The Diffuse Interstellar Bands
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C_2 and Diffuse Interstellar Bands

M. Kaźmierczak[1], M. Schmidt[2], T. Weselak[3], G. Galazutdinov[4] and J. Krełowski[5]

[1]SRON Netherlands Institute for Space Research, Landleven 12, 9747 AD Groningen, The Netherlands, email: maja.kazmierczak@gmail.com

[2]Centre for Astronomy, Nicolaus Copernicus University, Gagarina 11, 87-100 Toruń, Poland

[3]Nicolaus Copernicus Astronomical Centre, ul. Rabiańska 8, 87-100 Toruń, Poland

[4]Institute of Physics, Kazimierz Wielki University, Weyssenhoffa 11, 85-072 Bydgoszcz, Poland

[5]Universidad Catolica del Norte, Av. Angamos 0610, Antofagasta, Chile

Abstract. C_2, the simplest multicarbon molecule is a useful astronomical tool, because the analysis of its lines allows to determine the physical conditions in interstellar clouds. C_2 abundances give information about the chemistry of interstellar clouds, especially on the pathway to the formation of long-chain carbon molecules, which may be connected with carriers of diffuse interstellar bands (Douglas 1977, Thorburn *et al.* 2003). Here we summarize all relations between C_2 and diffuse interstellar bands (DIBs).

Keywords. ISM: molecules, ISM: lines and bands

1. Introduction

Diffuse interstellar bands were discovered by Heger in 1922. In spite of being the subject of many observational and theoretical research even the strong features at 5780 Å and 5797 Å remain unidentified. Currently we know more that 400 DIBs (Hobbs *et al.* 2009), whereas the majority of them are weak and broad features.

Considering correlations between equivalent widths of different DIBs one can suggest a common origin of some features (Krełowski & Walker 1987). An analysis of correlations between DIBs and column densities of particular identified molecules may allow to suggest a possible DIB origin (Krełowski *et al.* 1999). Also an analysis of DIB profiles can help the task of their identifications (Herbig 1975, Sarre *et al.* 1995).

Two correlations between parameters derived from observations of C_2 and diffuse interstellar bands have been found so far. Thorburn *et al.* (2003) proposed a specific class of weak, narrow diffuse interstellar bands, whose equivalent widths are well correlated with the column densities of the C_2 (as well as with the column densities of CH and CN), thus called them "C_2-DIBs".

Kaźmierczak *et al.* (2009, 2010) showed that widths and shapes of profiles of diffuse interstellar bands at 6196 and 5797 Å depend on the rotational temperatures of C_2; a similar weak effect exists also for the gas kinetic temperatures. Their profiles are broader when the rotational temperatures are higher. It may suggest that carriers of some DIBs could be centrosymmetric molecules. DIBs 4964 and 5850 Å, however, do not fit to the above C_2 parameters.

In this work we re-analyse conclusions from these papers based on a new sample of data.

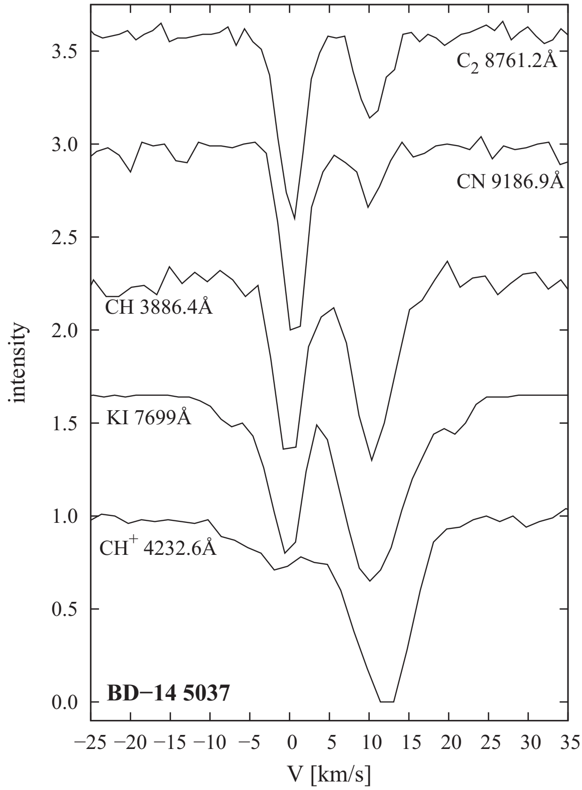

Figure 1. Profiles of C_2 and other simple species (CN, CH, KI, CH^+) toward BD-14 5037, where two Doppler components (different interstellar clouds) are well separated.

