Measuring the Fraction of CO2 in Air with Fourier Transform Infrared Spectroscopy

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Objectives

1. To measure the fraction of CO2 in air

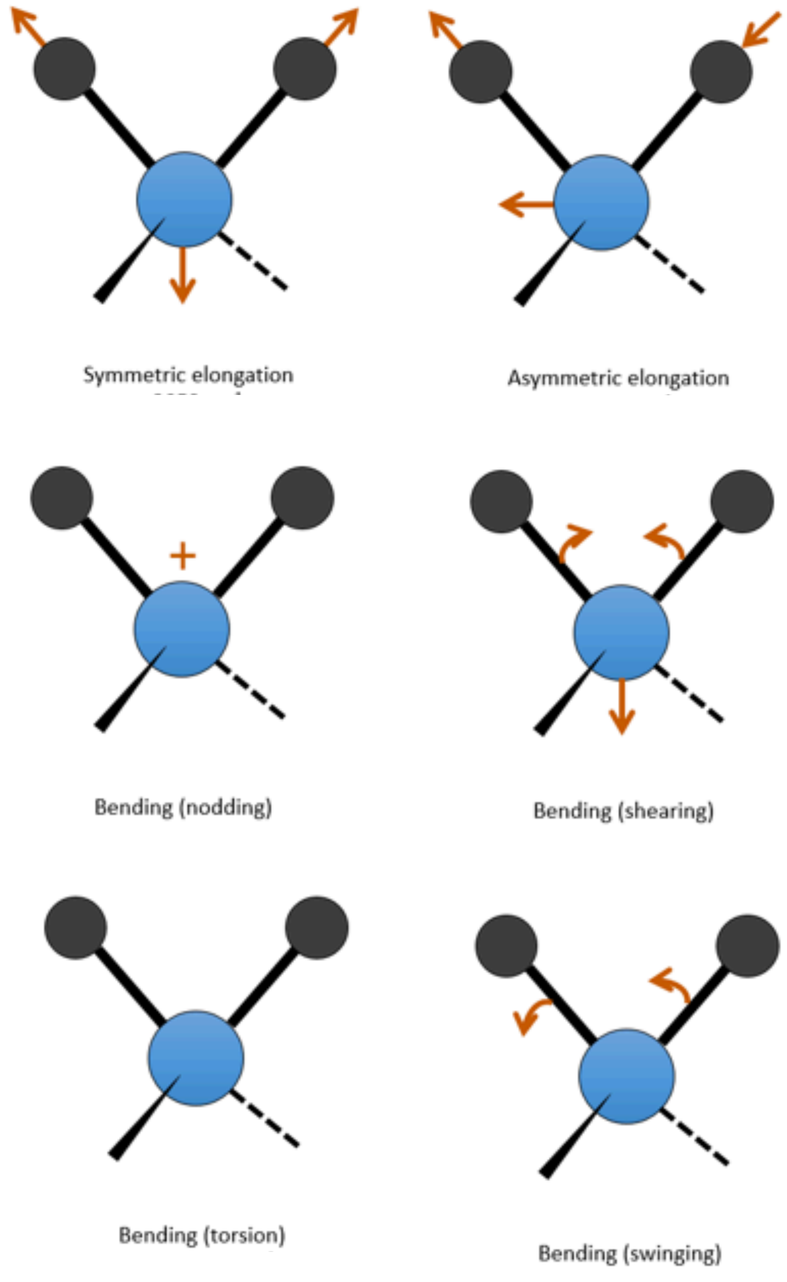
2. To measure and understand the absorption spectra of several gases

Theory

In the mid-infrared region of the electromagnetic spectrum, molecules absorb light through the interaction between the photons and the vibrating electric dipoles of the molecule.

