BAV Mitteilungen with results of observations (in the last years often identical with one number of IBVS) and BAV Rundbrief with internal matter of the organization, general discussion, but often also identification of stars, O-C diagrams, new elements and similar. Most of the text is still written in German, parts (summaries) in english. Old editions, back to 1950 (BAV = Berliner ...) are difficult to obtain. The current number of BAV Mitteilungen is about 80, BAV Rundbrief is issued four times a year. Mira observations are send to AFOEV and AAVSO.

BBSAG publishes the BBSAG bulletin, but 32 lists of observed minima times have been published in Orion, the journal of the Swiss Astronomical Society. The current number of the bulletin is 112, it contains almost numbers, only a few words, all in english. Years ago there did exist a BBSAG circular, but the last number (11) appeared several years ago. A few RR-Lyr observations made by BBSAG members use to be published in BAV Mitteilungen, one member observes Mira stars and sends the results to AAVSO.

BRNO publishes the results in "Contributions of the Nicolas Copernicus Observatory and Planetarium in Brno", called Contributions... or in Czech language Prace... There are 31 numbers published so far, but not all deal with variable stars. There was also an irregular publication without a title containing general matters, after about 30 numbers it was reorganized to the Perseus journal and now it is published four times a year. In contents and size it is similar to BAV Rundbrief, but in Czech, sometimes in English. The last numbers use to have an english translation of the titles, sometime english summaries. Older numbers of Prace... used to have russian summaries.

GEOS publishes several periodica for internal use. Mostly in french, but some times italian or spanish may be used. Results are published only irregularly, minima timings of eclipsing variables are often send to BBSAG for publication.

BAV owns a large collection of eclipsing star minima and a small collection of maxima of RR Lyr–type stars. Older Germans, young Czechs and Italians generally. The former is known as Lichtenkneckers database. Dieter Lichtenknecker was a manufacturer of telescopes. He did collect minima from the literature, all eclipsing stars brighter the magnitude 13 at normal light, north of -23 degrees, having an amplitude larger the 0.3 mag. Unfortunately he died before his collection was finished. Franz Agerer included the stars from the last constellations (Virgo, Vulpecula) and maintains the database since. He has now more then 110'000 minima stored. Edgar Wunder did begin to collect RR-Lyr maxima only a few years ago, he has covered about 100 well observed stars. BBSAG has published by now about 33'000 minima, the writer has (had) all of them on diskettes on the conference in Odessa, for anybody interested. Many BBSAG observed stars are not included in Lichtenkneckers database, they are to faint or southern.

BRNO has about 11'000 minima, all available on computer media. GEOS has had so far no own data storage, but Massimiliano Martignoni has started to collect maxima of RR Lyr–type stars . At present there is a certain cooperation between BRNO and GEOS (and the writer) directed to common data formats and periodical exchange of data. Cooperation between BAV and the Jagellonian Observatory in Krakow and between BRNO and Krakow is being discussed too. One goal of my journey to Odessa was to investigate similar possibilities here, as already mentioned I have several datafiles here with me and offer them to anybody interested.

One more point I would like to make public: the international conference planed in Brno in 1997, forms are available in Russian or English.

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BRNO = http://www.astro.cz/astro/cas/variable

VARIABLE STARS IN CANIS MINOR, APRIL 1996

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ABSTRACT. The list of poorly known variables in CMa which are studied by the author is presented, the directions for cooperation are pointed out.

Key words: Stars: variable: poorly studied

Canis Minor is the target of my interest for about 8 years, from 1989 on I do use a ccd camera. I have the intention to check the elements of all eclipsing and RR-Lyr variables in alphabetic order, not skipping faint or otherwise difficult stars.

How did I come to such an project? For practical reasons. Variable stars are observed in august and september, the winter season is obviously avoided by many amateurs. Consequently the constellation visible in winter contain many neglected stars. I the first year of my ccd observing I have had serious difficulties to get the desired object onto the chip, specially in Monoceros. Not so in Canis Minor, because with Procyon on the chip there are no doubts of identity. All the other stars are only a few rotations of the adjustment screws away and may be found in a few minutes. Many of them have been discovered long time ago and are neglected since. Remarkable findings have been made, often by friends of mine.

X * GCVS period was alias, light curve in BAV Rundbrief
Y - 2 maxima observed, no forecast
RS - several weakenings observed, GCVS period false, new period found
RT * period corrected
RV * period corrected
RW - 3 weakenings found, new period must be tested
RX - displaced secondary investigated by J.Manek
RY - period corrected by J.Manek, still scattering minima
SX - 1 minimum, coordinates corrected by G.Richter
SY - maximum found but not published (poor quality)
TT * period corrected
TU * 3 minima observed (+1 by R.Diethelm), period corrected
TW - 1 minimum observed
TX * GCVS period was alias
TY * period corrected
TZ - minimum found but not yet published, GCVS period false
UY - 1 minimum, GCVS period false
UZ - identification, several minima observed
XZ frequently observed
YY frequently observed
AA frequently observed
AB - minimum not yet found
AC * period found, but already published by D.Faulkner
AG frequently observed
AK frequently observed, secondary not displaced (several observes)
AL * period corrected
AM several minima observed by F.Agerer
AN * period corrected
AO * period corrected
AP * several minima, period found by J.Borovicka
AR - 2 minima found, period unknown
AS - faint, rarely observed until now
AT - faint, rarely observed until now
AV - minimum not yet found
AY - observed only once until now
BB - not yet observed
BF * several minima observed
BH one minimum observed, frequently observed at Mt.Suhora
BL * was NVS 3570, period found
NSV 3624 - 2 minima found, period unknown
NSV 3637 - no minimum found

Remarks: "*" success, forecast can be calculated, "-" more work has to be done.

