Diffuse interstellar bands vs. rotational temperatures of simple molecular species

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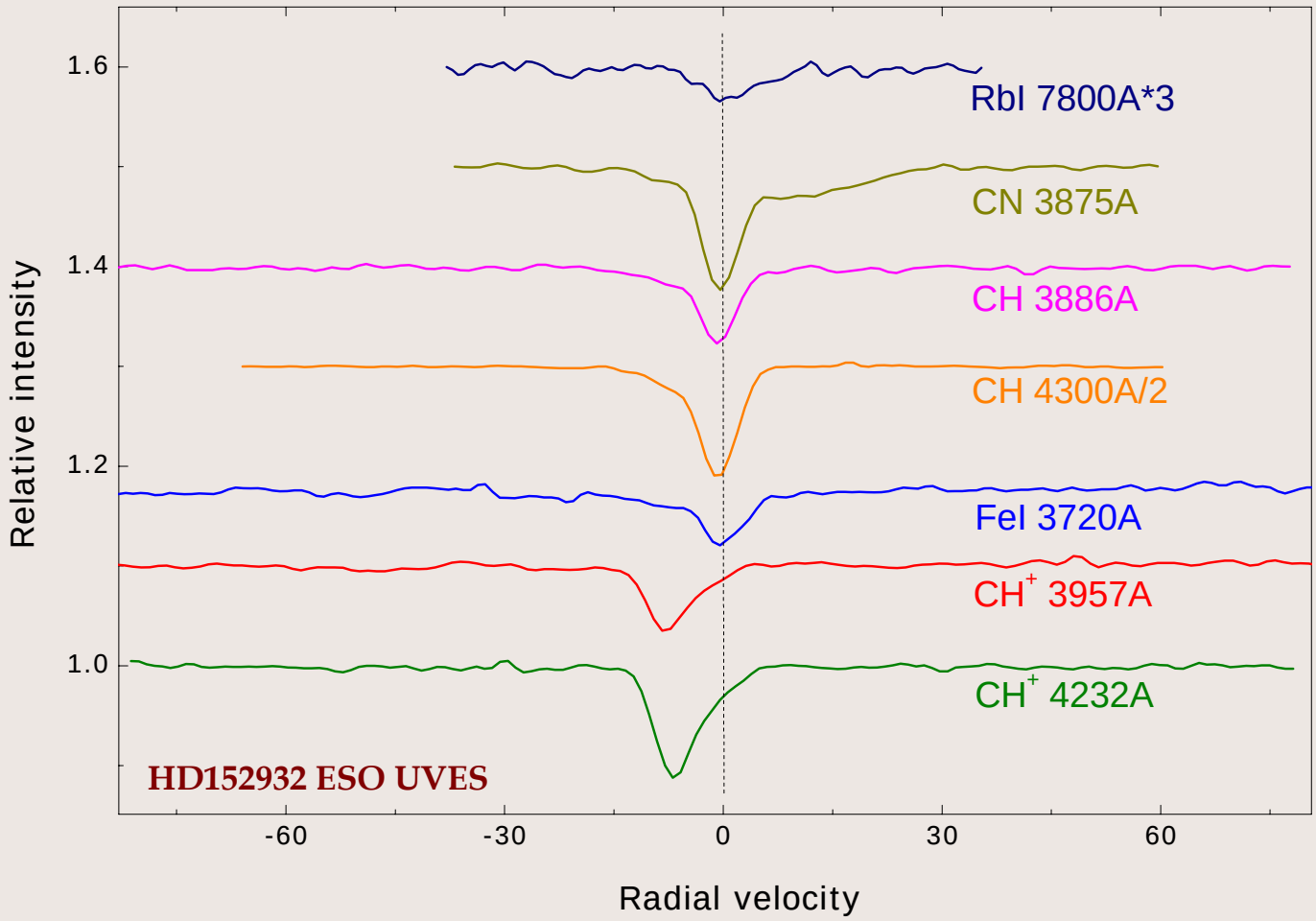
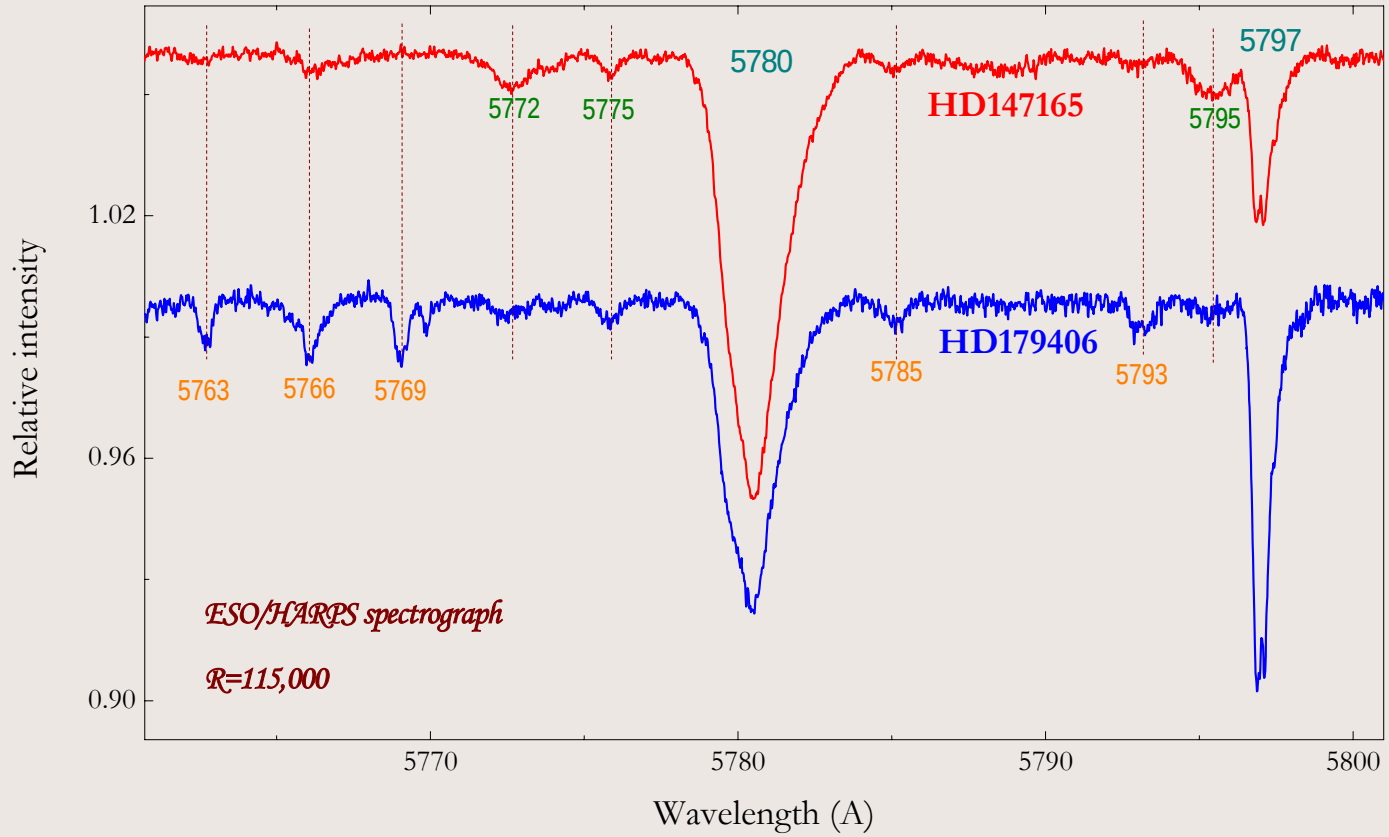
Absorption spectral features originated in interstellar clouds

Atomic lines from ground levels (known since **1904**)	Features of simple molecules (known since **1937**)	Diffuse interstellar bands (known since **1922**)
CaII, **NaI**, **KI**, CaI and LiI (vis.) Others – far-UV (Copernicus, IUE, HST)	**Polar** species: CH, CH^+, CN, CO **Homonuclear** ones: H_2, C_2, C_3	Unidentified; **Proposed carriers**: carbon chains, PAHs, fulleranes

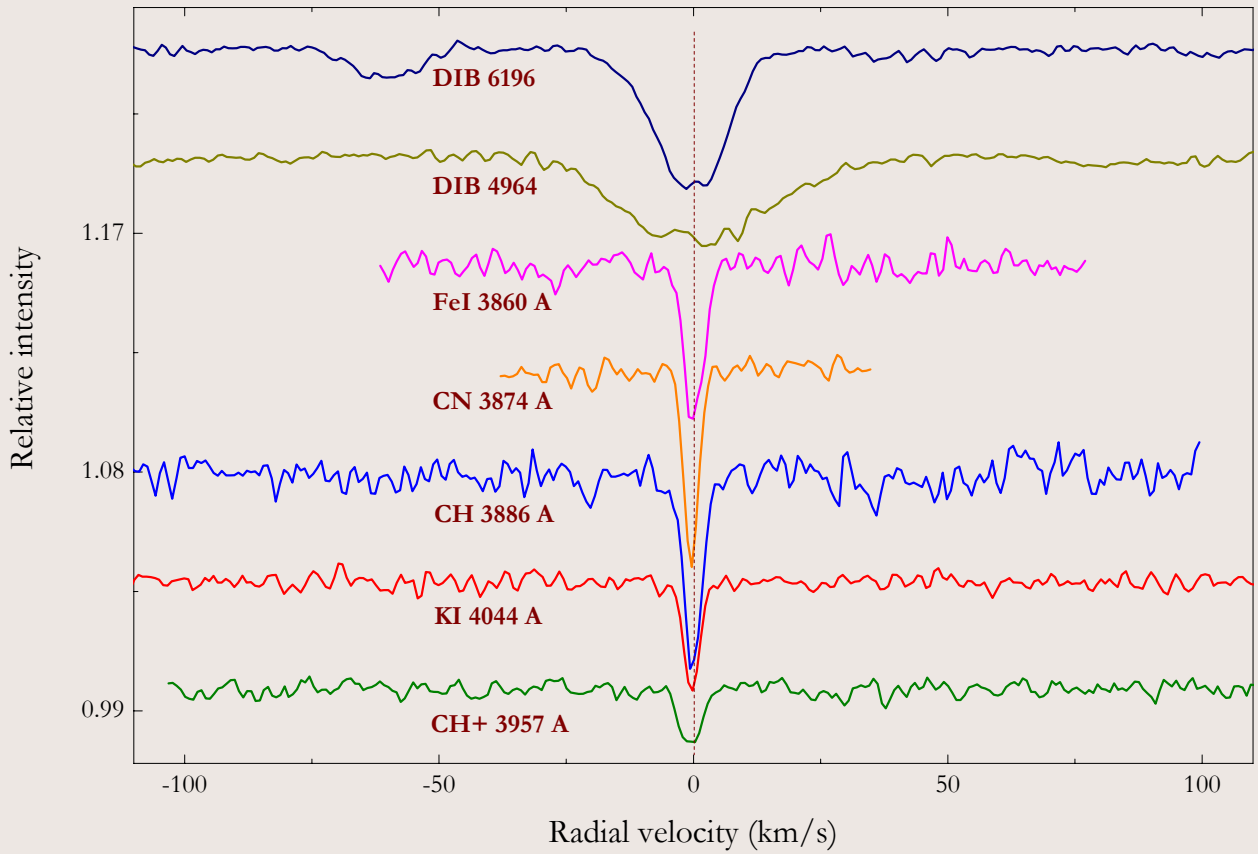
Radial velocity of CH+ can be different than those of other species



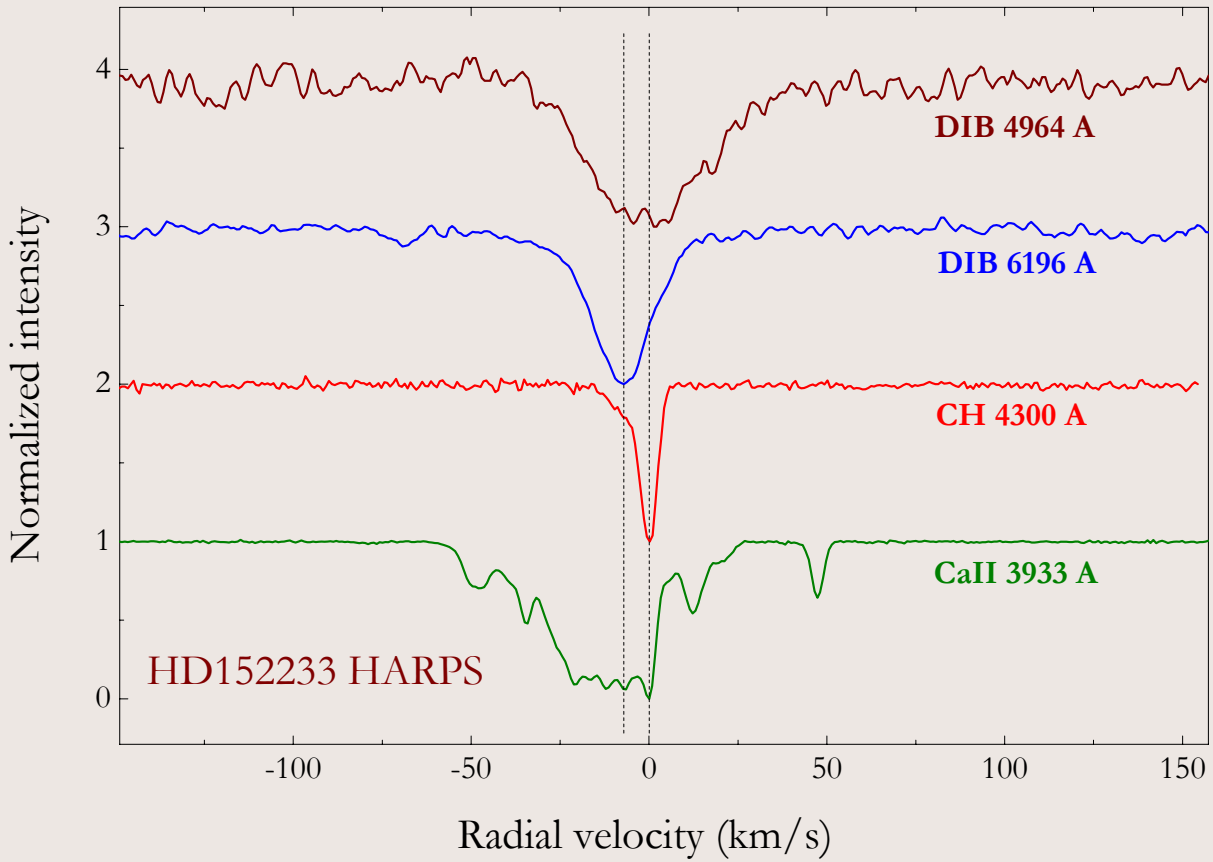
Diffuse bands (strong and weak) may be of different origin(s)



