

NOTES

NEW BRIGHT CARBON STARS FOUND IN THE DFBS

1. *Introduction.* Carbon-rich stars (C stars) of Population II, such as CH giants, can provide direct information on the role of low-to-intermediate-mass stars of the Halo in early Galactic evolution. Moreover, accurate knowledge of the CH stellar population is a critical requirement for building up scenarios for early Galactic chemical evolution. The first list of the faint high-latitude C stars (FHLCs), found in the Digitized First Byurakan Survey¹ (DFBS [1]) is given in paper [2]. In the present work, we report the recent discovery of two additional CH - type C stars (not previously catalogued), namely DFBS J075331.98+190344.3 and DFBS J111422.94+091442.7, detected on the DFBS plates with help of the image analysis softwares (FITSView and SAOImage DS9). Medium-resolution spectra confirm the C-rich nature for both of them. Using infrared colour-magnitude relationship, we estimated the distances and *K*-band absolute magnitudes to the new objects.

2. *Optical Spectroscopy and Photometry.* For our stars follow-up, photometry (Johnson *B*, *V*, *R*) and moderate-resolution CCD spectra (spectral range $\lambda 3900 - 8500 \text{ \AA}$, dispersion 3.9 \AA/pix) were obtained on 12/13 March 2012, with the 1.52 m Cassini telescope of the Bologna (Italy) Astronomical Observatory at Loiano (equipped with the Bologna Faint Object Spectrometer and Camera - BFOSC, $1300 \times 1340 \text{ pix}$ EEV P129915 CCD). All the spectroscopic and photometric data were reduced by means of standard IRAF² procedures. For these stars Table 1 presents: the DFBS identification, which includes the equatorial coordinates; the galactic coordinates *l* and *b*; the *B*, *V*, *R* magnitudes (typical errors are $\pm 0.05 \text{ mag}$); the spectral class (see chapter 3) determined from the CCD spectra and the value of $E(B - V)$ along the line of sight to the stars, computed using the Galactic reddening maps of Schlegel et al. [3]. The spectra, are shown in Fig.1, where on *Y*-axis we plotted relative fluxes, corrected for the atmospheric extinction.

¹ <http://byurakan.phys.uniroma1.it> and <http://www.aras.am/Dfbs/dfbs.html>

² IRAF is distributed by the NOAO which is operated by AURA under contract with NCS

Table 1

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DFBS Number	l (deg)	b (deg)	B (mag)	V (mag)	R (mag)	Sp. Type	$E(B-V)$ (mag)
J075331.98+190344.3	202.03492	+21.96567	13.36	11.67	10.98	CH	0.044
J111422.94+081442.7	247.8377	+60.27028	12.96	11.69	11.14	CH	0.031

