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ИЗВЕСТИЯ КРЫМСКОЙ АСТРОФИЗИЧЕСКОЙ ОБСЕРВАТОРИИ

Looking for spectroscopic families among diffuse interstellar bands

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Abstract. Among the diffuse interstellar bands (DIBs), observed in the spectral range from 5590 to 6830 angstroms, we have searched for some candidates to be spectral 'relatives' of DIBs at 5780 and 5797 angstroms. We have found that structures at 5719, 5766, 5769, 5773, 5793, 5819, 5829, 5850, 6090, 6439, 6449 and 6492 angstroms are good candidates to belong to 5797 spectroscopic family. On the other hand, DIBs 5776, 5795, 6108, 6162, 6597, 6793, 6795, 6827 tend to belong to the family of 5780.

Key words: Interstellar matter, diffuse interstelar bands, spectroscopic families

1 Introduction

Diffuse interstellar bands (DIBs) (see e.g. Herbig 1995), first discovered more than 80 years ago, are absorption lines of interstellar origin that still await an explanation. The attempts at solving the mystery of the carriers of DIBs have been by interdisciplinary spectroscopic collaborations between molecular physicists, chemists and astronomers. To the present day, huge amounts of observational data on DIBs have been stored by astronomers and many laboratory and theoretical works were dedicated to the subject. About 300 of DIBs one may easily indicate in high resolution optical and near infrared spectra (see e.g. Galazutdinov at. al., 2000). Unfortunately, the astronomical data are still not sufficiently well understood from the point of view of laboratory spectroscopists.

It is expected that some progress will be possible in this field when all known DIBs are divided into spectroscopic families in such a way that only one carrier is responsible for all bands belonging to a given family. The dividing of such kind is to do by analyses of astronomical data. One should note that 'morphological' families isolated by the other authors (see e.g. Krełowski & Walker 1987) may contain DIBs belonging to different spectroscopic families and therefore they represent not a satisfactory starting data to identify DIBs' carriers.

One expects that intensity ratios between DIBs originated by the same carrier are very stable from one target star to the other. Spectroscopic family should therefore contain only such bands which are mutually very good correlated. To isolate spectroscopic families of bands, one has to bypass in some way the problem of 'noisy correlation' between intensities of DIBs. Interstellar medium contains different species and abundances of some of them may strongly depend on a number density of the others. Such situation leads directly to that what we call noisy correlation. The problem of an adequate method to isolate spectroscopic families of DIBs was considered by Wszołek & Godłowski (2003). The authors propose the method called 'investigating the figures with arranged spectrograms', as the most promising

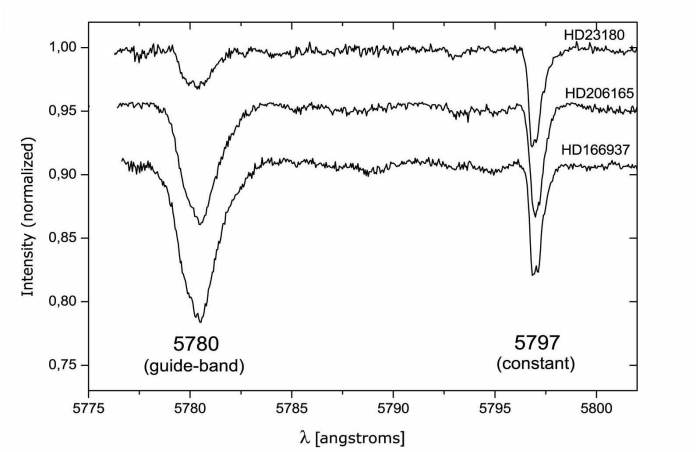

Fig. 1. The arranged spectra for the first set of targets, with constant intensity of 5797 DIB and with 5780 band substantially raising when going down the figure

one to attack the problem. They indicated also two candidating 'relatives' to 5780 band (5776 and 5795) and the four others to 5797 band (5793, 5819, 5829 and 5850). DIBs at 5780 and 5797 angstroms may well be treated as the representing ones, for two different spectroscopic families. They are relatively strong bands in numerous spectra and the ratio of their equivalent widths may vary drastically from one target star to another, as was shown by Krełowski & Westerlund (1988).