This list has been used as a poster at the Odessa conference, in search of cooperation more then to present specific results.

HISTORY OF METEOR RESEARCH IN ODESSA

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ABSTRACT. The short history of the development of meteor investigation was examind in Odessa Astronomical observatory.

Key words: history of meteor investigation.

As wrote well-known meteor researcher I.S.Astapovich, progress of meteor astronomy in Russia in XIX century "passed in an atmosphere of Bredihin works".

Thirteen-years old boy Fjodor Bredihin turn out in Odessa in 1845. He come from Kherson province Thesalonihi country-seat for study in "noble boarding-school" at Risheliev's college. This college, founded in 1817, have had an astronomical observatory, that was used in study purposes. When he get a general education, F.A.Bredihin become a college student in 1849. In 1851 he join the Moscow university, but don't break connections with Odessa in the future. In 1897 Bredihin lived in Odessa more than a year. He recommend A.K.Kononovich on director post of Odessa astronomical observatory at the university. Bredihin assist to foundation in Odessa the branch of Pulkovo's observatory. In that time meteor research works was made by Moscow, Kiev and Odessa observatory collaborations under the guidance and the task of F.A.Bredihin. In Odessa, in particular, Perceus meteor stream observations was made by A.R.Orbinski, A.S.Vasiliev, N.D.Tzvetinovich. In 1895 results of observations was published in Izvestiya of Academy of science.

Side by side with observations in Odessa observatory, since it foundation they keep the theoretical works of celestial-mechanic nature. There was studies of orbits, indignations at small Solar system bodies motion and it interconnection.

Since Russian world-knowledge amateur society (RWAS) foundation in 1914, meteor observation was made by amateurs, that in future become specialists and scientists in different parts of science. In Odessa, in 1-st Public observatory (former L.Kefaly private observatory, Sadovaya str.4) on the roof playground meteors was observed by both Odessa citizens - Z.N.Aksentjeva (USSR Academy of Sciences academician in future), N.A.Kurnosova, N.D.Kolomietz and visitors from Petrograd: N.N.Thytinskaya, O.V.Petropavlovskaya and other. In 1925 they discovered the Kassiopeid stream. In 1924 future "fire constructor" academician V.P.Glushko with assistant in night from 3 to 4 January marked 400 meteors from Kvadrantid stream. At that time V.P.Glushko was the chairman of the observation group of RWAS Odessa branch. Science leaders of the observation group was university students V.A.Maltzev (well-known meteorists in future) and G.A.Gamov ("hot universe" author in future). But soon they go to Petrograd because the university was closed.

Odessa university was reopened in 1934. To director post was invite F.A.Bredihin's disciple, USSR's Academy of Science member professor K.D.Pokrovski. K.D.Pokrovski Scientific work was the extension and continuation of F.A.Bredihin works. Meteor research and meteor stream connection with parental comets K.D.Pokrovski made the main in observatory work.

Science development in former Soviet Union proceeded in direct dependence from given financial means and under the conditions of unprecedented secretness and isolation from outward world. In connection with successful start of first artificial satellites there was given means to International Geophysical year (IGY) in 1957-1958. Scientific problems was formulated by member of government V.V.Fedynski, chairman of comet and meteor commission at USSR Academy of Science Astronomy council.

At that time, observatory worker E.N.Kramer, who begin meteor observations in the group under K.D.Pokrovski head in 1940, incarnate an idea of variable section obturator, that need for meteor heliocentered orbit calculations. This idea was developed by prof. V.P.Tsessevich, director of observatory. Model of device was made by E.N.Kramer and mechanician I.O.Timchenco. According to IGY program, there was built the corresponding stations in Majaki and Kryzanovka villages and in Botanical garden, equipped by meteor patrol, made on KINAP plant. During the IGY and International Quiet Sun year (IQSY) Odessa observatory becomes the main institution and E.N.Kramer - head of meteor department. Army radars were given for carry out meteor observations. This observations was soon break, but photographic observations was continued until 1991.

Observed data was worked up by department workers - R.B.Teplitzkaya, A.K.Markina, V.A.Vorobjova, N.N.Izraetskaya, O.A.Rudenko, E.P.Shirjaeva,

G.V.Danilenko-Roshina, V.I.Musij and others.

Result of research works was published by E.N.Kramer co-author with collaborations. In common with A.K.Markina was published data of meteor orbit elements, which was photographed in 1950- 1972. With Markina there was carried out the meteor flash statistics. With V.A.Vorobjova was made a research of meteor breaking in atmosphere. Most fruitful was cooperation between E.N.Kramer and I.S.Shestaka. They made the research of photographic meteors height statistic, bolid after-shining, and have print co-author monographs.

Because of system errors, which author mentioned in 60-s, meteor method of nondirect atmosphere parameters measuring have not give the expected results. That is why the research become to classical celestial-mechanic problem. Doctor degree thesis, which was defended in 1993 by I.S.Shestaka named "Origin, evolution and genetic ties of small bodies of Solar system and their combinations". In systematic sense, very useful was E.N.Kramer and I.S.Shestaka book "Photographic methods of meteor astronomy", published in 1989.