2. The observational data

Our observational material was obtained during observing runs between 2006 and 2010 using 3 echelle spectrographs: UVES (resolution R=110,000), HARPS (R=115,000) and BOES (R=44,000). All spectra were reduced with *IRAF* (The Image Reduction and Analysis Facility) and DECH20T code (Galazutdinov) [for more details about instruments and data reduction - see Kaźmierczak *et al.* (2009)].

For this work a sample of 23 objects with quite strong absorption lines of the C_2 molecule was selected. Analysed objects are OB stars: HD 23180, HD 24398, HD 34078, HD 76341, HD 110432, HD 115842, HD 136239, HD 147889, HD 148184, HD 148379, HD 149757, HD 151932, HD 152236, HD 154368, HD 154445, HD 163800, HD 169454, HD 170740, HD 179406, HD 204827, HD 207538, HD 210121 and HD 278942.

Analysed DIBs are: 4964, 4985, 5176, 5513, 5769, 6729, 5780, 5797, 5850, 6196, 6270, 6376, 6379, 6614 and 6660 Å.

3. Conclusions

The analysis of 15 DIBs confirms that DIBs: 4964, 4985, 5176, 5513, 5769, 5850, 6376, 6729 Å are C_2-DIBs as proposed by Thorburn *et al.* (2003). The remaining 7 DIBs (i.e., 5780, 5797, 6196, 6270, 6379, 6614, 6660 Å) do not show any correalation with the column density of C_2 (see Figure 2).

