EXPERIMENTAL LINE SHAPE STUDY OF METHANE

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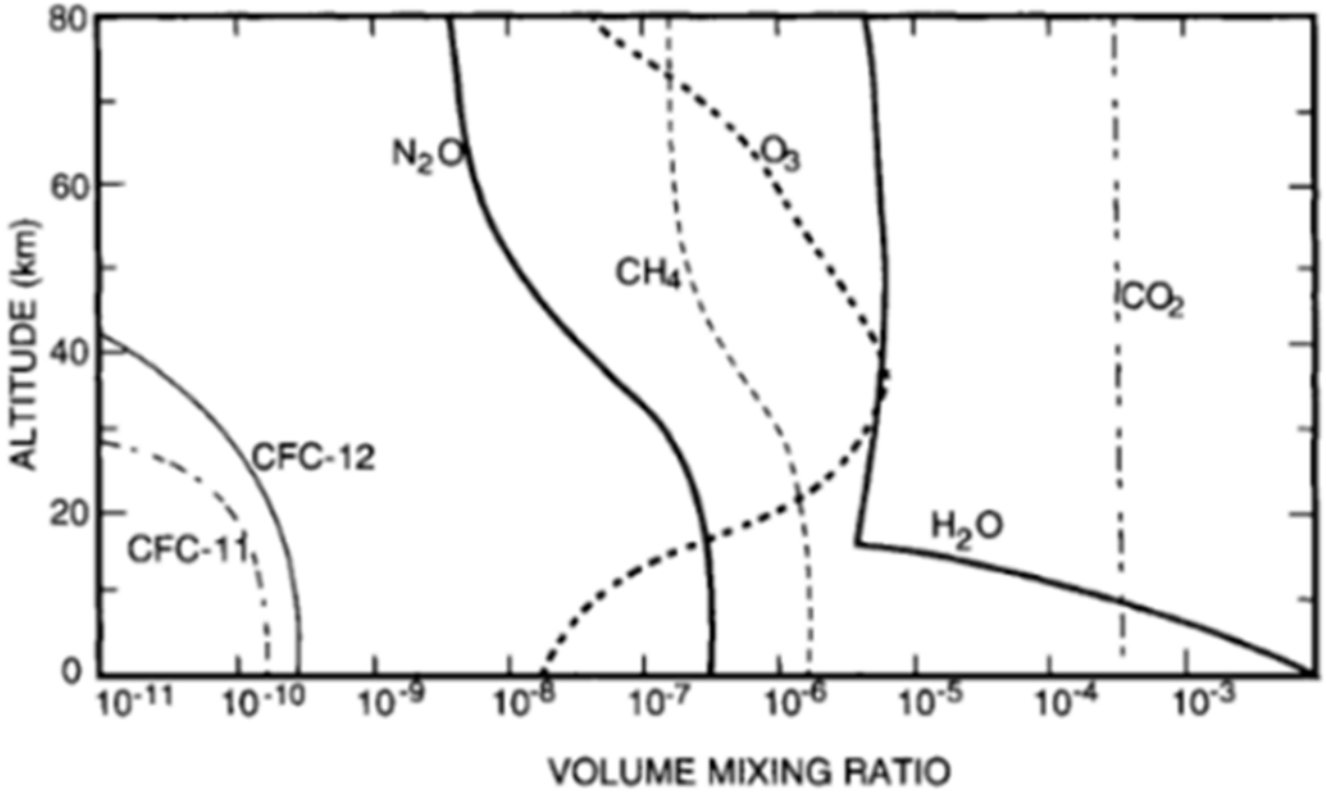
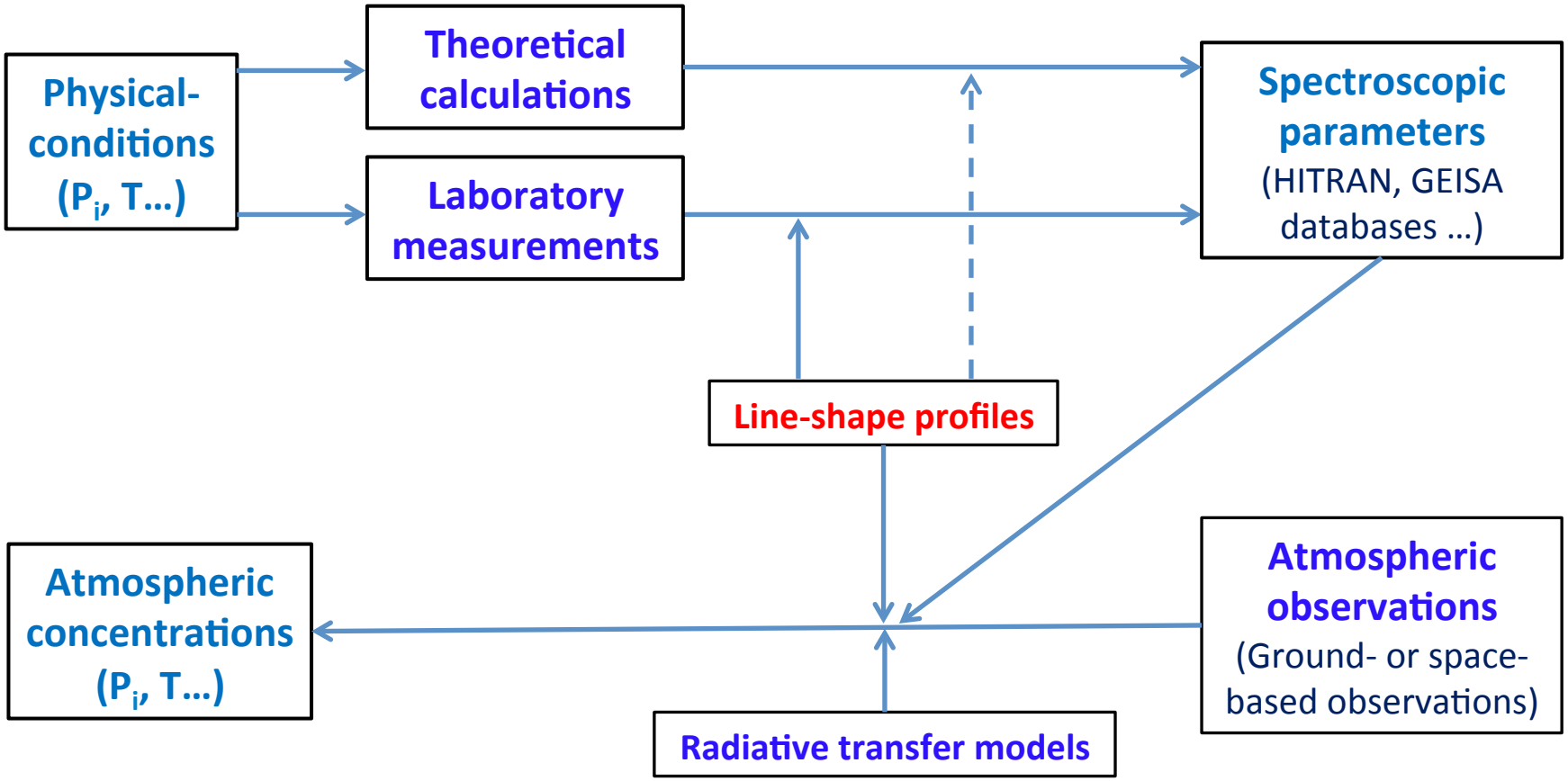
Motivations and subject of study