Follow the traditions of new obturator inventor, E.N.Kramer offered V.P.Orlov to realize small cut obturator construction for obtain meteor "instant exposure". This idea was shared with meteor photography observation manager P.B.Babadzhanov, who come to Odessa many times. In general, in result of photographic observations in Odessa and Dushanbe there was published some monographs and defended nearly 10 candidate and two doctor degree thesis. However, collaborator I.N.Kovshun, who was the first who defended the candidate degree thesis, get one vote less than it need to defense doctor degree thesis. There are exist references to the I.N.Kovshun works in scientific literature.

Unfortunately, in spite of spend means, bolid observation station network, that was create in 70's, didn't give the scientific results and was write off.

Note, that in 1960/61 study year in Odessa university, meteor astronomy lecture course was delivered by I.S.Astapovich. Specially for this course V.P.Tsessevich translates in Russian the E.Öpic's book "Physics of meteor flight in atmosphere".

Author of this essay, worked in 60-s in observatory, got near 20 meteor spectrums and worked up it with special laboratory created equipment. The works were made under I.S.Astapovich and V.P.Tsessevich head and was generalized in monography "Spectrums of short atmospheric light phenomena: meteors" (Fizmat literature, Moscow, 1994).

Going to the USA city of Portland, professor E.N.Kramer continues now to consult meteor department collaborations.

So, in spite of viewpoint collisions, the meteor science gets it progress in Odessa.

ECLIPSING STARS IN OPHIUCHUS

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ABSTRACT. In a previous contribution some amateur organizations have been described. Here is presented one example of the work performed. Possibilities of cooperation are discussed.

Key words: eclipsing variables, period of V 448 Oph cooperation of observers

In this poster is presented a work on stars in CMi, started 8 years ago. By now all eclipsing and most RR Lyr–type stars in that constellation have been observed, for many of them reliable forecasts can be calculated. Canis Minor is a winter constellation, a similar project for the summer was be started too. Ophiuchus

is an area with many neglected stars. But it is to large for an single observer. A few years ago I selected only 12 obviously neglected eclipsing stars and started to observe.

One of them was V 441 Oph, discovered here in Odessa 50 years ago. Relatively bright, very large amplitude, easy to observe and - completely ignored. By now two CCD minima have been published in the BBSAG bulletin and a forecast is again possible. The work is done, for the moment at least.

Most of the selected stars have no known period and will take more time. Two of them have been recently solved by other observers, my contribution was little or nothing:
AL Oph by V.Marsakova (Odessa)/ M.Wolf (Prague)
V 974 Cyg by L.Chinarova (Odessa)/ M.Wolf (Prague)
V 415 Oph by I.Kondratenko / S.Shugarov (Moscow)

The star I was interested most is V 448 Oph, we worked on it together with Jan Manek, Stefanik observatory, Prague, Czech Republic. I shall describe it here in more detail and neglect the others.

A peculiar fact about southern part of Ophiuchus, where most of the selected stars are, is the lack of photographic plates. For example Sonneberg Sky survey: they exist old plates of the declination -20 zone, but the field was abandoned because of light pollution from the city. V 448 Oph is to faint to be studied on Sonneberg Sky Survey. On the Klet observatory in southern Bohemia are stored about 10'000 plates taken by Prof.Mrkos and his assistants in search of small planets. Only 2 (in words: two) cover V 448 Oph. As far as I presently know the only large plate collection is the one at Mt.Palomar, already carefully examined by Plaut. He has discovered many new variables, but V 448 Oph he mentioned explicitly as not found. (The star was published and cataloged with erroneous coordinates). One of the goals of my journey to Odessa was to find out, if somebody somewhere in eastern Europe has a collection of good photographic plates covering this part of the sky?

The other possibility of course is to find the star (I succeeded with V 448 Oph some years ago) and to observe it as frequently as possible. This is quite time consuming for a set of isolated stars somewhere in the sky, the original idea of the CMi project was exactly that all the studied stars should be close to each other and easy to find. Anyhow, during several years I collected a set of CCD images and found 3 weakenings: 49098.609, 49888.387, 50281.404. There is only one reasonable solution: 3.743 days period.

Shajn, who discovered V 448 Oph, published 4 weakenings: 23586.467, 26130.432, 26514.398 and 26867.378. They do not fit the period I would prefer. The GCVS gives and uncertain period (6.086 days) also not fitting the times given by Shajn. May be other minima, unknown to me, have been used. Indeed, future observation will clear the questions in one or two years. But a discussion with people knowing the background may do it immediately. Verifying the period will be much faster if done from several distant stations in different weather conditions.

Stars synchronous to Earth rotation

Eclipsing binaries with periods or ratios of periods very close to one day (Earth rotation) are difficult to study. Specially if they are placed near the equator. The most extreme case known to me is CX Ser, discovered here in Odessa by Prof. Tsesevitch. Nobody has published a minimum since.

The difference to the sidereal day should be only a few seconds. In other words - the shadow is sitting somewhere on Earth and moving only a few kilometers each day. As eclipsing stars use to change their periods we even do not have certainty, if the shadow moves east- or westward.

Jindra Silhan from Brno, Czech Republic, has drawn attention to this star several years ago, but the minimum was not yet found. We have done some sporadic observations each year since, but how many years will it take until the minimum reaches central Europe?

This year, in the spring 1996 I have observed an increase of brightness. The minimum of CX Ser must have been observable from eastern Europe, most probable from the longitude of the Ural. It is not sure, if it is the primary or the secondary minimum. But is somebody here in the audience living near the Ural and willing to spend a night on CX Ser? And how are the chances to establish a similar cooperation for future targets? Stars with periods more or less synchronous are many and a cooperation between observers will be less costly then an expedition to the north or south pole, from where of course one could do the work alone.

