PHOTOMETRY OF LOW AMPLITUDES δ SCUTI TYPE STAR VW ARI

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ABSTRACT. 48 hours of VW Ari observations during 11 nights in October 1993 were analyzed. The data were obtained with the dual-channel photometer at the Mt. Dushak-Erekdag (Central Asia) during multisite campaign of STEPHI network. Frequency solution derived from Mt. Dushak-Erekdag data was compared with the solution from STEPHI data. The conclusion was made about the necessity of inside calibration system with using of an artificial source. The suggestion that VW Ari belongs to λ Booti group of stars was considered.

Key words: Stars: δ Scuti: oscillations - star: Individual: HD 15165, BDS1269A, VW Ari - Techniques: photometric

VW Ari (HD 15165) is a primary component of binary system BDS 1269. A feature of the system is that its primary component has strong metal-deficient chemical composition whereas the secondary component is normal F type star. For the first time this fact was discussed by Mechler (1974) and recent investigations Andrievsky et al. (1995) confirm it. The existing of such an unusual system is an enigma, the history of BDS 1269A investigations is intriguing, too.

Mechler suspected the low amplitudes variability of the star, which was confirmed by Seeds & Horan (1976) and McMillan et al.(1976). Further Rucinsky (1978) and Persy (1980) revealed two periods using a very poor data. The frequency pattern was similar to δ Scuti type star, but Rucinsky (1978) assumed that VW Ari might be SX Phe (or RRs) type star because of its extreme metal-deficiency. Kurtz

