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The unique galactic Cepheid V473 Lyrae revisited

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Abstract. We present elemental abundances found for the peculiar galactic Cepheid V473 Lyr. Results were obtained for 38 species of 32 chemical elements. We confirmed previous conclusion that this s-Cepheid is slightly underabundant in metals ([Fe/H]=-0.16). Carbon follows the usual rule to be deficient in the Cepheid atmospheres. No significant overabundance was detected for sodium. Other elements with determined abundances do not show any marked anomalies.

Atmospheric parameters of V473 Lyr derived in the present study are the following: T_{eff}=6100 K, $log\ g$=2.2, V_{micro}=3.8 km s^{-1}, V_{macro}=4.5 $km\ s^{-1}$.

Key words: stars: V 473 Lyr; abundances; cepheids; fundamental parameters

1. Introduction

Among the small-amplitude s-Cepheids there is one interesting star that reveals an unusual character of the pulsational activity. Having a pulsational period of 1.4909^d, V473 Lyr shows an amplitude (of the light and radial velocity) variation with period of about 3 yr. The origin of such variation is not clear.

This star has often been studied photometrically (separate studies or multi-site campaigns) but only two spectroscopic analyses have been done. First work on this topic was performed in 1994 by Andrievsky at al. (1994). The results of that study were based only on analyses of blue spectra.

A second attempt was made in 1996 (Kovtyukh at al., 1996): abundances of 22 elements were derived using two red CCD spectra. It was somewhat surprising, but no remarkable anomalies in chemical composition of this star were found in that work (more detailed comparison with present results will be given below).

After those determinations it became clear that the peculiar behavior of V473 Lyr is not directly displayed in the elemental abundances. Nevertheless, we decided to repeat the fine analysis using spectra of higher resolution and S/N ratio and wider spectral range. It enabled 1) to specify the fundamental parameters of this unique Cepheid, 2) to enlarge the number of investigated chemical elements, 3) to increase the reliability of the obtained abundance results.

This exceptional Cepheid is close to the red edge of the instability strip, either entering or leaving the strip. The physical mechanism causing a modulation of the amplitude by a factor of ~ 15 is completely unknown. In order to compute any kind of model to explain this behaviour, one need to know the pulsation mode. We will exploit the very low amplitude behaviour to determine accurately the effective temperature. We then determined the absolute magnitude, radius, mass and luminosity of V473 Lyr and discuss the pulsation mode of the star (Sect. 6).

2. Observational material

Three spectra of V473 Lyr were employed to investigate the elemental distribution. These spectra have been obtained with ELODIE, a fibre-fed echelle spectrograph installed on the 1.93m telescope of Observatoire de Haute-Provence (France). It is equiped with a 1024 × 1024 CCD camera, covering the wavelength range 3900-6800ÅÅ in 67 orders. The resolving power is 40000.

An automatic reduction pipeline is associated with the spectrograph and images are reduced a few minutes after the exposure (bias and flat-field correction, order extraction, cosmic rays removal, wavelength calibration). For all the spectra the signal-to-noise ratio is larger than 150. Baranne et al. (1996) give detailed descriptions of the spectrograph and reduction procedure. Some useful information concerning the spectra is presented in Table 1.

Further work with the spectra (continuum level, equivalent widths measurement, etc) was carried out using DECH20 package (Galazutdinov, 1992). On the whole, equivalent widths of 2170 lines were measured from three spectra. Finally, from the list of measured lines we have excluded those having not well-expressed profiles or $W_\lambda \gtrsim 165\ m$Å. Some lines were re-

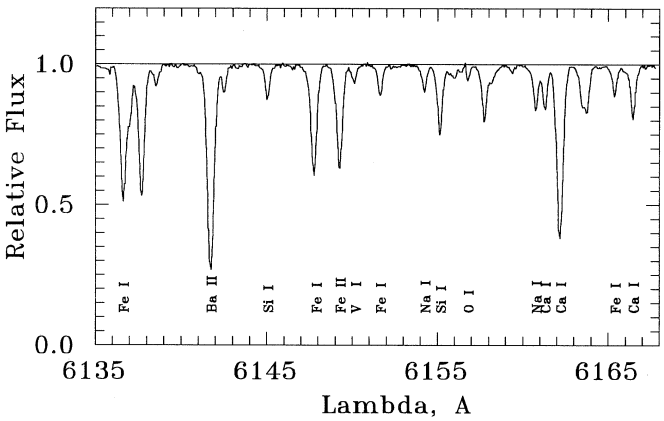

Fig. 1. A slice of the V473 Lyr spectrum.