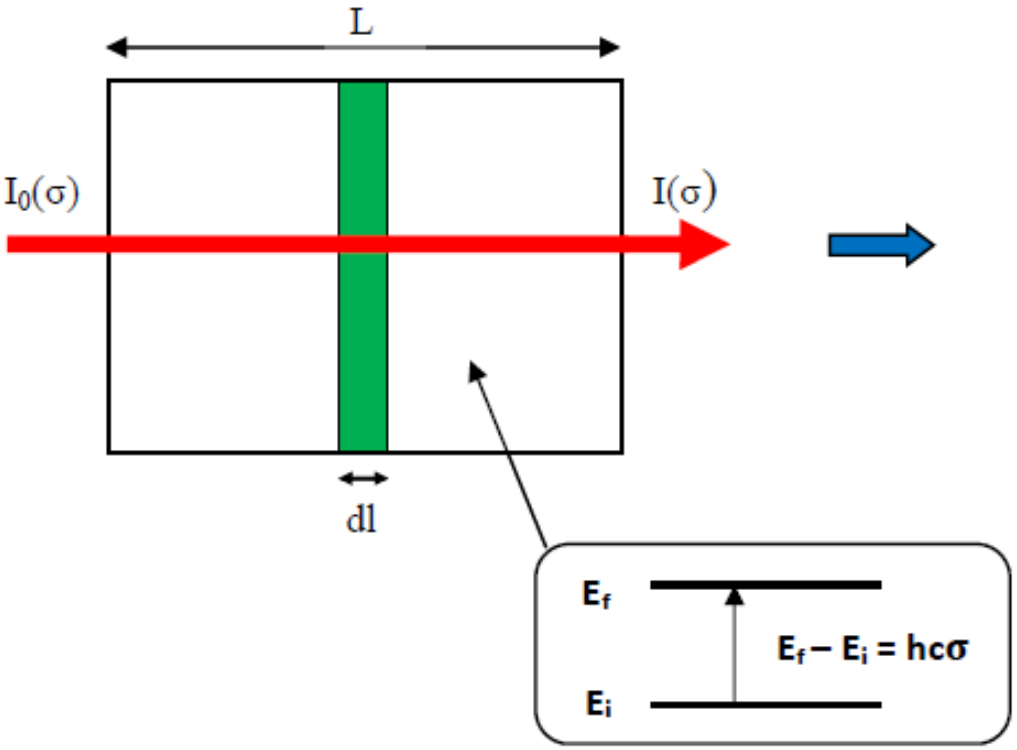
Salby Fig. 1.20 p33. Volume mixing ratios (proportion of total volume) of radiatively active trace species as functions of altitude. *Source:* Goody and Yung (1989).

