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NEW MULTICOLOUR CCD PHOTOMETRIC ANALYSIS OF BI CMi

LIAKOS, A.; NIARCHOS, P.

Department of Astrophysics, Astronomy and Mechanics, University of Athens, GR 157 84, Zografos, Athens, Hellas, e-mail: alliakos@phys.uoa.gr, pniarcho@phys.uoa.gr

BI CMi (=HD 56167) was discovered as a δ Sct type pulsator by Kurpinska-Winiarska et al. (1988), with a period of ∼0.1194660 days, a V_{mag} of 9.279, and a $B-V$ index of 0.359. Mantegazza & Poretti (1994) performed a frequency analysis on their photoelectric data and resulted in 10 pulsation modes. The most complete study of the star was made by Breger et al. (2002) who included the star into a multisite photometric and spectroscopic campaign. They found 29 pulsation frequencies in the data of two observing seasons, calculated its rotational velocity and proposed a spectral type of F2.

The observations of the star were made at the Gerostathopoulion Observatory of the University of Athens, from January to March 2010 for 9 nights in a time span of 45 days, with a 20-cm Newtonian reflector telescope (f/5) and the ST-8XMEI CCD equipped with the Bessel B, V, R, I photometric filters. The differential photometry method was applied to the data using the software *MuniWin* v.1.1.26 (Hroch, 1998). TYC 194-498-1 (V_{mag} = 10.293 and $B-V$ = 0.379 mag) and TYC 194-292-1 (V_{mag} = 10.604 and $B-V$ = 0.503) were used as comparison and check stars, respectively. In this study, although the amount of data is less than the ones in the studies of Mantegazza & Poretti (1994) and Breger et al. (2002), we present for the first time 4-band photometry of the star based completely on CCD observations. In Fig. 1 the data of all nights in B-filter are illustrated.

The frequency analysis was made with the software *PERIOD04* v.1.2 which is based on the classical Fourier analysis (Lenz & Breger, 2005). Since our data cover less time span than the ones of Mantegazza & Poretti (1994) and Breger et al. (2002) we tried to find a solution based on their results. Initially, we performed frequency-search of all the available observational points in the interval from 8 to 9 c/d in order to detect the frequency f_1 ∼8.25 c/d reported as the dominant one by the previous authors. The latter, after the removal of this frequency, we continued to search for another ones in the interval 5-80 c/d (typical range for δ *Scuti* stars; Breger, 2000). In addition, we searched for frequencies in the range 0-1 c/d, which potentially could be caused from atmospheric reasons or observational drifts. These frequencies are indicated as f* in Table 1. After the first frequency computation, the residuals were subsequently prewhitened for the next one. The calculations stopped when the detected frequency had a signal-to-noise ratio ∼4 and its amplitude reached our magnitude error limit (∼4.5 mmag in B and V and ∼5 mmag in R and I filters). The results of the frequency search for all filters are given in Table 1, where we list: the identification number of the frequency (No), the frequency (F) value,

