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MULTIPERIODICITY IN PULSATING LAMBDA Boo STAR 29 Cyg (HD 192640, V1644 Cyg)

The first and firm detection of pulsation phenomena in λ Boo type stars was made for classical λ Boo star 29 Cyg by Gies & Percy (1977). Gies & Percy (1977) (G&P) reported about the 45 min variability of 29 Cyg with an amplitude of about 0.03 mag. They suggested that, in contrary to Am and Ap stars lying in the δ Scuti instability strip, the moderate amplitude pulsations cannot be an exclusion in λ Boo group. Until the early 90-ies few attempts were carried out for investigation of pulsational activity of this group of stars or the attempts were made for nonclassified members of this group as for suspected δ Sct-type stars. At present, up to 10 pulsating members are known (Kuschnig et al. 1994).

The new observations of 29 Cyg were obtained during eight nights of July-September 1995 within the frames of collaborative program of the Odessa Astronomical Observatory (Ukraine), the Sternberg State Astronomical Institute (Russia) and Tien Shan High Altitude Observatory (Kazakhstan) for the search and investigation of pulsating northern chemically peculiar and δ Scuti type stars. We used a 4-channel W,B,V,R photometer (Kornilov & Krylov, 1990) attached to the 0.48m telescope of the Tien-Shan High Altitude Observatory. The integration time was 10 seconds simultaneously in the four filters and the data were binned in 40 second time intervals prior to the analysis. The comparison stars HD 192661 (G8 III, V=6.567) and HD 192538 (A0V, V=$6\overset{\mathrm{m}}{.}468$) were used.

This brief note represents the periodicity analysis of B−R index data less affected by the influence of the marginal weather conditions, the atmospheric scintillation noise and extinction variations. This technique is based on the fact that the atmospheric scintillation noise is strongly coherent in different wavelength bands, and amplitudes of variability are maximal in the blue region of spectra of A stars and decrease at the long wavelengths.

Figure 1 shows the resulting instrumental B−R data, for JD 2449920, JD 2449943, JD 2449949, JD 2449955, JD 2449956, JD 2449957, JD 2449963, and JD 2449969 reduced to the mean level. The analysis of separate nights shows that the main periodicity at the frequency near 37.5 c/d is present in the B−R data.

The amplitude spectra of B−R data combined for 8 nights of photometry are given in Figure 2. The highest peak with semi-amplitude of about 6 mmag is present at frequency 37.43 c/d (38.47 min). After the application of consecutive prewhitening procedure and frequency analysis we have resolved up to 7 frequencies. The amplitudes of frequencies are slightly variable from night to night. The frequencies f6 and f7 can be the artifacts produced by the variability of main frequencies 37.43 and 29.43 c/d. Frequencies, amplitudes and phases were corrected by the application of the simultaneous 7-frequency iterative sine-wave least-squares fitting procedure.

The resulting frequencies and amplitudes are given in Table 1. The 7-frequency synthetic curve is shown in Figure 1 by the solid line.

Table 1. Frequency fit for JD 2449943 - 2449969 (B−R) and G&P V data sets

	(B−R) data Freq. (c/d)	(Present paper) Semi-ampl.(mag)		V data Freq.(c/d)	(Gies & Percy, 1977) Semi-ampl.(mag)
f1	37.43	0.0051	f1	29.59	0.0085
f2	29.43	0.0031	f2	37.86	0.0069
f3	5.73	0.0024	f3	20.09	0.0041
f4	26.19	0.0032	f4	12.02	0.0036
f5	12.85	0.0025	f5	28.86	0.0030
f6	31.71	0.0024			
f7	38.03	0.0018			