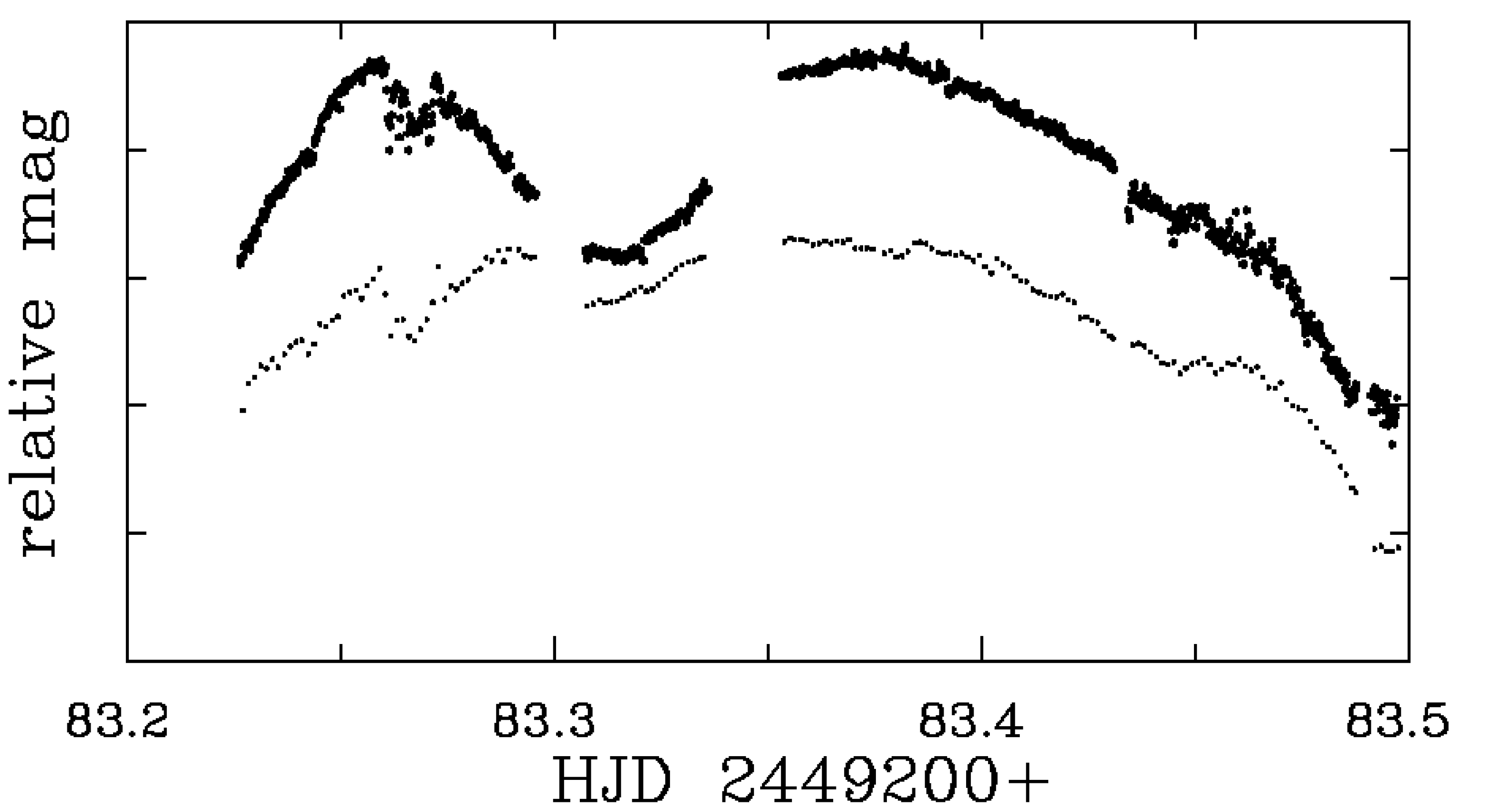

Figure 1: Typical instrumental light curve of VW Ari (upper) and comparison star HD 15095 (lower) obtained on 22 Oct. 1993 in dual channel mode. The intervals in light curves were used for channel calibrations. $0^m.9$ is added to data of comparison star for viewing convenience. A value of the point at magnitudes' axis is $0^m.01$.

(1980) put forward that metallicity of the star may be normal.

McNamara & Horan (1984) obtained measurement on BDS 1269A on 17 nights during time interval of 6 months. But they did not reveal strong component at 10.74 c/d, and supposed the redistribution of power into alternative modes.

A decade later Li & Jiang (1993) analyzing their own observations and reanalyzing the data of Persy and Rucinski obtained the very elegant 5 frequencies' solution. They noted the constancy of the frequencies' distribution between 1976 and 1987 years, but admitted the possibility of amplitudes' variation.

In 1993 the star was observed by STEPHI network (Liu at al, 1996, hereafter STEPHI93). STEPHI (STellar PHotometer

Table 1.

Date	JD 2449200+	ΔT (hrs)
08.10	69.	4.0
09.10	70.	5.0
11.10	72.	3.6
12.10	73.	3.6
13.10	74.	4.2
16.10	77.	4.6
19.10	80.	3.4
20.10	81.	2.6
21.10	82.	6.4
22.10	83.	6.4
23.10	84.	4.5

International) network was provided by three identical four-channel photometers allocated in three observatories: Xinglong observatory (China), Medon (France) and Observatorio del Teide (Spain) for program of δ Scuti stars' observations (see Michel et al, 1992). WET (Whole Earth Telescope) technique was applied for such multichannel observations (see Nather et al., 1990). In VW Ari campaign 1993 two observatories participated, Xinglong and Teide. The Mt. Dushak-Erekdag station of Odessa Astronomical Observatory (Central Asia, Dorokhov et al., 1994) with 0.8m Ritchey-Chretien telescope is just located in longitude "gap" between these. Participation in multisite δ Scuti campaign was by the first trial of such observations for our dual-channel photometer (Dorokhov & Dorokhova, 1994).

We obtained 48 hours of VW Ari observations during 11 nights of October 1993 in the same manner as STEPHI observations. The data comprise continuous 10 sec. or 20 sec. integrations through v Ströemgren filter in both channels simultaneously. A comparison star HD15095 was observed in the second channel.

The data were corrected for coincidence counting losses, the sky background contribution was subtracted. Then these were transformed to instrumental magnitudes and corrected for the atmospheric extinction. The example of such dual-channel observations is shown in Fig.1. The data have been binned to 2 min. integrations by taking 12 points' averages. The time is given for the middle of interval. A mean square error is $0^m.001$ of a single observation for variable and comparison stars.

Table 1 gives a journal of the observation listing the civil date, Julian date for that night, observational interval in hours.

Channel calibrations (the observations of the comparison star through the primary channel and the secondary one in turn) were carried out 2-4 times a night. The calibrating values were approximated by polynomial of 1 or 2 degree and the interpolated values were added to magnitudes' differences V-C. All the light curves were jointed and an average for the data ($-1^m.017$) was subtracted from the united light curve.