Table 1. Observations. In July 1995, the radial velocity full amplitude was $\sim$ 4.2 km s^{-1}

Spectrum	Date	HJD,2440000+	Phase	Exp., (s)
SP1	7 Jul 1995	9906.4316	0.793	1500
SP2	8 Jul 1995	9907.5736	0.559	1800
SP3	9 Jul 1995	9908.4334	0.136	1800

Note: phases are calculated using elements from Burki (1997).

moved after preliminary analysis. Thus, in the final analysis we have used $\approx$ 1900 lines. For some of them we had two estimates of W_λ from adjacent orders. In all cases, the differences between two estimates did not exceed 10%, being usualy less than 5%. The quality of the spectra can be evaluated from Fig. 1.

3. Method of analysis

The WIDTH9 code and a new grid of atmosphere models (Kurucz, 1992) were used to derive the abundances. Special attention was given to oscillator strengths' system. In this work we used the "solar" $log\ gf$. Those values were derived by us using unblended solar lines (from the solar spectrum by Kurucz et al. 1984).

All selected solar lines were accurately measured using software of Galazutdinov (1992). Then, for each line of the considered element we corrected the $log\ gf$ value to produce the currently adopted solar elemental abundances (Grevesse and Noels, 1993). This procedure was performed using the WIDTH9 code, solar atmosphere model from Kurucz's grid with microturbulent velocity of 1 km s^{-1}.

Abundances of some elements having only weak lines in the spectra were derived using synthetically generated spectra (our implementation of SYNTHE code Kurucz [1995] and Tsymbal [1996] software). Among them one finds Sr I (4607.33), Sr II (4161.79), Ba II (4166.00), Er II (4759.65 and 4951.74), Hf II (4096.16). In each case synthesis was performed taking into account all possible blending atomic and molecular lines. As an example, we present in Fig. 2 the synthetic and observed spectra in the region of Er II line.

Similar synthetic procedure was also applied to derive the abundances of such elements as Mg, Sc, V, Mn, Co and Cu whose lines are strongly influenced by the hyper-fine structure. This effect was taken into account using input information on hyper-fine and isotopic splitting from Kurucz (1995) database (CD-ROMs 1,15,18,23) and Steffen (1985). Oscillator strengths of investigated lines and blends were initially adjusted from a comparison with the solar flux spectrum (Kurucz et al. 1984).

4. Atmosphere parameters

4.1. Temperature

Fortunately, in summer 1995 V473 Lyr was at the minimum amplitude (a few hundredths of magnitude). So, we can expect that during a pulsation cycle the effective temperature variation should be negligible. The most important problem was to find the "mean" temperature. To this aim we compiled BV data covering the period from 1979 to 1994 that were gathered and reduced by Berdnikov and Pastukhova (1994). Using their numerical results we plotted $B-V$ against phase in Fig. 3.

We adopted a colour excess E_{B-V} = 0.04, following Burki et al. (1986) because of its intermediate position (e.g., Fernie [1995], van Genderen [1981] and Arellano Ferro [1984] give E_{B-V}=0.026, 0.030 and 0.035 respectively, while Fabergat et al. [1990] found E_{B-V}=0.09). With the adopted E_{B-V} correction, the effective temperature appears very close to 6000 K (Kurucz [1991] calibration).

According to recent results of Burki (1997), during the summer of 1995 V473 Lyr had an amplitude of $(B-V)$ = 0.02 with mean value $\simeq$ 0.63. Burki also gives E_{B-V} = 0.04. His results reproduce the same effective temperature value.

An independent temperature estimate was also made using $(b-y)$ colour index. Adopting E_{B-V} = 0.04, Burki et al. (1986) obtained $(b-y)_0$ = 0.36 and c_1=0.73. Supposing that an average colour is constant, one can determine mean value of the effective temperature and gravity: $T_{eff} \simeq 6100\ K$ and $log\ g \approx$ 1.8 (Kurucz's [1991] calibration).

Small colour variations in 1995 (within 0.02) correspond to a temperature variation of about $100K$. Therefore, we adopted T_{eff} = 6100 K for ϕ=0.793; T_{eff}=6050 K for ϕ=0.559 and T_{eff}=6150 K for ϕ= 0.136. The temperature choice was verified by checking any dependence of the calculated abundances for individual FeI lines upon line excitation potential. The result is shown graphically in Fig. 4.