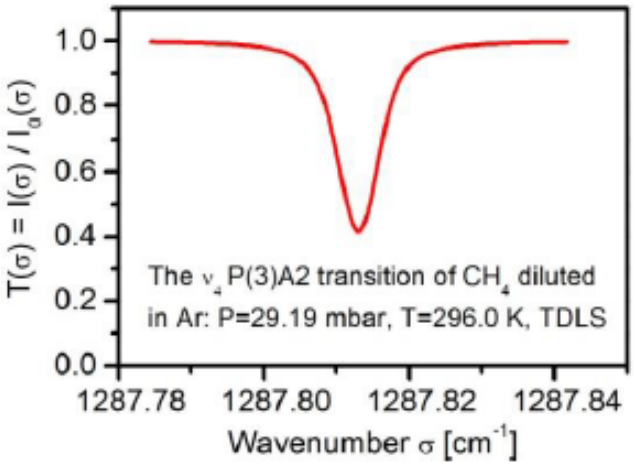
Motivations and subject of study



ISOLATED LINE SHAPE STUDY OF METHANE WITH VARIUS COLLISION PARTNERS

Radiative transfer in gas



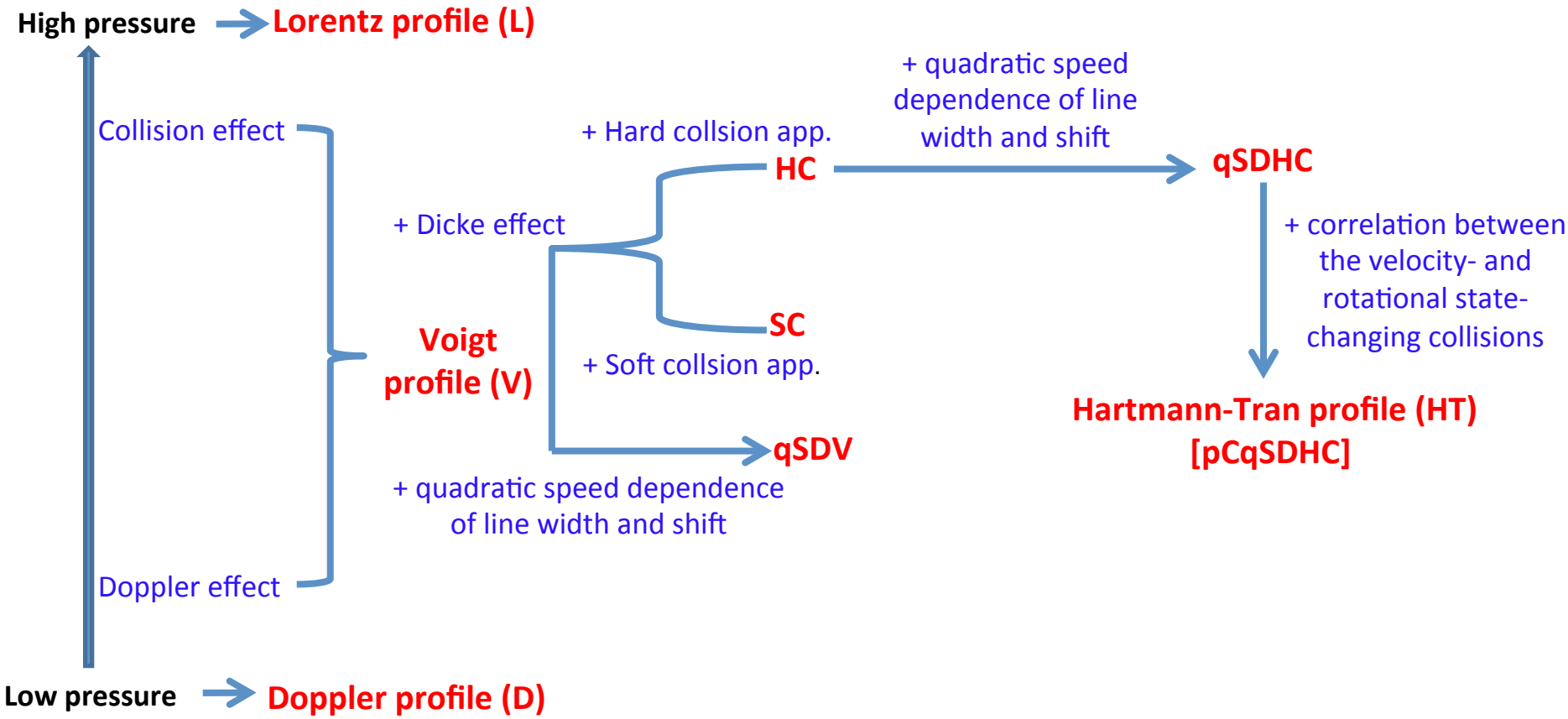


The line-shape profile

Beer-Lambert law: $T(\sigma)=I\downarrow t\ (\sigma)/I\downarrow 0\ (\sigma)=\exp[-\mathrm{A}(\sigma)]=\exp[-k(\sigma)L]$

