Comm. in Asteroseismology,
Vol. 159, 2009, JENAM 2008 Symposium № 4: Asteroseismology and Stellar Evolution
S. Schuh & G. Handler

The pulsating component of the B[e]/X-Ray transient and multiple system CI Cam (XTE J0421+560)

E. A. Barsukova [1] and V. P. Goranskij [2]

[1] Special Astrophysical Observatory, Nizhny Arkhyz, Karachai-Cherkesia, 369167 Russia
[2] Sternberg Astronomical Institute, Moscow University, Moscow, 119992 Russia

Abstract

We provide evidence that the rapid intranight variability of CI Cam is due to multiperiodic pulsations of the primary B4III-V component.

Individual Objects: CI Cam

CI Cam underwent an outburst in all ranges of electromagnetic waves in 1998. This is a multiple system which consists of a B4 III-V star displaying the B[e] phenomenon, a compact object, probably a white dwarf (WD) on an eccentric orbit with the period of 19.407 day (Barsukova et al. 2006), and a third massive component of unknown nature which causes the slow shift of the wind lines of the B[e] star including the forbidden line [N II] 5755 Å (Barsukova et al. 2007). The 1998 outburst is treated by some investigators as a thermonuclear explosion of hydrogen accumulated on the surface of WD from the dense circumstellar envelope and stellar wind. So, CI Cam is a unique system which resembles a classical nova.

We carried out an extensive photometric CCD monitoring in the V band using the SAI Crimean Station 50-cm Maksutov telescope during 18 nights in 2006 December. The set includes 2366 observations. A fragment of the V-band curve is presented in Fig. 1a. The duration of night monitoring reached 13.2 hours in some nights, and the accuracy of measurements was between 2 and 4 mmag. Methods of analysis were discrete Fourier transform with decomposition into periodic components including a prewhitening procedure and light curve model reconstruction. The set was cleaned for low-frequency noise at frequencies less than 0.2 c/d. The amplitude spectrum in the frequency range $0.2-20$ c/d is shown in Fig. 2.

The intranight variability of CI Cam is due to multiperiodic pulsations of its B4-type component (Barsukova & Goranskij 2008). Two waves predominate with periods of 0.4152 and 0.2667 day and full amplitudes of 19 and 17 mmag, correspondingly. They are extracted and shown in Figs. 1c and 1d, separately. The ratio of their periods is close to 3:2. At times, the maximum pulsation amplitude reaches 70 mmag owing to a resonance between these waves, and the pulsations are seen as mini-flares. Pulsations of CI Cam resemble those of Be stars, but they are observed in a B[e] star for the first time. The details of this study will be published in the paper by Goranskij & Barsukova 2009.