4.2. Gravity

A preliminary gravity estimate was performed using $(b-y)_0$ vs. c_1 diagram. This yielded $log\ g \approx$ 1.8. Next calculation has shown that FeI/FeII ionizational balance can be obtained only for $log\ g \approx$ 2.1-2.2 that is rather close to the photometrical result.

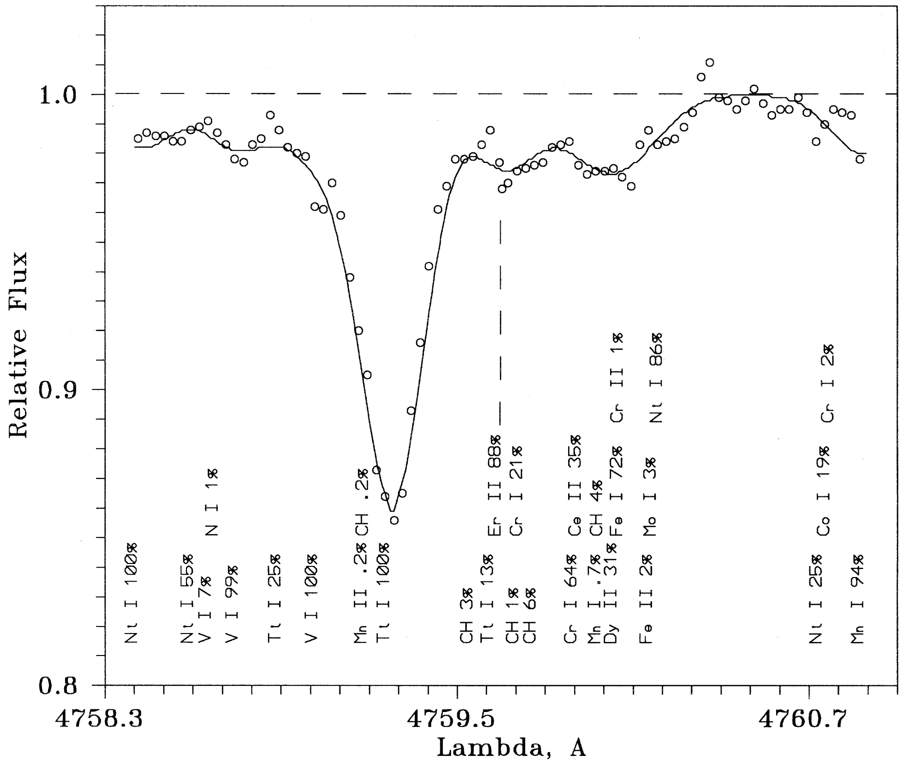

Fig. 2. An example of the fit of observed spectrum (circles) with synthetic spectrum (solid line) in the region of Er II 4759.65 line. Positions of all used lines and the relative intensities in percents of the total line absorption at the given wavelength are indicated.

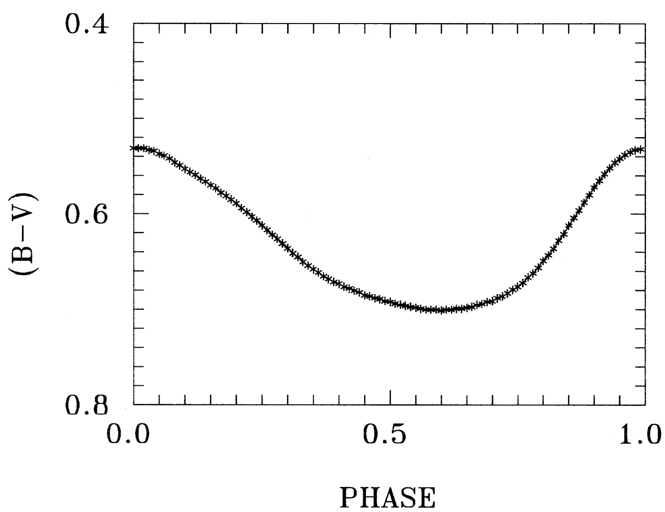

Fig. 3. (B-V) vs phase for V473 Lyr.