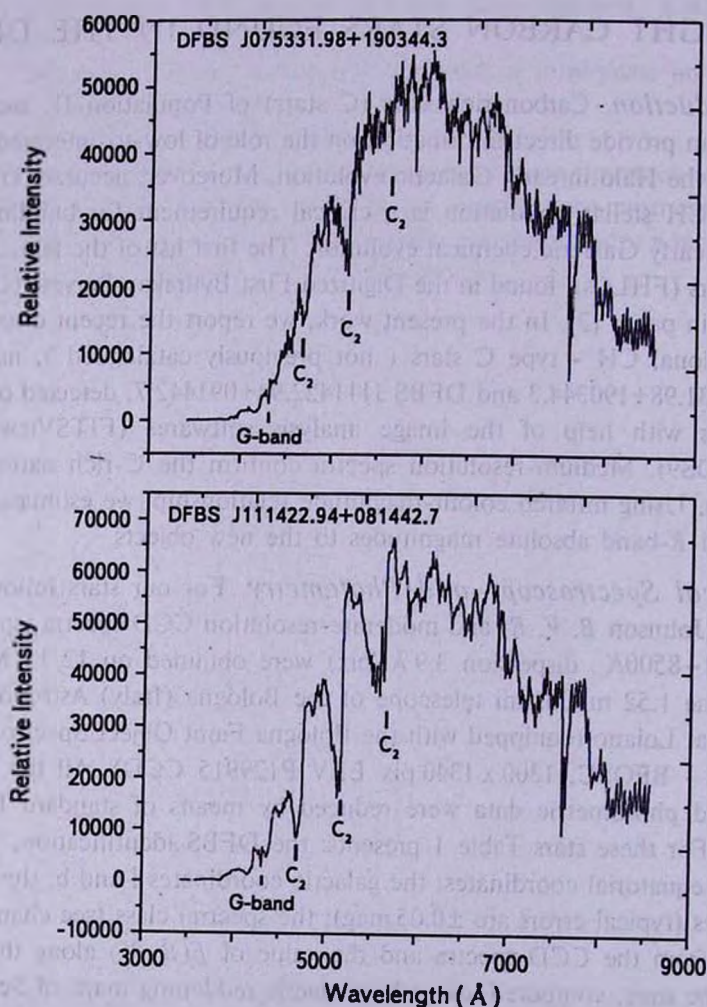


Fig.1. Loiano 1.52 m telescope medium - resolution CCD spectra in the range $\lambda 3900 - 8500\text{\AA}$ for new detected DFBS C stars. The absorption band heads of the C_2 molecule and G-band of the CH-molecule is indicated. The Y-axis is intensity in relative units.

3. *Spectral Types And Characteristics.* The new data were analyzed to clarify the subclass of the new C stars. The spectra show strong G-band

of CH-molecule at 4300 Å, which is a main spectroscopic characteristic feature of CH-type stars [4,5]. Also, they show the secondary *P*-branch of the *G*-band (with head at 4342 Å), clearly indicating the belonging of these objects to the class of CH-giants [6]. Prominent features of the C_2 molecule at 4737, 5165, 5636 Å, those in the region 6000-6200 Å, the ^{13}CN band near 6360 Å and the atomic lines 4554 and 4935 Å of Ba II are very well expressed.

Near infrared photometric data were also considered for the new C stars. Table 2 presents the 2MASS magnitudes (available online at <http://irsa.ipac.caltech.edu>) and the *J* - *H* and *H* - *K* colours, transformed to the SAAO photometric system according to the formulae by Koen et al., [7] and corrected for the interstellar extinction according to [3]. The uncertainties are 0.040 and

Table 2

2MASS PHOTOMETRIC DATA FOR THE NEW DFBS C STARS

DFBS Number	2MASS Identification	<i>J</i> (mag)	<i>H</i> (mag)	<i>K_s</i> (mag)	<i>J</i> - <i>H</i> (mag)	<i>H</i> - <i>K</i> (mag)
J075331.98+190344.3	J07533198+1903441	9.224	8.462	8.272	0.87	0.15
J111422.94+081442.7	J11142294+0814427	9.544	8.940	8.796	0.69	0.11

0.046 mag for the colours of J075331.98+190344.3 and J111422.94+081442.7, respectively. In the *J* - *H* vs. *H* - *K* diagram of Fig.3 by Totten et al. [8], where the different carbon classes were established, the colours of the two stars are typical for CH-type C stars, confirming the spectral classification (see papers [8,9] for more details).

4. *Luminosities and Distances.* To compute the absolute magnitudes M_K and the distances to the new detected objects we used the empirical color-magnitude relationship:

$$\log(M_K + 9.0) = 1.14 - 0.65(J - K) \quad (1)$$

obtained by Totten et al. [8] from a selected sample of C giants in nearby Galactic satellite systems and successfully applied to all their faint high-latitude carbon stars. Table 3 presents the absolute *K*-band magnitudes (M_K) in the SAAO system, Heliocentric distances (*D*) and the distance to the Galactic plane (*Z*).

Table 3

ABSOLUTE *K*-BAND MAGNITUDES AND DISTANCES TO THE DFBS C STARS

DFBS Number	M_K (mag)	<i>D</i> (kpc)	<i>Z</i> (kpc)
J075331.98+190344.3	-5.80 ± 0.2	6.3 ± 0.7	2.4 ± 0.7
J111422.94+081442.7	-4.75 ± 0.2	5.2 ± 0.6	4.5 ± 0.6

5. *Summary.* Optical spectra in the range 3500-8500 Å and photometric data for two carbon stars found in the Digitized First Byurakan Survey database is presented. Both objects are CH-type giants, consequently at distances 6.3 and 5.2 kpc from the Sun.

Acknowledgments. The authors thank the staff of the Cassini telescope for technical assistance during the observations. This research has made use of the SIMBAD database operated at CDS, Strasbourg, France. This publication makes use of data products from 2MASS, which is a joint project of the University of Massachusetts and the Infrared Processing and Analysis Center, California Institute of Technology, funded by the National Aeronautics and Space Administration and the National Science Foundation.

Новые яркие углеродные звезды, открытые в DFBS. Приводятся оптические спектры в диапазоне длин волн 3500-8500 Å, а также фотометрические данные для двух новых углеродных звезд J075331.98+190344.3 и J111422.94+081442.7, открытые в базе данных DFBS, которые являются СН - гигантами на расстоянии 6.3 и 5.2 кпк от Солнца.

Ключевые слова: *яркие углеродные звезды*

12 апреля 2012

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