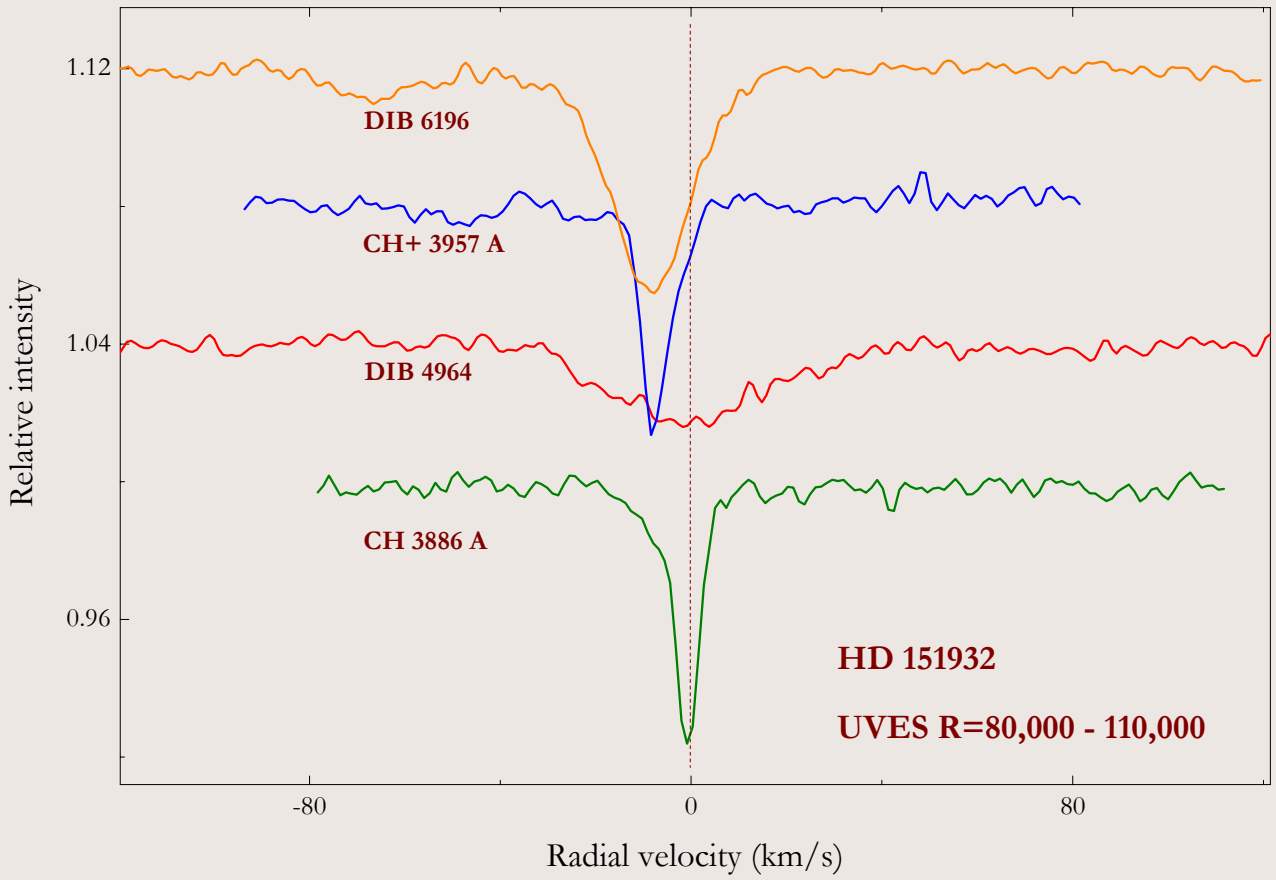
Standard DIB wavelengths(radial velocities according to CH and KI) in HD179406



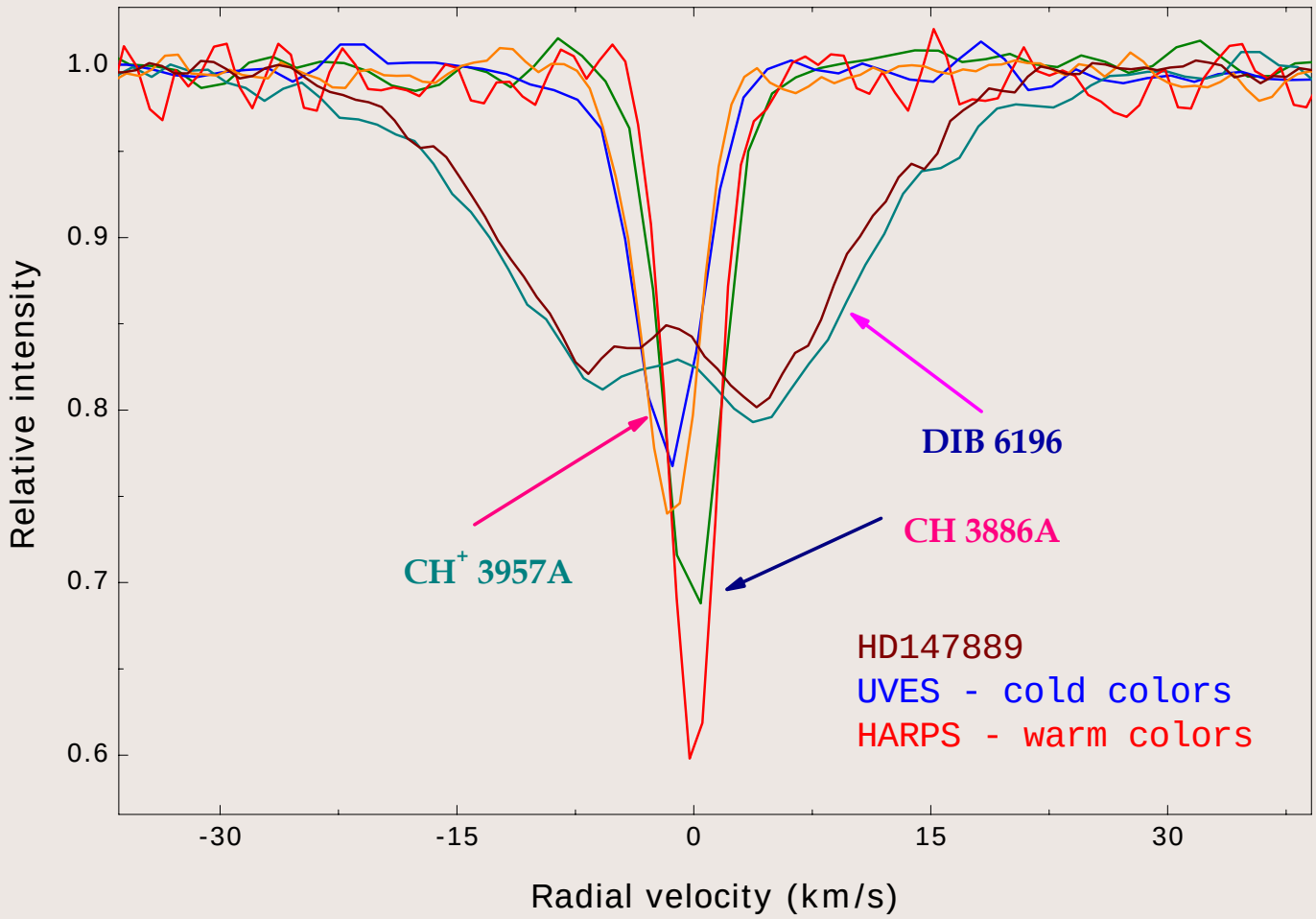
High precision HARPS spectrum suggests that DIBs belong to at least two"families"



Diffuse band 6196 seemingly shares Doppler shift with CH^+...



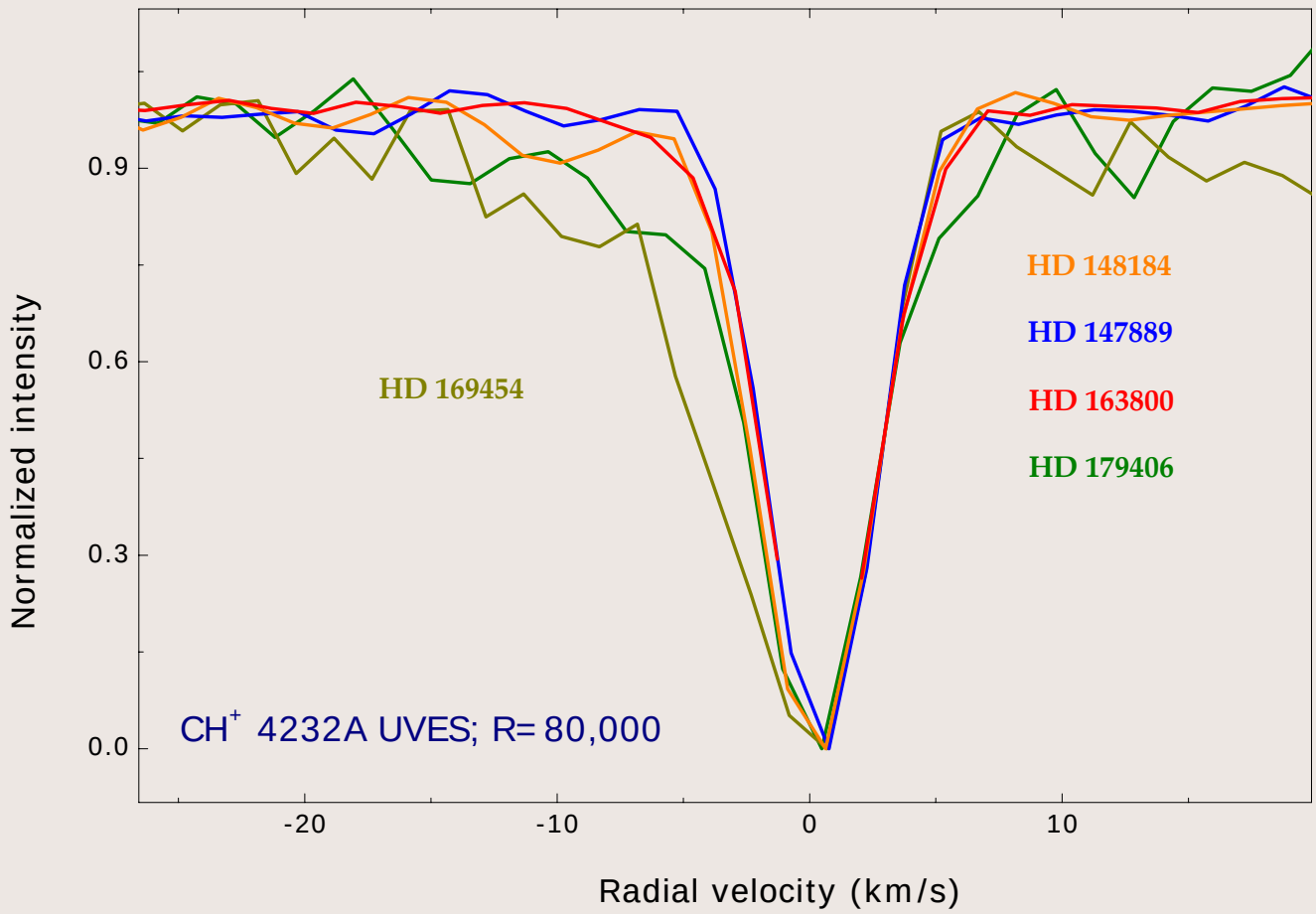
... even when it is very small



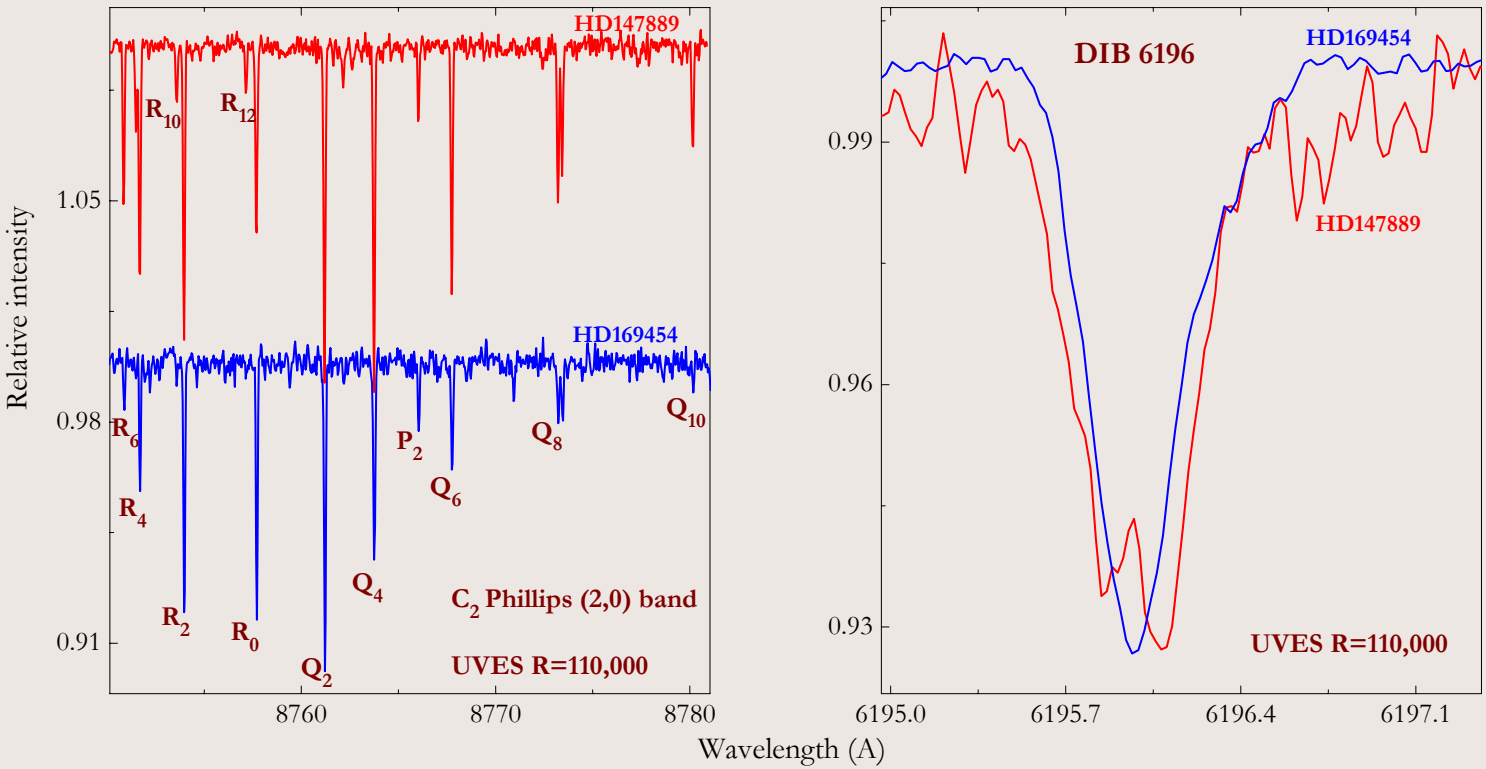
Comment

- It is of basic importance to establish spatial correlations of DIB carriers and well known atoms (ions) and molecules (their ions)
- Profiles of interstellar features depend on both: physical parameters of interstellar clouds and distributions of radial velocities along sightlines

