Raman spectroscopy on methane, ethylene and propane flames

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Raman Spectroscopy on Methane, Ethylene and Propane Flames

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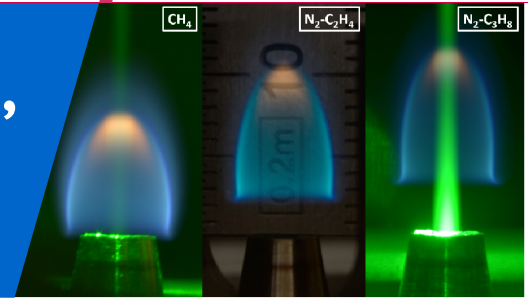
Background

- To understand "complicated" Raman spectra, known parts can be subtracted using spectral modeling
- Methane was used as a benchmark flame
- Diluted ethylene and propane flames were measured to validates the techniques application

Experimental Setup

- $\varnothing$4 mm fuel tube, $\varnothing$50 mm uniform coflow
- 3 frames x 1 million gates x 200 ns exposure
- OD4 notch filter to block Rayleigh scattering
- Spectral resolution of 0.195 nm (FWHM)
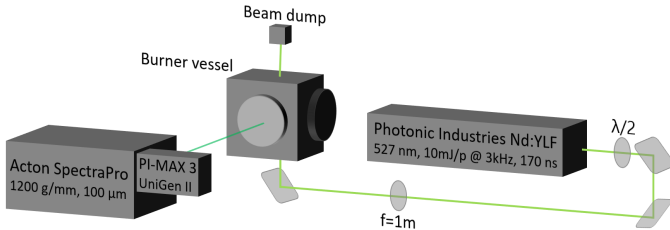
Approach

- N_2, O_2, H_2O, CO, and H_2 spectra were modeled
- Least square fitting of the models to measured spectra for obtaining temperature and molar fractions
- Calibration using pure gases at room temperature
- Accuracy is determined by creating artificial datasets (Monte Carlo method, see figure 1)
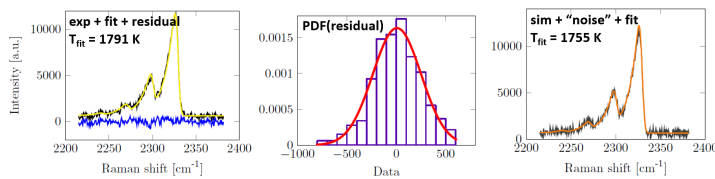- Interference in CO_2 spectra is removed by fitting clean spectra measured in a doped H_2 flame

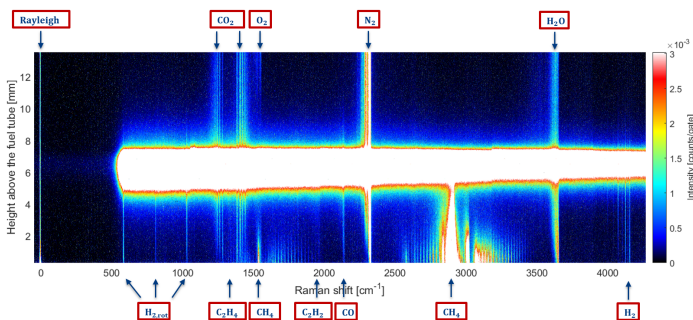*Figure 1: Example of an artificially created nitrogen Raman spectrum (right)*

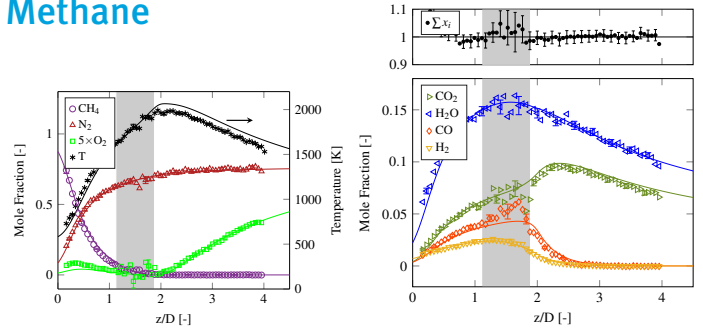*Figure 2: Raman spectra of the methane flame*

Methane

Figure 3: Temperature and molar fractions of the methane flame. Solid lines represent numerical results. The gray area is the region of strong background, possibly due to PAH-LIF
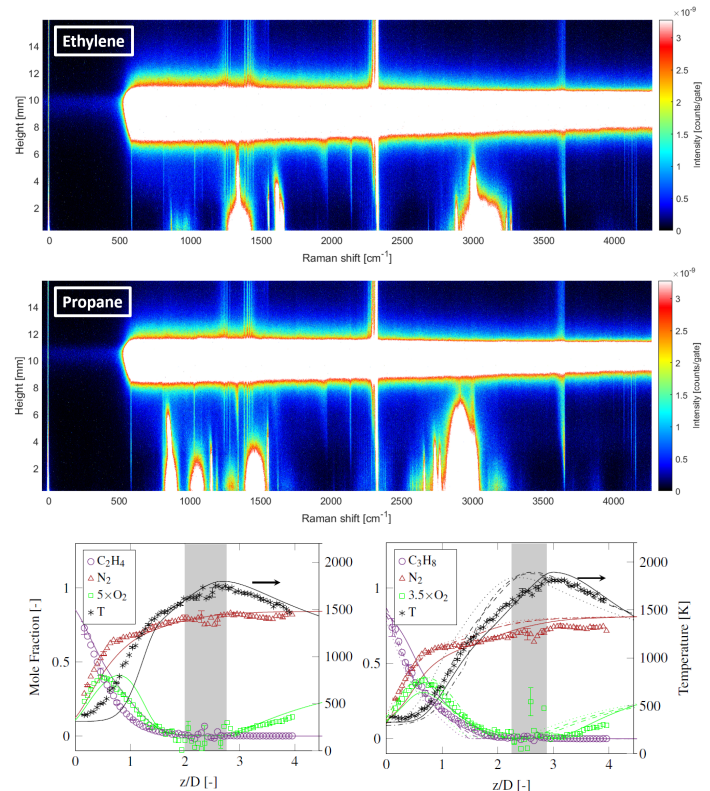
Diluted Ethylene, and Propane

Figure 4: Top two figures show the spectra, while bottom left (ethylene) and right (propane) show temperature and molar fractions of the two flames

Conclusions

- Quantitative data is obtained from 3 different flames
- Uncertainties of below 40 K and 10% in molar fractions
- Good agreement between experiments and simulations