Summary

Observing occultations of stars by small planets or meteors are teamwork. Variable stars are the field of patient individuals. But cooperation may speed the work, specially in cases as named above. We can join and build a chain or net of small telescopes placed in different time zones, mutually disposable for each of us. With CCD cameras and the Internet we have the technical means. The obstacles are "only" administrative, financial and psychological.

EMINENT ASTRONOMERS - GRADUATES OF THE ODESSA UNIVERSITY

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ABSTRACT. The brief description of scientific activity represented of the eminent Astronomers - graduates of the Odessa University named after I.I.Mechnikov (earlier named as Novorossiyski university).

Key words: History of Astronomy: Personalities.

In the Odessa University the Chair of an Astronomy was open almost simultaneously with creation of Observatory (1871). It was the only astronomy Chair in Odessa University unlike many other Universities where Chairs on astronomical disciplines were a few. For a period of about 30 years, beginning in 1881, Alexander Konstantinovich Kononovich (1850–1910) headed the Chair and the Observatory. A foremost authority in the field of astrophysics and stellar astronomy, a perfect teacher and educator of the young scientist. In 1871 he has graduated from "the Novorossiyski" University in Odessa, was transferred to the Observatory. Continued his education in Germany (1873–1876), studying astrophotometry under guiding of I.K.F.Zöllner. Then he taught mathematics and physics in the Richelieu Lyceum in Odessa, and from 1881 he has headed of the Observatory. In 1886 he was elected the ordinary Professor, was also Dean of physics-mathematical faculty.

His early works deal with binary stars' orbits calculations. One of the pioneers of astrophysical investigations in the country. Under the direction of Kononovich and at his direct participation, were carried out large series of photometric observations of Mars, Jupiter and Saturn with Zöllner photometer, the regular taking photos of the Sun's surface and measurements of solar spots positions, systematic observations of protuberances. As to more details about Kononovich see (Korpun, Tsessevich, 1956). Contemporaries characterized Kononovich as excellent leader who took care of the students' needs and the future of astronomy. There was no specialization on astronomy at that time but the course on astronomy fundamentals was obligatory for all the students of physics-mathematical faculty. Kononovich used to notice the most capable students, who took in interest in astronomy, and tried to have them at the Astronomy Chair after graduation for preparing them for scientific and teaching activities.

Many of his disciples became eminent scientists of their time though their contribution to the Universe investigation was not equal. Some of them as A.R.Orbinsky continued to work at the Odessa University; others as V.V.Stratonov, A.P.Gansky, A.S.Vasilyev leaved in metropolitan Observatories; still others as N.N.Donich, B.Zalesky, J.Witkovsky, V.Zhardecky worked abroad. But all the disciples of Kononovich distinguished with scientific erudition and love for observations.

One of the first of the advanced and capable students keep on University by Kononovich for research and teaching work was Vsevolod Victorovich Stratonov (1869–1938). He was born in Odessa in the family of Director of classical gymnasium. On finishing the gymnasium he was awarded a gold medal, and after graduating from the University - the Diploma of the first degree and a gold medal for the diploma work " A transit instrument and determination of geographical coordinates". In the same year he have invited to work at the Pulkovo Observatory by its Director F.A.Bredikhin who has visited Universities' observatories during the first year of his Directorate in search for capable young astronomers for their perfection in the Pulkovo.

Within 1891–1892 Stratonov worked at the Odessa Observatory, and then was sent on assignment to Pulkovo where two years laboured there under direct guiding of Bredikhin. He took a particular interest in astrophysics, and in 1898 Bredikhin has recommended him as in astrophysicist in Tashkent Observatory, where the new normal astrograph, like that in Pulkovo, had been mounted. The scientific activity of Stratonov was fruitful in Tashkent. He turned his attention to the stellar statistics and has achieved valuable results in this range of science. Virtually, he was one of the pioneers in this trend development. By using 400 photos of the sky obtained on the normal astrograph, including nearly 200 photos of open and globular stellar clusters, he carried out much of various stellar-astronomical investigations. In the stellar cluster Pleiades he has measured proper motions of stars, studied luminosity-spectrum ratio, structure of nebulae surrounding bright stars, discovered their filamentary

and at times tufty structure. He investigated in detail the open stellar cluster χ and h Persei as well as globular stellar clusters in Hercules and Scutum, ring nebula in Lyra, etc.

Based upon the statistic analysis made by him of 900.000 stars of Bonner Durchmusterung and Cape Photographic Durchmusterung, Stratonov studied distribution of Milky Way stars according to the galactic latitude and longitude. In 1900 he has published a large work, the crux of which implies that all the stars are scattered over the space not randomly, these are condensed considerably in some areas, the density in all the directions from them decreasing more or less regularly. Dimensions of these "stars' clouds" are different, however, their centres are, mainly, close to the mean plane of the Milky Way. So, Stratonov discovered a complex structure of the Galaxy. Simultaneously with the work on stellar statistics Stratonov continued to investigate the Sun, observed variable stars, the Leonids meteor shower in 1896–1897. In 1897 he has published big memoirs comprising 100 pages devoted to the Sun, and won a State prize. Stratonov was become Director of the Tashkent Observatory. However, in 1904 has become of eye-disease he had to abandon the work as an astronomer. He has served as an official, then he has opened a small bank. Two fine scientific-popular books "The Sun" and "Stars" were also issued by him. Particularly luxurious was the edition of the "Sun", it contained poetry including a translation of an old egyptian pray to the Goddess Sotys (Sirius). Each of the books was awarded a prize of the Russian Astronomical Society. His text-book "Cosmography" was issued in three editions. After the revolution in 1918 Stratonov moved to Moscow, has become Professor and Dean of the physics- mathematical faculty of the Moscow University. One of his students was B.A.Vorontsov-Velyaminov who proved to be a famous astronomer afterwards. He remembered that Stratonov had delivered his lectures well accompanying them with lantern-slides demonstration, which helped to follow what was being explained. Stratonov was also Chairman of Organizing Committee of the Main Russian Astrophysical observatory projected. However, soon he turned out to be among the group of Professors displeased with the new order at the University, and in 1922 amidst many writers and scientists he was exiled abroad, first to Germany and then to Prague. There he was busy with teaching and writing text-books.