The aim of this paper is to search for the further candidates to spectroscopic families of 5780 and 5797 bands. First we describe shortly observational material that revealed the considered DIBs. Then we explain the method of 'arranged spectrograms' and present some figures for example. Finally we propose a list of candidates wich may enlarge spectroscopic families of 5780 and 5797 DIBs.

2 Observations

We used spectra aquired at McDonald Observatory with an echelle spectrograph fed with the 2.1 m telescope, covering the spectral range from 5590 to 6830 Å (Krełowski and Sneden, 1993). We took data from the archives of Prof. Jacek Krełowski (Astronomical Center of Nicolaus Copernicus University in Toruń, Poland). The spectra have S/N of about 200 and resolution R of about 100 000. We used echelle spectra (each spectrogram contains 25 rows) for six reddened target stars and for few stars (unreddened) needed for data reduction. These target stars are (HD numbers): 23180, 147165, 166937, 206165, 206267 and 207198. All spectra were accessible in binary FITS format.

3 Data analysis

We started an analysis from transformating FITS format of our data into ASCII format. Then, we carried out the procedure of removing of telluric lines by dividing spectra of the targets by spectra of appropriate standards. In the next step we normalized all spectrograms, dividing them by their continuum. Our choice of six target stars was not fully accidental. From the larger set of observational data we took three spectrograms with DIB at 5797 angstroms being almost of the same intensity. The further three spectrograms have, in contrary, almost the same intensities of the 5780 band. Furthermore, for the first group of spectrograms the intensity of the 5780 band changes substancially from one case to the other. In the second group, such a change relates to 5797 band. The way of our analysis consists of the direct investigation the figures with arranged spectrograms (Wszołek & Godłowski (2003), Wszołek & Nagel (2002)). Figures 1 and 2 demonstrate arranged spectrograms for the both groups of stars. Rows of spectra

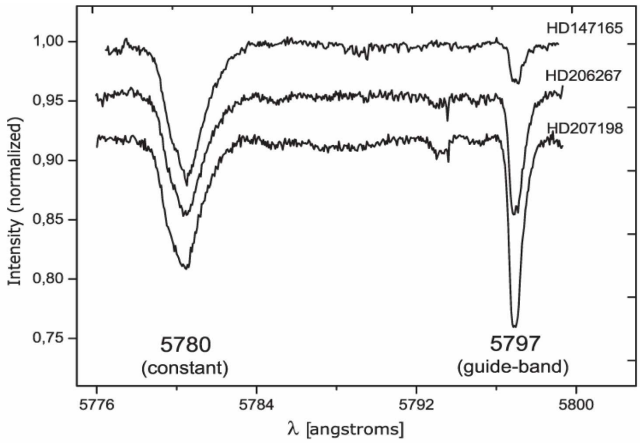

Fig. 2. The arranged spectra for the first set of targets, with constant intensity of 5780 DIB and with 5797 band substantially raising when going down the figure