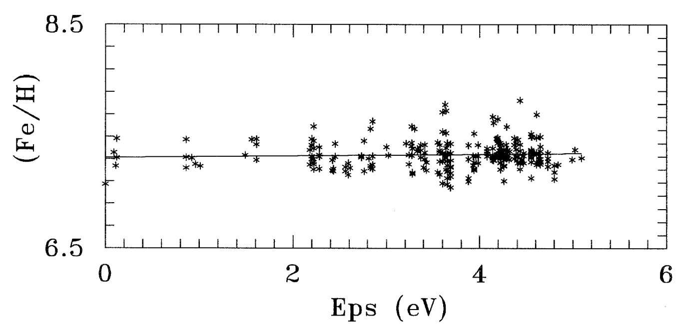

Fig. 4. To the effective temperature specification.

4.3. Microturbulent and macroturbulent velocities

In order to derive the microturbulent velocity V_{micro}, we used the standard method by imposing that there should be no dependence of iron abundance upon equivalent width (see Fig. 5). For all the spectra we obtained the same value: V_{micro} = 3.8 $km\ s^{-1}$. The visible dependence between iron abundance and equivalent width appeared when V_{micro} parameter was changed by $\pm$ 0.2 $km\ s^{-1}$.

The broadening of spectral lines by macroturbulence was estimated using spectral synthesis. Assuming the Gaussian case and fitting the observed spectrum in the regions of unblended iron lines with oscillator strengths measured by Blackwell et al. (1979, 1982) we obtained V_{macro} = 4.5 $km\ s^{-1}$. We must also note that the same broadening can be obtained assuming the rotational velocity of V473 Lyr $vsini$ = 7 $km\ s^{-1}$.

5. Abundance results

In Table 2 we give the calculated abundances for the three phases. There are no noticeable differences between the results from different spectra. Mean abundances are presented in Table 3. One can compare them with the results of the previous investigations.

Only two studies were devoted to a detailed abundance analysis of V473 Lyr atmosphere. The first of them (Andrievsky et al., 1994) was based on blue photographic spectra, therefore we will not discuss it here. In the others, by Kovtyukh et al. (1996) two CCD spectra were analysed. The results of that study are

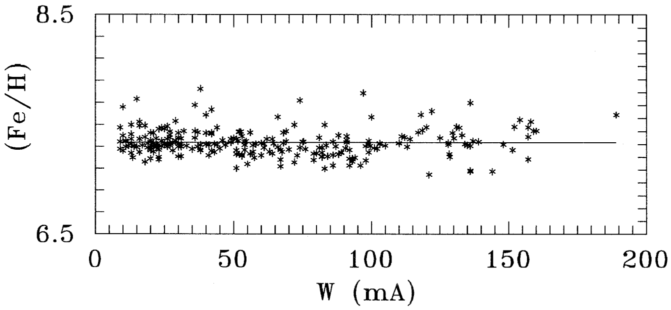

Fig. 5. To the microturbulence determination.

presented in Table 3 (note that we give recalculated abundances for two CCD spectra based on solar oscillator strengths).

Generally, we are in the satisfactory agreement with the previous results, although we should not to expect an exact coincidence in the abundances derived from different spectra. We believe that present spectra yield the more accurate abundances because of the higher resolving power (40000 versus 24000 for SAO CCD spectra).

Together with an increasing of the accuracy of elemental abundances, we also enlarged the list of investigated chemical elements. In addition, we tried to derive the abundances of such "exotic" elements as Er, Hf etc. In addition to well-known hafnium and erbium lines, we also used one erbium line 4951.74 which was recently identified by Gopka and Yushchenko (1995).

6. What can we learn about V473 Lyr?

6.1. Chemical composition

Let us briefly discuss the main results of abundance analysis.

Carbon. This element is apparently deficient in V473 Lyr atmosphere. It suggests that V473 Lyr has already passed the red supergiant phase. The carbon abundance obtained here is somewhat lower than deduced earlier (Kovtyukh et all., 1996). It is probably caused by difference in the resolving power of the spectra used in two independed investigations. Lower resolving power can lead to overestimation of the equivalent width of 6587.62 Å carbon line (this line is blended with telluric line and also located in the H_α wing). It is the only one carbon line used for carbon abundance determination in the previous study, while present estimate of carbon abundance is based on the analysis of seven lines.

Oxygen. Note that estimated [O/Fe] of about -0.2 is consistent with previous Cepheid and supergiant results by Luck and Lambert (1985), Luck and Wepfer (1995). Such an oxygen deficiency cannot be explained within standard dredge-up scenario.