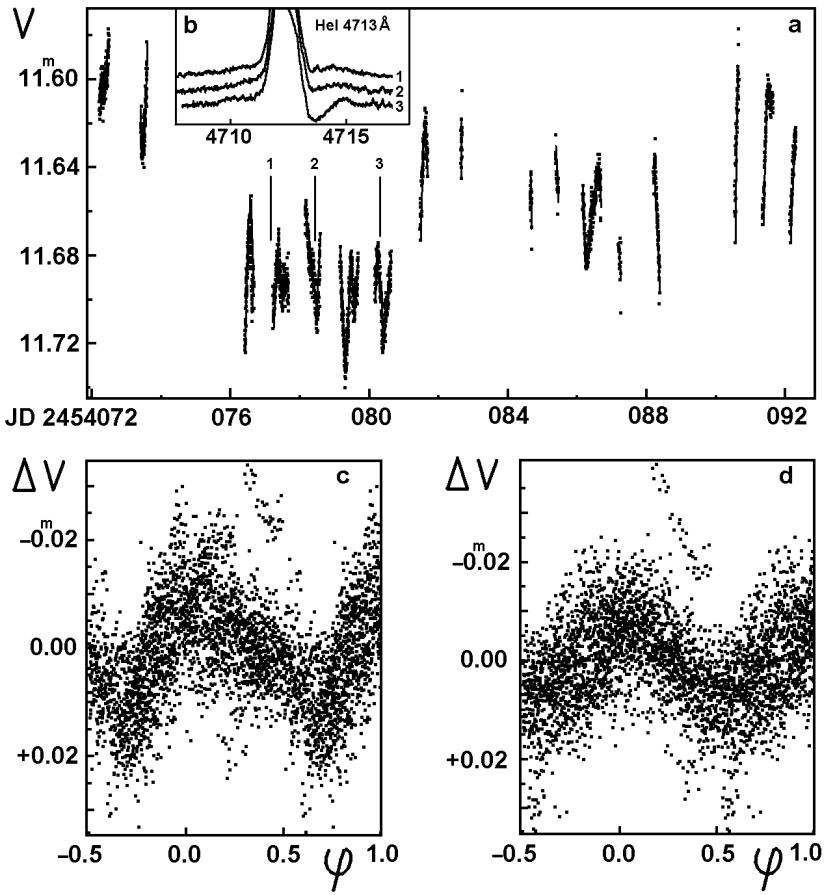

Figure 1: Light curves of CI Cam. a) Fragment of the V-band light curve taken in 2006 December. Digits 1−3 denote times of high resolution spectra using BTA/NES. b) HeI 4713 Å line profiles in the moments of spectral observations. c) Data cleaned for low-frequency noise and periodic variation with $P = 0.2667$ day are folded with $P = 0.4152$ day. d) The same data cleaned for the noise and periodic variation with $P = 0.4152$ day are folded with $P = 0.2667$ day.

We analyzed 20 high-resolution spectra of CI Cam, three of them were taken with the Russian 6-m telescope in the nights of our photometric monitoring. One of these three spectra (No. 3) shows inverse P Cyg type profiles in the weak HeI lines (Fig. 1b). In the total sample of spectra, three show inverse P Cyg profiles in HeI lines and one spectrum displays a classical P Cyg profile. This behaviour is typical for pulsations. The matter thrown out into the stellar envelope by shock waves falls backwards and absorbs photospheric radiation. In this sense, high-resolution spectroscopic observations allow to distinguish pulsations from circumstellar phenomena, while photometric variations potentially not only include photospheric but also circumstellar variability.

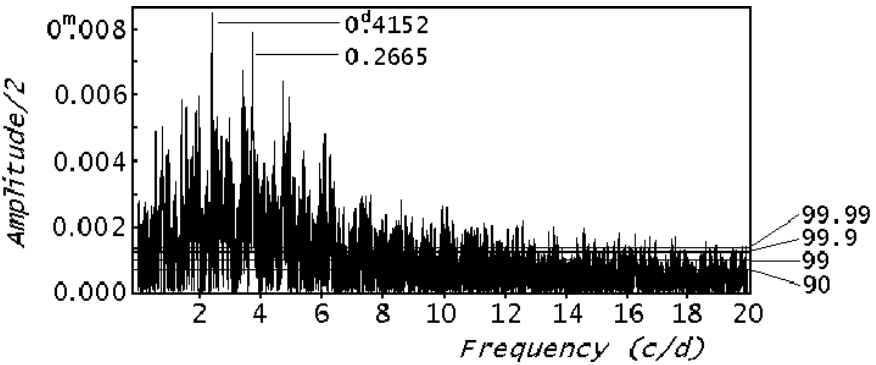

Figure 2: The amplitude spectrum of CI Cam. Horizontal lines and digits to the right are significance levels and their corresponding per cent values.

Evidently, the pulsation of CI Cam, like pulsations in Be stars, is a factor playing an important role in the formation of the circumstellar disk and gas transfer from the star into the disk. Additionally, our result may be an asteroseismologic clue to the further study of the internal structure of stars with the B[e] phenomenon.

Acknowledgments. We thank the Russian Foundation for Basic Research for the Grants No.06-02-16865 and 07-02-00630. E.A.B. is grateful to the Organizing Committee of the Symposium for the invitation.

References

Barsukova, E. A., Borisov, N. V., Burenkov, A. N., et al. 2006, Astronomy Reports, 50, 664

Barsukova, E. A., Klochkova, V. G., Panchuk, V. E., et al. 2007, ATel, 1036

Barsukova, E. A., & Goranskij, V. P. 2008, ATel, 1381

Goranskij, V. P., & Barsukova, E. A. 2009, Astrophysical Bulletin, 64, 50


sign up for poster presentation
Wednesday