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FBS 0137+400: A MASS LOSING AGB CARBON MIRA?

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Absolute *K*-band magnitude determined for the object FBS 0137+400 are typical for an Asymptotic Giant Branch (AGB) carbon stars. The large $J-K$ colour index as well as large amplitude variability ($\Delta K > 0.4$), and the presence of Hα in emission indicate also, that this star is a mass-losing long period Carbon Mira variable with thick circumstellar shell. The IRAS LRS spectrum indicates the presence of a dust shell surrounding this object. Monitoring of the *K*-band magnitude is necessary for the determination of the pulsation period of FBS 0137+400.

Key words: *stars:Mira type - stars:individual:FBS 0137+400*

1. *Introduction.* The carbon star FBS 0137+400 was first identified on the plates of the First Byurakan Spectral Sky Survey - FBS [1]. Spectral classification, photometric data-provided by various astronomical databases - a distance estimate based on two methods, and cross-identification with IRAS PSC 01373+4000 for this object have been presented in a previous paper [2] devoted to our search for new FBS carbon stars. Among the 79 new detected carbon stars [2,3], this object have the reddest colour indices. Two IRAS Low-Resolution Spectrometer spectra (LRS [4]) have also been extracted for this star from two databases.

2. *Slit spectra.* The first spectrum of FBS 0137+400 was obtaied on August 21, 1989, using a UAGS universal diffraction spectrograph combined with an UMK-91V image tube at Byurakan Astrophysical Observatory (BAO, Armenia). The Kodak 103a-O emulsion allowed us to cover a 4700-6800 Å spectral range (Fig.1a) while a He-Ne-Ar filled spectral lamp was used to secure the dispersion curve. The spectrum was recorded using an automatic PDS-1010A microdensitometer. The ADA image-processing macrofile system [5] was used for data reduction.

An additional spectrum of FBS 0137+400, in the range 5700-6600 Å (Fig.1b), was also obtained by M.A. on October 21, 2001, with the Haute Provence Observatory (OHP, France) 1.93-m telescope, equipped with the CARELEC spectrograph and a 2048×1024 ($13.5\mu m \times 13.5\mu m$) pixels EEV-42-20 CCD camera as a detector. A 1200 lines/mm grating was used, providing a resolution 0.45 Å/pixel (2 arcsec slit width). This spectrum was

reduced and wavelength calibrated with the ESO-MIDAS reduction package.

Both spectra show Hα line in emission, especially strong on the first one (see Fig.1a).

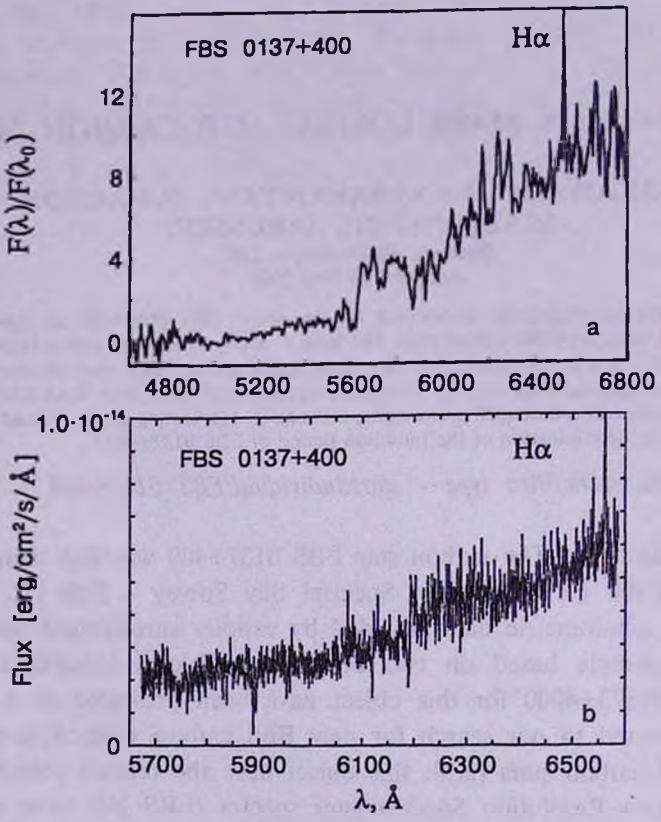

Fig.1. a) BAO 2.6m telescope spectrum of FBS 0137+400 in the range 4700-6800 Å . Flux is in relative units (normalized to λ_0 = 5555Å). b) OHP 1.93-m telescope spectrum of FBS 0137+400 in the range 5700-6600 Å .