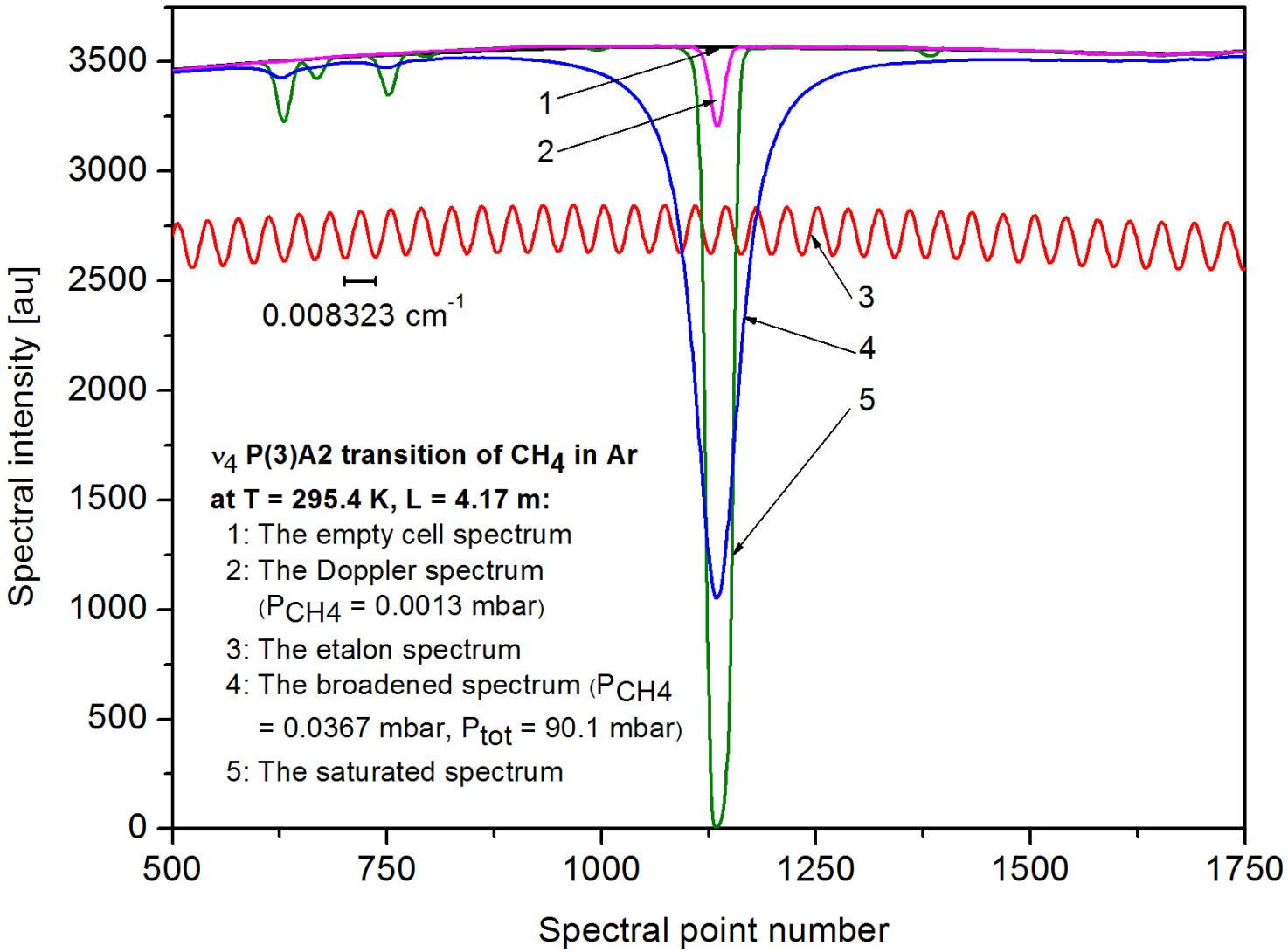
Line-shape models

Depending on the experimental conditions (P, T), molecules and spectral region, the measured spectrum can be modeled by different line-shape profile!