We revealed that amplitudes of the light curves were significantly different for the first series of the data (from 8 to 16 Oct.) and for the second one (from 19 to 23 Oct.). Apparently, the "jump" in the values of amplitudes was a result of amplifiers' modernization. We used an advice of Pelt (1980) and normalized our data for mean dispersion. The mean dispersion including star's variability for the first set of the data was $0^m.0274$, for the second one - $0^m.0324$. Then all the data were multiplied by mean dispersion, $0^m.299$. This way we lost in ampltudes accuracy, but gained in frequencies determination.

The data set shown in fig.2 was analyzed by using package FOUR (Andronov, 1994). The amplitude Fourier spectrum of the data after successive pre-whitening is presented in fig.3, the revealed frequencies are given in Table 2.

The first frequency of our data coincide completely with f_1 of STEPHI93, the second frequency is one day alias, apparently, of frequency f_4=10.82 c/d in STEPHI93. Next frequency, 7.515 c/d, evidently, correspond to f_2=6.52 c/d, and frequencies 9.35 c/d and 9.48 c/d coincide with STEPHI93 solution. The next revealed frequency, 3.54 c/d, close to 3.5 c/d from McNamara & Horan (1984), but we regard it to noise due to small amplitude ($0^m.013$), which is comparable with the noise level.