Sodium. Denissenkov (1989) gives some theoretical arguments that sodium overabundance must be correlated with supergiant luminosity. The surface Na abundance should be altered after the dredge-up phase when Ne-Na processed material appears in the atmosphere. Without making special supposition about initial Ne content on the main sequence (three times

Table 2. Abundances for individual elements

Species	SP1			SP2			SP3		
	[M/H]	σ	NOL	[M/H]	σ	NOL	[M/H]	σ	NOL
C I	-0.47	0.15	7	-0.46	0.13	7	-0.46	0.20	7
O I	-0.35	0.20	4	-0.47	0.06	3	-0.31	0.19	3
Na I	0.01	0.13	6	0.00	0.15	5	0.04	0.13	7
Mg I	-0.25	0.19	4	-0.24	0.13	4	-0.24	0.13	4
Al I	-0.07	0.03	2	-0.13	0.09	2	-0.06	0.12	2
Si I	-0.01	0.10	26	-0.07	0.07	24	-0.01	0.11	27
Si II	0.13		1	0.12		1	0.12		1
S I	0.11	0.10	3	0.00	0.08	2	0.02	0.15	3
Ca I	-0.03	0.16	21	-0.12	0.15	20	-0.08	0.13	20
Sc II	-0.20	0.07	8	-0.20	0.07	8	-0.16	0.08	8
Ti I	-0.11	0.14	35	-0.08	0.16	91	-0.07	0.18	37
Ti II	-0.16	0.09	14	-0.12	0.11	14	-0.09	0.12	23
V I	-0.13	0.07	3	-0.13	0.06	3	-0.09	0.07	3
V II	-0.25		1	-0.25		1	-0.25		1
Cr I	-0.02	0.14	25	-0.19	0.12	31	-0.10	0.11	32
Cr II	-0.16	0.11	15	-0.13	0.09	11	-0.15	0.11	14
Mn I	-0.28	0.12	6	-0.29	0.14	5	-0.26	0.14	5
Fe I	-0.16	0.12	246	-0.16	0.12	258	-0.14	0.11	190
Fe II	-0.16	0.08	14	-0.16	0.11	28	-0.16	0.11	31
Co I	-0.22	0.04	5	-0.23	0.03	3	-0.23	0.03	4
Ni I	-0.15	0.10	72	-0.23	0.10	62	-0.17	0.10	68
Cu I	-0.10	0.12	2	-0.12	0.18	2	-0.05	0.15	2
Zn I	-0.22	0.22	4	-0.25	0.25	4	-0.28	0.14	3
Sr I	0.10		1	0.08		1	0.05		1
Sr II	-0.06		1	-0.05		1	-0.03		1
Y II	-0.02	0.16	7	-0.03	0.09	6	-0.04	0.08	5
Zr II	-0.06	0.04	3	-0.07	0.12	5	0.02	0.07	2
Ba II	0.19		1	0.25		1	0.29		1
La II	-0.18	0.28	6	-0.16	0.22	3	-0.05	0.19	6
Ce II	-0.03	0.15	13	-0.06	0.23	15	0.00	0.11	13
Pr II	-0.36	0.15	2	-0.48	0.16	2	-0.27	0.00	2
Nd II	-0.09	0.12	11	-0.15	0.16	18	-0.11	0.18	16
Sm II	-0.24	0.16	5	-0.24	0.17	4	-0.21	0.20	6
Eu II	-0.12	0.06	2	-0.22	0.12	2	-0.14	0.06	2
Gd II				-0.17		1			
Dy II	0.18		1	0.06		1	0.19		1
Er II	-0.19	0.02	2	-0.09	0.12	2	-0.07	0.05	2
Hf II	-0.01		1	-0.06		1	0.08		1

greater than solar Ne abundance, as Denissenkov proposes), [Na/Fe] $\approx$ 0.18 found for V473 Lyr corresponds to the minimal possible Cepheid mass and $log\ g \approx 2$ (see Fig. 5 and Fig. 6 from Denissenkov, 1989). It means that V473 Lyr is apparently a low-luminosity supergiant.

Such a conclusion can also be qualitatively confirmed by results of El Eid and Champagne (1995). Their calculations suggest that a star with sodium excess less than 0.2 possesses a mass less than 5 $M_\odot$.

The majority of α- , iron-group and s-process elements do not show any significant anomalies.