3. *Photometric characteristics.* For FBS 0137+400, the USNO-A2.0 catalogue gives $R = 10^m.5$ and $B-R = 7^m.0$. While 2MASS data are $J-K = 3^m.34$ ($K = 5^m.74$, $J-H = 1^m.82$ and $H-K = 1^m.52$) [2] (see location of this object in the $J-H$ vs. $H-K$ diagram displayed on Fig.5b of paper [2]). Near-infrared *JHK* photometry was also obtained at the 1.26-m telescope of Beijing Astrophysical Observatory (Hinglog, China) using the infrared photometer of Nagoya University (Japan) [2]. On the $J-H$ vs. $H-K$ diagram (Fig.5b [2]) the FBS 0137+400 is located in the region where usually the Carbon Mira variables with circumstellar shells are found. Near-infrared *JHK* colours are very similar to the colours of IRAS 12560+1656 [6], APM 0418+0122 [7], and 2MASS J0326599+143957 [8], which are dust enshrouded Asymptotic Giant Branch (AGB) carbon stars in the Galactic Halo.

Using anempirical relationship (M_k vs. $J-K$) obtained by Totten and Irwin [7] for carbon stars in the LMC, SMC and for C stars in other nearby galaxies, we estimate for FBS 0137+400 [2] an absolute K-band magnitude and a distance as $M_k = -8^m.9$ and $d = 8$ kpc, respectively. This M_k value is consistent with those of dust enshrouded Carbon Mira variables [9].

We have considered two colour indices ($J-K$ and K - [12]) as a measure of the optical depth of the dust shells around carbon stars. Assuming, that this object have a thick circumstellar shell ($J-K > 2^m.0$ [10]) it is possible to estimate the total mass-loss ratio taking into consideration the calibrations presented in papers [11,12] for carbon stars. This allowed us to determine the total mass-loss rate as $1.2 \cdot 10^{-7}\, M_\odot$/yr and $1.4 \cdot 10^{-7}\, M_\odot$/yr based on $J-K$ and K - [12] colour indices accordingly.

The approximate value for the bolometric correction (see for more information Fig.2 in paper [13] and Fig.8 in paper [14]) $BC_k \approx 3^m.35$ is