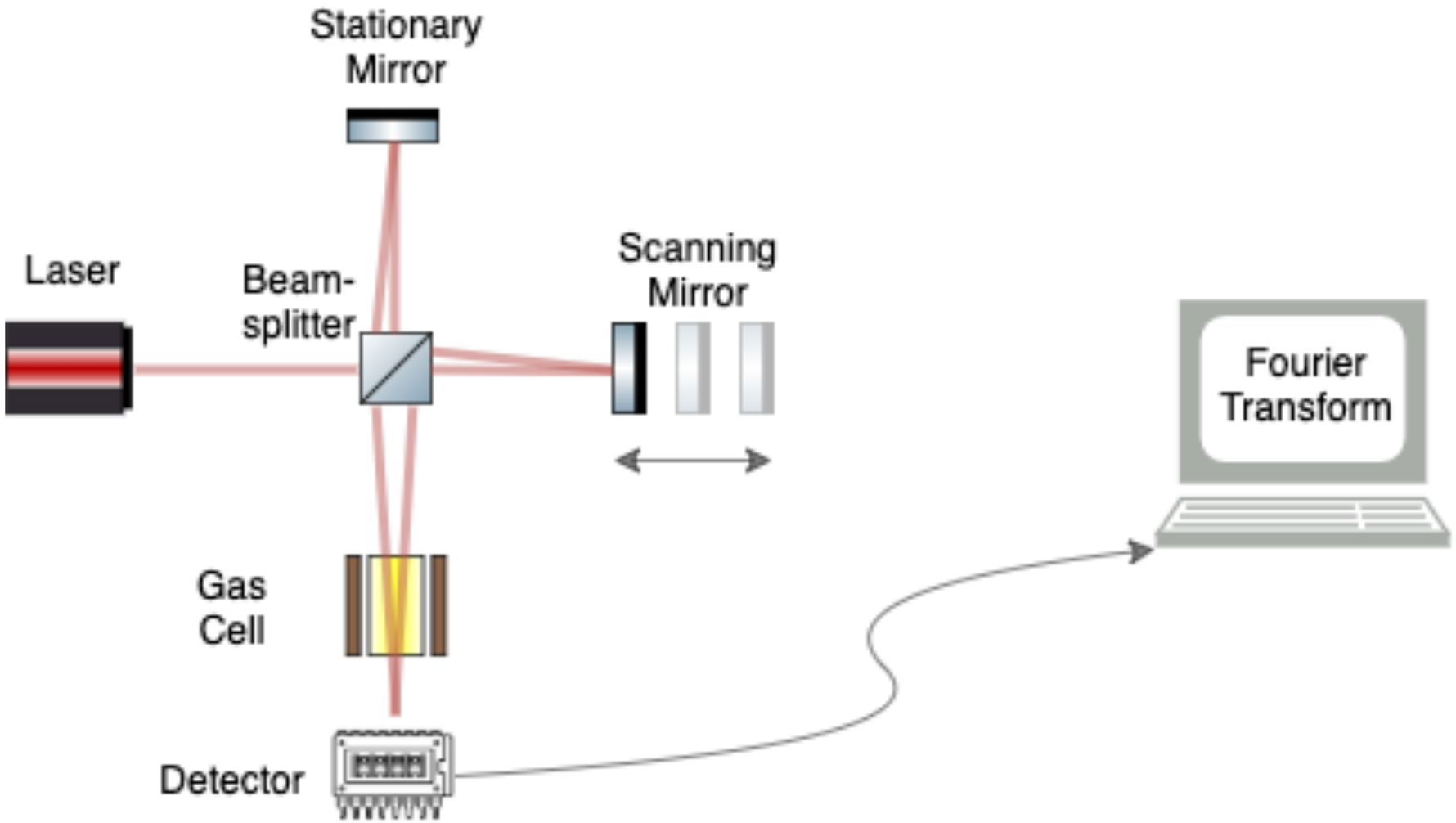
In FTIR, a beam carrying many frequencies irradiates a sample. We measure how much of that beam is absorbed and transmitted by the sample.

With the transmission and absorbance spectra, we can **identify** the molecules in the sample.