Tunable diode laser spectrometer at LLS, Namur

A typical set of recorded spectra



Experiments and Data analysis

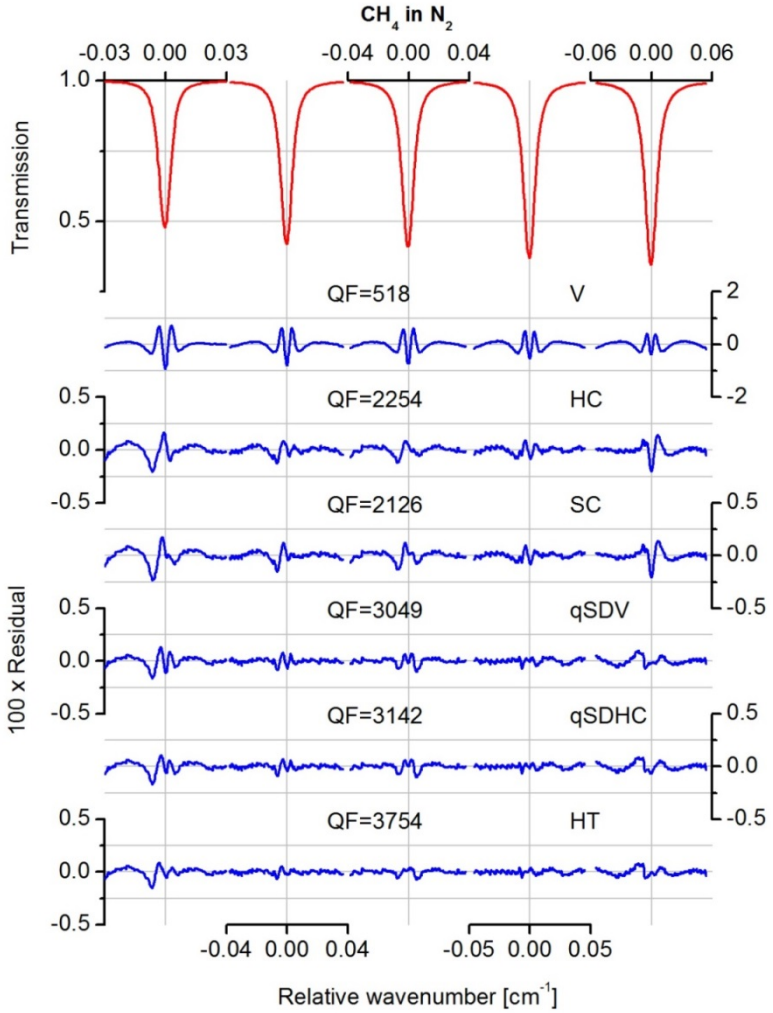
✓ **Experiments:**

- Using the tunable diode laser spectrometer in LLS, Namur
- CH_4 diluted in N_2, O_2, Ar, He
- Transition ν_4 P(3)A2, 1287.813279 cm^{-1}
- 5 different pressures (29.15 – 95.50 mbar)
- T= 296 ± 1 K

✓ **Analysis:**

- 6 line-shape models (V, HC, SC, qSDV, qSDHC, HT)
- Multi-spectrum fitting procedure
- Taking into account the instrumental distortions

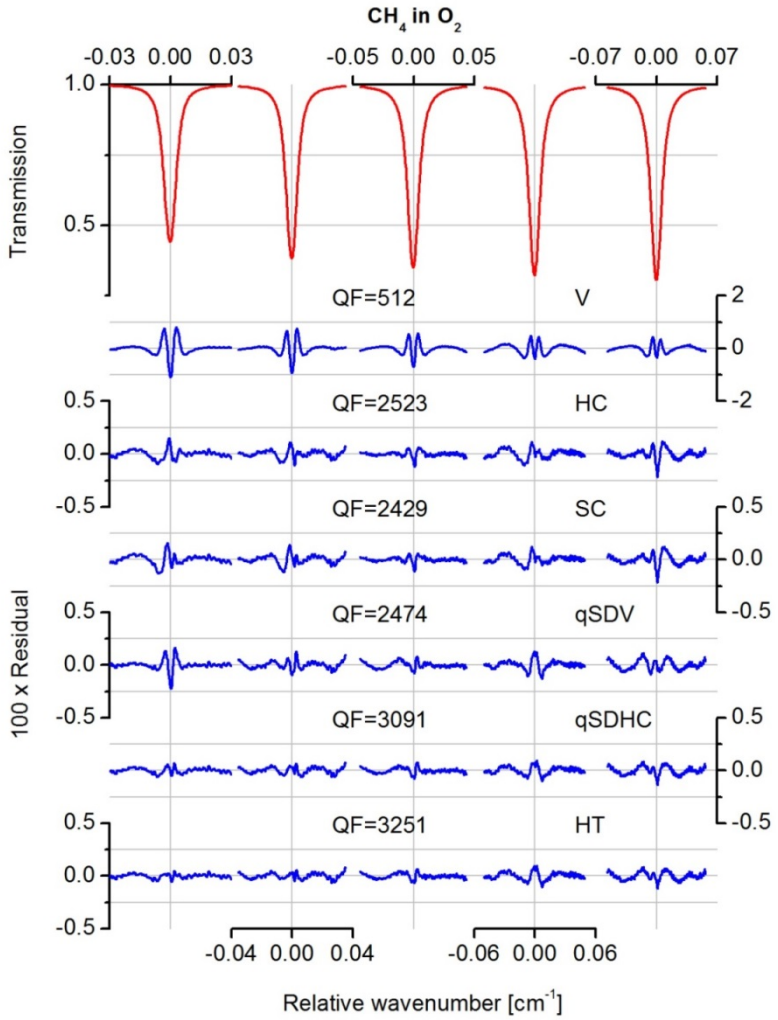
The measured spectra and the fit residuals of the ν_4 P(3) line of CH_4 in N_2