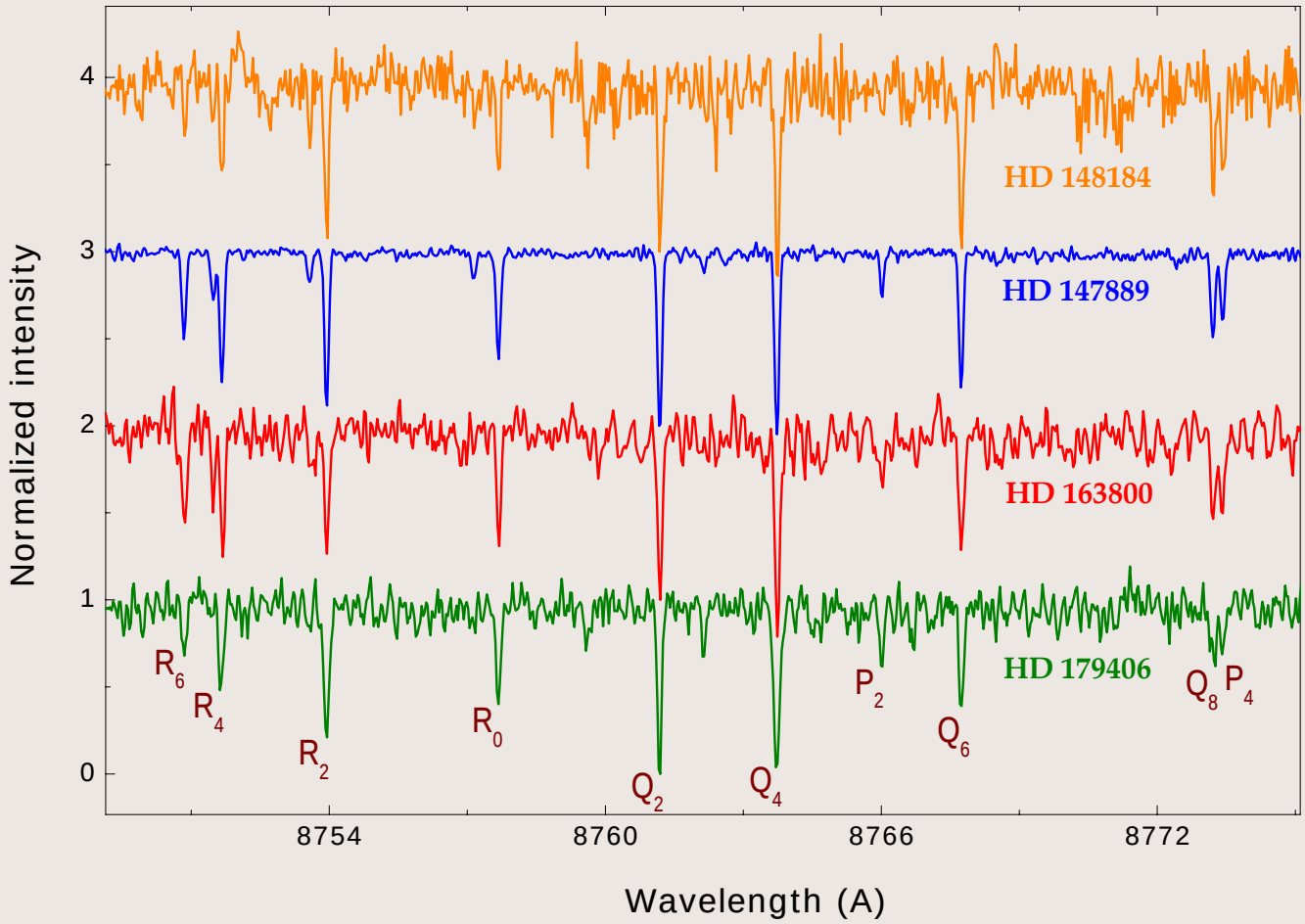
Difficult choice of a sample where CH^+ line is narrow, free of Doppler splitting and shares radial velocity with other molecules



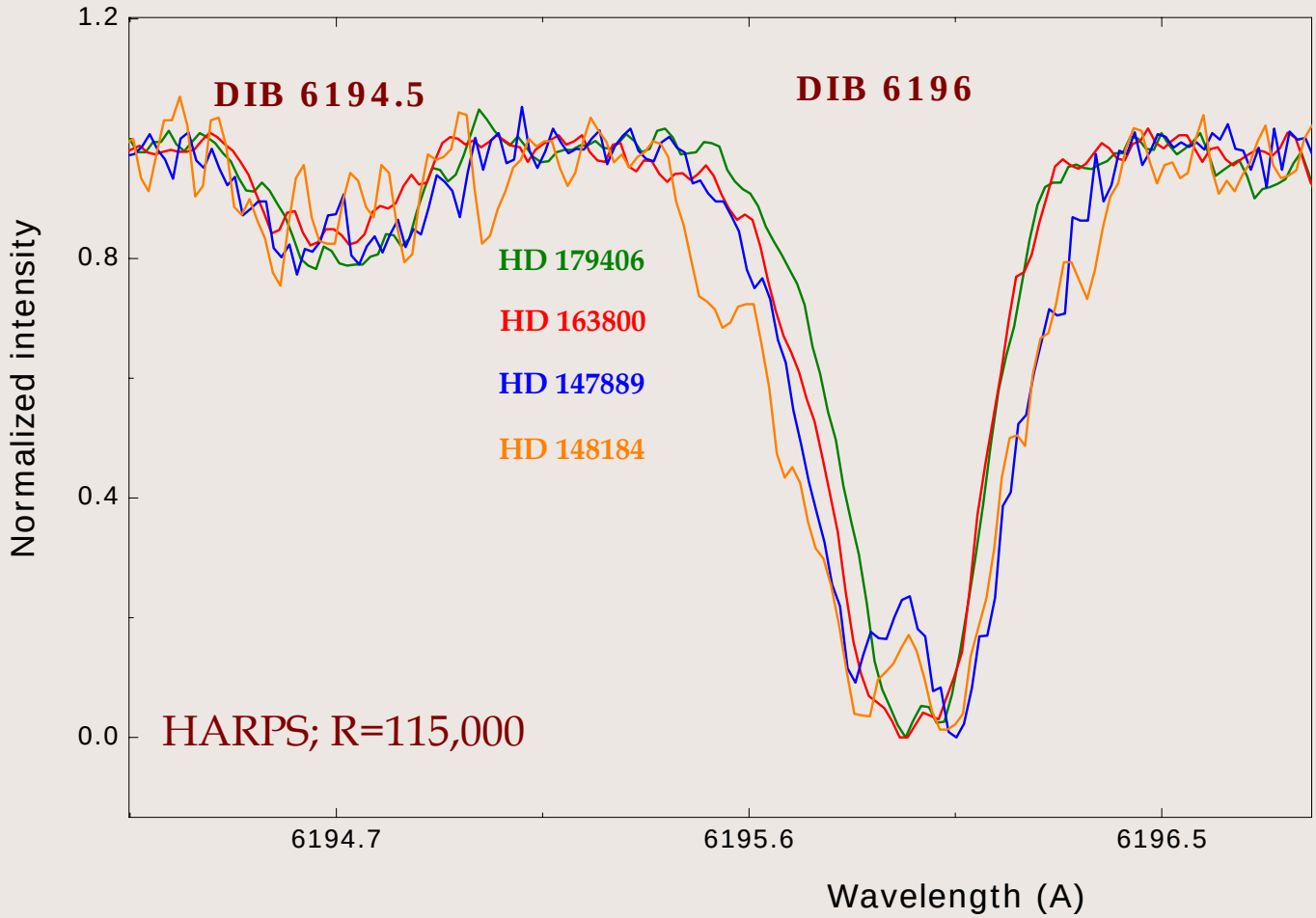
DIB broadening with T_{rot} of C_2; note also substructures



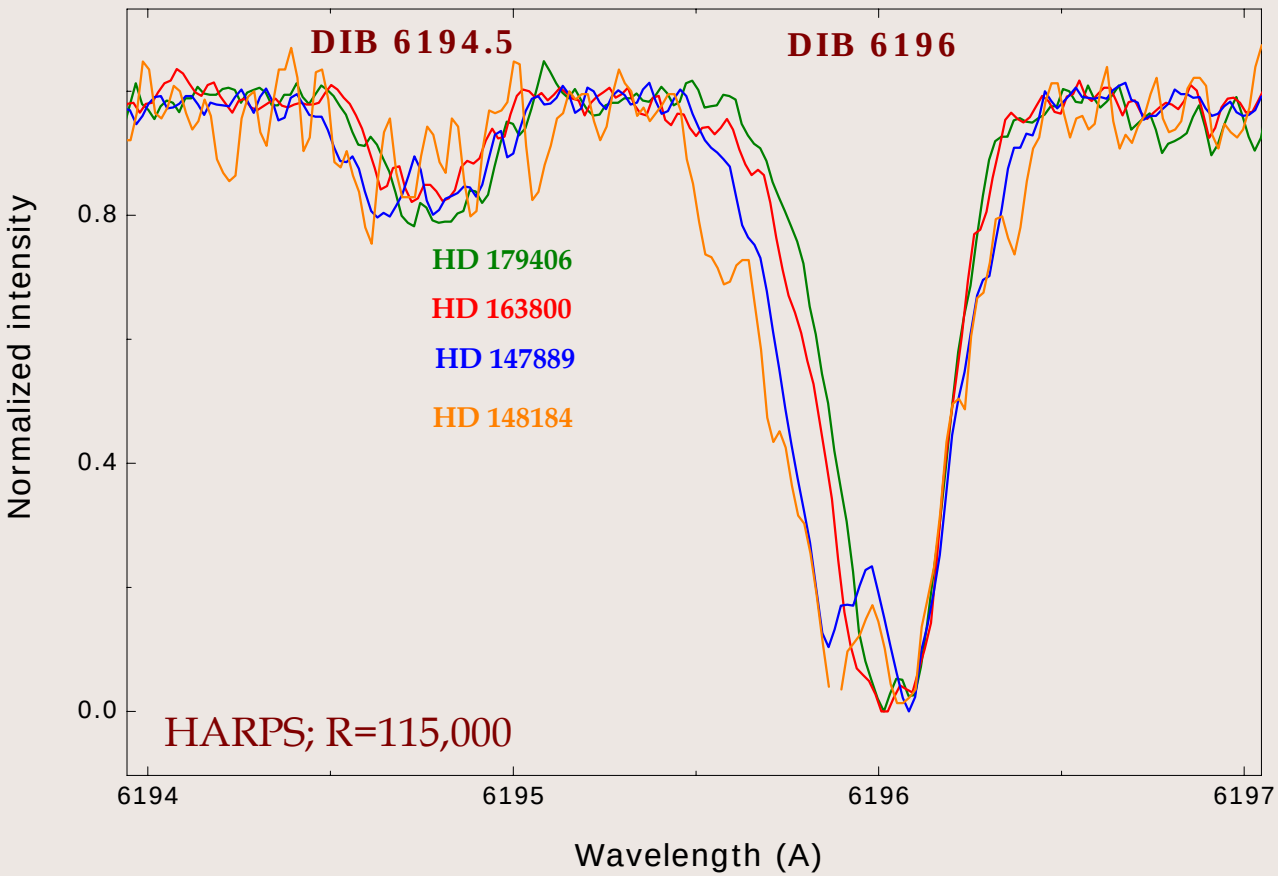
Strength ratio of Q_6/Q_2 transitions in C_2 indicates growth of T_{rot} from 179406 to 148184



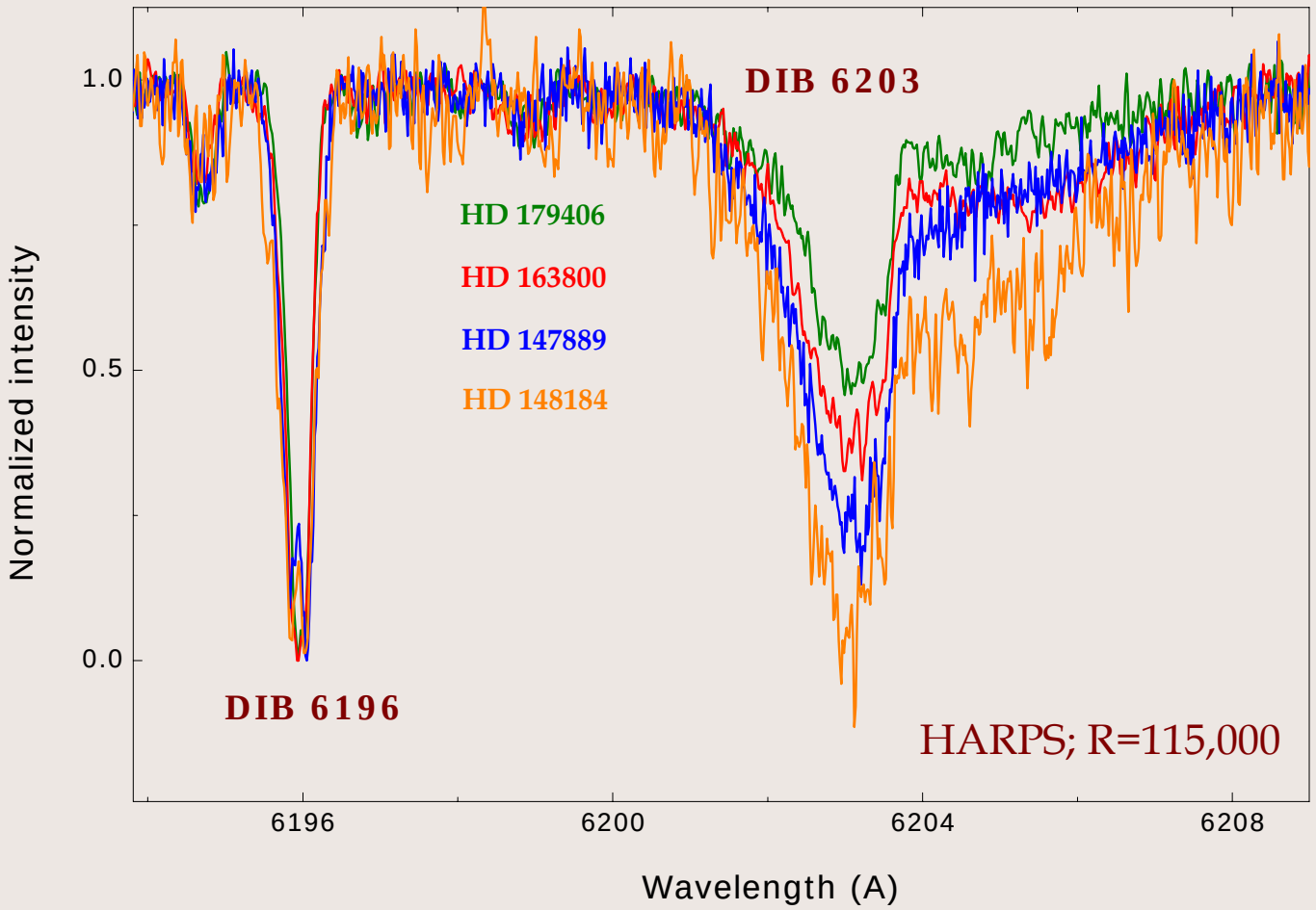
Diffuse interstellar band 6196 seen in the same, high quality spectra



