INFRARED LASER HETERODYNE OZONE SPECTRUM

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An infrared laser heterodyne spectrometer (IRLHS) has been developed for both laboratory and atmospheric studies. A long path and temperature adjustable cell has been designed for laboratory spectra. An ozone spectrum with 5 MHz (0.00016 cm⁻¹) resolution is presented.

Key Words: Infrared, Ozone, Atmosphere, Laser heterodyne system, high resolution spectroscopy.

INTRODUCTION

The IRLHS was primarily built for geophysical studies. It enables ground based measurements of atmospheric transmission using the sun as an infrared source. The line profile is related to the vertical distribution. This distribution is deduced from the observed lineshapes (1). A preliminary laboratory study is required for determining the dependance of the line broadening on temperature and pressure. Stratospheric pressure and temperature are simulated in a special optical cell.

APPARATUS

The IRLHS was constructed in the laboratory (2). It consists of a CW CO₂ laser and two thermal sources. The
three beams are mixed on a fast HgCdTe diode. One of the beams issuing from the thermal sources passes through a sample cell. The second one is used as a reference. The 1.8 m laser is frequency and amplitude stabilized. It works in single axial and single line mode with an output power stability is about $10^{-3}$. Because the absorption is weak, we use a 1-10 m multiple pass cell. The cell temperature is adjustable between -100°C and +20°C with a precision of ±1°C, in order to simulate the atmospheric conditions. The stainless cell is ozone proof. Ozone is obtained with an electric discharge in a capacitor filled with oxygen. The output signal of the optical mixer (with a bandwidth about 1500 MHz) is analyzed with a microcontrolled Y.I.G. (Ytrium Iron Garnet) sweeper. In this laboratory device a micro-computer, a Y.I.G. oscillator and a frequency meter are combined to produce a digitally controlled sweeper. The microcomputer is also used for data processing. A 5 MHz resolution is achieved with this single filter spectrometer.

**OZONE SPECTRA**

The IRLHS was first tested with ethylene by studying the $\nu_7$ transition near the 10.6 and 9.6 microns bands of CO$_2$. Ozone spectrum has been already studied by (4) and re-investigated with our IRLHS. Ozone transitions have been observed up to 1500 MHz (0.050 cm$^{-1}$) away from the CO$_2$ center line. The different observed ozone transitions are near the CO$_2$ lines between 9P28 and 9P14 and belong to $\nu_3$, $\nu_1$ and $(\nu_3 + \nu_2) - \nu_2$ bands (5). Absorption from isotopic ozone species are also observed (6). The figure below gives the observed lines near the 9P22 CO$_2$ line. Recording conditions are 0.6 torrs, -45°C degrees and 10 m path length. The precision is 0.0001 cm$^{-1}$.

**CONCLUSION**

A dual beam infrared laser heterodyne spectrometer has been used to obtain spectra with 5 MHz (0.00016 cm$^{-1}$) resolution, which is less than the Doppler width. About 60 lines have been observed and attributed to the $\nu_3$, $\nu_1$, $(\nu_2 + \nu_3) - \nu_2$, $(\nu_1 + \nu_2) - \nu_2$, $2\nu_3 - \nu_3$ and isotopic bands.