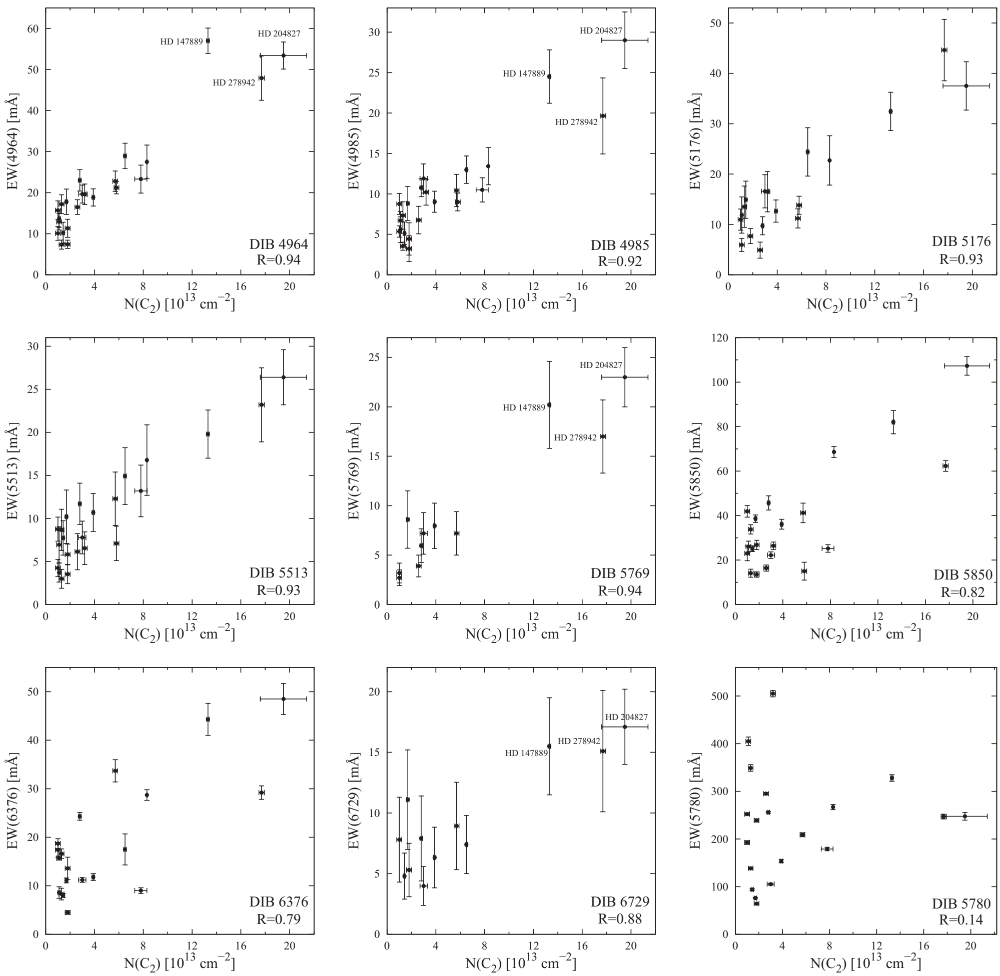

Figure 2. Relations between column densities of the C_2 molecule and equivalent widths of analysed diffuse interstellar bands as well as column densities of CH, OH, CN, CH^+ and OH^+. The correlation coefficients are written in the bottom-right corner of each panel. Column densities derived from: N(CH) – Weselak *et al.* (2008,2009c,2010); N(OH) – Weselak *et al.* (2009b,2010); N(CN) – Słyk *et al.* (2008); N(CH^+) – Weselak *et al.* (2009a,b,c) and N(OH^+) – Krełowski *et al.* (2010).

DIBs whose profiles do not show any correlation with the rotational temperatures of C_2 seem to be correlated with the C_2 column density (they are C_2-DIBs), whereas DIBs which profiles show changes with C_2 rotational temperatures, cannot be classified as C_2-DIBs.

There is also a strong correlations between column density of C_2 and CH, OH and CN. Neither CH^+ nor OH^+ correlate with C_2 (compare Figures 1 and 2).

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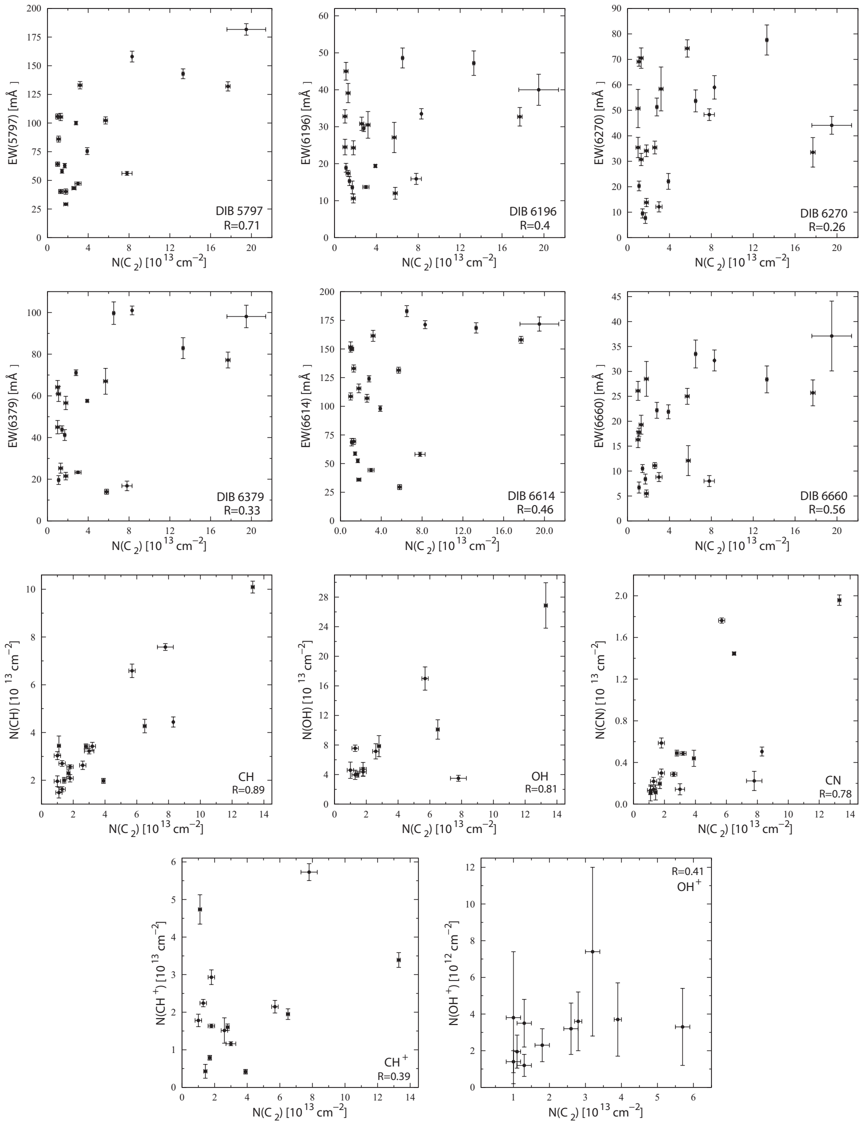

Figure 2. (continued).

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