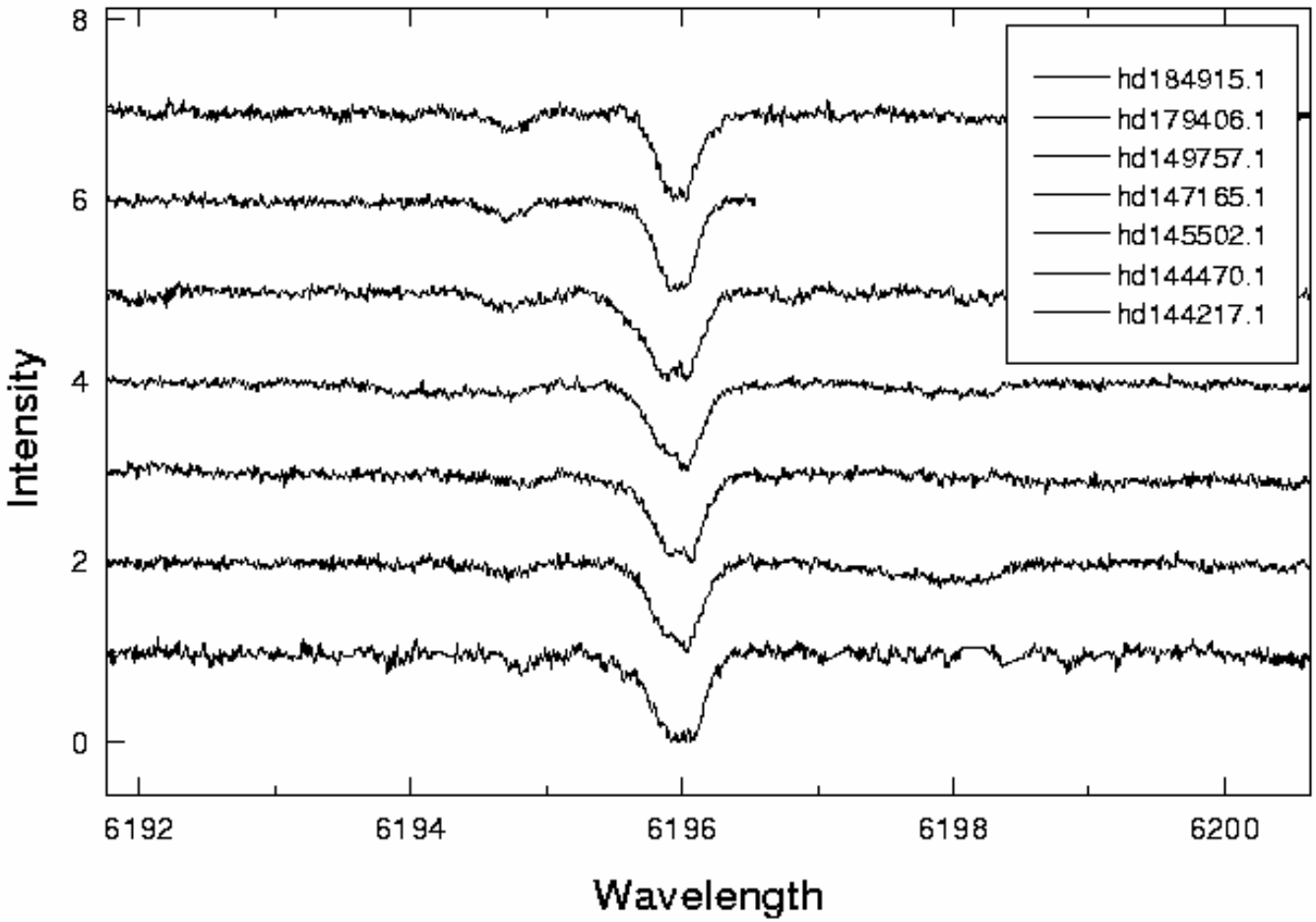
Here red wings overlap each other



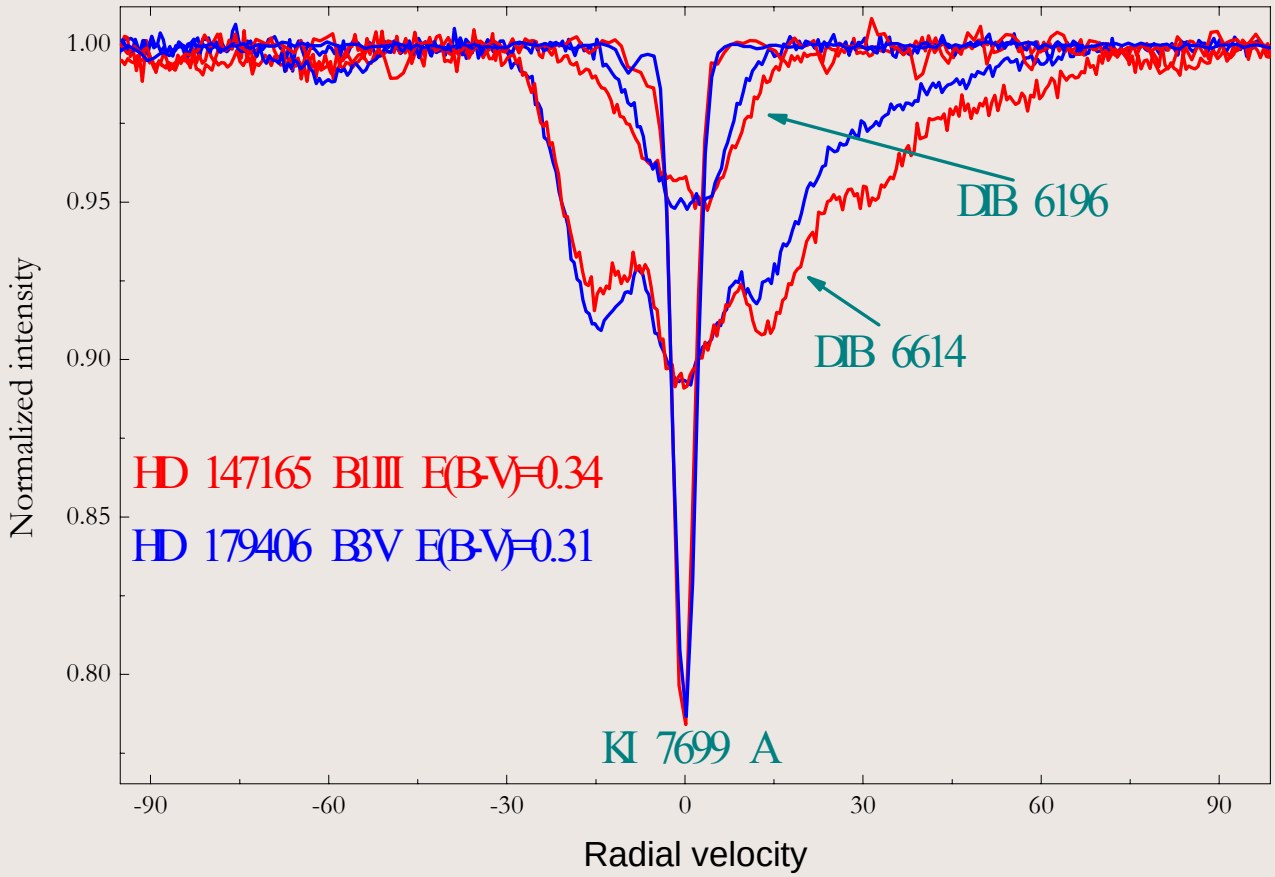
Growing FWHM of 6196 is accompanied with the intensity growth of the neighbour 6203 DIB



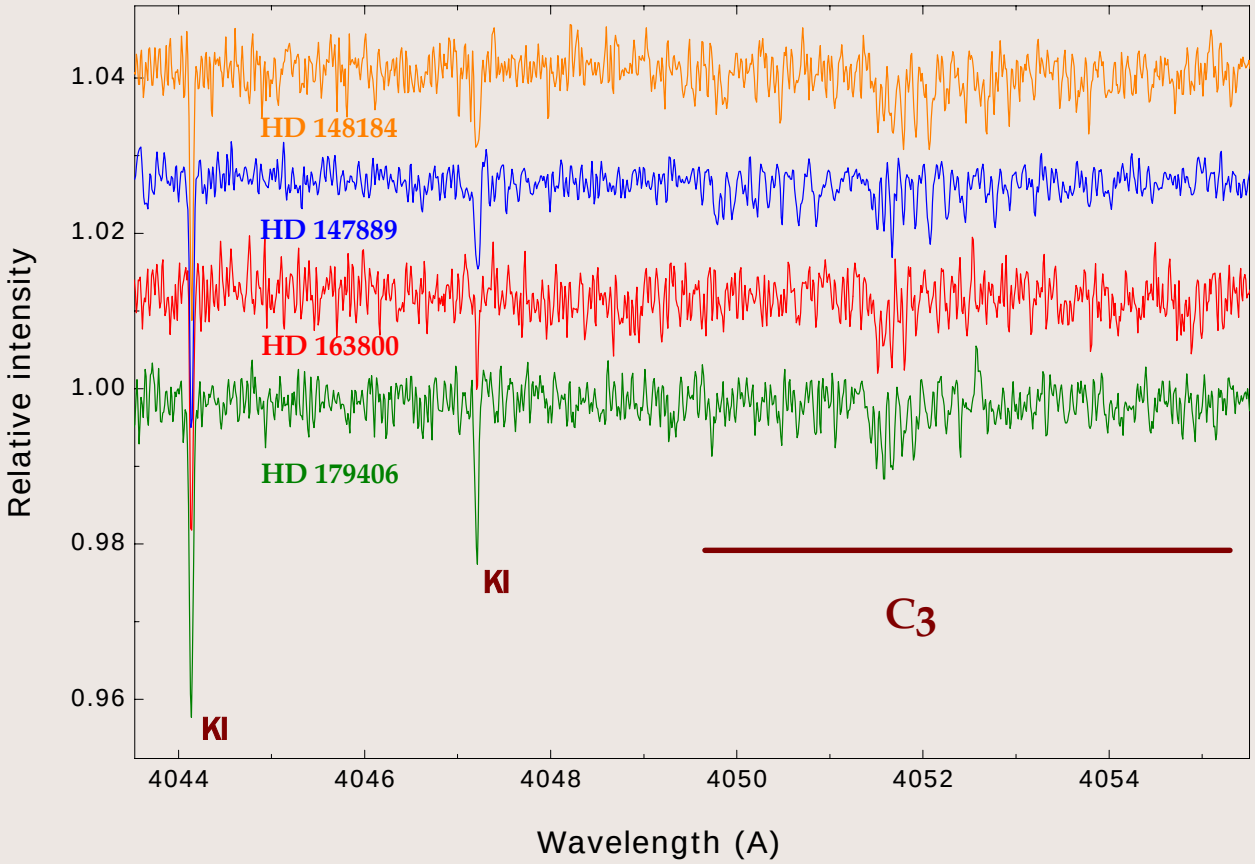
Physically caused variations of the 6196 profile (spectra from ESO, R=220,000, S/N~1000)



Physical broadening of diffuse band profiles CES/3.6m ESO R=220,000; profiles normalized



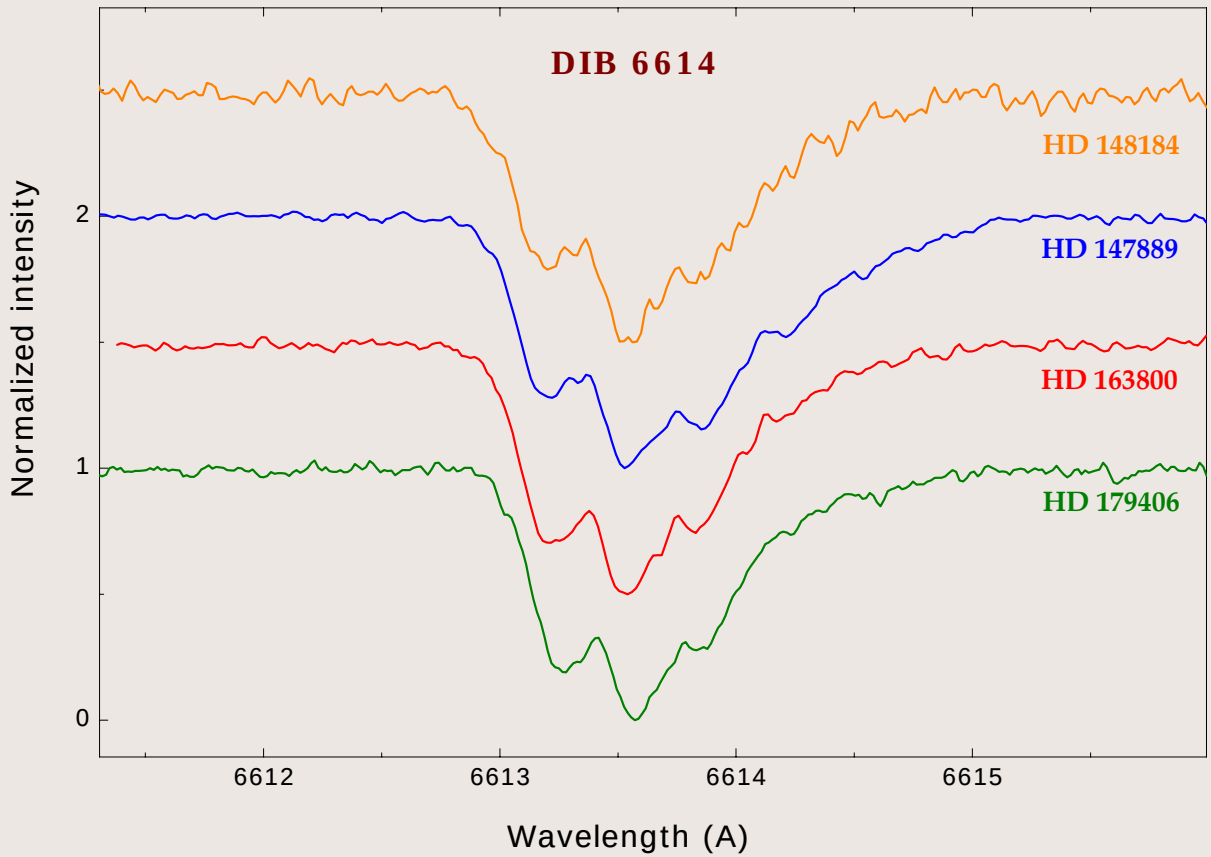
Rotational temperature of C_2 seems to be correlated with that of C_3



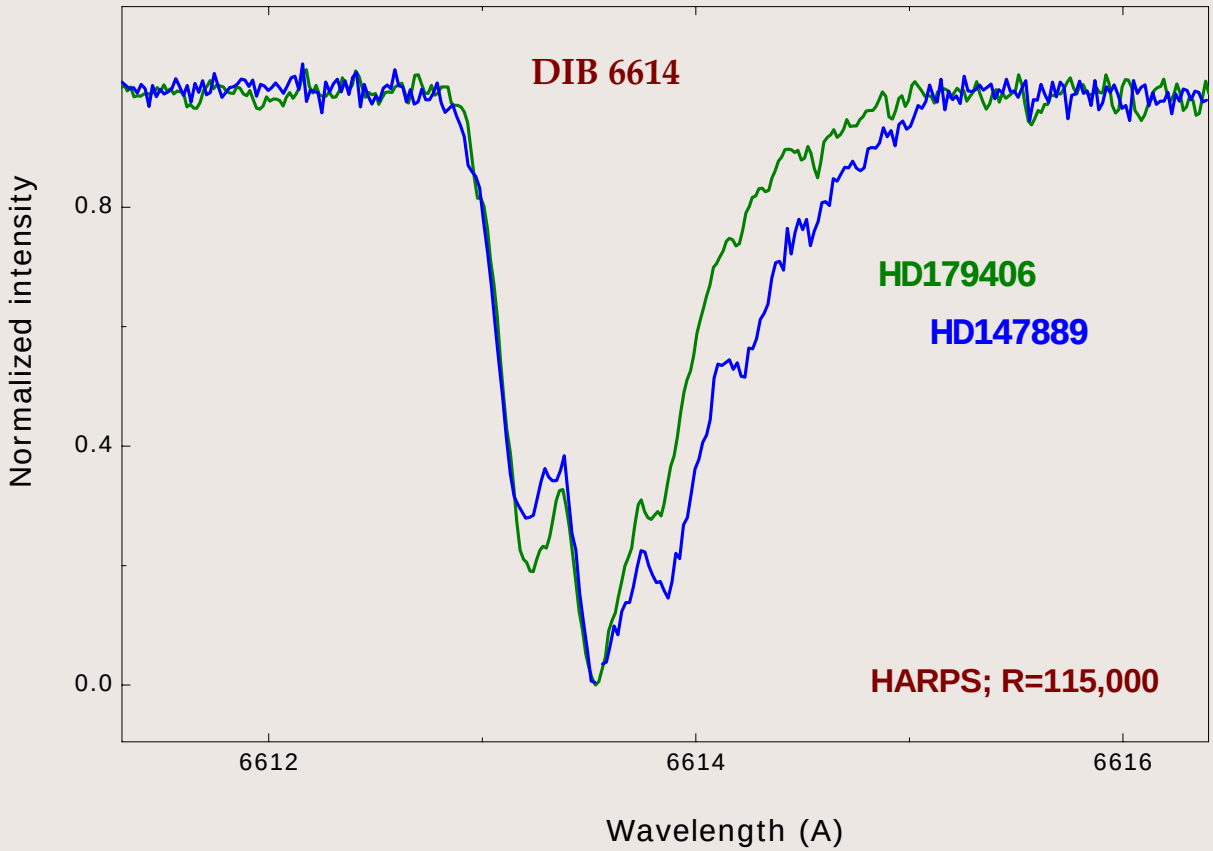
Comment

- Rotational temperatures of simple carbon species (C_2 i C_3) seem to be correlated
- Molecules C_2 i C_3 are the only species, available to ground-based observations, for which the observed T_{rot}'s are evidently different
- 6196 DIB profile gets broader while T_{rot} gets higher