The residuals ($0^m.012$) after 5-frequencies so-

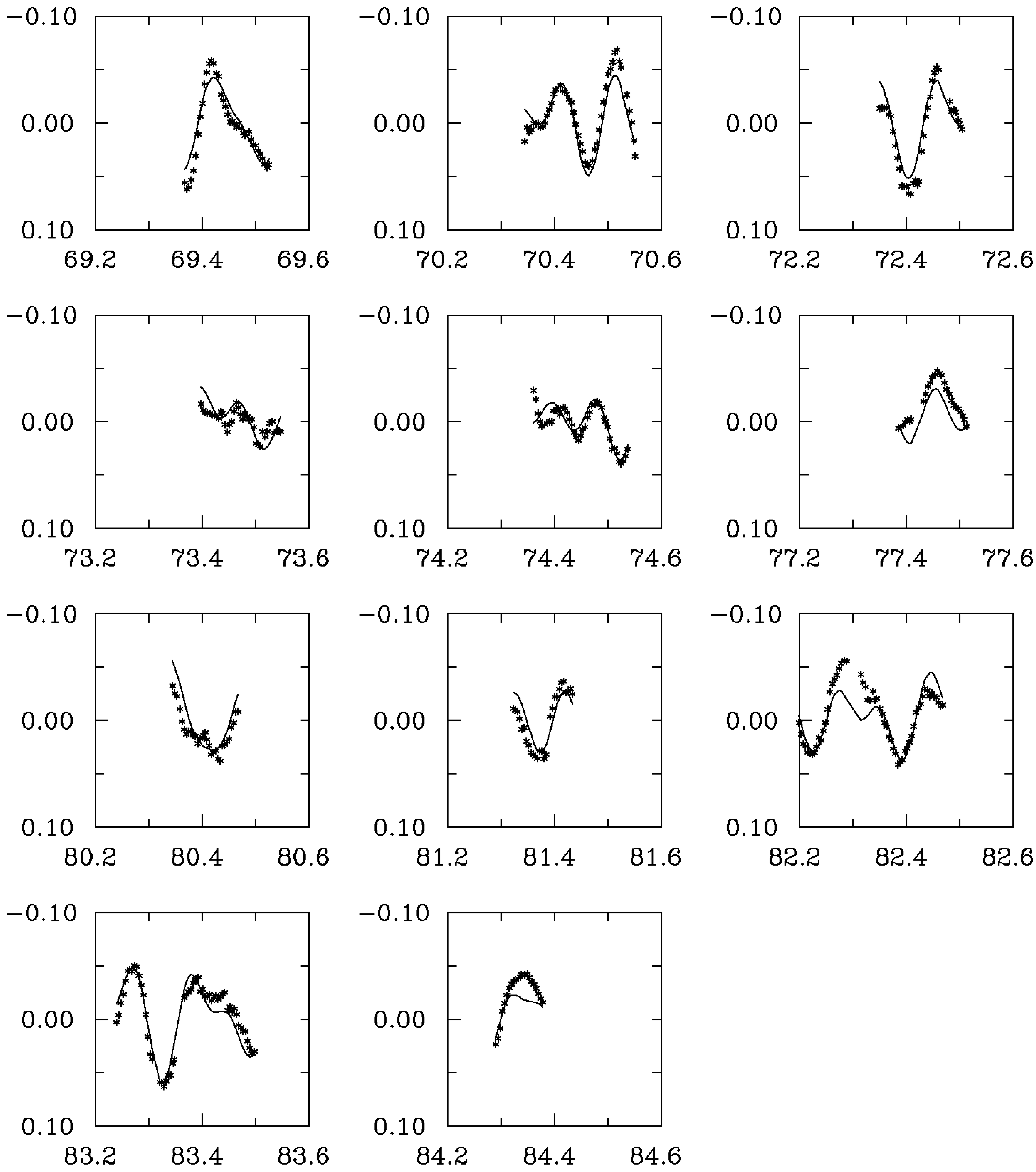

Figure 2: The light curves of VW Ari for 11 nights and their fit of 5-frequencies solution derived in this paper. The epoch is HJD 2449200+, amplitude is in mag

Table 2.

Frequency c/d	Amplitude mmag	Phase 2πrad
6.225 ±0.001	21.5 ±0.9	0.539
11.820 ±0.001	18.4 ±0.9	0.342
7.515 ±0.002	17.9 ±1.0	0.024
9.345 ±0.002	15.2 ±0.9	0.804
9.480 ±0.003	10.9 ±1.0	0.142
rms residual $\sigma = 0^m.012$		

lution are much more than a mean square error of a single observation ($0^m.001$) in each channel. A basic reason of the fact lies in calibrations uncertainties, which is amount of statistical and setting errors in both channels, differencies in atmospheric extinction at the time of observations target star and comparison star and actually channel drifts. Due to these uncertainties the trends in differential light curves appear. The trends increase the noise level in frequency region below 25 c/d (see Breger & Handler, 1993) and lower the accuracy of frequencies determination. More reliable calibration system is needed. Apparently the inside

