Development of an Infrared Multi-Mode Absorption Spectrometer (MuMAS)

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MuMAS Measurements

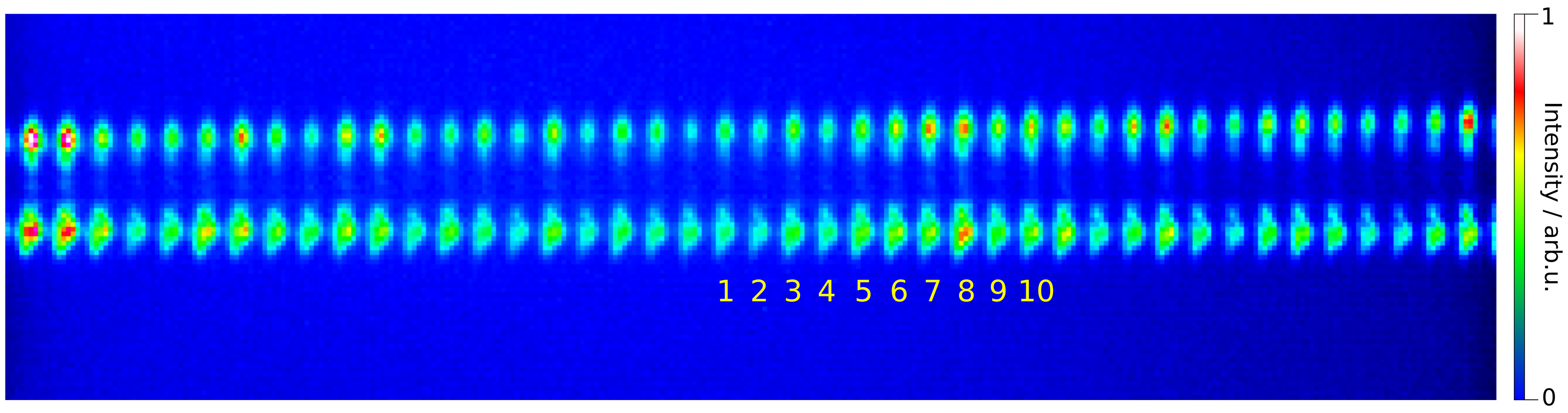

Figure 1: Laser modes detected by an infrared detector array. (a) absoprtion signal (b) calibration signal. Integers indicate the number of modes (see also Figure 5). Intensity calibration is done via (a-b)/(a+b) for each laser mode.

Experimental Conditions

- Laser modes are seperated by reflection grating with 150 lines/mm
- Sample: N_2O
- Absorption length: 20 cm
- Pressure: ~ 2 mbar
- Temperature: ~ 20 °C
- Vib. Transition: $(0,0^0,0) \leftarrow (0,2^0,0)$

Introduction

The multi-mode absorption spectroscopy [1-3] method allows to access new broadband laser sources. Especially the finger-print-region from 2 to 12 microns is of great interest since many rovibrational transitions of astrophysically relevant molecules (e.g. carbon-chains and silicon carbides) can be detected in this region. In addition, this method allows to scan different frequencies simultaneously.