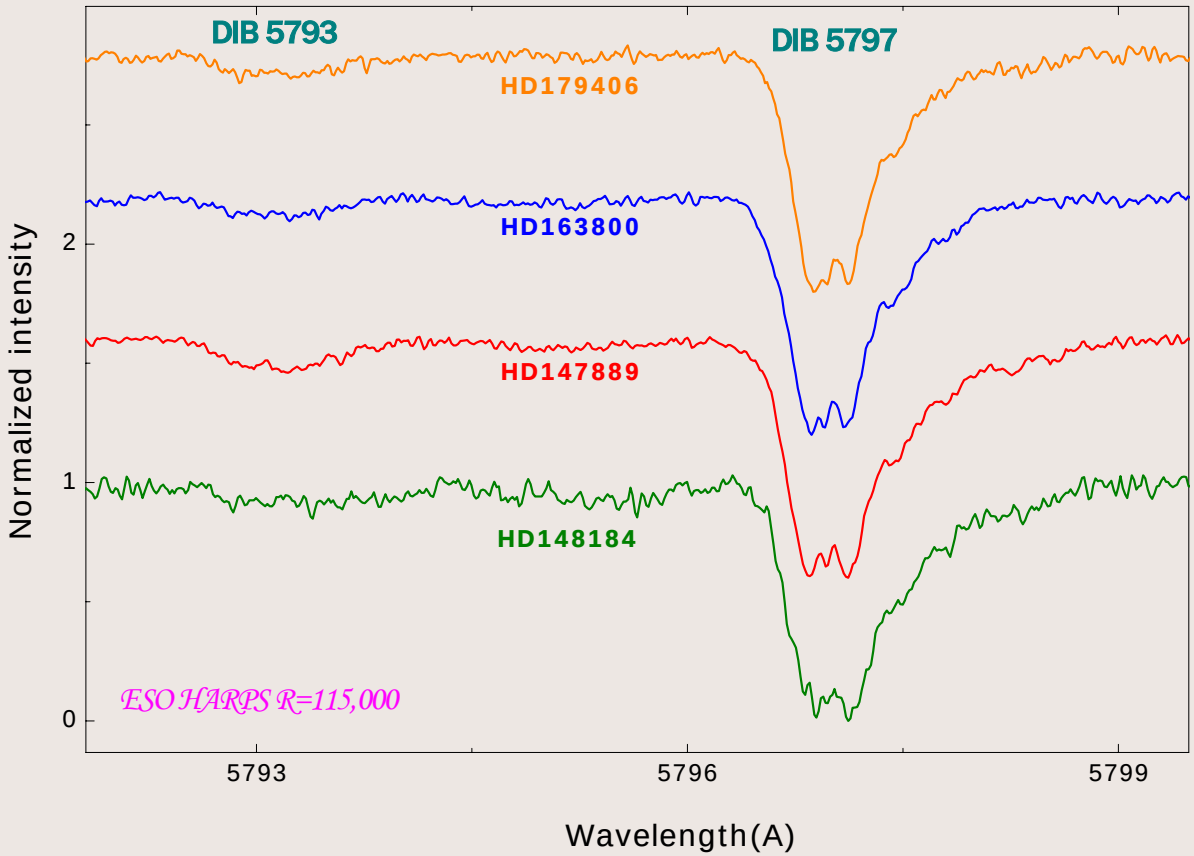
Profile of the 6614 DIB, well correlated with 6196, changes the shape with T_{rot} of C_2 i C_3



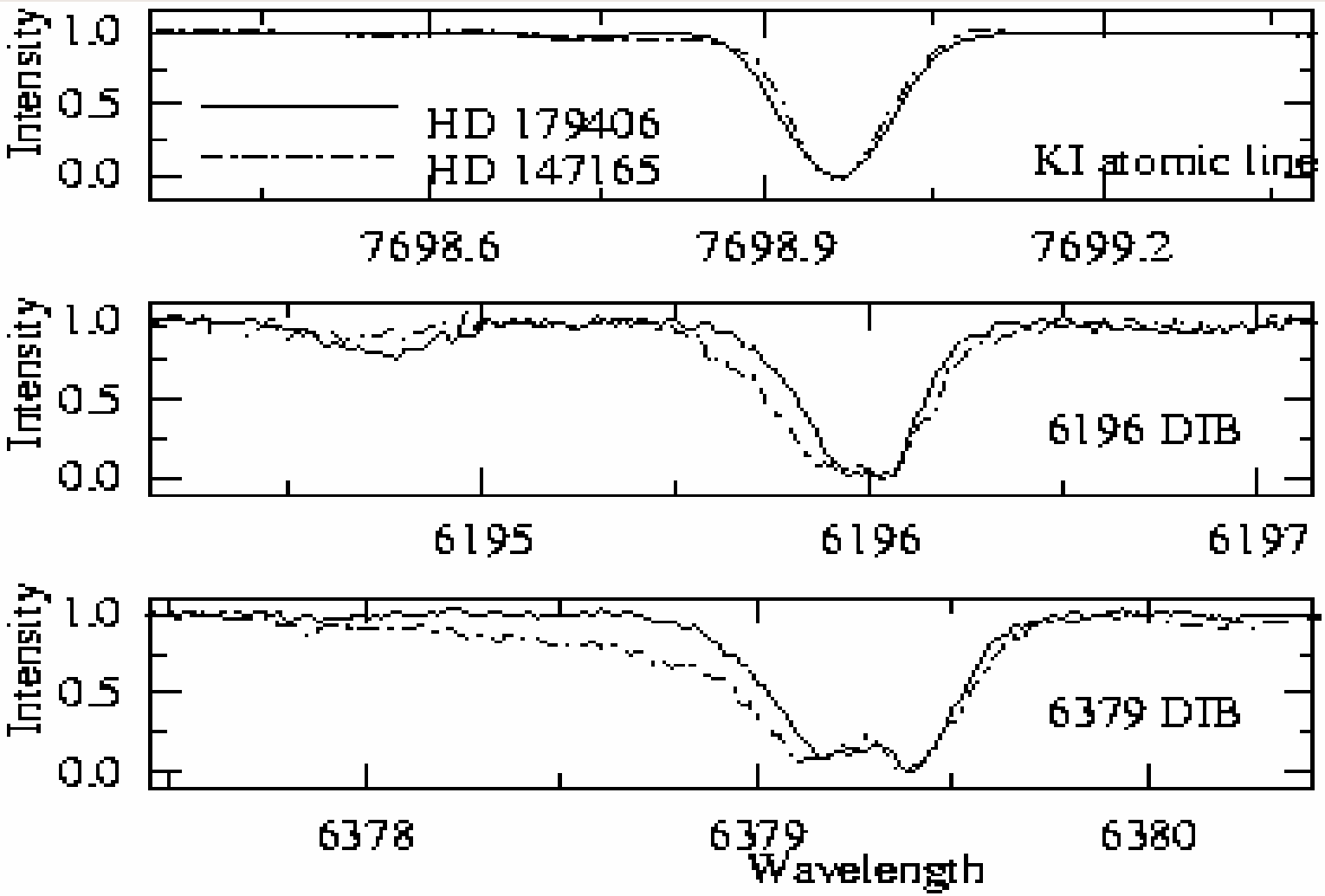
Trot(179406) < Trot(147889)...



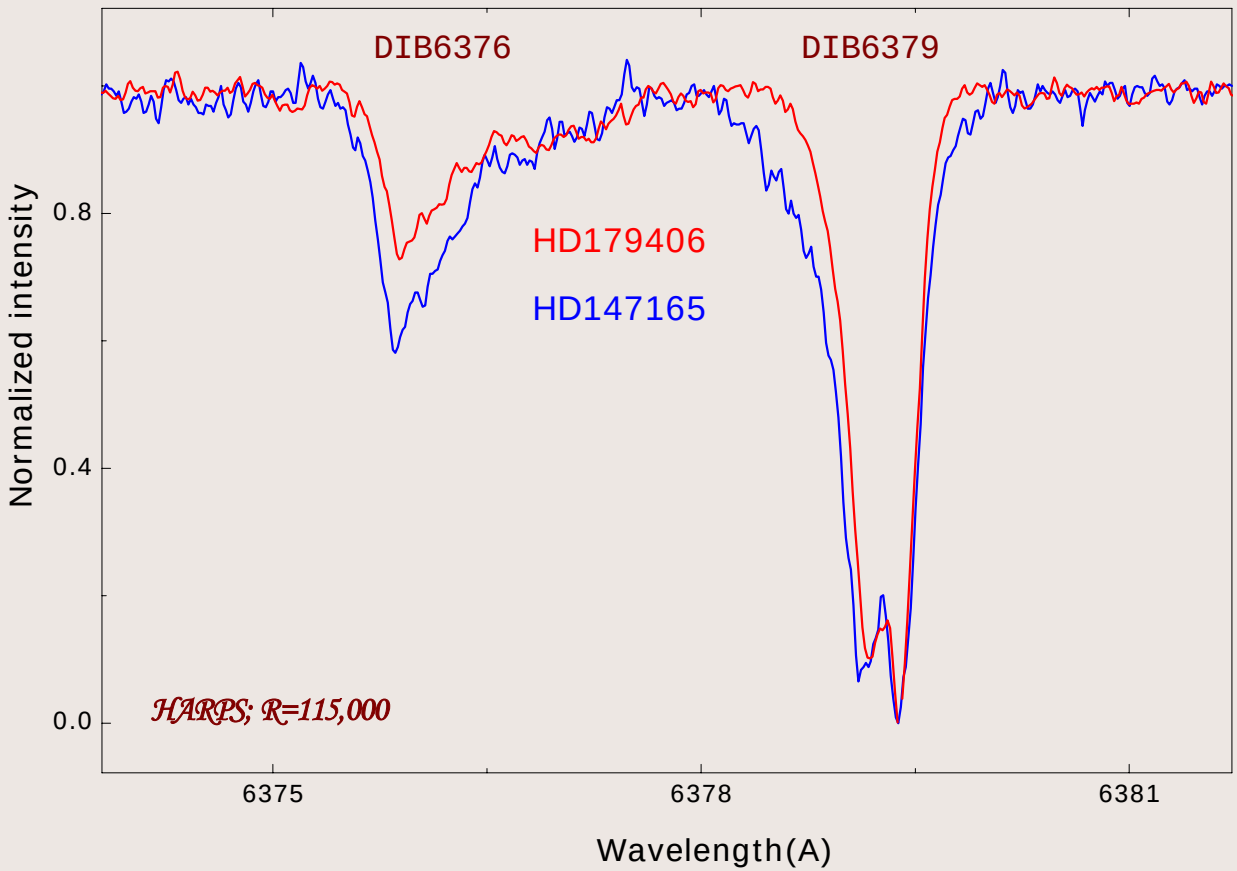
Profile of 5797 DIB behaves in a fashion similar to that of 6196



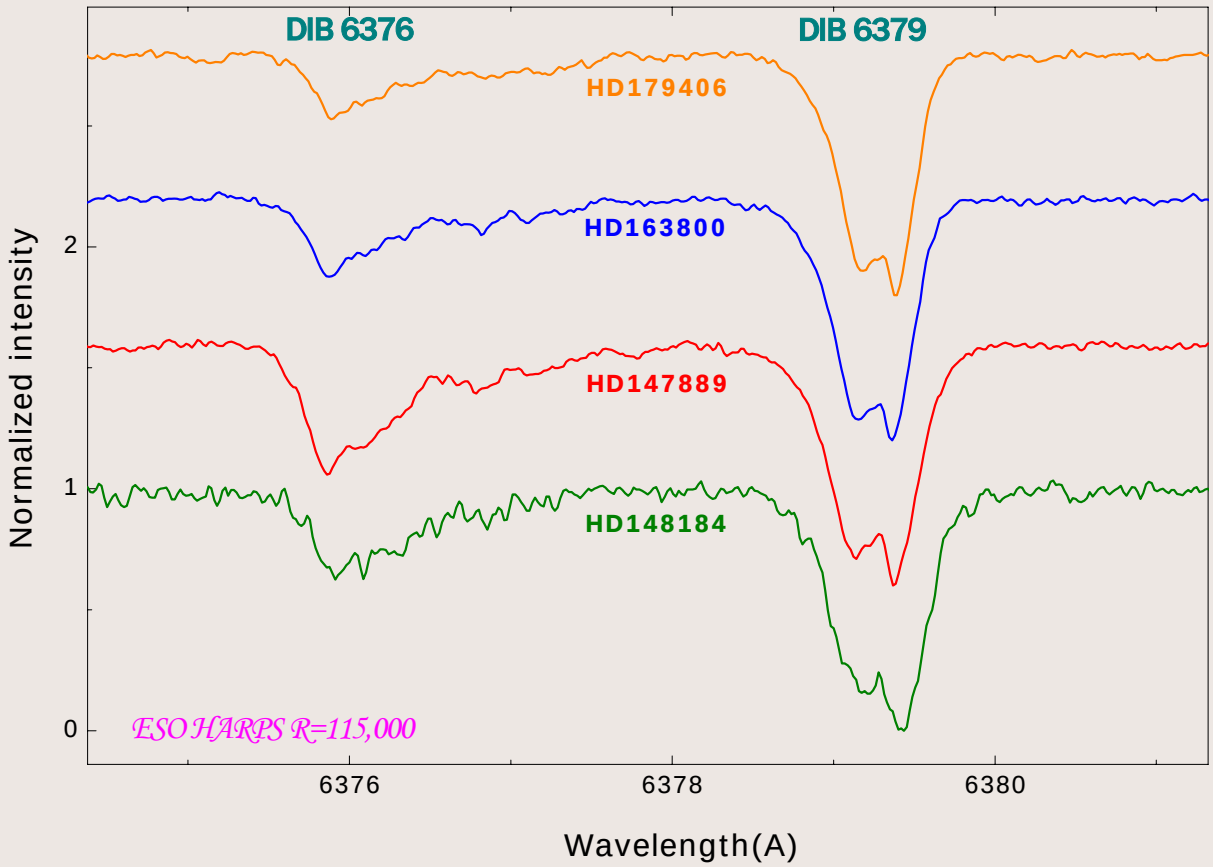
Profiles of the DIBs: 6196 i 6379 change in unison (spectra from Gecko CFHT)



