Measured laser frequencies from the optically pumped methanol isotopologue $^{13}CD_3OD$

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Abstract

The far-infrared region of the electromagnetic spectrum, informally defined as the wavelength region between 0.025 mm and 2.00 mm, is an area that has been investigated using laser radiation for over 50 years. Research with far-infrared lasers has a range of applications including terahertz imaging, a form of noninvasive imaging. Creating a catalog of far-infrared laser emissions is also beneficial for their use in high-resolution spectroscopic investigations of stable molecules and short-lived free radicals. The purpose of this research was to measure the frequencies of known far-infrared laser emissions generated by $^{13}CD_3OD$, an isotopic form of methanol. This was achieved using an optically pumped molecular laser and two carbon dioxide reference lasers. In this work, the frequencies for 16 far-infrared laser emissions have been measured with a one-sigma uncertainty of approximately 0.7 MHz. This poster will cover the experimental procedure used for this research along with the data that was recorded.

Introduction

The underlying principle of a laser was first hypothesized in 1917 by Albert Einstein. LASER is an acronym for: **L**ight **A**mplification by **S**timulated **E**missions of **R**adiation. They can simultaneously emit monochromatic, highly directional, coherent light and have a wide range of applications. In the far-infrared (FIR) region, they have applications in high-resolution spectroscopy and terahertz imaging.

Experimental System

- High voltage power supply excites the molecules in the CO_2 pump laser emitting infrared radiation (around 9 and 10 μm).
- CO_2 laser radiation subsequently excites the $^{13}CD_3OD$ sample present in the far-infrared laser cavity.
- Several operating parameters are adjusted. Any far-infrared lasing that occurs is monitored by the MIM (metal-insulator-metal) point contact diode detector.

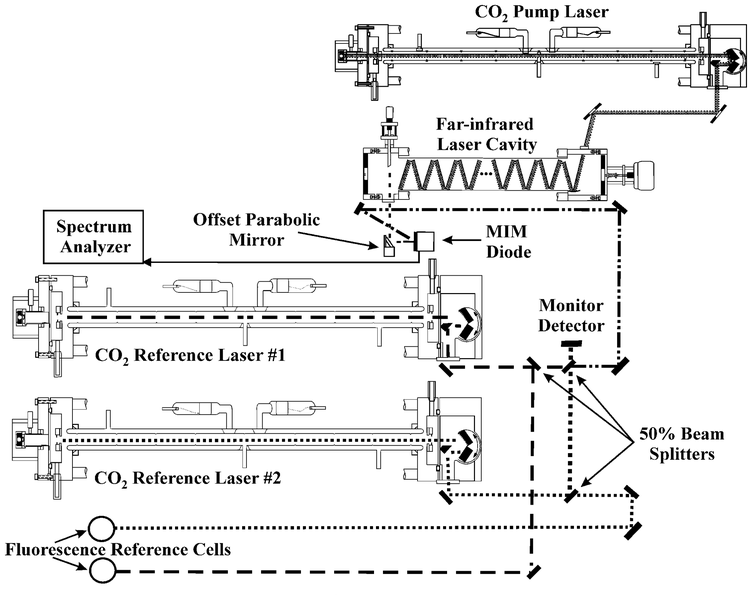

Figure 1. Schematic of experimental system.

Experimental Procedure

Figure 2. Generating CO_2 laser radiation as observed on a beam stop.

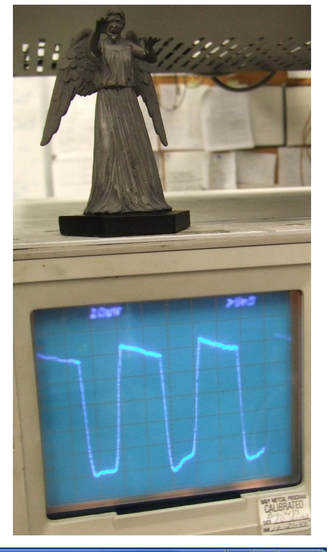

Figure 3. Typical waveform seen on the oscilloscope when FIR laser radiation is detected.

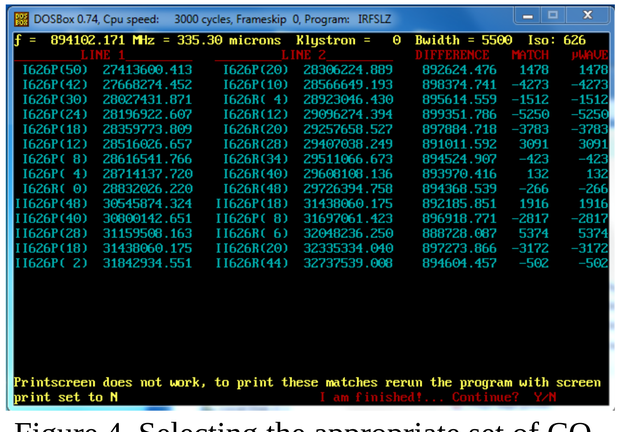

Figure 4. Selecting the appropriate set of CO_2 reference lasers.

Results

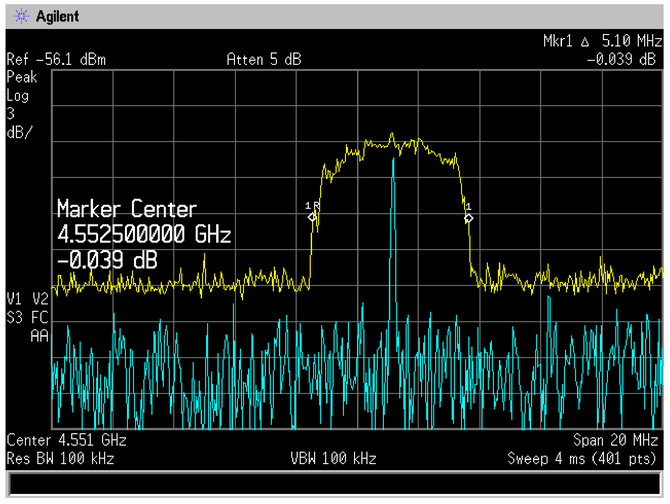

Figure 5. A strong beat frequency corresponding to the 335.039 μm emission of $^{13}CD_3OD$ produced using the 10*P*20 pump line and the 10*P*24 and 10*R*12 reference lines.

Table 1. Select measured laser frequencies generated by optically pumped $^{13}CD_3OD$.

Pump	Wavelength (μm)	Frequency (MHz)	Wavenumber (cm^{-1})
9*R*20	417.410	718 220.6 ± 0.4	23.9573
10*R*08	669.114	448 043.9 ± 0.4	14.9451

Conlusion

During this investigation, sixteen laser emissions generated by the methanol isotopologue $^{13}CD_3OD$ have had their frequencies measured for the first time. The wavelengths for these laser emissions range from 220.406 to 845.168 μm.