Note: $\mathrm{QF}=1/S\sqrt{R}$ with $S\sqrt{R}$ the standard deviation of the fit

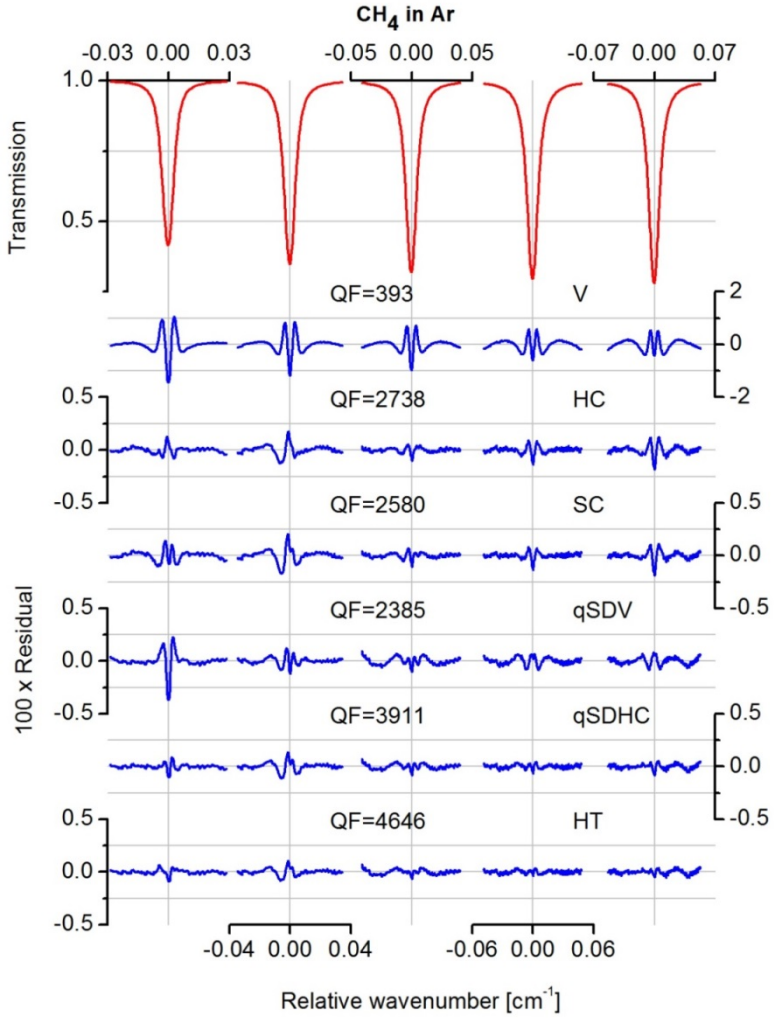
- **Voigt profile is only an approximate**
- **HT model leads to the best agreement with the measured profile**

The measured spectra and the fit residuals of the ν_4 P(3) line of CH_4 in O_2



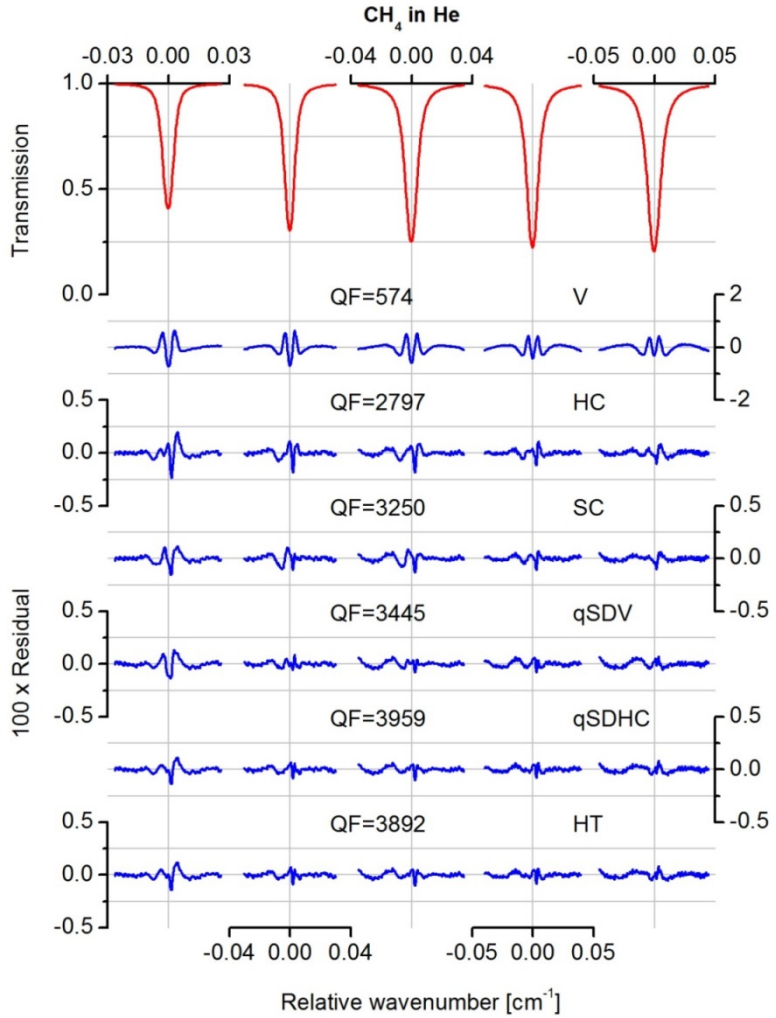
- **Voigt profile is only an approximate**
- **HT model leads to the best agreement with the measured profile**

