Glenn Research Center

Species, Density, and Temperature Measurements

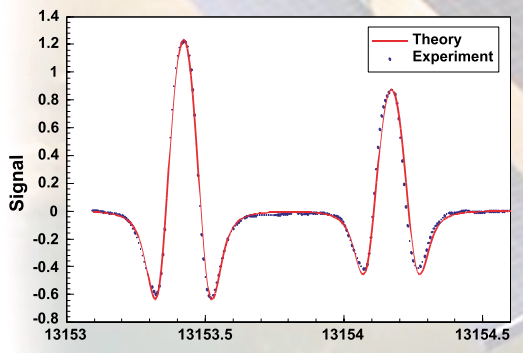
III. Frequency-Modulated (FM) Laser Absorption Spectroscopy

Beer-Lambert Law: $\frac{I}{Io} = \exp[-\sigma(\upsilon, T) \cdot N \cdot \ell]$

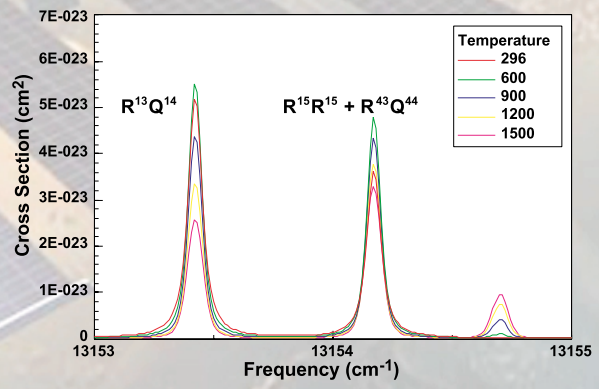
- ℓ: Path length
- N: Number density
- $\sigma(\upsilon, T)$: Absorption cross section

- **Advantages of Absorption Spectroscopy:**
  - Linear in laser intensity
  - Linear in concentration
  - High sensitivity
  - Species selective
  - Large bandwidth
  - Low power sources (e.g. diodes)
  - Temperature from line ratios
- **FM:**
  - High frequency detection ⇒ 1/f noise essentially absent
  - Ability to extract small signals from large background
  - Near quantum-limited sensitivities
- **Numerous species of interest:**

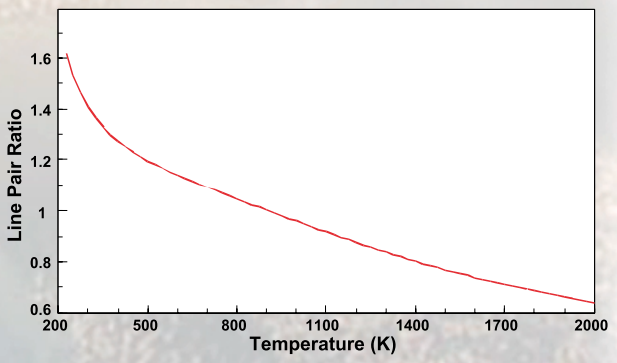
  H_2O, O_2, CO, CO_2, NO_2, NH_3, HCN, $HC\ell$, OH, CH, HCO, H_2CO, Hydrocarbon fuels,...



O_2 Spectrum
(2.2 Second Drop Tower)



$\sigma(\upsilon)$ vs. T



Line ratio vs. T

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