V.V.Stratonov died in Prague in 1938. His reminisces of interest on his last years of life in Russia have been recently published (Stratonov, 1992).

Artemiy Robertovich Orbinsky (1869–1928) was born in Odessa in the family of University Professor. He graduated from the University in 1892 being awarded Diploma of the first degree and a gold Medal for his composition "Transit instrument and its application for geographic coordinates determination". His observations were as precise as the best ones of this kind. In the character given by Kononovich to Orbinsky to leave him as a Professor fellow a lot of various works on astronomy are enumerated which were carried out by him together with the Observatory astronomer N.D.Tsvetinovich and Professor Kononovich himself according to the plans of the Observatory works. Besides, the fellow had good command of several foreign languages and was able to discourse clearly and with great interest, too. Subsequently, he became not only a famous scientist but also a remarkable disseminator of astronomical knowledge. Orbinsky took an active part in Sun profile observations, taking photos of prominences and reducing the observations, taking photos of planet satellites, participated in mounting and studying astronomical instruments. His professional level grew higher after having practice in the Pulkovo Observatory where he used to measure spectrograms and precise positions of stars of cluster Canum Venaticorum, to observe on the vertical circle and transit instrument. Later on, Orbinsky became a researcher of the Pulkovo Observatory, took part in creating a South Affiliate of the Pulkovo in Odessa, was in charge of this Affiliate, a principal observer on the transit instrument. All in all he managed to observe right ascensions of 400 stars of the wide equatorial zone by the absolute method. Orbinsky had been assistant Professor of the Odessa University since 1897 and educated a few astronomers together with Kononovich. Simultaneously, he was an editor and translator of many books on astronomy. His versatile activity in Odessa is worth studying more thoroughly.

Alexey Pavlovich Gansky (1870–1908) was born in Odessa, graduated from the University in 1894 and was left at the University without fellowship. However, in 1895 Kononovich succeeded in the fellowship assignment, and in the very year Gansky took up his famous works on solar spots investigations and was a great success in the art of astronomical photography. In 1896 Gansky left for Pulkovo for the sake of perfection, and in the same year he took part in the expedition to Novaya Zemlya to observe the total solar eclipse. Afterwards, Gansky went to Paris where according to the educational plan he was to get familiar with the work of observatories and attended the Sorbonne courses in astronomy, mathematics and physics. At the Meudon Observatory near Paris, he worked under guiding of an outstanding astronomer P.Z.C.Jansen together with whom he would climb up the Mont Blanc to the Observatory to make observations. Later on, in 1897–1905, Gansky has made yet 8 climbing on Mont Blanc to made extraeclipsing observations of the solar corona, observations of the Venus planet. Then Gansky had been a researcher at the Pulkovo observatory since 1905. He took part in the expedition to Spitsbergen for degree measurement and gravity determinations. In the works of Gansky from 1896 though 1905

the periodicity was started of solar corona shape variations and the relation of these variations with other processes in the Sun. Taking photos of solar granules in 1903–1907 permitted to determine the velocity of their motion and their life-time. In 1904 for his contributions to the field of astrophysics Gansky was awarded a medal named after P.J.C.Jansen of the Paris Academy of Sciences. Being in active observer Gansky was elected Secretary of Russian affiliate of the International Solar Commission, Vice-President of the Russian Astronomical Society. He was one of the initiators of creating the Simeiz affiliate of the Pulkovo Observatory, first Director of the Simeiz Observatory. In 1908 A.P.Gansky perished tragically in Simeiz - drowned while bathing in the sea. The lunar crater is named after him as well as the minor planet.

Alexander Semenovich Vasilyev (1868–1947) a former fellow of A.K.Kononovich became a famous Pulkovo astrometrist. He graduated from the University, physics-mathematical faculty, in 1895 with Diploma of the first degree. While a student he was observing a lot. In the last but one course, the Naturalists' Society charged him with an important mission - to determine the level differences of Khadjibeysky and Kuyalnitsky coastal salt lakes as well as the sea. He managed to be a success with this laborious work. In the summer 1895 Vasilyev together with Gansky and Babichev (the disciple of Kononovich) participated in compiling a precise map of Andreevsky (Kuyalnitsky) coastal salt lake. Laying out the basis with wooden poles he measured a line as long as one kilometer with in error 3 mm. Soon Vasilyev was assigned to go to Pulkovo where he first worked on the meridian circle and then on the vertical circle. The work was completed by his publishing the work " Observations of stars' declinations with the Pulkovo vertical circle in 1896–1897 for the Catalogue of 1900". Later on, Vasilyev being charged with a mission by special Commission of the Academy of Sciences took degree measurements on the Spitsbergen island, during the winter stay there he carried out photographic observations of aurora spectra. In 1916 he submitted his Doctor thesis to the Novorossijsky (Odessa) University to defend it, but he didn't have to do it. In 1919 Vasilyev was conferred a Doctor degree "honoris causa". He became one of the leading astronomers in the Pulkovo observatory, took charge of Astrometry department.