The measured spectra and the fit residuals of the ν_4 P(3) line of CH_4 in Ar



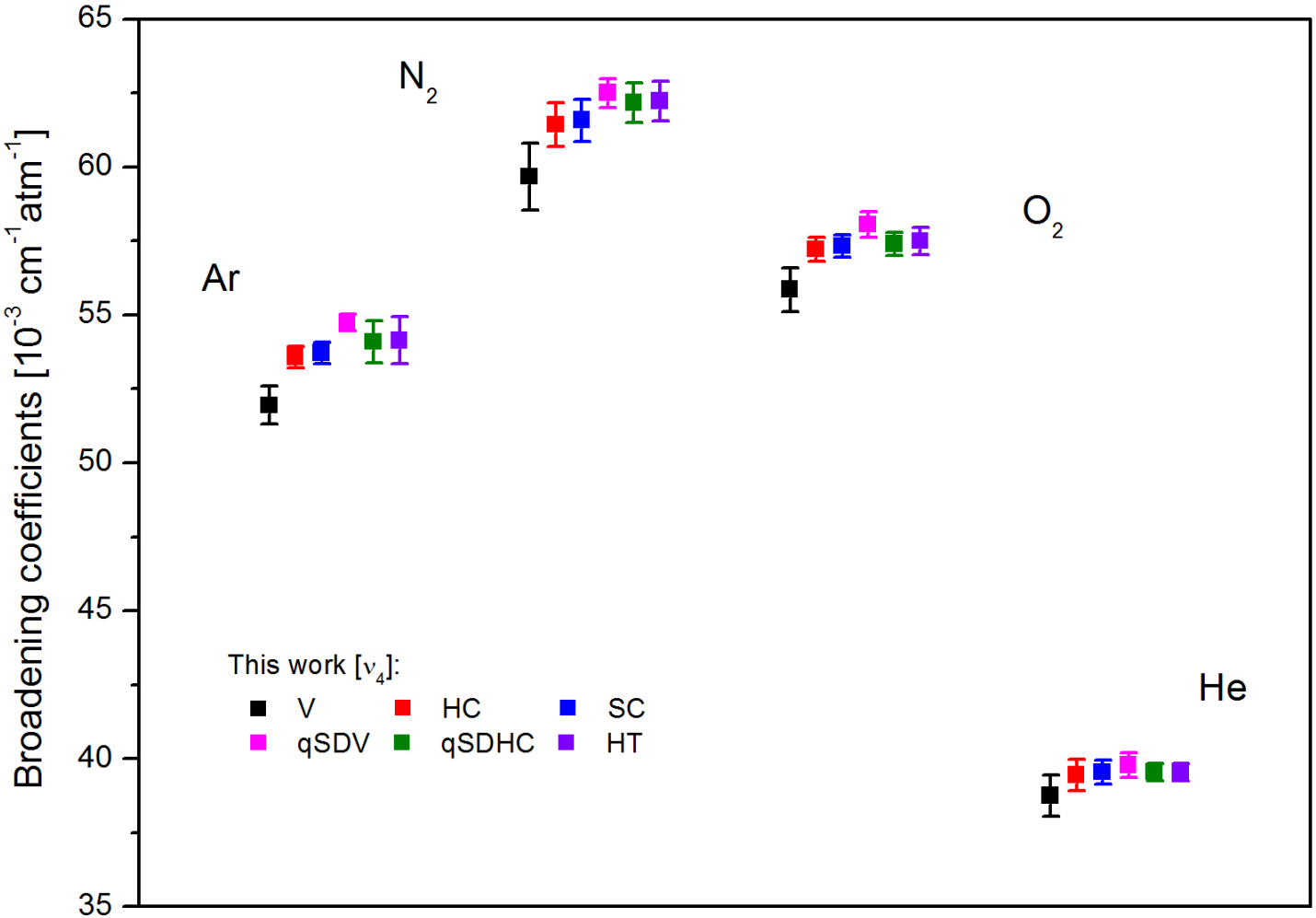
- **Voigt profile is only an approximate**
- **HT model leads to the best agreement with the measured profile**