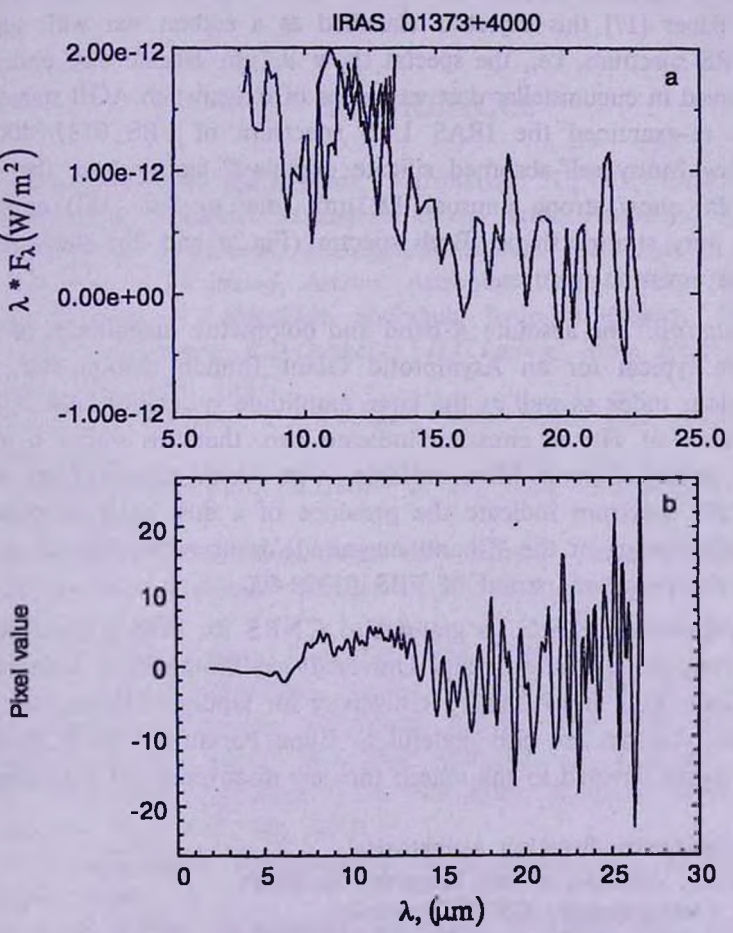

Fig.2. IRAS LRS spectra of FBS 0137+400 in the range 7-23 μm . a) Extracted from database of Calgary University. b) Extraced from the Groningen database.

used to determine the bolometric apparent magnitude ($m_{bol} = m_k + BC_k$) and consequently the absolute bolometric magnitude (M_{bol}) for FBS 0137+400 ($M_{bol} = -5^m.55$).

A comparable absolute bolometric magnitude value ($M_{bol} = -5^m.70$) can also be obtained using for bolometric correction $BC_k \approx 3.20$ with respect to K - [12] colour index (see Fig.13 of paper [15]).

We avoid to use the period-luminosity relations for Carbon Miras [16], assuming the existence of a thick circumstellar envelope surrounding FBS 0137+400 ($J-K > 2^m.0$) and a large-amplitude variability for this object (if $\Delta K > 0^m.4$ [15]). K light curve monitoring will allow us to determine pulsation period of FBS 0137+400.

4. *IRAS LRS Spectra.* Two IRAS Low-Resolution Spectrometer Spectra (LRS) from the two different databases (http://www.iras.ucalgary and http://www.sron.rug.hl/irasserver) were extracted for FBS 0137+400 (Fig.2a and 2b). In paper [17] this object is classified as a carbon star with silicate features in LRS spectrum, i.e., the spectra show 9.7μm silicate dust emission, which is observed in circumstellar dust envelopes of oxygen-rich AGB stars [17].

We have re-examined the IRAS LRS spectrum of FBS 0137+400. It seems to show "noisy self-absorbed silicate emission" features i.e. the LRS spectra (Fig.2a) show strong unusual 11.3μm (due to SiC [18]) emission which has a very strange shape. Both spectra (Fig.2a and 2b) show strong 18μm silicate emission features.

5. *Conclusion.* The absolute K-band and bolometric magnitudes of FBS 0137+400 are typical for an Asymptotic Giant Branch carbon star. The large $J-K$ colour index as well as the large amplitude variability ($\Delta K > 0.4$), and the presence of Hα in emission indicate also, that this star is a mass-losing, long period Carbon Mira variable, with thick circumstellar shell. The IRAS LRS spectrum indicate the presence of a dust shell surrounding this object. Monitoring of the K-band magnitude is necessary for the determination of the pulsation period of FBS 0137+400.

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FBS 0137 + 400: УГЛЕРОДНАЯ МИРИДА С ПОТЕРЕЙ МАССЫ?

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Абсолютная величина в *K*-полосе данного объекта характерна для звезд на Асимптотической Ветви Гигантов (АВГ). Большой $J-K$ показатель цвета, большое изменение амплитуды в *K*-полосе ($\Delta K>0.4$) а также присутствие Hα эмиссии указывает на то, что этот объект является Углеродной Миридой с потерей массы и с плотной околозвездной оболочкой. IRAS LRS спектр указывает на то, что звезда окружена пылевой оболочкой. Мониторинг в *K*-полосе необходим, чтобы определить пульсации объекта FBS 0137+400.

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