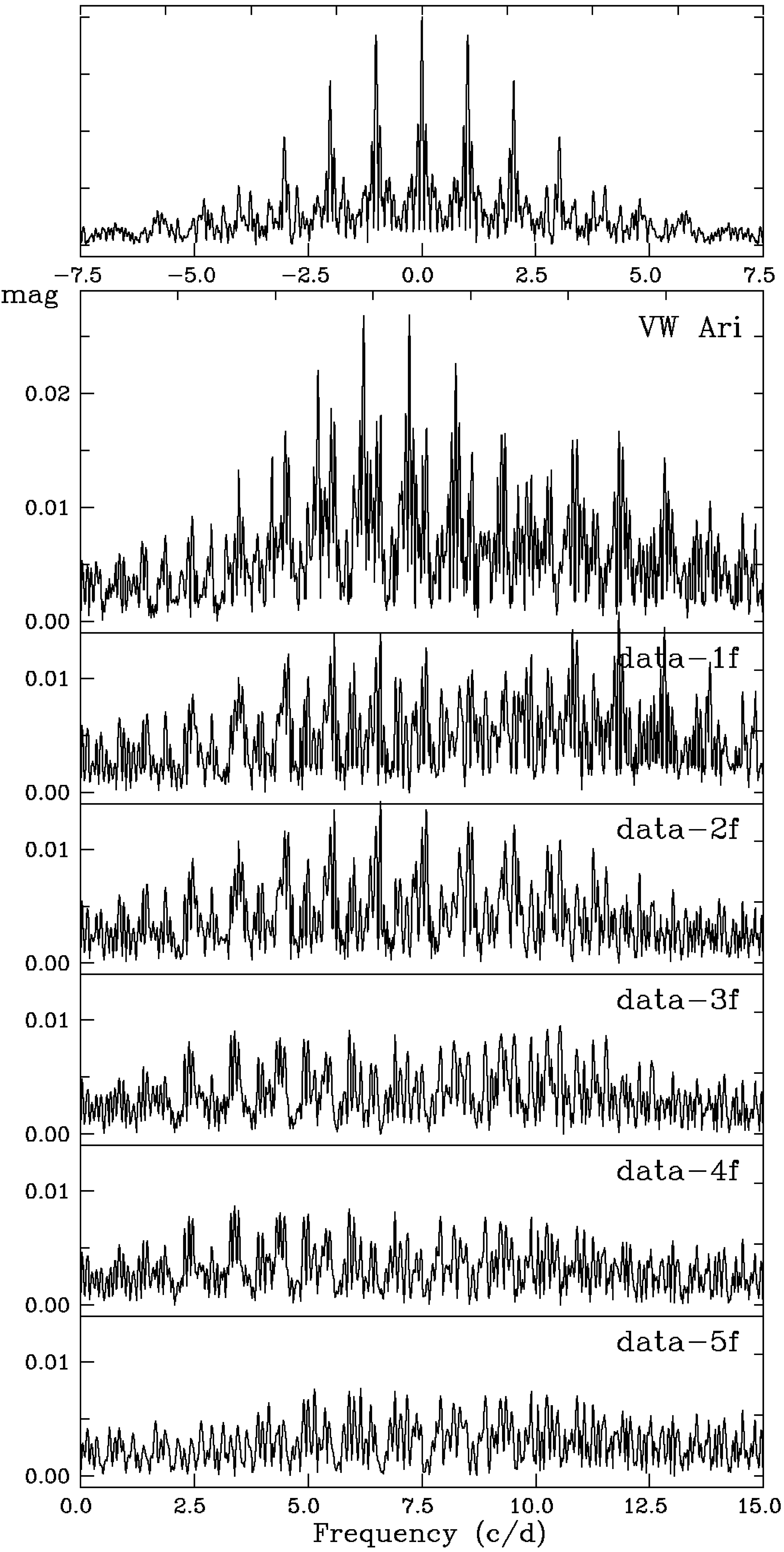

Figure 3: A spectral window and amplitudes' Fourier spectra of VW Ari before and after removal of one or more periods.

calibrations using a single artificial source for both channels is the most available. Such calibrations would be independent of sky transparency.

In this communication we presented the analysis of observations only at the Mt. Dushak-Erekdag observatory. Evidently it is difficulty to obtain a correct solution for the star with such complite frequency spectrum and low amplitudes using the data of a single observatory. The separate data from Mt.Dushak-Erekdag and STEPHI established only the fact of existing 3 frequency group based on 6.2 c/d, 9.3 c/d, 10.8 c/d. All the data are united and the more accurate frequency solution will be presented in the next paper.

We would like to concern briefly the problem of mode identification for this star. Percy (1980) and Rucinsky (1978) assumed that 6 c/d relates to fundamental mode of the star. Kurtz (1980) supposed that 6.35 c/d (6.22 c/d in our data) is the first overtone of radial pulsation. Li & Jiang (1993) and Liu et al. (1997) were inclined to the opinion that only nonradial p-modes degree l=2 and l=3 presents in the star. These authors operated the well-known alignment for pulsation constant Q from Breger & Bregman (1975) and tables from Fitch (1981) for evolutionary models of the stars. McNamara & Horan (1984) and Li & Jiang (1993) undertook the searches of frequency splitting in the suggestion that the star rotates slowly (less than 20 km/sec.) according to conjecture by Rucinsky (1978). But Abt (1980) claimed vsini=90 $\pm$ 10 km/sec. It should be noted that important problem of rotate velocity of VW Ari has not been solved yet.

The supposition on high rotation velocity of VW Ari was made by our colleagues on the basis of 8 Å/mm spectra (Andrievsky et al., 1995). The effect of equidistant frequency splitting is not observed for rapidly rotating stars (Ledoux, 1951). Andrievsky (1997) drew attention that VW Ari may be related to a little group of λ Booti stars (see Gray & Corbally, 1993). A strong metal deficiency and rapid rotation are the typical characteristics of these stars being actively investigated now. The pulsations of λ Booti stars like that in δ Scuti stars are detected recently (see, for example Weiss et al., 1994).

The mode identification by using Fitch (1981) tables may be inaccurate taking into account these reasons. The model values as well as were made for BN and BU Cancri, for example (see Perez Hernandez et al., 1995) should provide more reasonable identification.

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