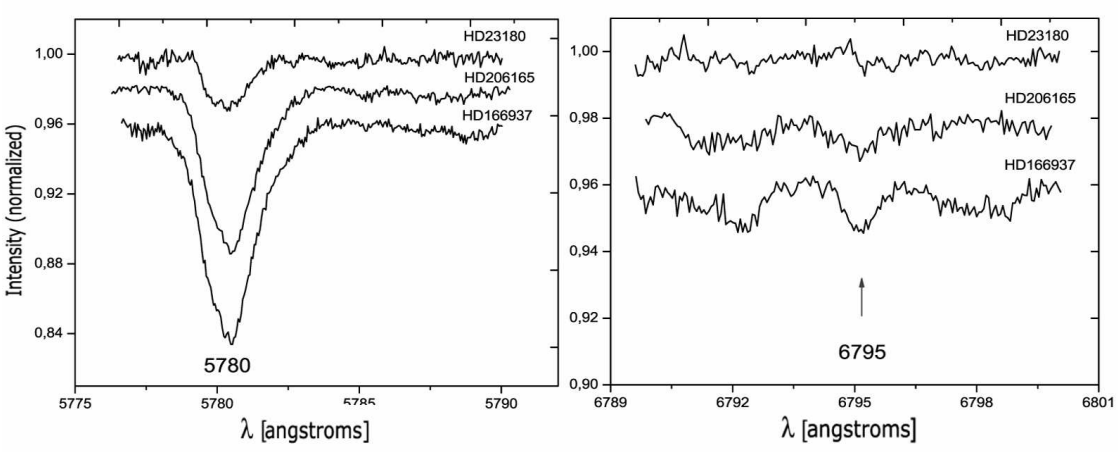

Fig. 3. In right panel the intensity run was exposed for the 6795 DIB. The left panel of the figure demonstrates the behaviour of 5780 guide-band

exposed in these figures contain 5780 and 5797 DIBs. Spectra are arranged in such a way that intensity of one band is substantially raising, when going down the picture, while the intensity of the second band tends to remain constant. We expect that DIBs belonging to the 5780 spectroscopic family should follow the changing behaviour of their guide-line. The same is expected for DIBs from 5797 family. Figures, similar to that of 1 and 2 were drawn and investigated for all 25 rows of spectra. Here we expose two of them (Figures 3 and 4) as examples. Figure 3 shows that the intensity of 6795 band follow very nice the intensity raise of 5780 DIB. Similarily, figure 4 shows that 5829 band is a good candidate to join 5797 spectroscopic family.

4 Discussion

After searching all arranged spectrograms (there were 50 of them) we propose few candidates to spectroscopic family of 5780 band and few other ones as possible spectroscopic relatives of the DIB at 5797 angstroms. These two sets of candidates are: (5780) – 5776, 5795, 6108, 6162, 6597, 6793, 6795, 6827 and

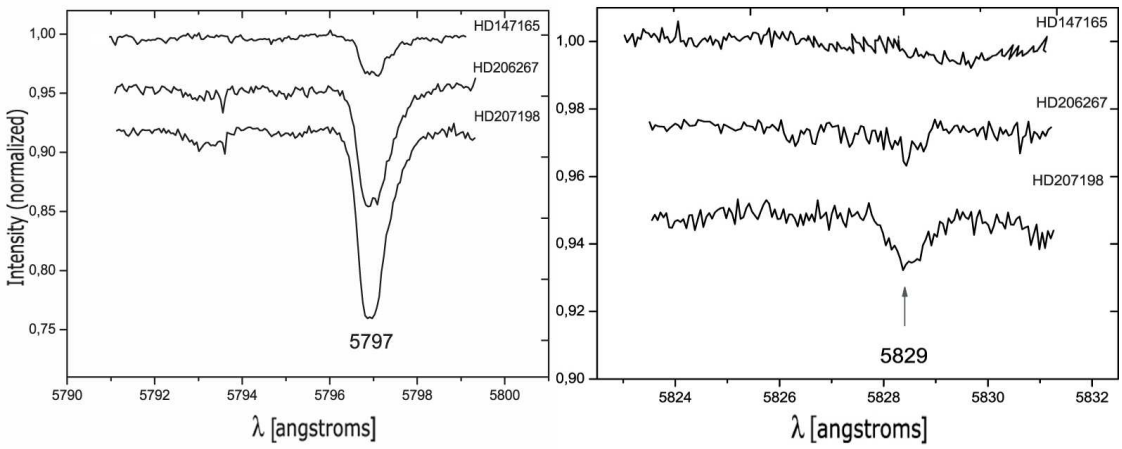

Fig. 4. In right panel the intensity run was exposed for the 5829 DIB. The left panel of the figure demonstrates the behaviour of 5797 guide-band

(5797) – 5719, 5766, 5769, 5773, 5793, 5819, 5829, 5850, 6090, 6439, 6449, 6492. Sets of candidates, given here, contain much more candidates than was proposed by Wszołek & Godłowski (2003). We are aware of a very preliminary status of our candidates. Each candidate has to be confirmed by more detailed studies based on spectra of reasonable high quality and for greater number of the targets.

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