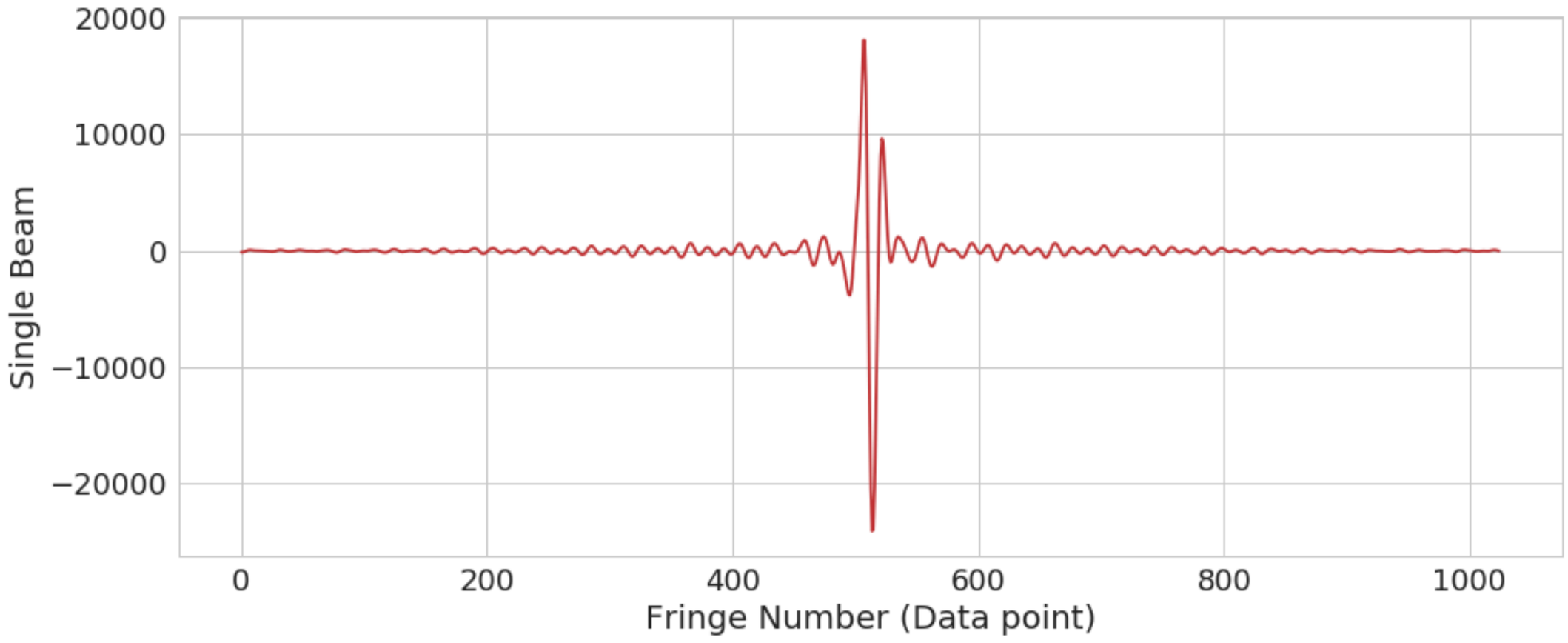
Vibrational modes of molecules
http://brussels-scientific.com/?p=5975