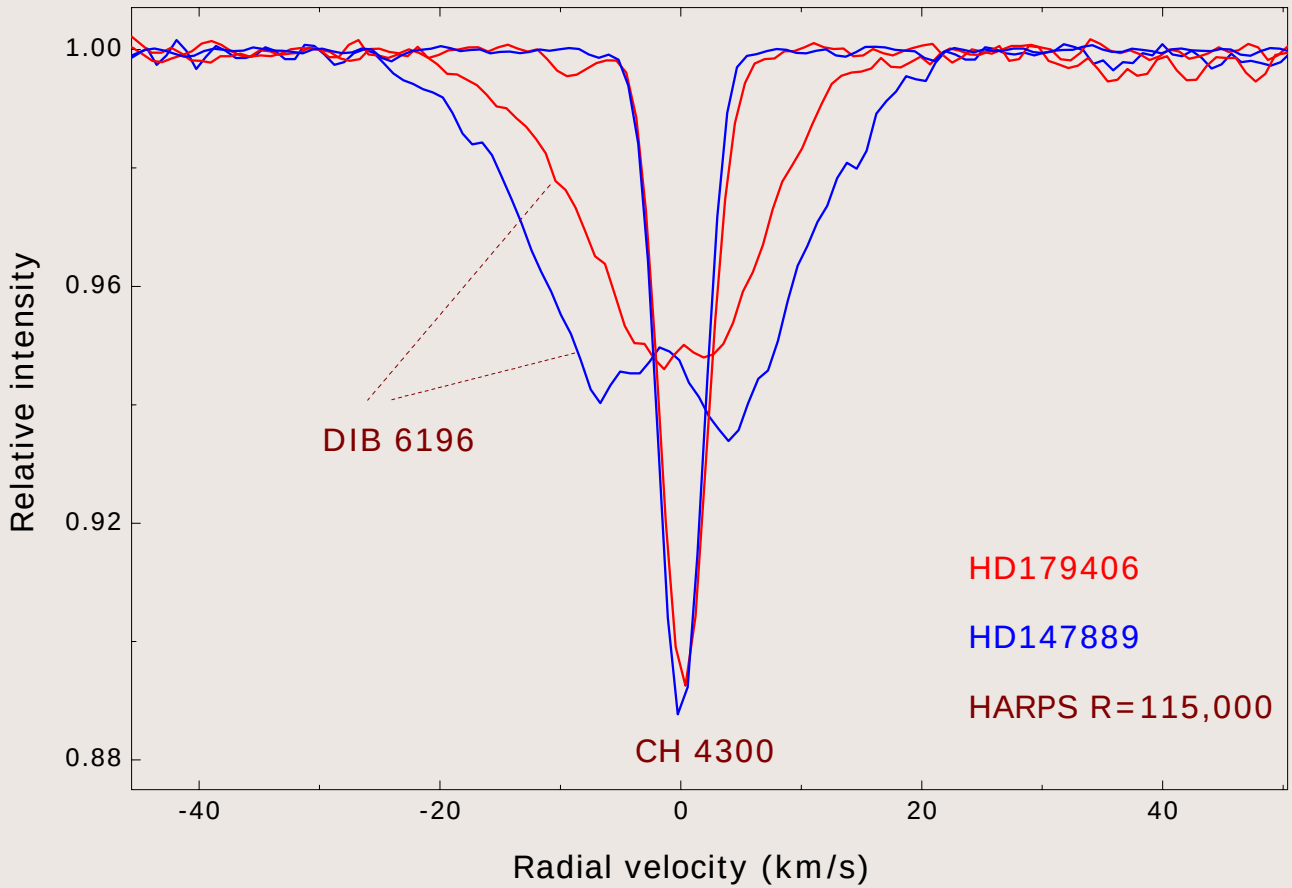
The same effects seen in high quality spectra from ESO HARPS spectrograph



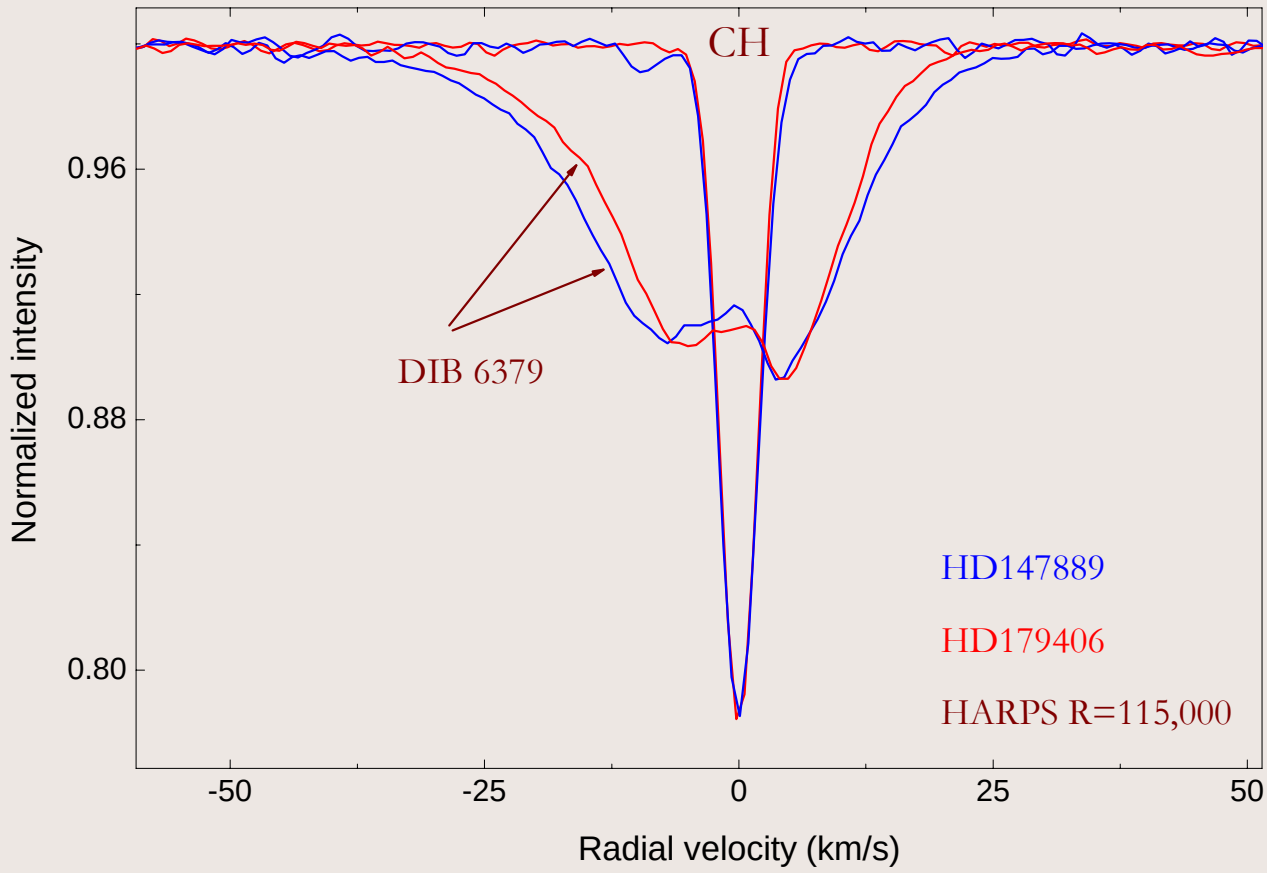
6379 DIB profile behaves in our sample as that of 6196



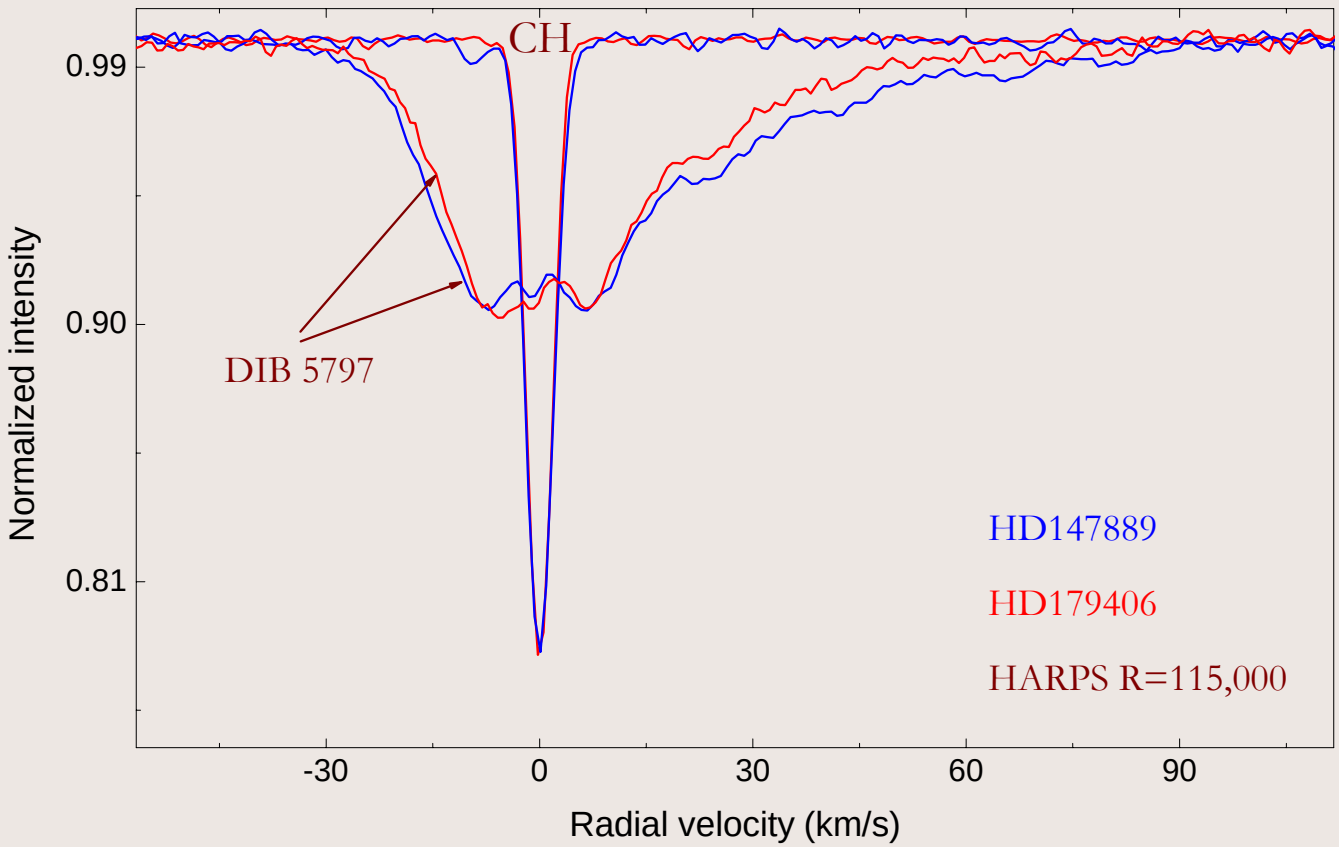
6196 profile broadening is not caused by Doppler splitting – absent in CH lines



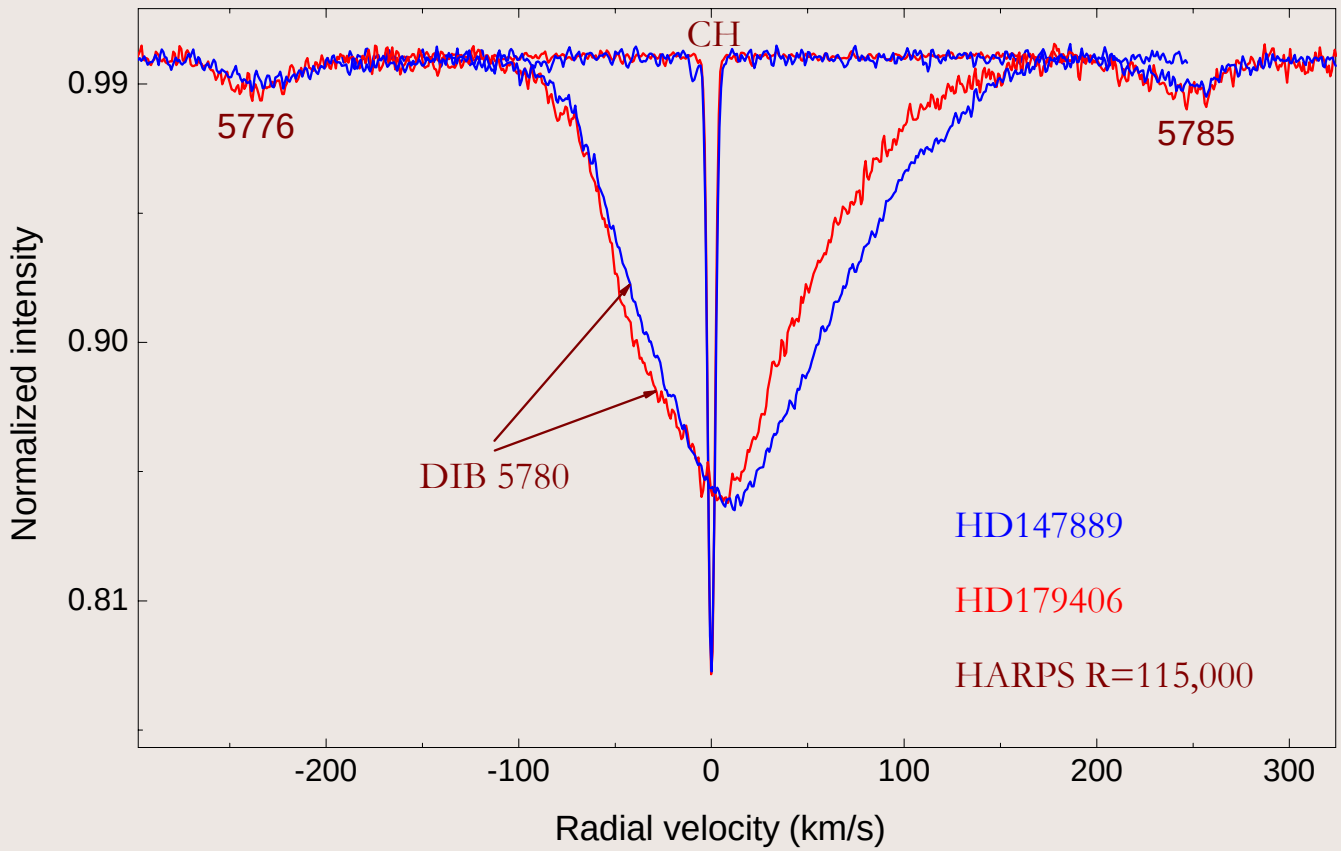
Substructures are not equally spaced in all spectra which is the argument against isotope shift