From Table 3 we can note that V473 Lyr is slightly deficient in metal when compared with solar abundances. A general slight metal deficiency is a common feature for the majority of small-amplitude s-Cepheids. More likely is that the smaller masses

Table 3. Averaged abundances for V473 Lyr

	OHP			SAO		
El.	[El/H]	σ	NOL	[EL/H]	σ	NOL
C	-0.46	0.01	21	-0.29	0.02	4
O	-0.37	0.08	10	-0.33	0.04	2
Na	0.02	0.02	18	0.10	0.05	6
Mg	-0.24	0.01	12	0.02	0.09	4
Al	-0.09	0.04	6	0.14	0.11	4
Si	-0.02	0.12	80	0.05	0.01	22
S	0.05	0.06	8	0.27	0.02	4
Ca	-0.08	0.05	61	0.00	0.01	12
Sc	-0.19	0.02	24	0.02	0.05	8
Ti	-0.09	0.04	214	0.02	0.18	22
V	-0.15	0.07	12	0.03	0.08	10
Cr	-0.12	0.06	128	-0.05	0.09	34
Mn	-0.28	0.02	16			
Fe	-0.16	0.01	767	-0.10	0.02	182
Co	-0.23	0.03	12	-0.22	0.07	3
Ni	-0.18	0.04	202	-0.15	0.03	41
Cu	-0.15	0.15	7			
Zn	-0.25	0.03	11			
Sr	-0.06	0.02	6			
Y	-0.03	0.01	18	0.12	0.03	11
Zr	-0.05	0.05	10	0.05	0.09	3
Ba	0.08	0.05	3			
La	-0.12	0.07	15	0.08	0.00	2
Ce	-0.03	0.03	41	-0.06	0.09	4
Pr	-0.37	0.11	6	-0.41	0.04	4
Nd	-0.12	0.03	45	0.05	0.04	6
Sm	-0.23	0.02	15			
Eu	-0.13	0.01	4	-0.21		1
Gd	-0.17		1			
Dy	0.14	0.07	3			
Er	-0.23		1			
Hf	0.05	0.02	3			

NOL-total number of lines.

for s-Cepheids coupled with overtone pulsation exacerbated by the small metal deficiency pushes them to the blue edge of instability strip.

It is clearly seen in Fig. 6, where we plotted all s-Cepheids investigated by Andrievsky et al. (1996) and Kovtyukh et al. (1996). For sample of 17 stars we obtained the mean value of [Fe/H] ≈ -0.10.

At the same time V473 Lyr having all properties of the s-Cepheids occupies the red edge of instability strip.

6.2. Mass, radius and position on HR diagram

There were several attempts to estimate the mass and radius of this Cepheid. In Table 4 we gathered some results of the different studies.

One can independently derive the radius of V473 Lyr using relation recently found by Laney and Stobie (1995) on the base of $BVRI$ and JHK photometry of 49 Cepheids (note that their statistics includes only Cepheids with period $\geq 3^d$).

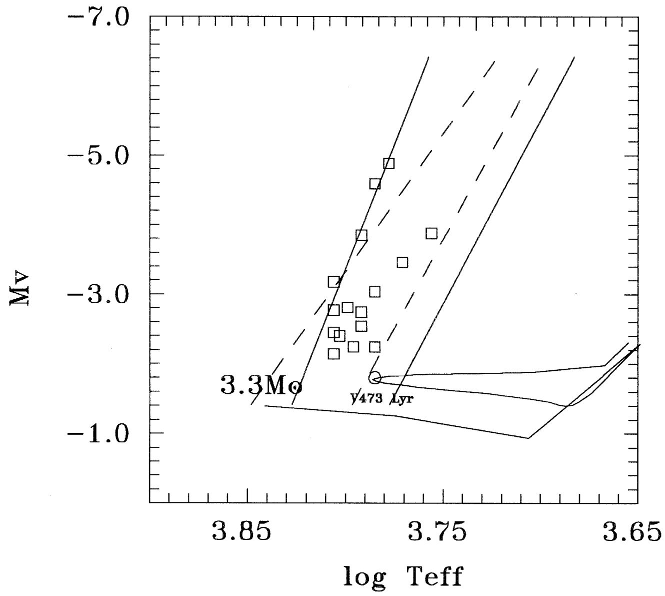

Fig. 6. Investigated s-Cepheids on HR diagram (V1162 Aql re-classified as a classical Cepheid is not indicated). Absolute magnitude are calculated using the "period-absolute magnitude" relation for fundamental pulsators by Gieren and Fouqué (1993). Temperatures are taken from the work by Andrievsky et al. (1996) and Kovtyukh et al. (1996). Instability strip edges (solid line for fundamental mode and dashed line for first overtone) are found using a relations from Chiosi et al., 1992).

Table 4. Mass and radius of V473 Lyr.

