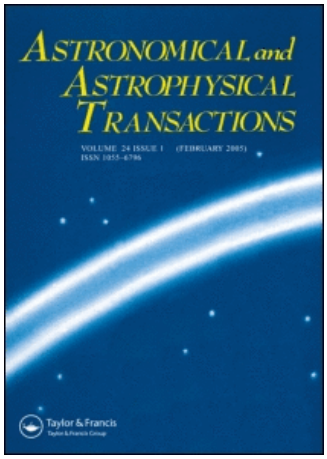

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INVESTIGATION INTO BROAD INTERSTELLAR ABSORPTION LINES

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Diffuse interstellar bands (DIBs) are investigated mainly with high-resolution spectroscopy, which allows very fine structures to be detected. However, the rapidly increasing resolution of echelle spectra becomes a disadvantage when broad absorption structures are involved. These can extend over several dozen angstroms, taking up a significant part of a single echelle order and thus posing an impediment to a proper continuum tracing. This is where low-resolution spectroscopy can regain its importance in DIB research. Recently, an attempt has been made to connect the broader DIBs with polycyclic aromatic hydrocarbons, and more specifically with the naphthalene cation. We present spectra obtained with a spectrograph obtaining information from the 90 cm Torun telescope, accompanied by high-resolution observations made at the Terskol Observatory.

Keywords: Interstellar absorption lines; Observations

Beals and Blanchet (1937) and Wilson (1958) discovered broad diffuse interstellar bands (DIBs) shortly after interstellar lines were introduced. Like all DIBs, they lack positive identification. There are much fewer broad structures known than narrow structures (which are very common; about 300 lines detected so far), as they are more difficult to trace. Weak broad lines are hardly discernible because of their shallowness, irrespective of the signal-to-noise ratio.

High-resolution echelle spectra seem to be less suitable for broad DIB research than are low-resolution single-order spectra. The wavelength coverage of an echelle spectrum order hampers proper continuum setting and merging adjacent orders.

Polycyclic aromatic hydrocarbons (PAHs), suggested as DIB carriers in the 1980s and identified in the infrared, are undergoing extensive laboratory research, which aims at producing astrophysically relevant data. Recent laboratory results, obtained by cavity ring-down spectroscopy at the Ames Research Center, National Aeronautics and Space Administration, show the unusual width of PAH bands (of the order of 10 Å) (Romanini *et al.*, 1999).

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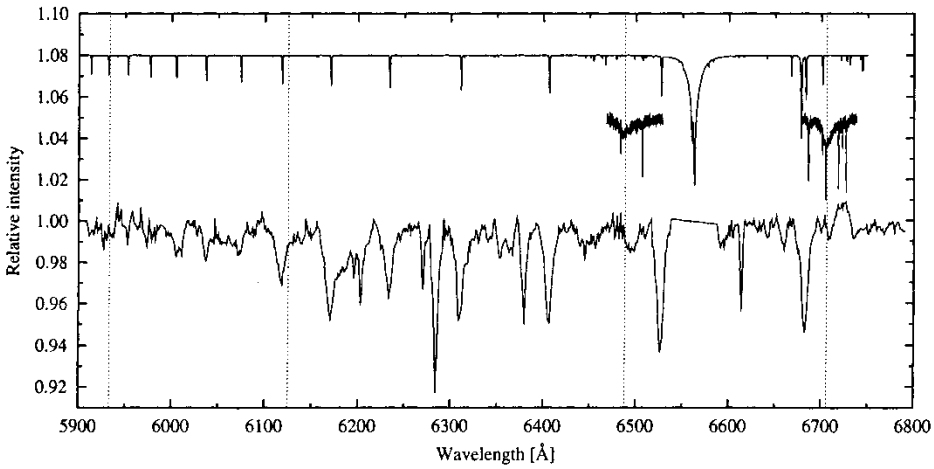

FIGURE 1 Low-resolution spectrum of λ Cep = HD 210839 (lower curve) compared with the laboratory spectra of naphthalene (middle curve) and the synthetic spectrum of the star (local thermodynamic equilibrium; $T = 40{,}000$ K; $\log g = 5$) (upper curve).