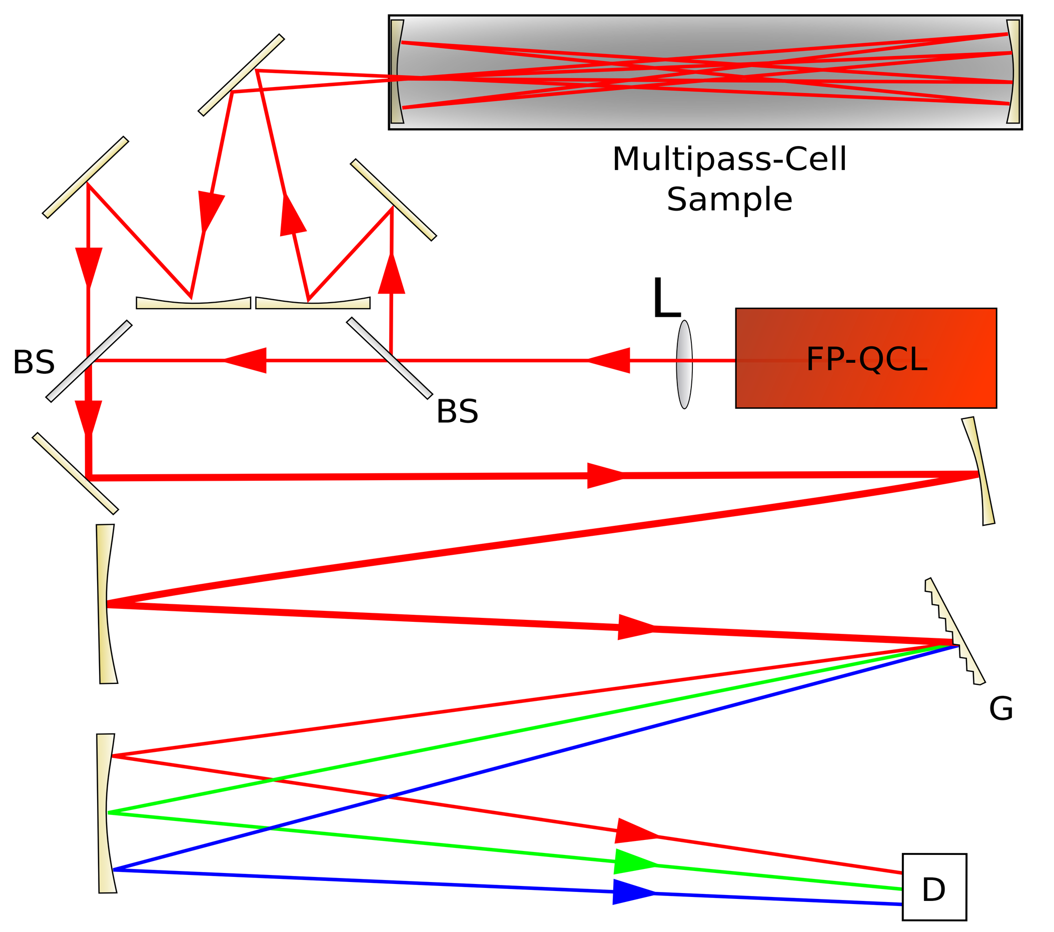

Figure 2: Experimental Setup for multi-mode absoprtion spectroscopy. BS: Beamsplitter, L: Lense, G: Grating, D: Array-Detector

Frequency Calibration

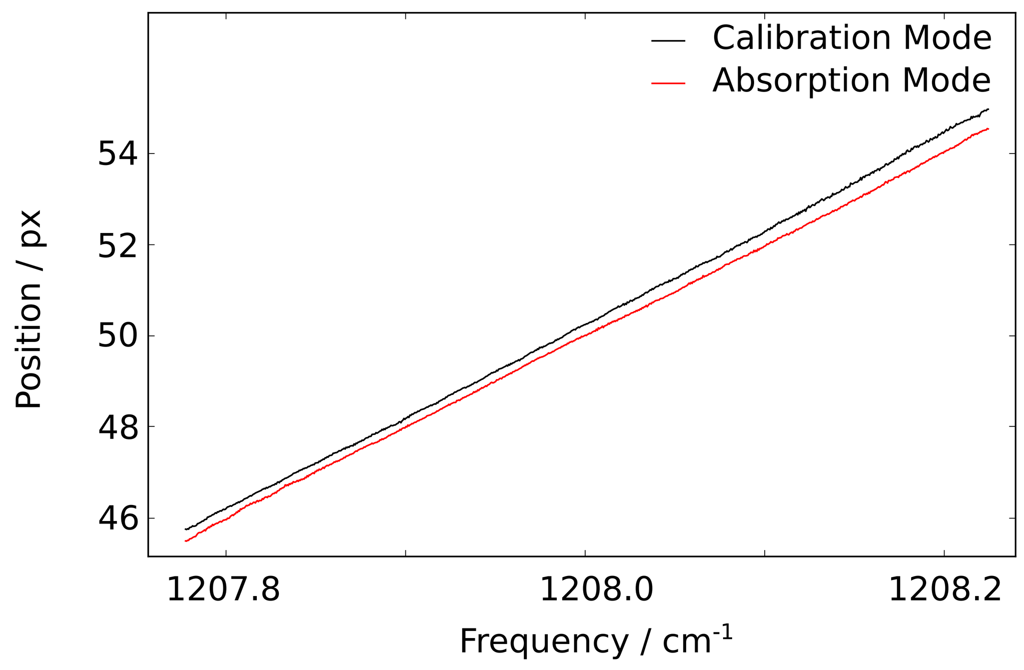

Figure 3: Measured spot position of a single mode as function of laser frequency used for calibration purposes.