Author	R	method	M_v	M_{ev}	M_{BW}
Van Genderen, 1981	19.7	$UBLVW$	-1.9		
Fernie, 1982	29±5	SB	-1.0		
Burki et al.,1982	34±5	BW	-3.1		
Arellano Ferro,1984	20	SB	-1.8	3.8	4.7
					2.7[1]
Burki et al.,1986	50±15	ML			
	41±11	BW			
	38±15	BW			
	32±10	BW			
Fabergat et al.,1990	30±6	uvbyβ			4.1

1-first overtone; SB-surface brightness, BW- Baade-Wesselink, ML-maximum likelihood.

Extrapolated result for the program Cepheid is the following: 16 $R_\odot$, which being combined with temperature T_{eff} = 6100 K gives the luminosity ≈ 320 $L_\odot$ and M_v ≈ -1.4.

For mild overshoot case (Chiosi et al., 1992) one has:

$$log\frac{L_*}{L_\odot} = 3.52 log\frac{M_*}{M_\odot} + 0.7 \quad (1)$$

It gives $M \sim 3.5\ M_\odot$ (or even less for full overshoot case). Both the mass and radius estimates reproduce the $log\ g$ value ≈ 2.5 which is close to the spectroscopic estimate of the gravity value ≈ 2.2.

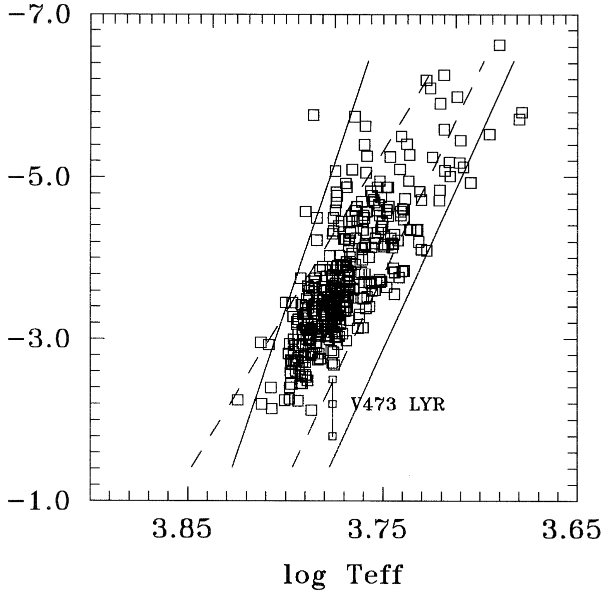

Fig. 7. V473 Lyr and other Cepheids within the instability strip. Note that here for all the stars (including V473 Lyr) the temperatures were calculated on the base of $(B-V)_0$ values (Fernie [1995] catalogue) and $(B-V)_0 - T_{eff}$ calibration by Kurucz (1991). Absolute magnitudes are from PM$_v$ relation by Gieren and Fouqué (1993). For V473 Lyr three different positions are shown (see Table 5).

In Fig. 6 we plot investigated s-Cepheids and V473 Lyr together with evolutionary track for $3.3M_\odot$ (evolutionary track is interpolated from Schaller et al. 1992 grid for Z=0.01, for V473 Lyr we used an intermediate value M$_v$=-1.8 given by PM$_v$ relation of Gieren and Fouque, 1993). All the plotted stars are supposed to be the fundamental pulsators. It is clearly seen that 1) V473 Lyr is situated near the red edge of the instability strip, 2) with rather high probability its position can be associated with a critical portion of the evolutionary track: a termination of the core helium burning. Such an extreme position within instability strip can result in some kind of the secular instability and lead to the amplitude changes.

Why we do not see a similar behaviour among other Cepheids? Firstly, probably because of transitoriness of such instability operation. Secondly, because the region occupied by V473 Lyr is poorly populated with Cepheids (see Fig. 7).

This conclusion does not critically depend upon the supposition about excited pulsational mode (for more details see discussion on V473 Lyr pulsation mode in the next section).

6.3. The pulsation mode of V473 Lyr

There are several indications that V473 Lyr can pulsate in the second overtone mode (e.g. Burki et al. 1986 and references therein), one of the main arguments being its large radius found by some authors. However, given the difficulty of obtaining accurate photometry over the whole pulsation phase because of its period and varying amplitude, the errors on the radii derived with the Baade-Wesselink method are usually large, therefore we cannot have a clear-cut answer regarding the pulsation mode.