Nikolay Nicolayevich Donich (1874–1956) finished the Richelieu Lyceum in Odessa and afterwards, in 1897, graduated from the University. In graduating from the University he submitted his work on the spectrum of the meteorite "Grossliebentahl" which was published on six pages in 'Astronomische Nachrichten' in 1898. Donich was mainly interested in investigating objects of the Solar system. He became a master in the field of studying such phenomena as solar and lunar eclipses. Being an inexhaustible traveler Donich himself took part in observations of seven solar eclipses and a great number of lunar ones in different regions of the world. To observe the Sun Donich could afford to design and manufacture a spectroheliograph, the first in Russia, with the assistance of a famous Odessa mechanic J.A.Timchenko. This instrument enabled to obtain high–quality photos of Sun's surface and prominences. It was mounted together with the coelostat in the private Observatory of Donich built in the village of Stariye Dubossary in 1908 - the first astronomical observatory on the territory of today's Moldova. Besides the heliograph,the Observatory of Donich was equipped with a five-inch refractor- equatorial with numerous instruments for various observations. The instruments and devices(gears) were mainly manufactured by Donich himself in workshops equipped very well. Of the other instruments should be mentioned: " a comet triplet" - an instrument consisting of a guiding refractor (D=60mm, F=1000mm), a photographic camera (D=82mm, F=1000mm) and a spectrograph with an objective prism (D=61mm,F=273mm). Donich was lucky enough to observe rare astronomical phenomena. He observed the transit of Mercury on the disk of the Sun on November 14,1907 and shoved the atmosphere absence in this planet; observed Halley's comet with the " comet triplet" in 1910, the bright Pons-Winnecke comet in 1927. In 1933, from September to December, he was carrying out observations of Saturn which permitted him to determine the rotational period of the planet - 10 hours 17 minutes (present value - 10 hours 14 minutes). Eight scientific papers on the zodiacal light investigation were published by Donich. Through the H.Shapley's recommendation he obtained in his observatory by means of the modernized "triplet" a number of stellar sky photos which he sent to the Harvard Observatory for H.Shapley. Donich published his observational results in the leading astronomical editions. Nicolay Nicolayevich Donich was a brilliant personality in the astronomical community of his time. He was a member of many scientific societies, including the Russian astronomical society, International Astronomical Union, International Commission on the Sun investigation, an honorary member of the Rumanian Academy of Sciences (1922–1944) and others. Thanks to his efforts Rumania was admitted to the International Astronomical Union. He represented it at the first six Congresses of IAU. Hard and sad times came to Donich during the last years of his life. At first he had to leave Bessarabia, then Rumania for Germany, France, where he found himself under trying financial situation. According to same finding the last days he spent in the old people's home and died in 1956 in Nice. By the 120th anniversary of his birthday a monument to N.N.Donich was erected in his native village of Stariye Dubossary in 1994.

Bogdan Zalesky (1887–1927) became a well–known astronomer in Poland. Graduated from the Univer-

sity in 1909. Was a disciple of Kononovich and Orbinsky. Specialized in Pulkovo under Bonsdorf, Vittram, Rentz. From 1913 through 1920 he worked in the Nikolaev Affiliate of Pulkovo, observing rather actively. He had lived in Poland since 1921. Was conferred the degree of Doctor of Philosophy in 1923 in Yagellonian University in Crakow for his work "Catalogue of declinations of 486 stars...". A specialist in the field of astrometry. One of organizers and first Director of the University Observatory in Poznan(Poland). See "J.Witkowski, 1928".

Zimmerman Nikolay Vladimirovich (1890–1942) graduated from the University in 1912 and was left there to prepare for the research activity. He had worked in the Pulkovo Observatory since 1915, for a number of years had taken charge of astronomical department, headed the Commission on astrometry. A specialist in fundamental astrometry. Took charge of the work and generalized observations of five observatories compiling " A catalogue of 2957 bright stars with declinations ranging from -10 to +90 degrees" for which he was awarded (posthumously) a prize named after F.A.Bredikhin in 1948. A coauthor of the observational plan Catalogue of Faint Stars. He died during the blockade in Leningrad. About disciples of A.K.Kononovich see "Stranitsy...,1996".

Witkowsky Josef (1892–1976). Graduated from the University in 1914. His scientific line was in the range of astrometry, practical astronomy , comet astronomy and tidal phenomena studies, history of astronomy. Collaborating with T.Banakhevich he observing many eclipses of stars with planets, their satellites, the Moon. Organized and took part in longitude determinations in Poznan and Riga according to the International program for a series of stations along the Baltic sea coast. A member of the editorial board and editor (1954–1966) of the journal "Acta Astronomica". An excellent organizer, Professor, Director of the Astronomical Centre in Poznan (see Acta Astron., 1976).

Orlov Alexander Yakovlevich (1880–1954) - famous astrometrist and geophysicist took charge of the Odessa Observatory and the astronomy Chair within 1912-1934. Educated a lot of fine astronomers. Among them:

Stoiko Nicolay Michailovich (1894–1976) graduated from the University in 1916. His main scientific works deal with investigations on irregularities of the Earth's rotation, the Earth's poles motions and universal time determination. In 1936 for the first time he discovered seasonal variations in the Earth's rotational velocity. A member of many scientific societies. He was awarded prizes of Paris Academy of Sciences, of the French astronomical society, of the Royal Academy of Belgium. He worked at the Paris observatory, was Director of the International time service (see Stoiko, 1969).