Fabry-Perot Quantum Cascade Laser (FP-QCL)

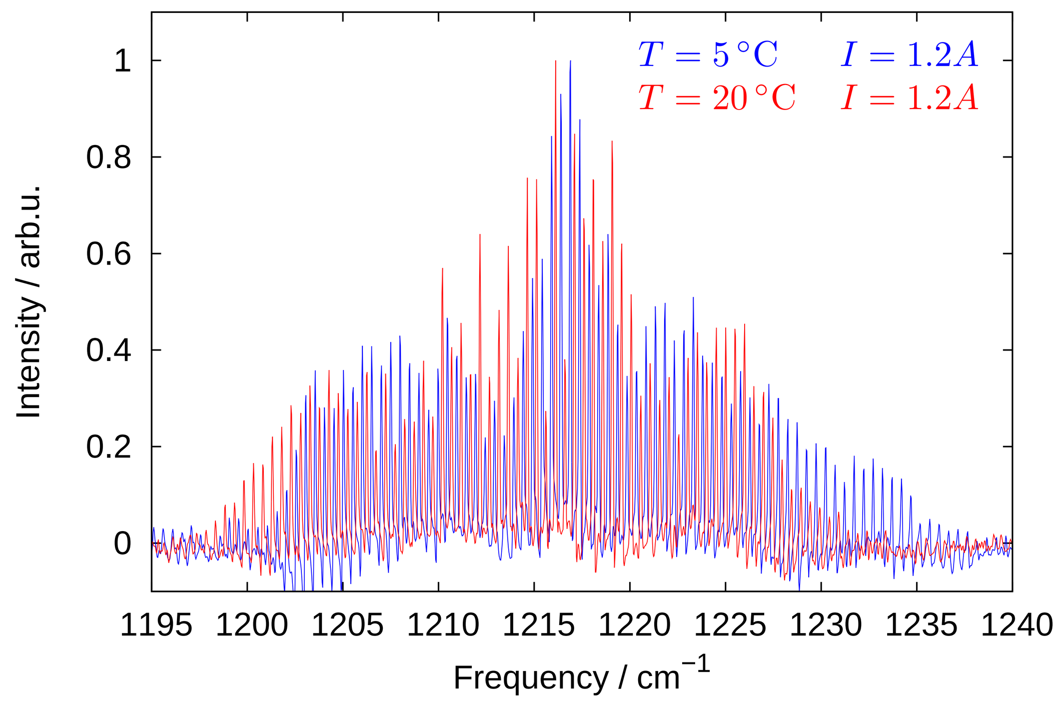

Figure 4: Multi-mode spectrum of the FP-QCL at different temperatures measured with a FT-Spectromter. The mode distance is approx. 0.5 cm^{-1}.