Table 5. Fundamental parameters of V473 Lyr as a function of assumed pulsation mode. The magnitudes have been computed with Gieren and Fouqué's (1993) PM$_v$ relation. The pulsational mass comes from Wood et al. (1997), the evolutionary mass has been found by interpolating in the evolutionary tracks (Fagotto et al. 1994, Bressan et al. 1993). The radii, luminosities and masses are in solar units.

Mode	M$_v$	R	L	M_{puls}	M_{evol}	$log\ g_{puls}$	$log\ g_{evol}$
Fundamental	-1.8	16	320	2.0	3.6	2.3	2.6
1st ov.	-2.2	20	530	2.1	4.2	2.2	2.5
2nd ov.	-2.5	24	740	3.0	4.6	2.2	2.3

It is clear that V473 Lyr is a Cepheid. Its spectral type (luminosity class Ib-II), period and colour place it close to the red edge of the instability strip. The fact that we had good photometry while the star was at minimum amplitude allows to accurately determine its colour index since the variation in $B-V$ is low. With its colour and reddening given above, the intrinsic colour $(B-V)_0$ is 0.59. With the M_v absolute magnitude coming from the PM$_v$ relation given by Gieren and Fouqué (1993), one can accurately place the star in the HR diagram (the magnitudes are given in Table 5). The above numbers show that it is not exceptional that V473 Lyr is pulsating in the second overtone.

Another possibility is that its reddening be higher. Adopting $E_{B-V} = 0.1$, the star could well be a first overtone pulsator however we do not favour this value of the colour excess (see discussion in Sect. 4). In any case, pulsation in the fundamental mode can be ruled out. Another point that has to be emphasized is that the PM$_v$ relation that we used gives brighter magnitudes for low-luminosity Cepheids. Had we used another one, the pulsation mode would still be the second overtone even with a higher reddening.

Since we have determined the temperature from its $B-V$ colour, and we are confident that this value is good (see Fig. 4 and the discussion in Sect. 4), we can determine the luminosity of V473 Lyr, assuming pulsation in the fundamental, 1st or 2nd overtone. This allows to determine its mass from evolutionary tracks. We found masses between $\approx 3\ M_\odot$ and $\approx 5\ M_\odot$, based on models with convective overshoot (Fagotto et al. 1994, Bressan et al. 1993). We also computed the mass from pulsation calculations (Wood et al. 1997). They are systematically lower than the evolutionary masses. However this disagreement should be taken with care since the star is on the red edge of the strip. It is impossible to reproduce this edge from linear pulsation calculation and thus the relations between P, M_v, L and T_{eff} can be in error. The evolutionary mass is in agreement with the slight sodium excess that has been found previously.

Once we have the mass, we can compute the gravity, taking account of the pulsation mode when determining the radius. In order to have agreement with the spectroscopic gravity determined above (log g = 2.2), pulsation in the second overtone can be preferred (both $log\ g$ values estimated using the 2nd overtone characteristics are close to spectroscopic result, see Table 5).

7. Conclusion

1. We derived abundances of 32 elements. Several elements were investigated for the first time.
2.The Cepheid's atmosphere is deficient in carbon. It indicates that V473 Lyr is post first dredge-up star. It then rules out the possibility that the star is crossing the instability strip for the first time.
3. Sodium shows a very modest overabundance reflecting a low value of the mass of this s-Cepheid.
4. The majority of the elements do not display any abundances anomalies.
5. V473 Lyr can be classified as a star which is slightly deficient in metals. Most reliable estimates for iron give [Fe/H]=-0.16.
6. The atmospheric parameters are the following: mean value of T_{eff} = 6100 K, $log\ g$ = 2.2, V_{micro} = 3.8 $km\ s^{-1}$, V_{macro} = 4.5 $km\ s^{-1}$.
7. Even if several parameters may be wrong (colour excess, absolute magnitude, radius, mass), there is accumulating evidence that V473 Lyr is pulsating in the second overtone. This is the only known Cepheid pulsating only in this mode (some double-mode Cepheids are known to pulsate in the first and second overtone simultaneously). The easiest way to settle this question of the pulsation mode would be to have the distance through the HIPPARCOS parallax. However, estimates of its distance show that the parallax will be known at best to 50%, which is too low to decide.

This star is situated in the low-luminosity and low-temperature region of the instability strip, entering or leaving the strip, on its second or third crossing. The amplitude change could be related to transitory phenomena occurring during this process. As such it could give essential information on the onset or damping of the pulsation at the edge of the instability strip.

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