Jardecky Viecheslaw (1896–1962) was born in Odessa, graduated from the University in 1917. The Diploma work on the subject " Investigation of the spectra of variable star Eta Aquilae" was made by him in Pulkovo Observatory. Worked at the Odessa University, and from 1921 at the Applied Mathematics Chair of the Beograd University. Doctor Dissertation on the subject "About rotation of solid body on the curve" he defended in 1923. A specialist in the field of Mechanic of Fluids. After Second World War he left for USA. He died in 1962 as a Professor of geophysics of Columbia University (New York).

Aksentieva Zinaida Nikolayevna (1900–1969) was also a disciple of A.Ya.Orlov. She was born in Odessa, graduated from the Odessa University in 1924. Worked at the Odessa Observatory, and from 1926 at the Poltava gravimetric observatory. She had been Director of the Poltava observatory since 1951. A specialist in the field of studying tidal Earth's deformations. Took part in the gravimetric survey of the Ukraine territory. Studied tidal phenomena of the Baikal lake. Made an analysis of eleven years' observations of plummet line variations in Poltava. Corresponding member of the Academy of Sciences of the Ukraine (1951), see (Astronomers, 1986).

Several astronomers who graduated from Odessa University in postwar years are not any more among us. These are:

Divari Nicolay Borisovich (1921–1993), graduated from the University in 1945. He defended his Doctor theses on the subject "The investigation of a dust component in the interplanetary space by the optical method" in Astronomical Institute after Sternberg (Moscow) in 1968. A specialist in the field of zodiacal light, antiglows, interplanetary dust cloud, the Earth's upper atmosphere pollution investigations. Participant of 12 scientific expeditions. Worked in the Odessa University, Institute of Astronomy and Physics in the Academy of Sciences of Kazakhstan in Alma-Aty, Odessa Polytechnical Institute. The minor planet is named after him (see "Stranitsy..., 1996").

Grigorevsky Vitaliy Michailovich (1930–1981) graduated from the University in 1954. His Doctor Dissertation was on the subject " Photometric observations of Sputniks and their use", defended it in Odessa in 1973. A specialist in the field of photometry and dynamics of AES, variable stars, investigations of atmosphere based upon observations of AES. Worked in the Odessa University, Kishinev University, Technological Institute after M.V.Lomonosov (see "Stranitsy..., 1996").

Shestaka Ivan Sofronovich (1937–1994) graduated from the Odessa University in 1959. His Doctor thesis on the subject "The origin, evolution and genetic relations between minor bodies of the Solar system and their complexes" was defended by him in Kiev in 1993. A specialist in the field of investigation of meteor matter in the circumterrestrial cosmic and interplanetary space. Identified groups and pairs of short–periodic

comets as well as comet-meteor and asteroid-meteor complexes based upon the criterion of kinship in minor bodies of the Solar system. Worked in the Astronomical Observatory of the Odessa University. The minor planet is named after him (see "Stranitsy..., 1996").

All the safe and sound graduate-astronomers are now successfully working in many astronomical institutions. Here, we'll mention only those who have been conferred the degree of Doctor of Sciences.

Kramer Efim Naumovich graduated from the University in 1949. He defended his Doctor dissertation "Investigation of motion and structure in meteor bodies of cometary origin" in Odessa in 1973. A specialist in the field of meteor astronomy. Suggested a method of meteor flight moment determination by means of an obturator for a variable profile - "meteor patrol"; elaborated the idea of "instantaneous exposition" in taking photos; developed a patrol mechanism for bright meteor-bodies. Worked in the Observatory and at the Astronomy Chair of the Odessa University up to 1994. He is living in USA now.

Teplitskaya Raisa Benzionovna graduated from the Odessa University in 1949. Doctor dissertation on the subject "Investigation of the chromosphere of solar spots and active stars from lines of ionized calcium" was defended by her at the Institute of solar-terrestrial physics of Siberian affiliate of Russian Academy of Science (Irkutsk) in 1993. Worked in the Lvov, Odessa observatories, is working in Irkutsk now.

Petrov Grigory Matveevich graduated from the University in 1950. Doctor dissertation on the subject "The creation of a system of absolute right ascensions of stars from observations at high geographical latitudes during polar nights" was defended in Golosievo Observatory (Kiev) in 1987. A specialist in the field of fundamental astrometry. The head of Pulkovo expedition to the island of Spitsbergen. Is working at the Nikolayev observatory now.

Abalakin Victor Kuzmich graduated from the University in 1953. A specialist in the field of celestial mechanics and ephemeris astronomy. The author of the monograph "Fundamentals of ephemeris astronomy" (1979). A coauthor of a series of works on the creation of a common relativity theory of inner planets motion in the solar system (State prize in 1982). His works on the creation of a mathematical apparatus and development of basic principles of using laser light detection and ranging lunar observations to solve geo- and selenium dynamics problems. Corresponding member of Russian Academy of Science. Worked in the Odessa University and Observatory, Institute of Theoretical Astronomy of Academy of Science of the USSR (Leningrad), since 1983 - Director of Pulkovo Observatory.

Popov Gennadiy Michailovich graduated from the Odessa University in 1956. A specialist in the field of optical systems and theirs using in astronomy. The author of monographs "Concentric optical systems and theirs application in instrument engineering" (1969), "Aspheric surfaces in the astronomical optics" (1980), "Modern astronomical optics" (1988). Worked at the Odessa Observatory, now - at the Crimean Astrophysical Observatory.