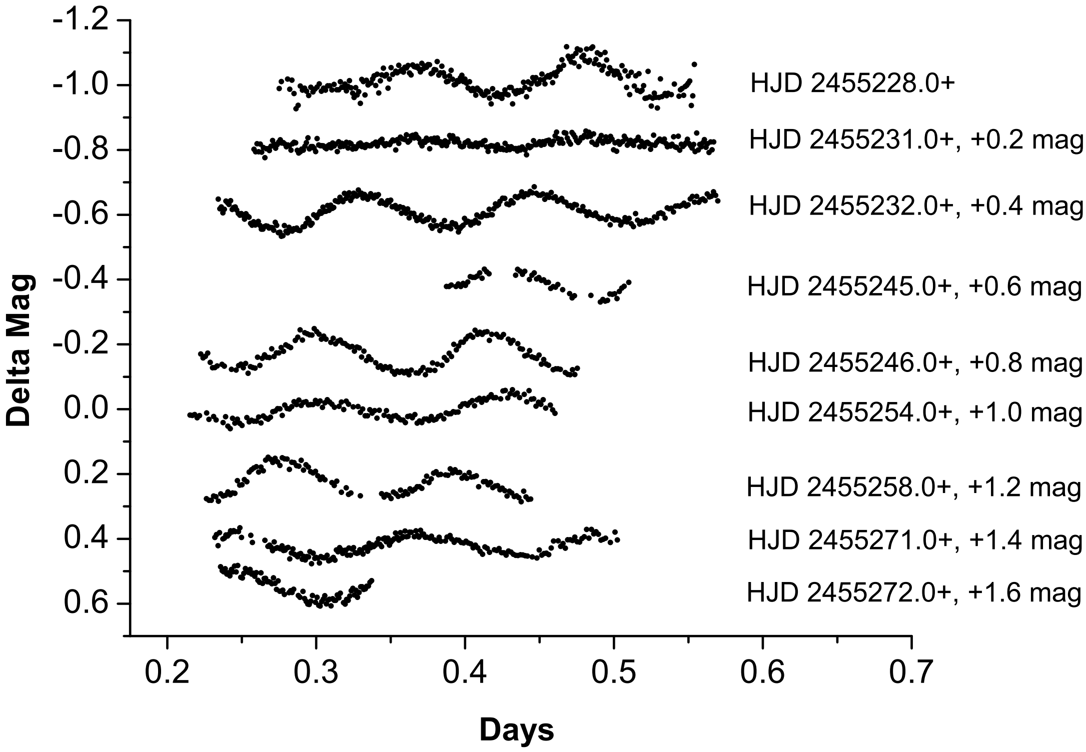

Figure 1. The observed light curves of BI CMi in B-filter.

its corresponding amplitude (A) and phase (Φ) and the signal-to-noise ratio (S/N) after prewhitening for the previous frequency(ies). The sum of the squared residuals (χ^2) derived from a multi-parameter least-squares fit of sinusoidal functions, is also given for each case. The Fourier fits on the observational points for the longest (data) sets of observations are presented in Figs 2 and 3, respectively, and the frequency spectra for B-filter is plotted in Fig. 4.

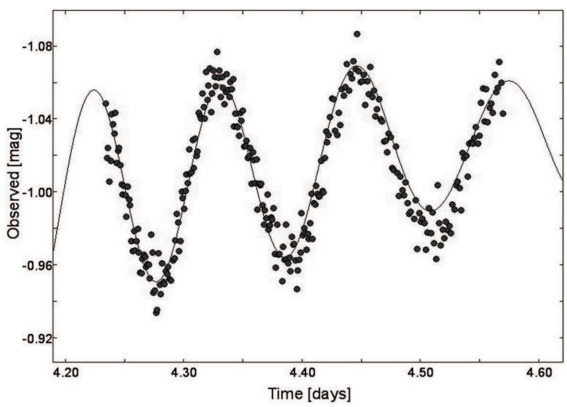

Figure 2. The Fourier fit on the B data.

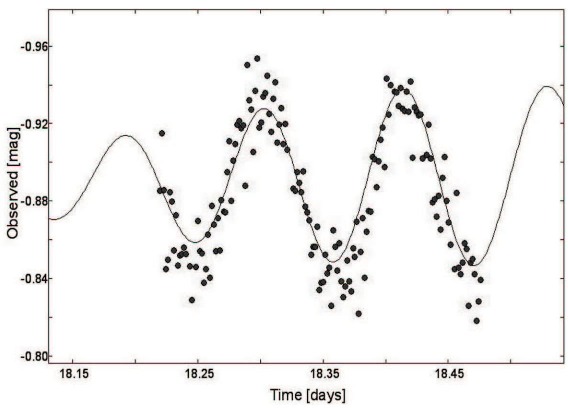

Figure 3. The Fourier fit on the V data.

The multifilter photometry helps us to verify which of the detected frequencies are physically originated, since they should be present in all filter observations. By this method, frequencies having a S/N>4 but not detected in all filter data, can be easily distinguished and characterized as observational errors (the lower ones) or residuals from