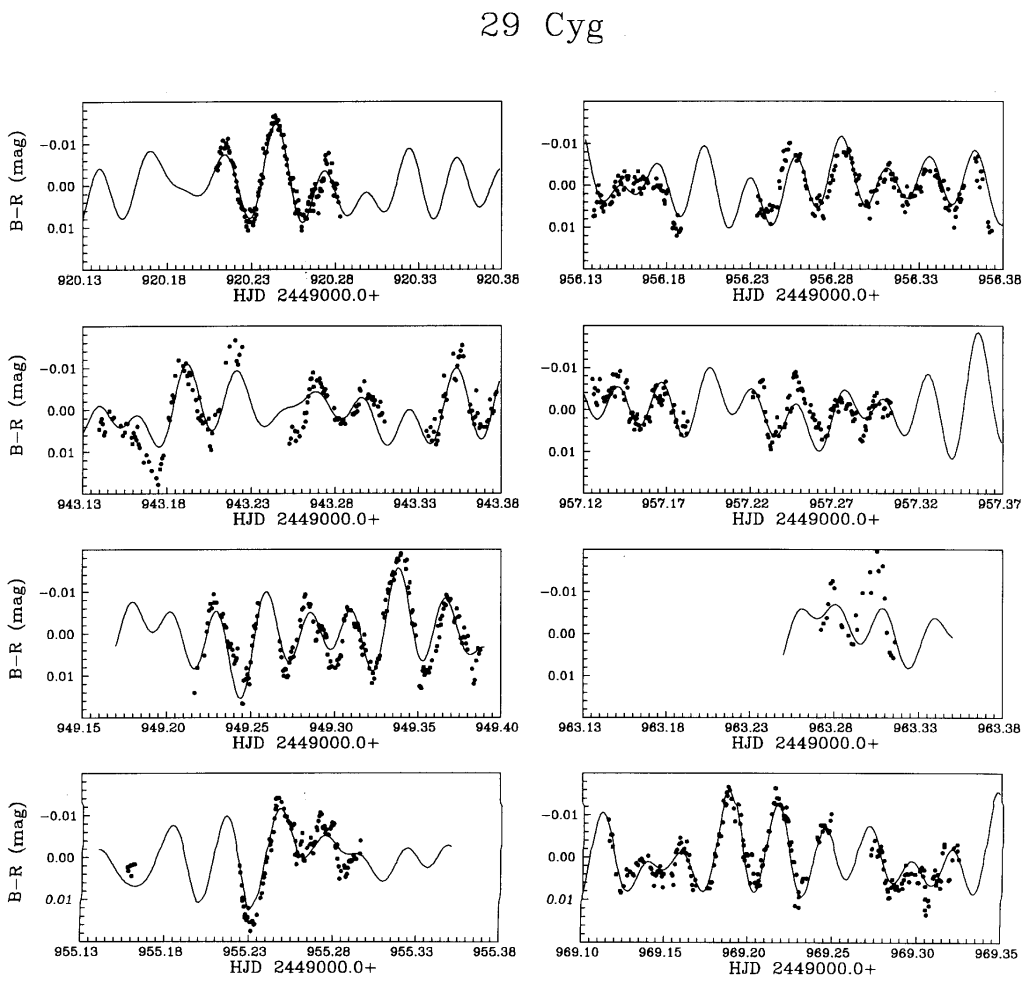

Figure 1. The B−R light curves for 29 Cyg. The solid line is the 7 frequency fit (see Table 1)