The measured spectra and the fit residuals of the ν_4 P(3) line of CH_4 in He



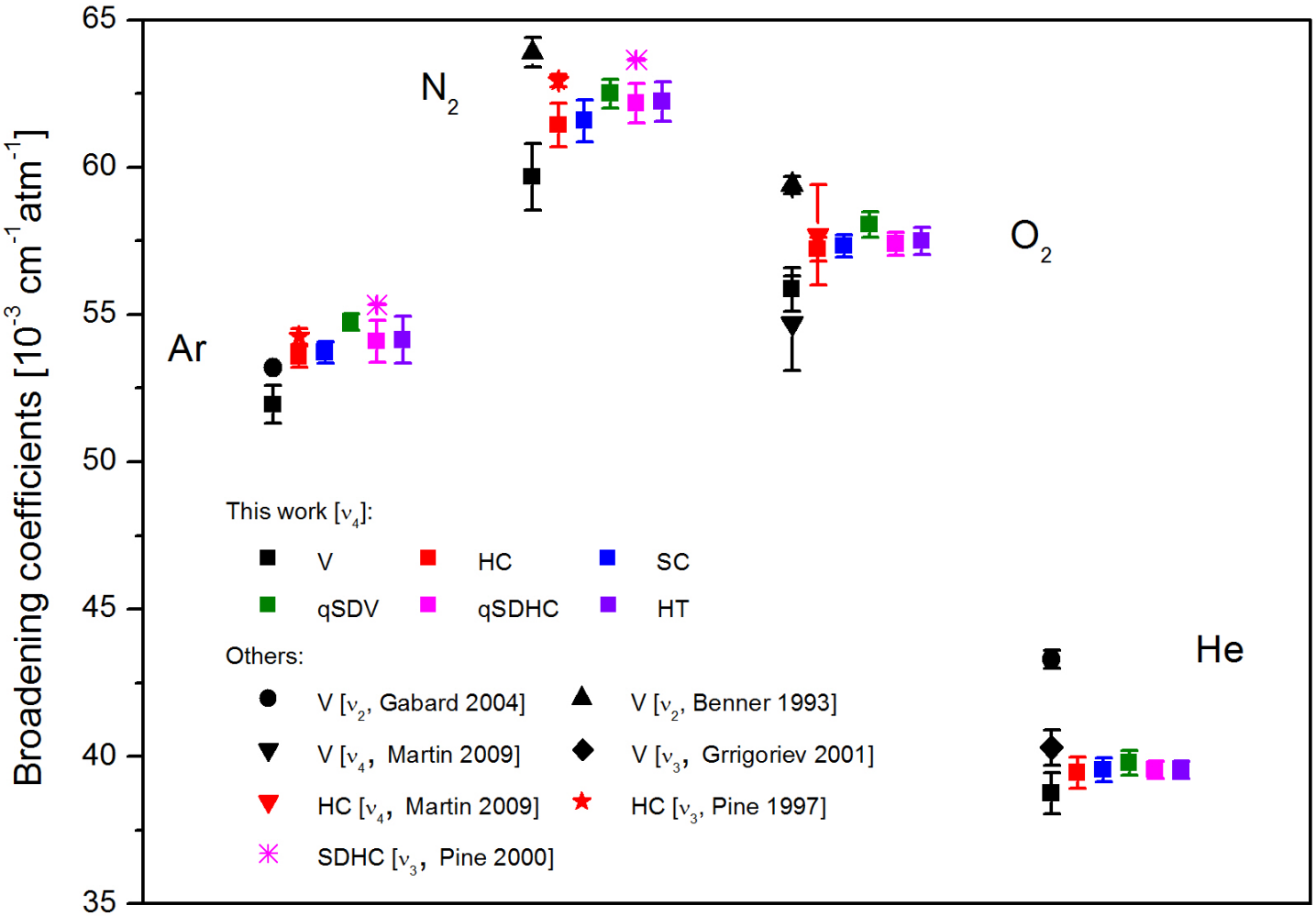
- **Voigt profile is only an approximate**
- **HT model leads to the best agreement with the measured profile**

Broadening coefficients of the considered transition of methane in different collision partners obtained from this work



➡ **The results obtained from fits with Voigt profiles are slightly smaller than those of other models**

Comparison between the broadening coefficients of this work and those of the other studies



The results of this work are in good agreement with those of the other studies

Conclusions

- Room temperature absorption spectra of the 2A11-3A21 line of the ν_4 band of methane diluted in Ar, N_2, O_2 and He have been measured and analysed for the first time

- For all considered perturbers, both the confinement narrowing and the speed dependences of the line broadening and shifting must be taken into account in order to correctly model the measured line profiles.

- Among the different considered line-shape models, the HT profile leads to the best agreement with the measured spectra for all considered perturbers.

Special thanks to…

CERUNA-
UNAMUR