Vitrichenko Eduard Alexandrovich graduated from the Odessa University in 1959. A specialist in the field of stellar spectroscopy and astronomical optics - methods of its investigation. The author of the monograph "Methods of astronomical optics investigation" (1980). A coauthor of monographs "Methods of astronomical optics manufacture" (1980) and "Problems of optical control" (1990). Worked at the Crimean AO, Special Astrophysical Observatory (Zelenchukskaya), Institute of Investigations of Cosmos (Moscow).

Pustylnik Izold Bentsionovich graduated from the University in 1960. A specialist in the theory of close binary systems. The author of the monograph "Models of stars with extended atmospheres of G–K spectral types" (1969). Works at the Institute of atmospheric physics and astronomy of the Estonian Academy of Sciences.

Komarov Nikolay Sergeevich graduated from the Odessa University in 1960. The dissertation on the subject "The structure of cool giant stars atmosphere" was defended by him at the Special Astrophysical Observatory AS USSR in 1989. A specialist in the field of stellar spectroscopy. Works at the Odessa Observatory, the head of astrospectroscopy department.

Karetnikov Valentin Grigorievich graduated from the Odessa University in 1962. Defended his Doctor thesis on the subject "Properties of eclipsing binary stars being at the first stage of mass exchange" in the Moscow in 1989. A specialist in the field of photometry and spectroscopy of stars, history of astronomy. Director of the Odessa Astronomical Observatory.

Panchuk Vladimir Evgenievich graduated from the Odessa University in 1968. Defended his Doctor thesis on the subject "Methods and results of spectrophotometric investigations of stellar atmospheres chemical composition" at the Special astrophysical Observatory (Russia) in 1990. A specialist in the field of stellar atmospheres investigations. Works in Special AO.

Andronov Ivan Leonidovich graduated from the Odessa University in 1980. His Doctor dissertation on the subject "The structure and evolution of magnetic close binary systems" was defended by him in Golosievo (Kiev) in 1995. Professor. Works at the Astronomy Chair of Odessa University.

Professor Vladimir Platonovich Tsessevich (1907–1983) headed the Chair of Astronomy and the Observatory in Odessa since 1944 to 1983. He was an eminent specialist in the field of variable stars. All the graduates of 1950–1980 years may consider themselves as the disciples of V.P.Tsessevich to a certain degree.

It should be noted that a significant contribution was made out to the astronomy development by those

Odessa astronomers on whom scientific degrees and titles were not conferred (see issues " Stranitsy...", 1994, 1995, 1996).

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THE ASTRONOMICAL OBSERVATORY OF THE ODESSA STATE UNIVERSITY

The Astronomical Observatory as the scientific institution was founded in 1871. Now it has two mountaneous and two suburban observational stations, and the base territory in Odessa (T.G.Shevchenko Park, Odessa 270014 Ukraine; e-mail astro@paco.odessa.ua). Director: Prof. Dr. Valentin G. Karetnikov.

The observatory is equipped by two 80-cm, a 60-cm, two 50-cm telescopes, a 35cm Schmidt Camera, a seven-camera Astrograph. Significant part of observations is obtained at other observatories (6m, 2.6m etc.).

The Astronomical Observatory can fulfil the following tasks :

- Photometric observations of the various types of astronomical objects in the spectral region ($\lambda\lambda$ 3500-22000 Å) by the photoelectric (to 11 mag) and the photographic and CCD (to 15 mag) methods. Analysis of the observational data of the constant and variable stars, the meteors, the comets and the artificial space bodies.

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- Observations of the rapid processes:
  - the occultations of the stars by the Moon and by the planets with a precision of 0.001 sec.
  - the phenomena accompanying the penetration of the natural and artificial bodies into the Earth' atmosphere.
  - the fast stellar variability by using a two-channel photometer at the Mount Dushak-Eregdag observational station in Turkmenia.

- Position determination of the objects (stars, planets to 10^m), by using the meridional circle. Elaboration of the astrometric catalogs and the investigation of the inertial frame of reference.

- Measurements of the brightness and the polarization of the twilight, night and day sky light in order to obtain the extinction and the dust abundance in the upper layers of the Earth' atmosphere. Modeling of the Earth' atmosphere and its ecology.

- Design and construction of the astronomical telescopes with the diameter of the mirror up to 0.8 m, the devices for operating the telescope and other instruments for astronomical observations (both scientific and amateur).

- Teaching the children and amateur astronomers by the correspondence course, holding the summer school camp, giving the consultations. Elaboration and distribution of the observational programs, instructions, finding charts and ephemerides for the selected variable stars and other objects necessary for carrying out the amateur astronomical observations.

- Computer modeling of the astrophysical processes (radiation transfer, synthetic spectra, polarization, binary star evolution etc.).

- Application of programs for the reduction of the astronomical data (periodogram, multifrequency, scalegram and wavelet analysis of the (irregularly spaced) data with and without a trend by using more than 20 methods, investigation of the period changes, approximation by using the 'smoothing' of the smoothing cubic splines, 'running' ordinary and trigonometric polynomials, 'asymptotic parabolae' etc.). Restoration of the autocorrelation function from the values biased by a removal of an arbitrary trend. Analytic and numerical study of the statistical characteristics of the model parameters and the smoothing functions. Applications of these complimentary methods to time series with an arbitrary nature. Elaboration of programs.

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