An attempt has been made to compare stellar spectra with the laboratory spectrum of the naphthalene cation $C_{10}H_8^+$ (Krelowski *et al.*, 2001).

The low-resolution spectra of highly reddened stars presented here (Figs. 1–4 and Tab. I) question this relation, but there is still need for further investigation.

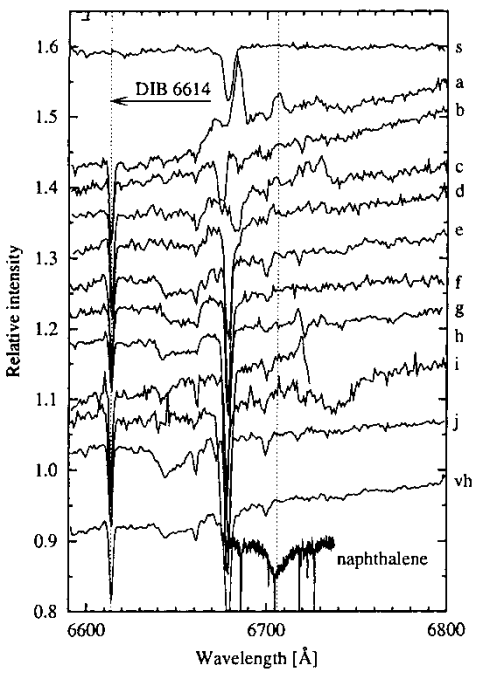

FIGURE 2 Low-resolution spectra of reddened stars compared with the laboratory spectrum of naphthalene. The averaged spectrum of all HD stars (vh) is also shown. The dotted vertical lines indicate the DIB 6614 and naphthalene band positions. In this and the subsequent figures all spectra are aligned on a DIB indicated in this way. The stars and their averages are labelled according to Table I.

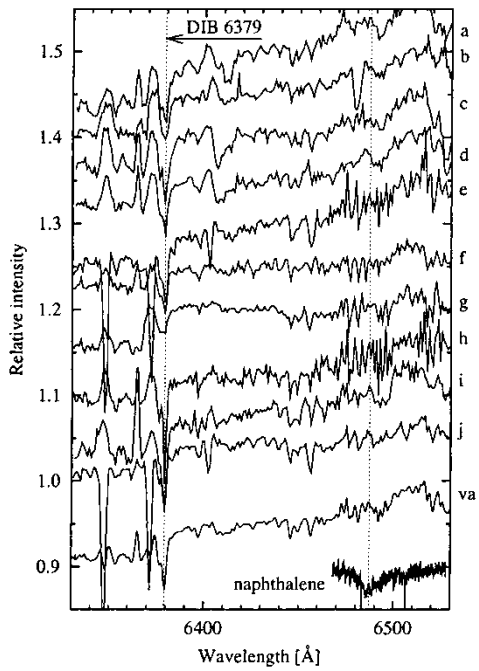

FIGURE 3 The same as in Figure 2, but for another naphthalene band. These spectra are divided by a telluric standard η UMa = HD 120315. The averaged spectrum of all stars (va) is also shown.

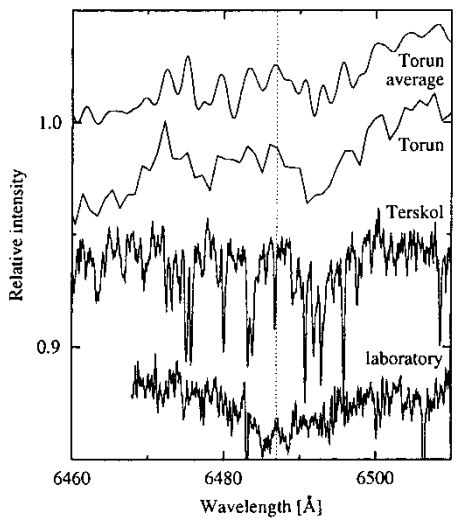

FIGURE 4 The 6488 Å naphthalene band (lower curve), high-resolution spectrum (Terskol) and low-resolution spectrum (Torun) of BD $+40^\circ 4220$ = V729 Cyg (middle curve) and Torun average ten-star spectrum (upper curve).