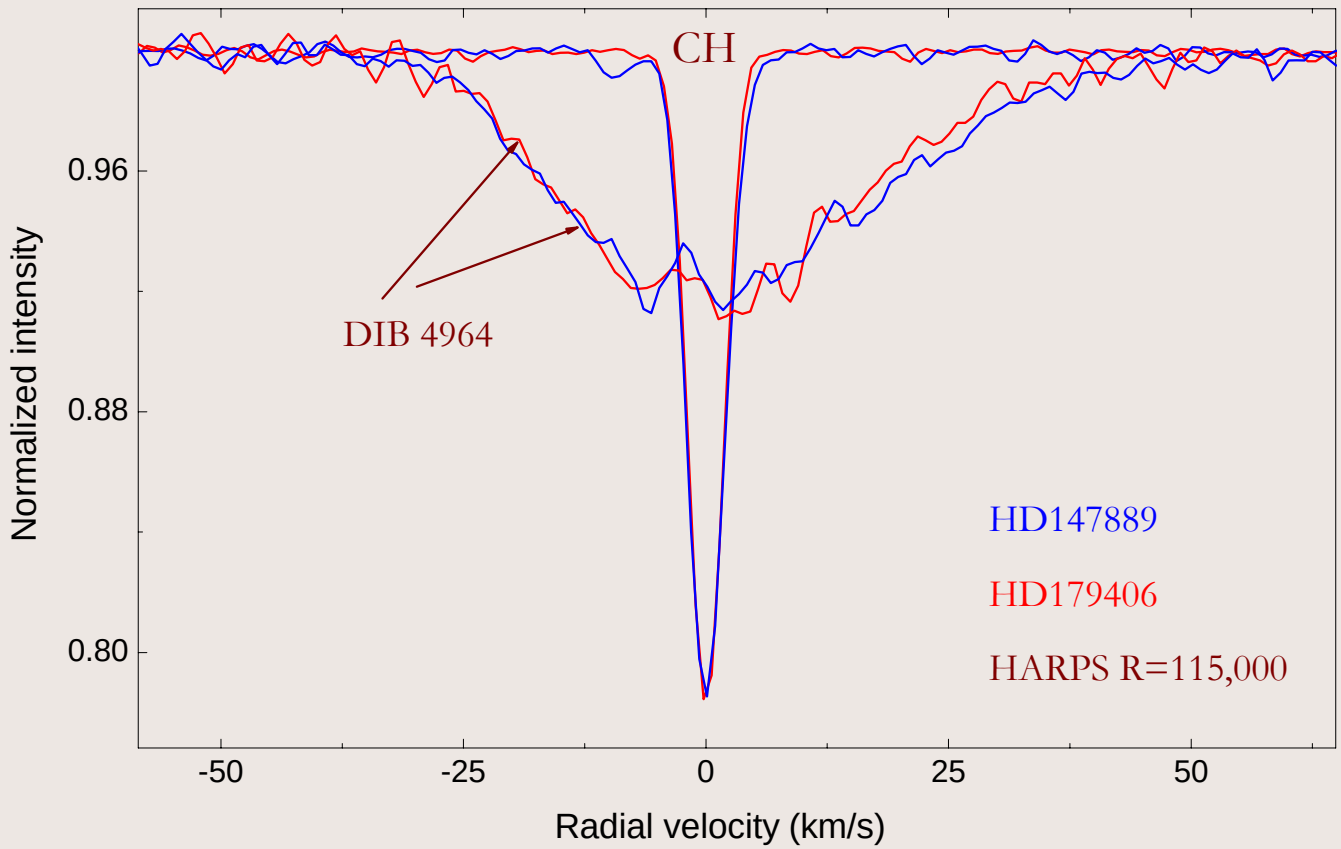
The same is true in the case of 5797 DIB (5796.97)



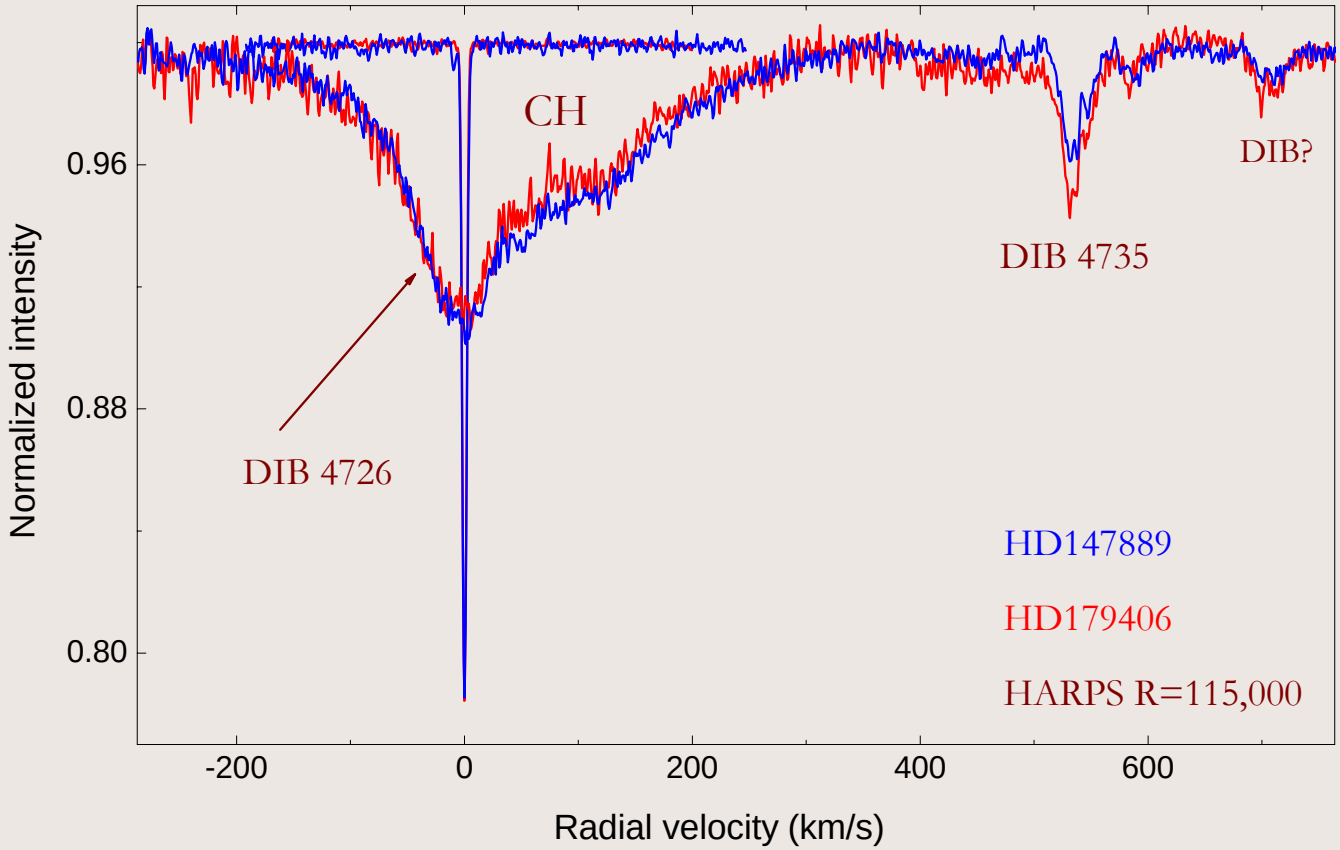
Broad 5780 DIB also changes profile together with T_{rot}



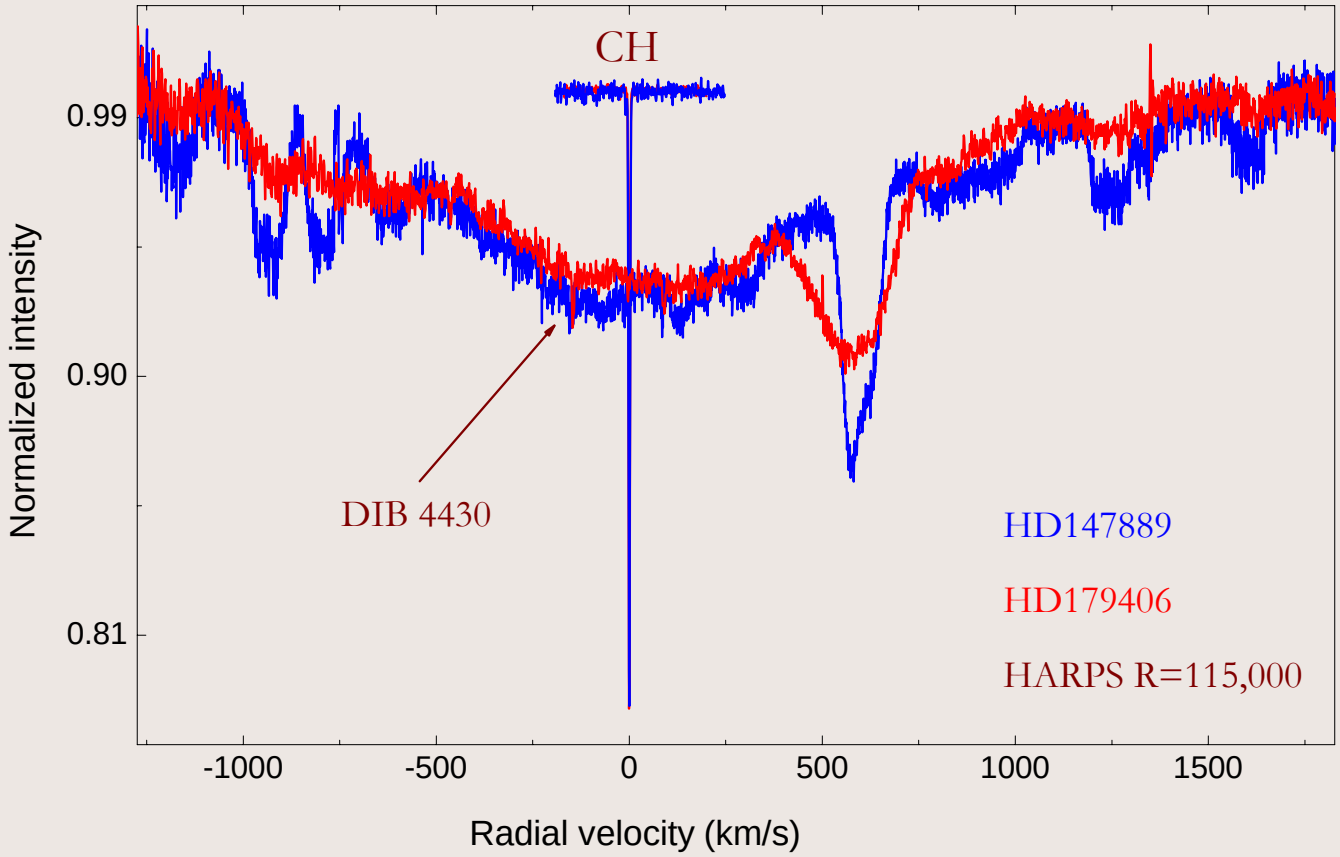
4964 DIB profile remains unchanged...



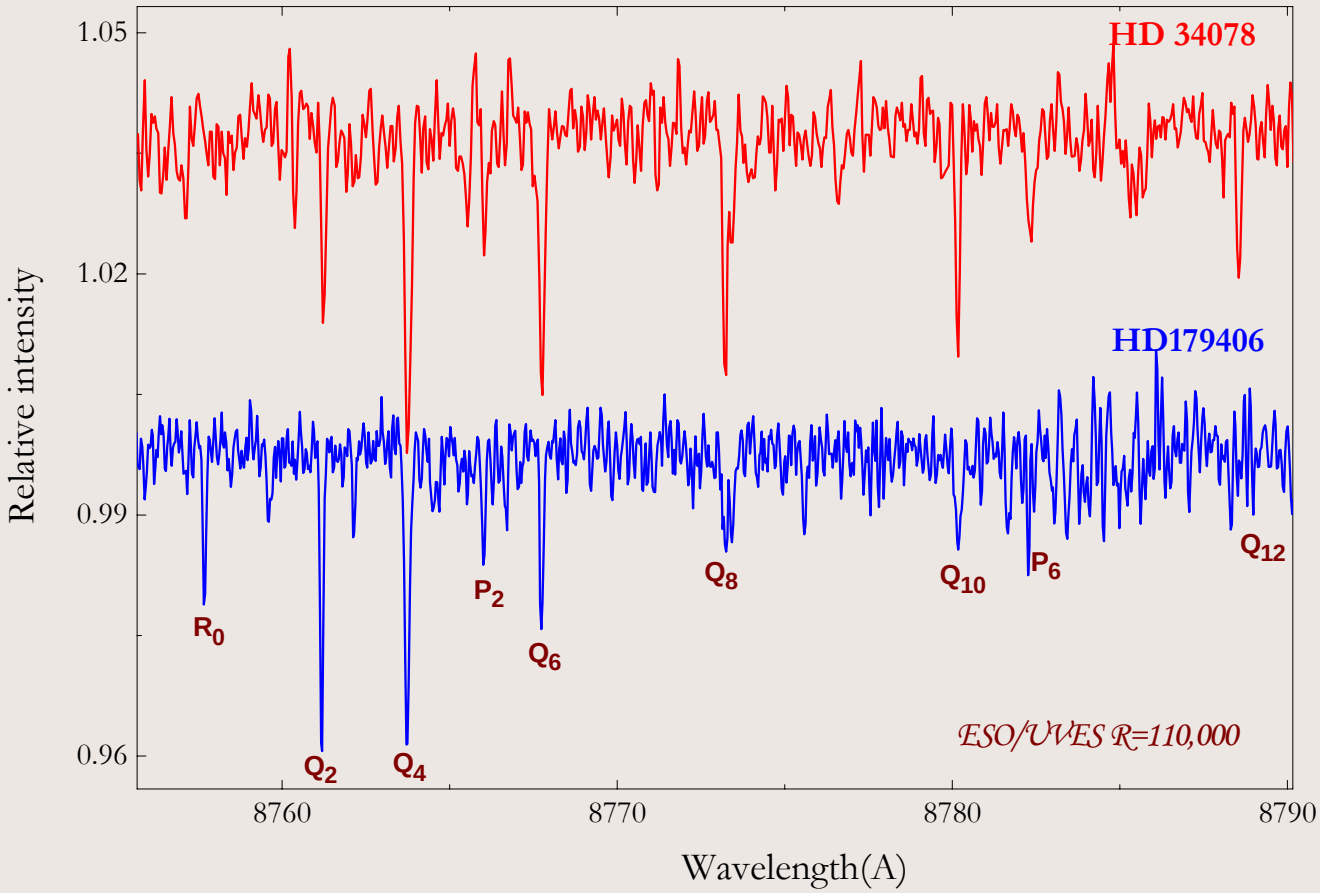
...as well as other blue DIBs...



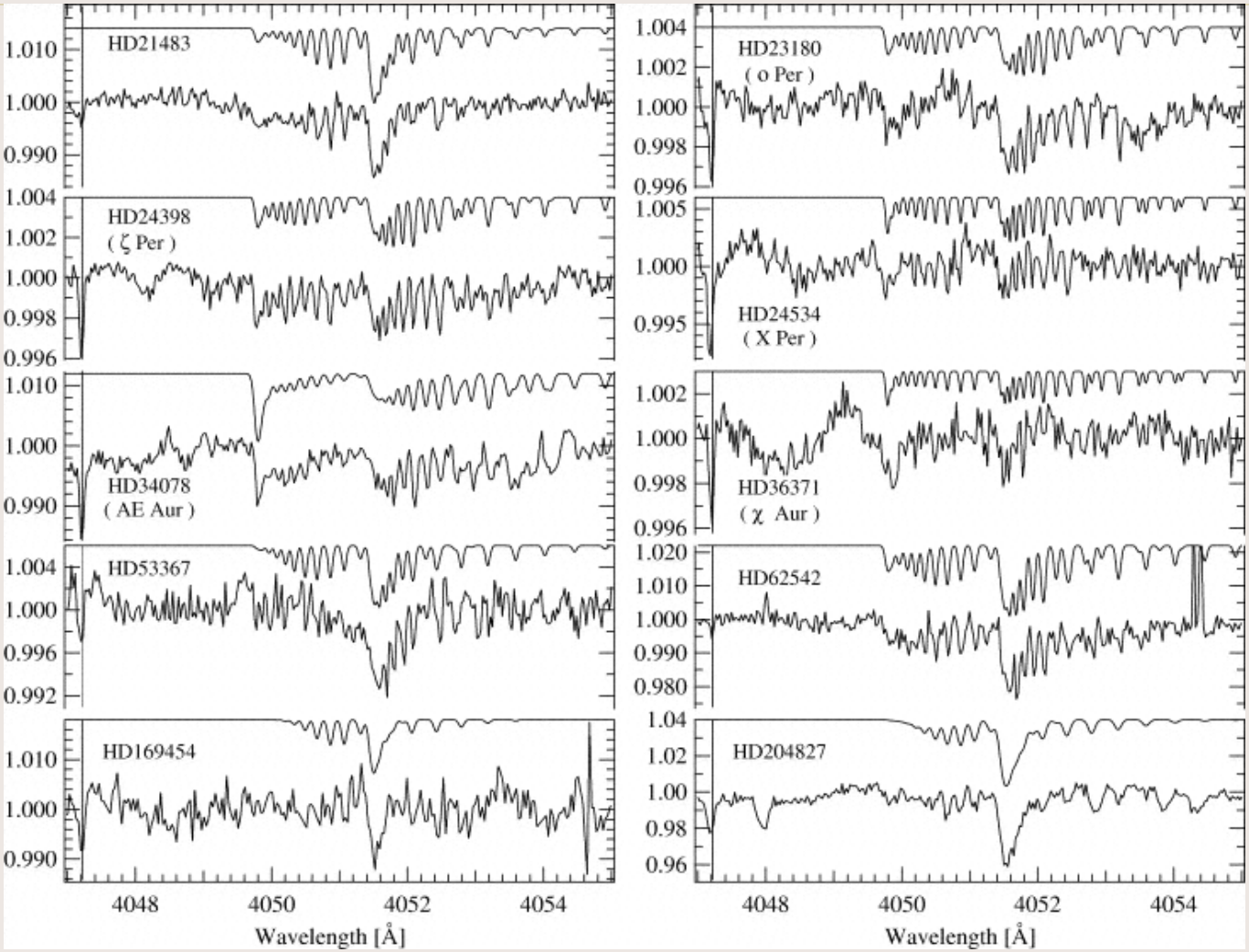
...including very broad 4430 as far as contaminating stelar lines permit to judge