General Setup



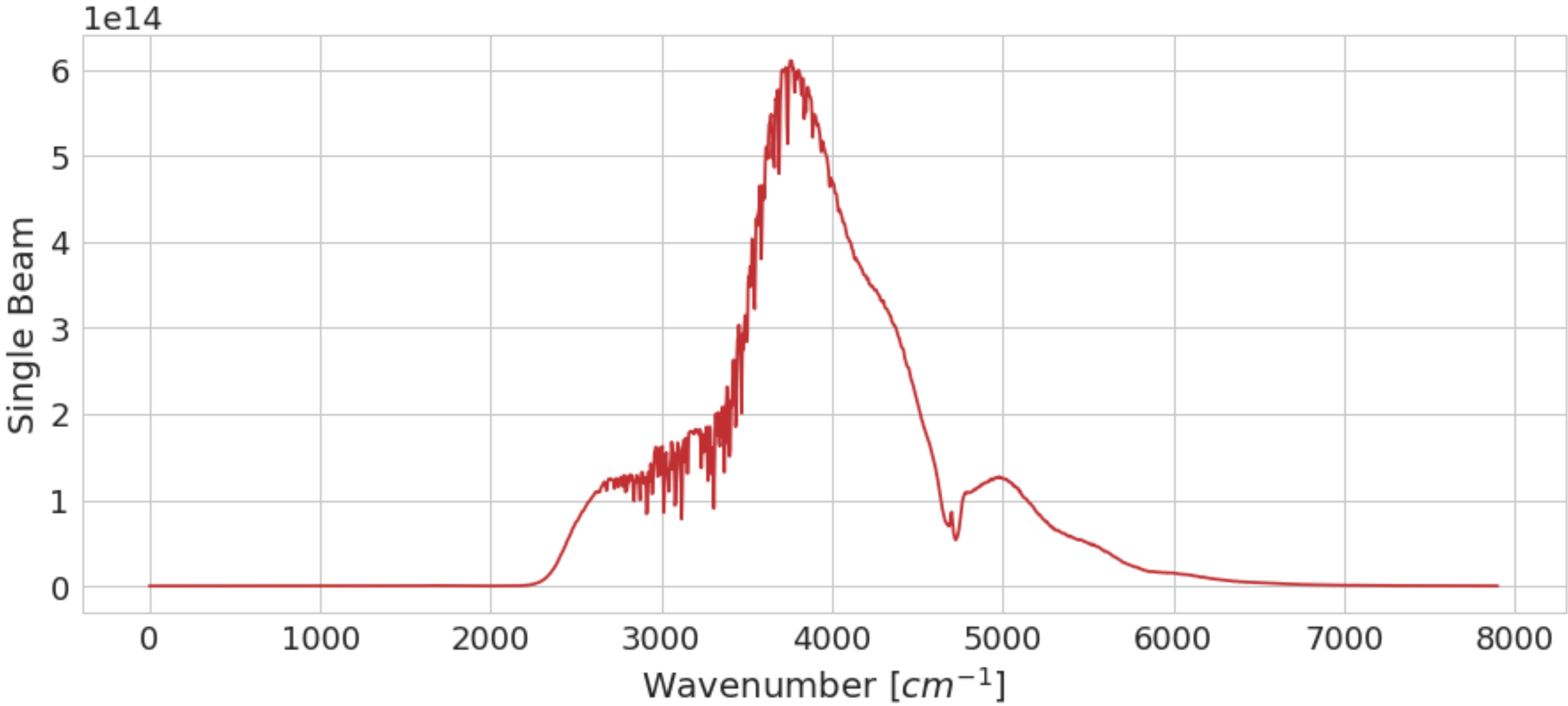
The FTIR is based on the Michelson interferometer. A multimode laser transmits light on the beamsplitter, which splits the light into two branches. The first branch hits the stationary mirror and gets transmitted to the detector through the gas cell. The second beam travels to the scanning mirror. By translating the scanning mirror, different wavelengths are selected to pass through the gas cell. The detector records the interaction of the beams with the molecules (interferogram) in the gas cell and sends the information to a computer for Fourier Transform analysis.

Method: Data Collection



Interferogram captured with no gas cell, and the FTIR flushed with N2. We proceed to capture interferograms where the gas cell is in place, flushed with N2, CO2, and air, all with FTIR flushed with N2.