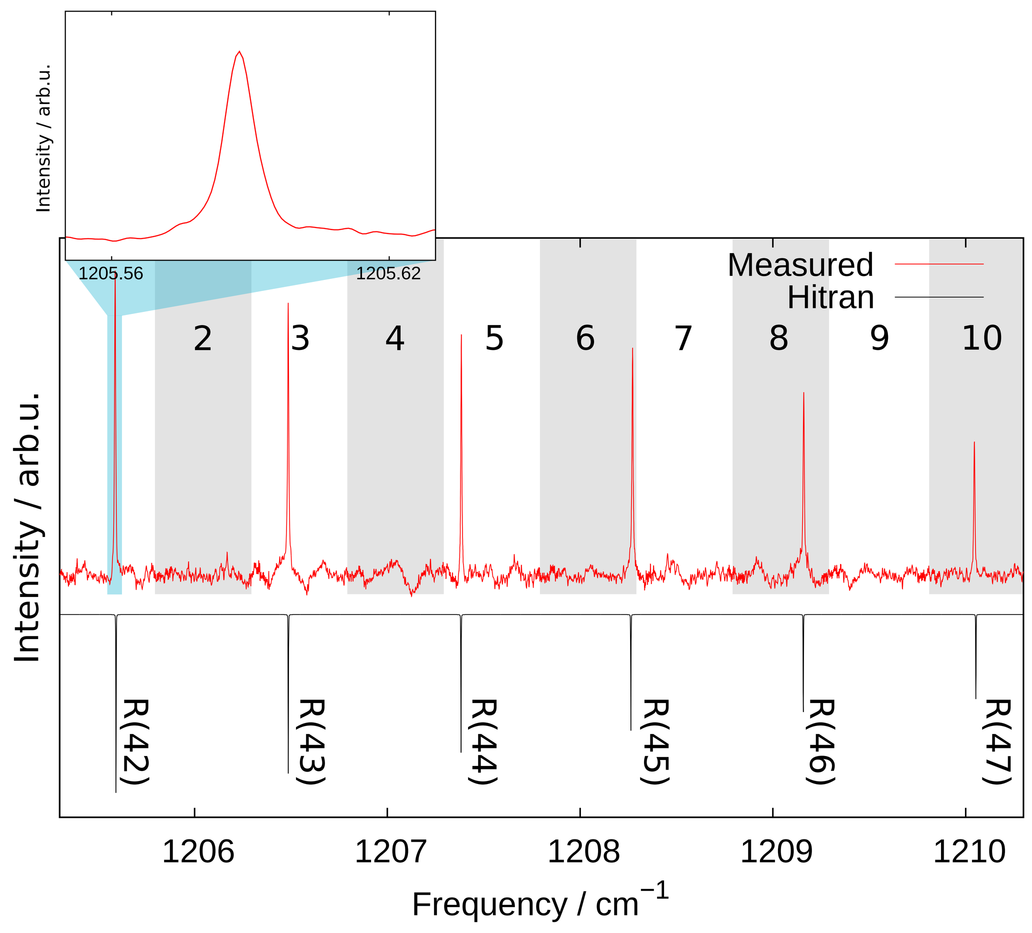

Figure 5: Measured spectrum of N_2O. The grey and white hatched numbered areas indicate spectra from different laser modes. The inlay shows a typical absorption line.

Experimental Results

- Exp. Accuracy: $5.4 \cdot 10^{-3}$ cm^{-1}
- N_2O line width: $3.4 \cdot 10^{-3}$ cm^{-1}

Molecular Parameters of N_2O

	Experiment	Literature [4]
ν_0	1167.10(10)	1167.0
B'	0.42080(10)	0.41948
D'	$4.57(23) \cdot 10^{-7}$	$1.64 \cdot 10^{-7}$
B''		0.41901
D''		$1.76 \cdot 10^{-7}$