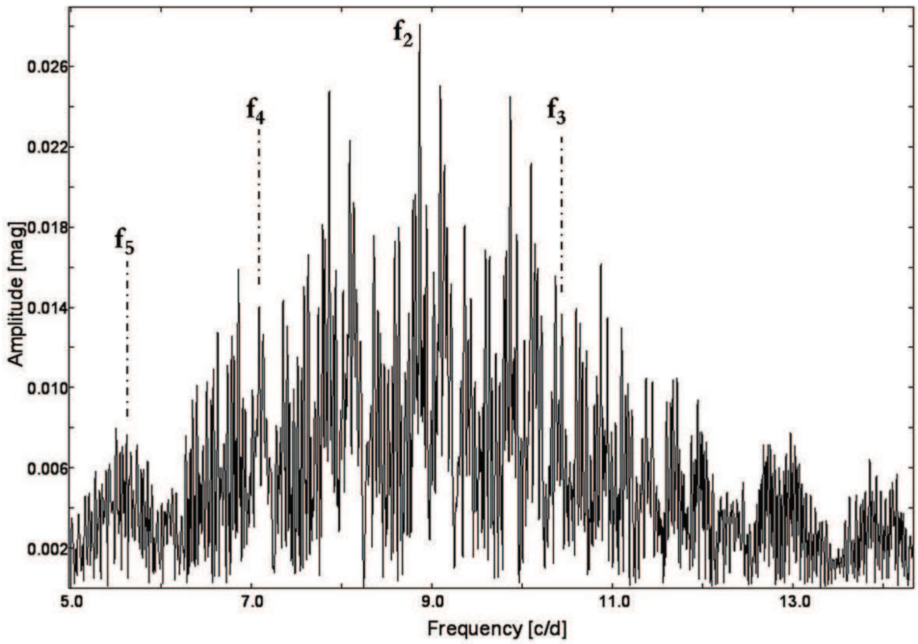

Figure 4. The periodogram in B-filter after the removal of f_1, where the detected frequencies are indicated.

Table 1. The pulsational frequencies of BI CMi for all filters

	B-filter				**V-filter**			
No	**F** [c/d]	**A** [mmag]	Φ [deg]	**S/N**	**F** [c/d]	**A** [mmag]	Φ [deg]	**S/N**
f_1	8.2476(3)	33.5(6)	335(1)	29.0	8.2464(4)	23.3(7)	336(2)	12.0
f_2	8.8675(3)	26.2(6)	130(1)	20.5	8.8654(4)	22.3(7)	147(2)	12.3
f_3	10.4391(7)	11.3(6)	230(3)	5.7	10.4358(11)	7.3(7)	238(2)	4.8
f_4	7.3966(7)	10.0(6)	54(3)	7.6	7.4452(14)	6.0(7)	345(5)	3.8
f_5	5.6487(9)	7.9(6)	220(4)	4.2				
f^*	0.7579(3)	27.5(6)	92(1)	5.8	0.2468(4)	22.3(7)	285(6)	4.0
χ^2		0.017				0.018		
	R-filter				**I-filter**			
f_1	8.2463(6)	15.7(8)	324(3)	12.0	8.2481(6)	15.7(7)	317(3)	13.8
f_2	8.8663(6)	16.6(8)	136(3)	12.3	8.8669(7)	16.6(7)	147(3)	12.5
f_3	10.4343(18)	5.4(8)	254(8)	3.8	10.4380(12)	8.7(7)	227(6)	5.2
f_4	7.3728(11)	8.7(8)	34(5)	4.8	7.3989(15)	5.4(7)	11(7)	4.4
f^*	0.6358(4)	22.9(8)	249(2)	3.8	0.0581(6)	22.9(7)	84(3)	3.9
χ^2		0.021				0.019		

a previous detected frequency after prewhitening (values close to the already detected ones). In the present work five pulsation frequencies in B-filter were found for BI CMi. The first four of them were also detected in V, R and I filter data. The Amplitude of the frequencies, as it is expected from the spectral type of the star, is decreasing from B to I filter. The current frequencies f_1, f_2 and f_4 were also detected by Mantegazza & Poretti (1994) and Breger et al. (2002). Our f_3 value is the almost the same with the f_5 (and f_6

as a close component) found by Breger et al. (2002). The frequency f_5 in the B-data was not detected by the other authors, while its signature was not traced also in the other filter data, a fact that creates uncertainty for its real existence.
Another solution could be achieved if one does not confine the initial search between 8-9 c/d, and search directly in the interval 5-80 c/d. The dominant frequency then is found to be $\sim$9.09 c/d and the f_3=8.51 c/d of Breger et al. (2002) (=f_4 of Mantegazza & Poretti 1994) is also detected. A different value for the dominant frequency was also found by Kurpinska-Winiarska et al. (1988) as f_1=8.37 c/d.
Concluding, we preferred to present the current solution (Table 1) as the most possible one, since the amount of data of the other authors is larger, and their solution describes more or less very well our data in all filters.

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