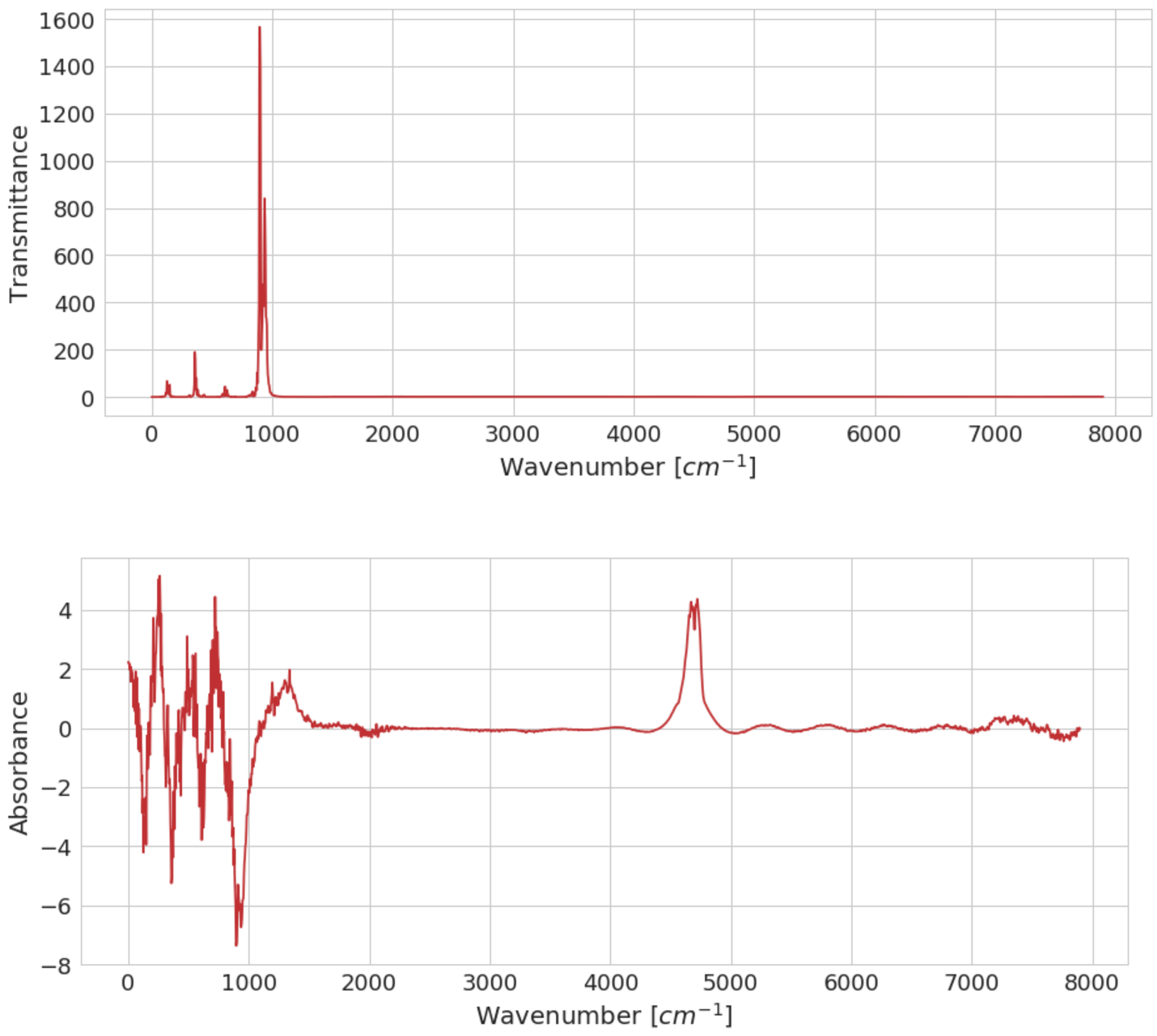
Method: Data Analysis



Normalization spectra, collected with a flushed N2 cell. Mertz correction was applied to smooth noise from from the Fourier Transform. The intensity of this spectra is used to calculate the transmittance (T) and absorbance (A) spectrums for CO_2 and air with the Beer-Lambert Law:

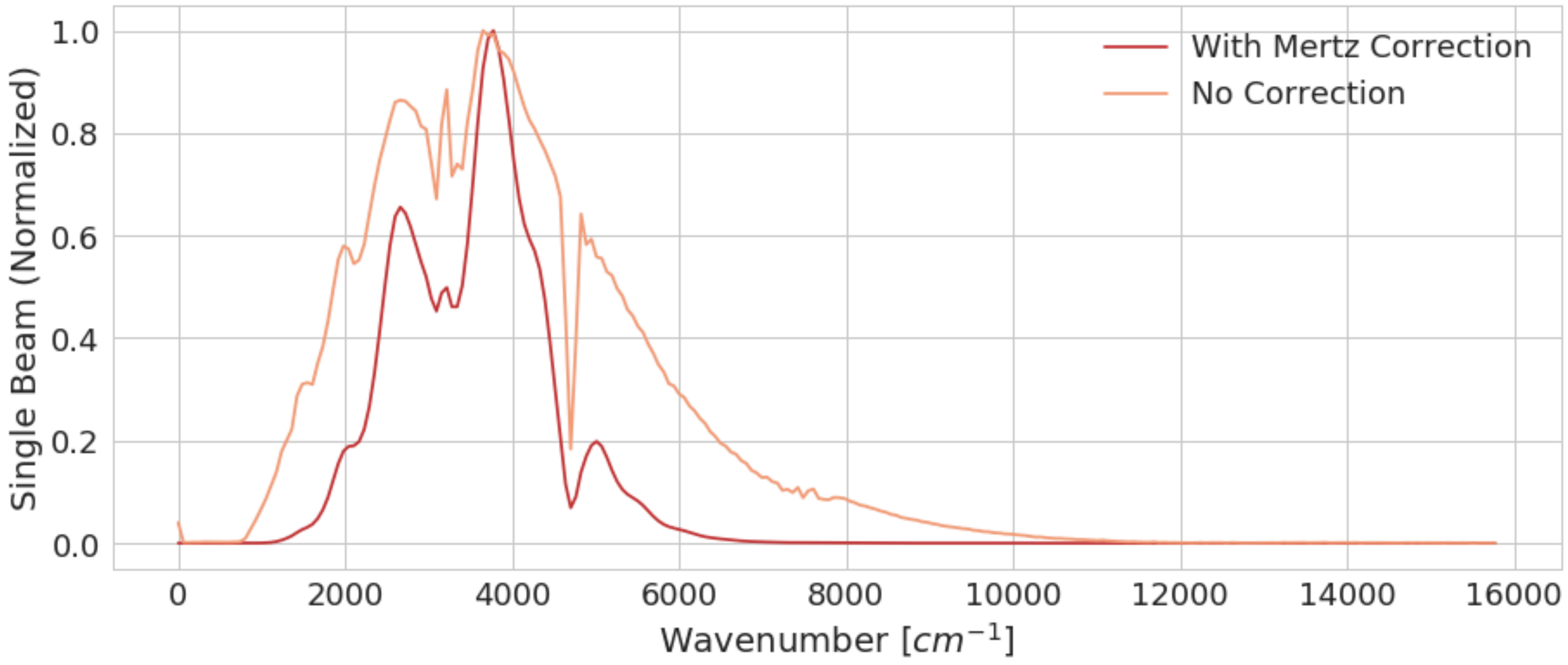
Transmission: $T = \frac{I}{I_0}$ Absorbance: $A = -\log T$