All numbers in cm^{-1}

High Repetition Valve

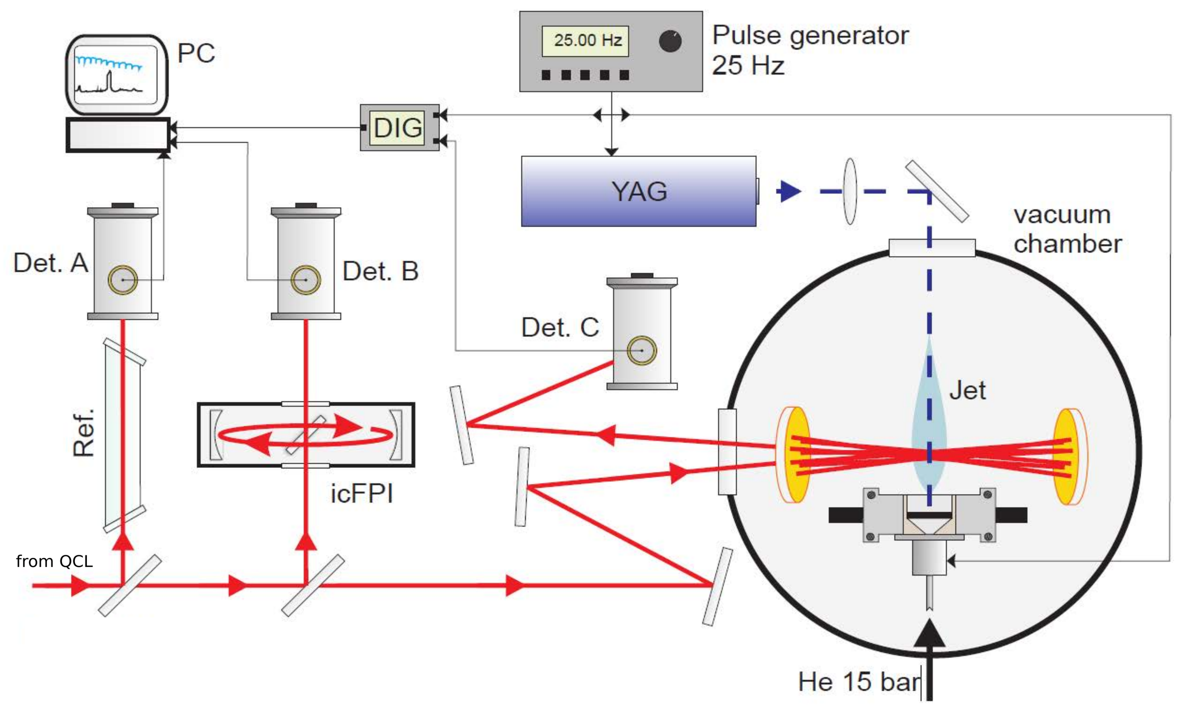

Figure 6: Cassel Carbon Cluster (CCC) Experiment

Current laser ablation spectroscopy suffers low duty cycles (20 to 30 Hz repetion rate). Using fast valves enables higher duty cycle and better signal to noise ratios.

Even-Lavie Vavle Properties [5]

- High repetition rate: 500 Hz
- Short pulses: 30-50 µs
- High pressure: up to 120bar

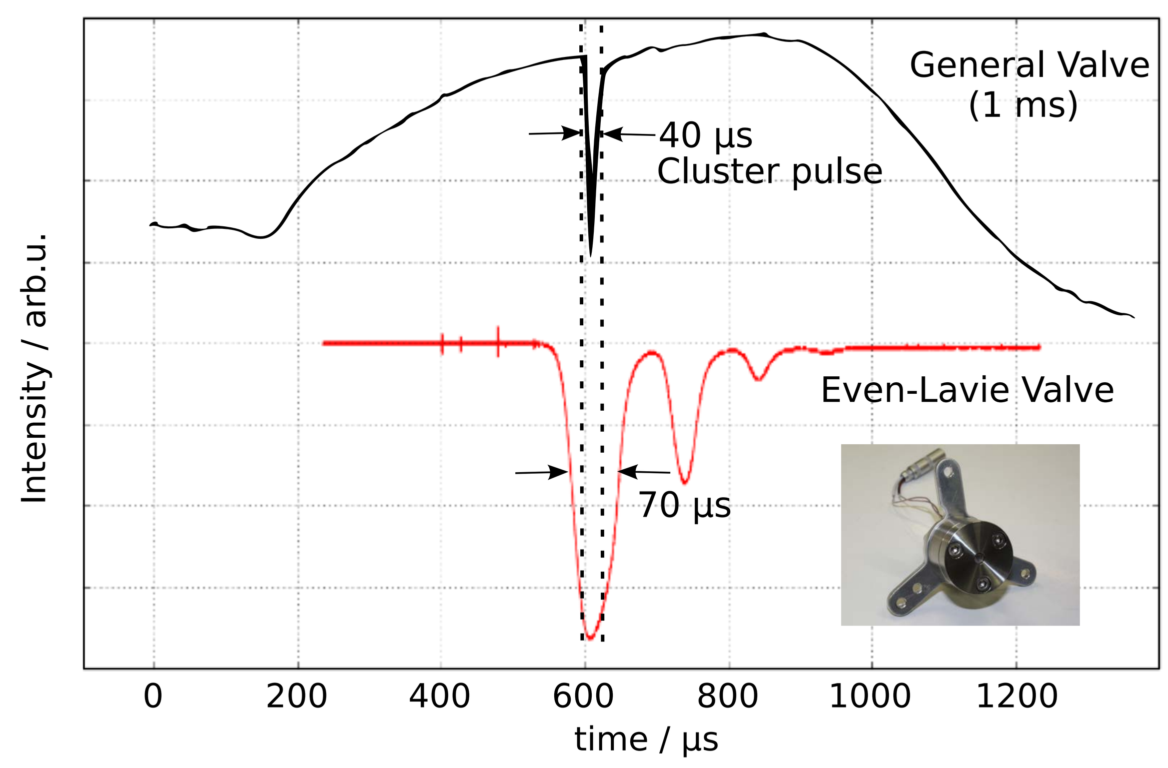

Figure 7: Measured opening time of EL-Valve measured by an ion preassure gauge (by Dirk Schwarzer) compared to General Valve. The inlay shows a picture of the Even-Lavie-Valve

References

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https://sites.google.com/site/evenlavievalve/home

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