TABLE I Labelling of Stars and Averages in Figures 2, 3 and 5.

Label	*Henry Draper (HD) Catalogue–Binner Dürchmusterung (BD) name*	*Spectral type*	E_{B-V}
a	BD +40° 4220	O7 e	1.99
b	HD 229059	B1.5 Iap	1.73
c	BD +40° 4227	O6 e	1.61
d	HD 228779	O9.5 Ib	1.55
e	HD 183143	B7 Ia	1.31
f	HD 204827	B0 V	1.06
g	HD 194839	B0.5 Iae	1.05
h	HD 186841	B1 Ia	1.04
i	BD +63° 1964	B0 II	1.01
j	HD 186745	B8 Ia	0.93
k	HD 206267	O6 e	0.54
l	HD 210839	O6 Iab	0.52
s	HD 120315	B3 V	0.00
va	Average of stars a–j		
vb	Average of all B-type stars only		
vh	Average of all HD-named stars only		

The very broad structure at 6177 Å escapes not only identification but even accurate description. Its equivalent width measurements in the HD 183143 spectrum vary from 1000 up to nearly 2500 Å, depending on the continuum set (based on DIB surveys (Herbig, 1975; 1995; Jenniskens and Désert, 1994; Tuairisg *et al.*, 2000)). Low-resolution spectra reveal that it stretches over a wide region beyond the narrow 6196 and 6203 Å DIBs (Figs. 5 and 6) (cf. Chlewicki *et al.* (1987)). It may consist of several bands.

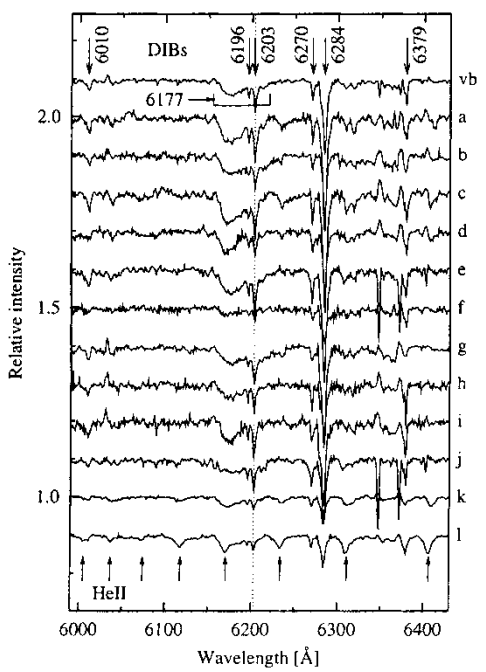

FIGURE 5 The 12 program stars and averaged spectrum of B stars (vb). The arrows indicate selected DIBs (arrows at the top) and stellar He II lines (arrows at the bottom).

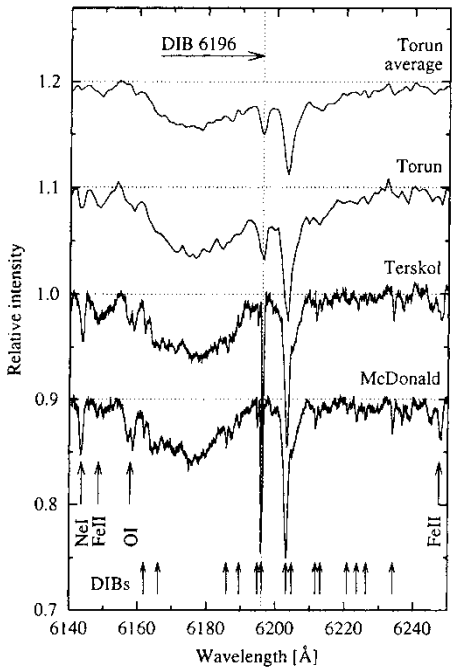

FIGURE 6 The 6177 Å diffuse interstellar band: high-resolution spectra (McDonald and Terskol) and low-resolution spectrum (Torun) of HD 183143 = HT Sge, together with the Torun average B-star spectrum (upper curve).

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