Results: Spectrums of CO_2



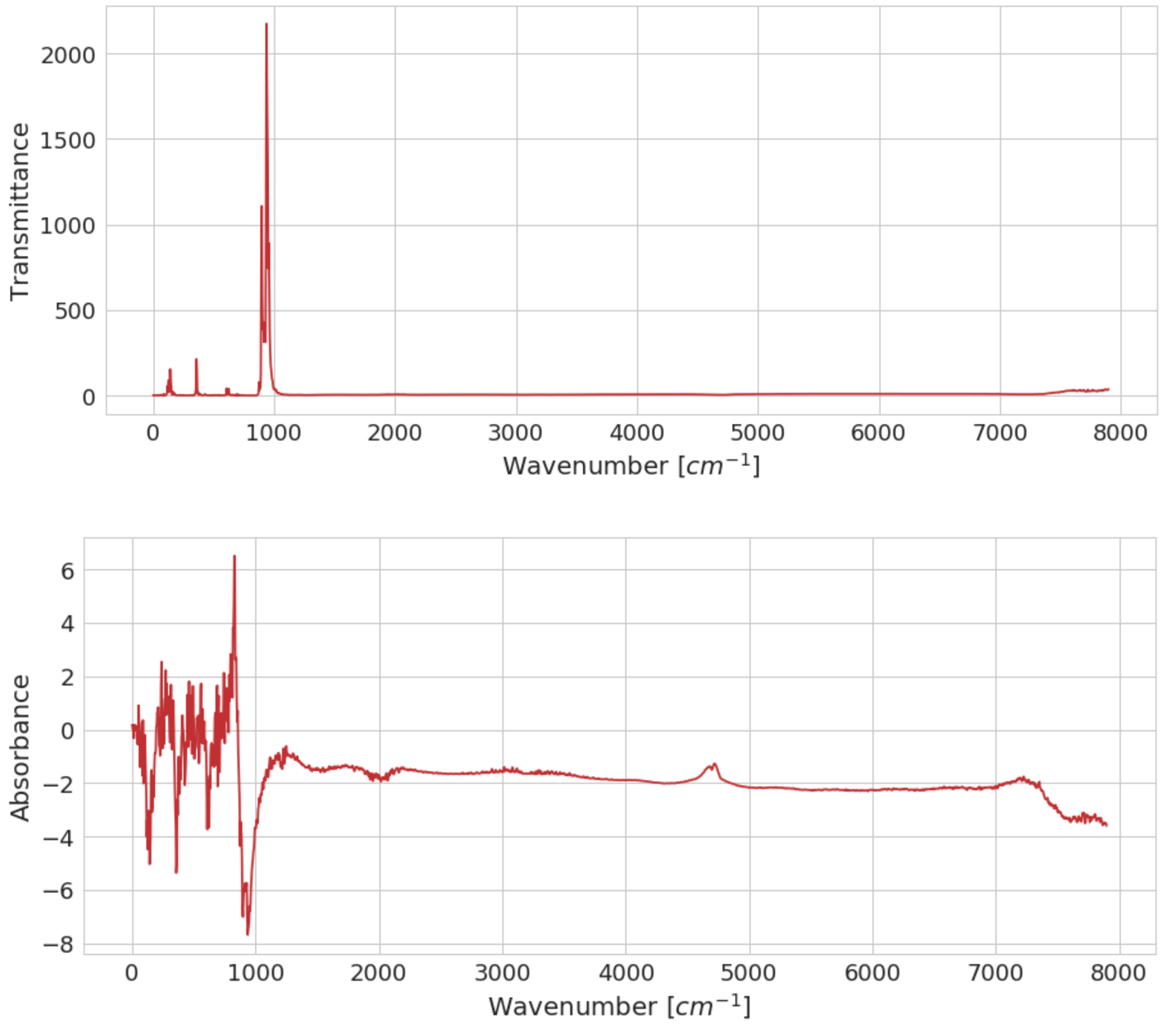
Say something

Results: Mertz Correction



Comparison of spectra with and without Mertz correction. The Mertz correction method modulates the spectra with a triangular signal, to smooth out ringing with taking the Fourier transform of the interferogram. The spectrum with the Mertz correction is smoother and less noisy.

Results: Spectrums of Air



Say something

Results: Summary

Bond	Measured Wavenumber [cm-1]
CH	4000
OH	1500
smth	
smth	

Measured Fraction of CO2 in Air: Some value

Conclusions

- Promising method?
- Can see different motions of molecules: doppler, pressure, temperatures, etc.

References