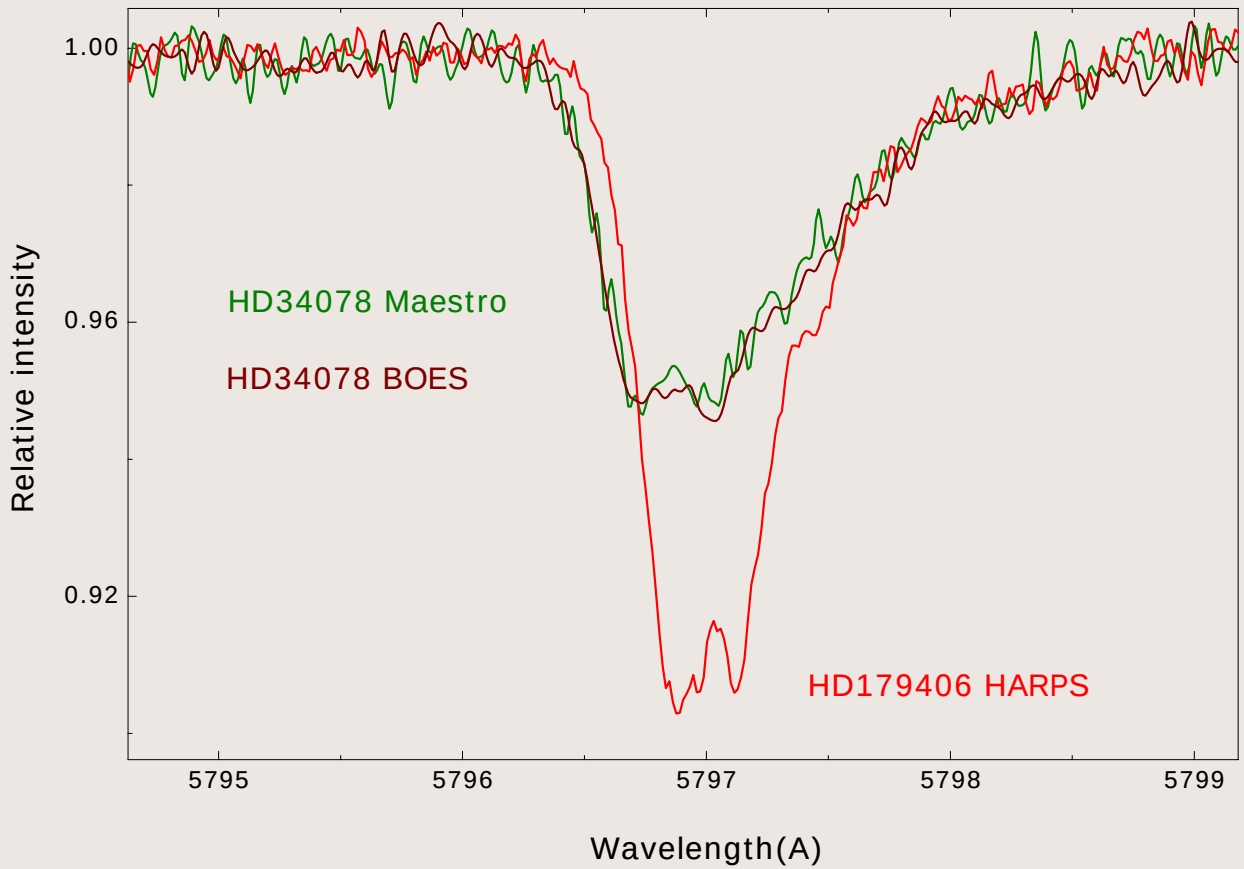
Extremely high rotational C_2 temperature toward AE Aur (BOES vs. UVES)



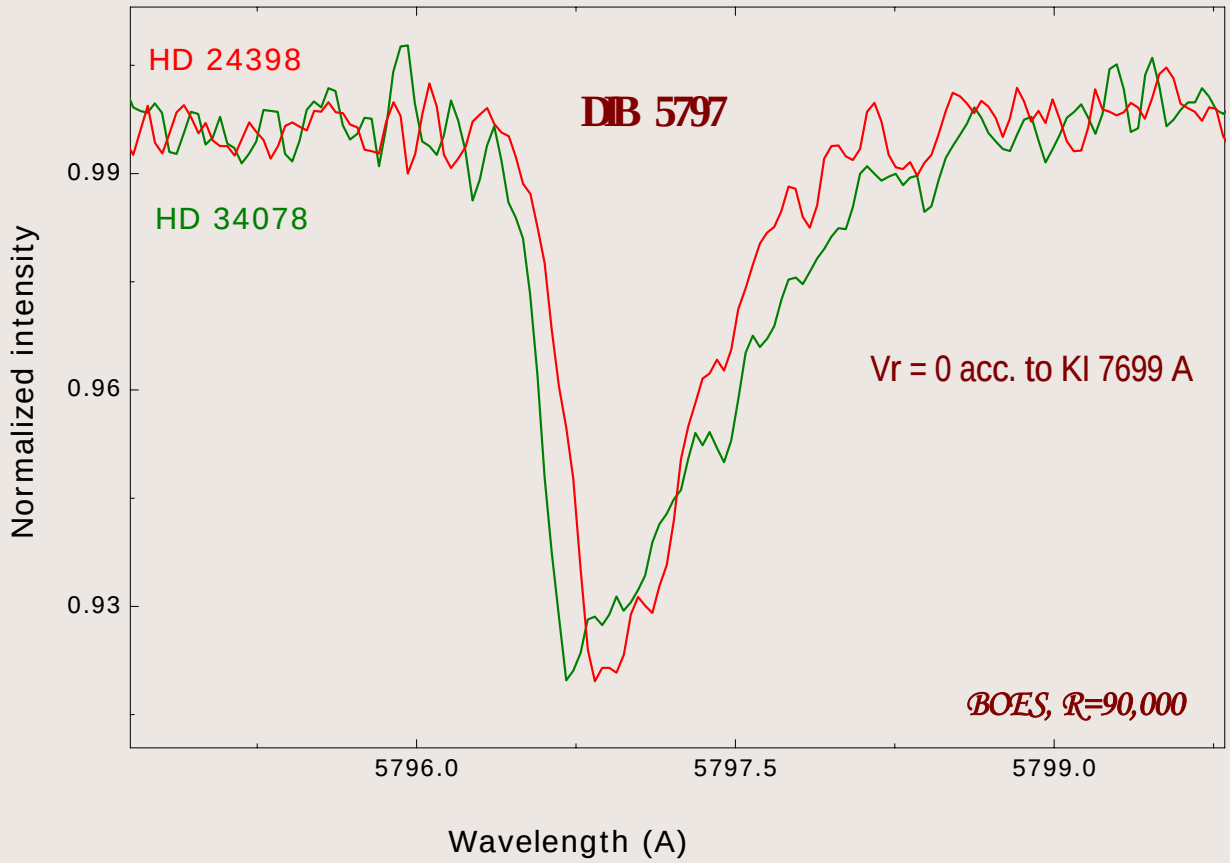
The same effects for C_3 (Adamkovics & al.. 2003)



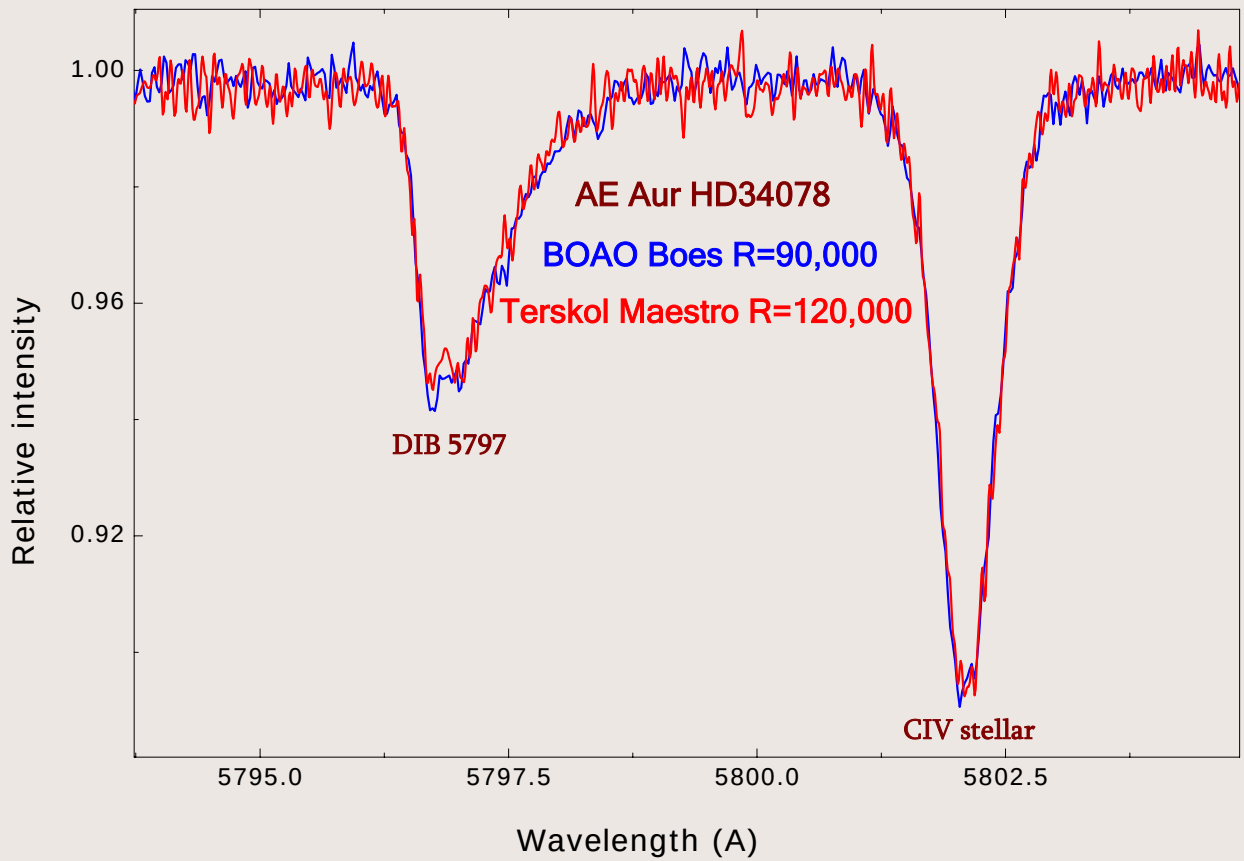
DIB 5797 blue-shifted and broadened in the spectrum of AE Aur



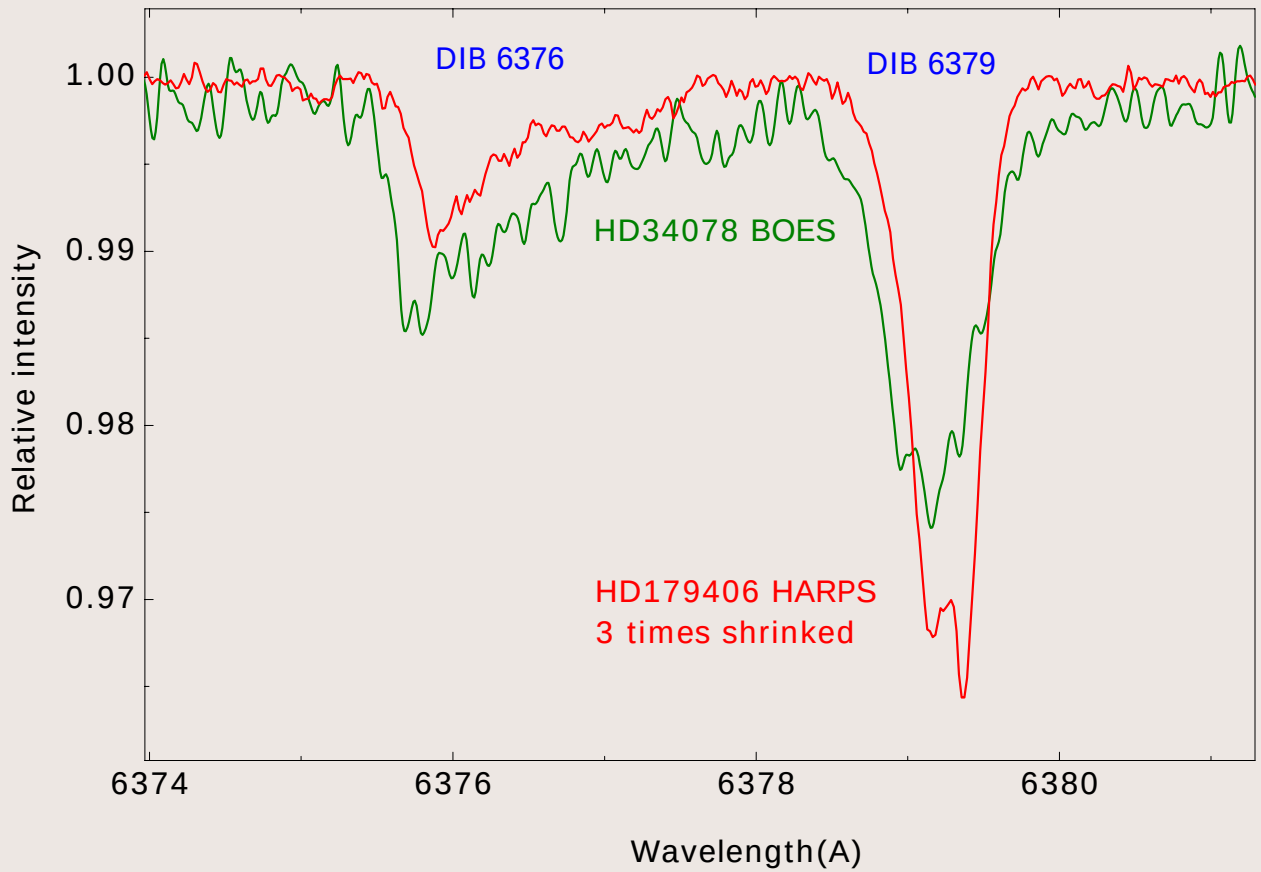
The same blue-shift confirmed by BOES spectrograph (ζPer vs. AE Aur).



Stellar and interstellar features identical in HD34078 spectra from two instruments



DIB 6379 in AE Aur is also blue-shifted and attenuated



Conclusions

- Rotational temperatures of simple, linear carbon species may be seriously different; a majority of cases fills a rather narrow range
- Profiles of some of the diffuse bands vary also with T_{rot} which may suggest their carriers are also **centrosymmentric** molecules