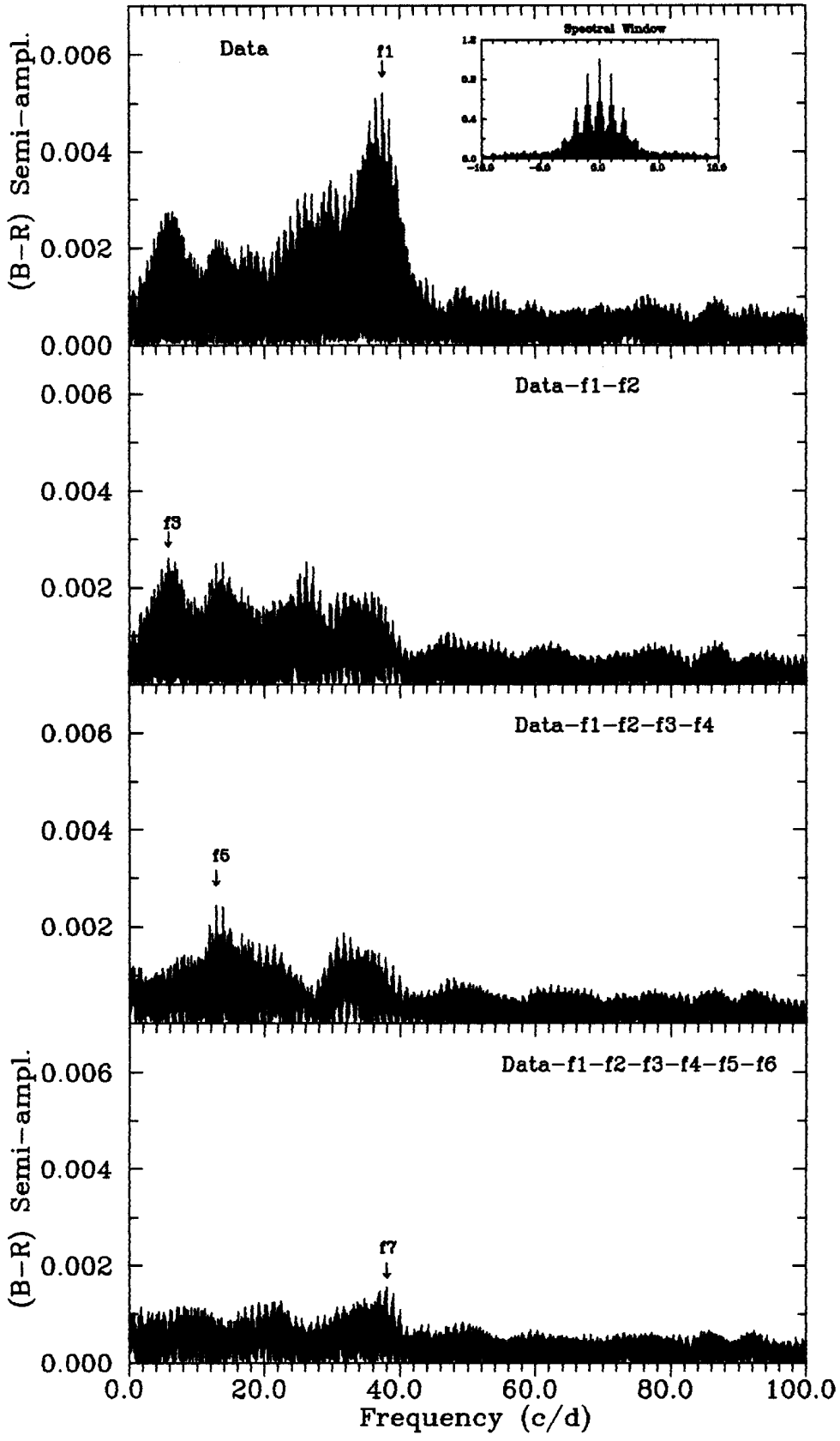

Figure 2. The amplitude spectra of B−R data shown in Figure 1

In order to confirm the frequencies detected we re-analysed the Gies and Percy's 1976 year data set (Gies and Percy, 1977). Our analysis of the G&P V filter data after removing the trends produced by the 1.54 c/d variability of comparison Be star 28 Cyg (Pavlovski et al., 1993) gives the 5 frequency solution also presented in Table 1. The comparison of two solutions shows that at least 3 frequencies in our data set are close to those presented in G&P data. In contrary to our 1995 year observation, the maximal amplitude of variability of G&P data set is at frequency of 29.59 c/d (48.7 min). For G&P data set the amplitude ratio for the mean amplitudes of two frequencies 37.5 and 29.5 c/d is equal to 0.81. For our data set this ratio is equal to 1.65, i.e. this result is a confirmation of amplitude variability of excited modes in 29 Cyg, and this fact of amplitude variability is not an exclusion for stars which occupy the blue edge of instability strip (see the extreme case of mode variability in HD 74292 (A2V) in paper of Kusakin & Goranskij, 1995).

The main results of our brief note are as follow:

- 29 Cyg is a pulsating λ Boo star with a multiperiodic structure of excited modes, the two highest amplitude excited modes have the frequencies near 37.5 and 29.5 cycles per day.
- We confirm at least 3 of detected frequencies by the re-analysis of 3 nights of Gies & Percy (1977) V data for 29 Cyg.
- The amplitudes of the excited modes are variable.

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