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LED-based Fourier transform spectroscopy of $^{16}\text{O}^{12}\text{C}^{18}\text{O}$ and $^{12}\text{C}^{18}\text{O}_2$ in the 11,260–11,430 cm^{-1} range



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ABSTRACT

The absorption spectrum of the $^{16}\text{O}^{12}\text{C}^{18}\text{O}$ and $^{12}\text{C}^{18}\text{O}_2$ carbon dioxide isotopologues has been recorded in the 11,260–11,430 cm^{-1} spectral range using Bruker IFS 125 HR Fourier transform spectrometer with resolution 0.05 cm^{-1} at temperature 297 K and path length 24 m. The ^{18}O enriched sample of carbon dioxide at total pressure 96.5 mbar was used for these purposes. The spectrometer used LED emitter as a light source. This gave possibility to reach the minimal detectable absorption coefficient $\alpha_{\text{min}} \sim 1.4 \times 10^{-7} \text{ cm}^{-1}$ using 23,328 scans. In the recorded spectrum we have assigned the 00051–00001 band for both $^{16}\text{O}^{12}\text{C}^{18}\text{O}$ and $^{12}\text{C}^{18}\text{O}_2$ isotopologues using the predictions performed within the framework of the method of effective operators. The line positions and intensities of the observed bands are found. The comparison of the observed and predicted line positions and intensities is performed confirming good accuracy of the predictions. The spectroscopic parameters for the observed bands are determined.

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1. Introduction

Carbon dioxide is the major species of the atmospheres of Venus and Mars. It has many vibrational bands with very different intensities from the far infrared to visible region. Because of this it could be used as a probe for the study of the atmospheres of these planets to different depths. The near infrared spectral region below 1 μm is promising for the study of the carbon dioxide isotopologue abundances in the whole column of Venus or Mars atmospheres. One of the bands which could be used for these purposes is the 00051–00001 band. This band for

the principal isotopologue $^{12}\text{C}^{16}\text{O}_2$ has been detected for the first time in 1953 by Herzberg and Herzberg [1] on their photographic plates using long exposure time and a pressure-pathlength product 1/3 atm \times 5500 m. In 1994 this band has been revisited by Campargue et al. [2] with ICLAS. In our recent paper [3] this band has been studied in details using Bruker IFS 125 HR Fourier transform spectrometer and 30 m base length multipass cell. Two bands 00051–00001 and 01151–01101 of $^{12}\text{C}^{16}\text{O}_2$ have been recorded using LED based Fourier transform spectrometer [4]. To our knowledge no any study of the 00051–00001 band of other carbon dioxide isotopologues has been performed. But vibrational state 00051 of $^{12}\text{C}^{18}\text{O}_2$, $^{13}\text{C}^{16}\text{O}_2$, $^{13}\text{C}^{18}\text{O}_2$, $^{16}\text{O}^{12}\text{C}^{18}\text{O}$ and $^{16}\text{O}^{13}\text{C}^{18}\text{O}$ has been reached through the hot bands 00051–00041 and 00061–00051 in emission spectra [5–8]. The calculated values for

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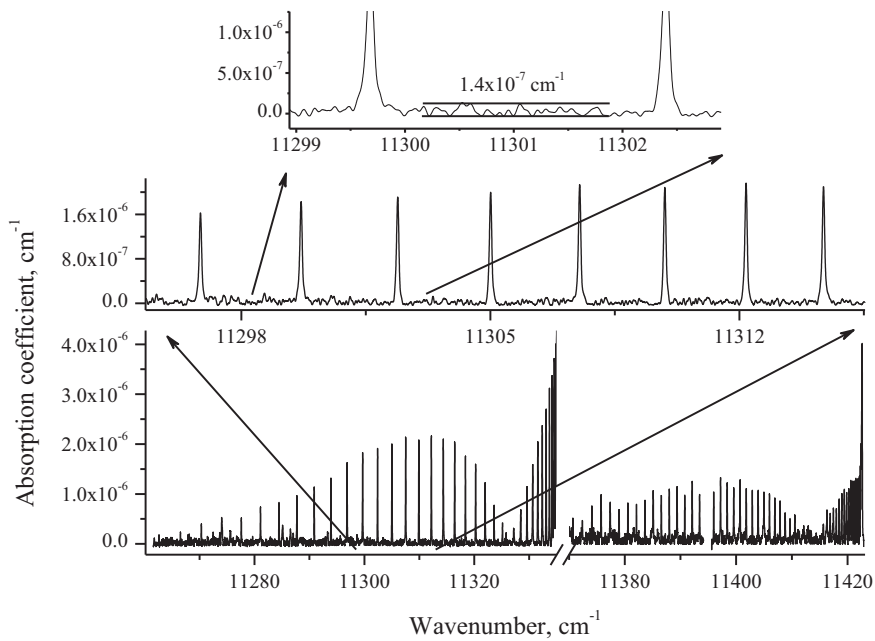


Fig. 1. Spectrum of ^{18}O enriched sample of carbon dioxide in the $11,261\text{--}11,423\text{ cm}^{-1}$ range. Three successive enlargements illustrate the high sensitivity of the recordings (noise equivalent absorption on the order of $\alpha_{\text{min}} \sim 1.4 \times 10^{-7}\text{ cm}^{-1}$).

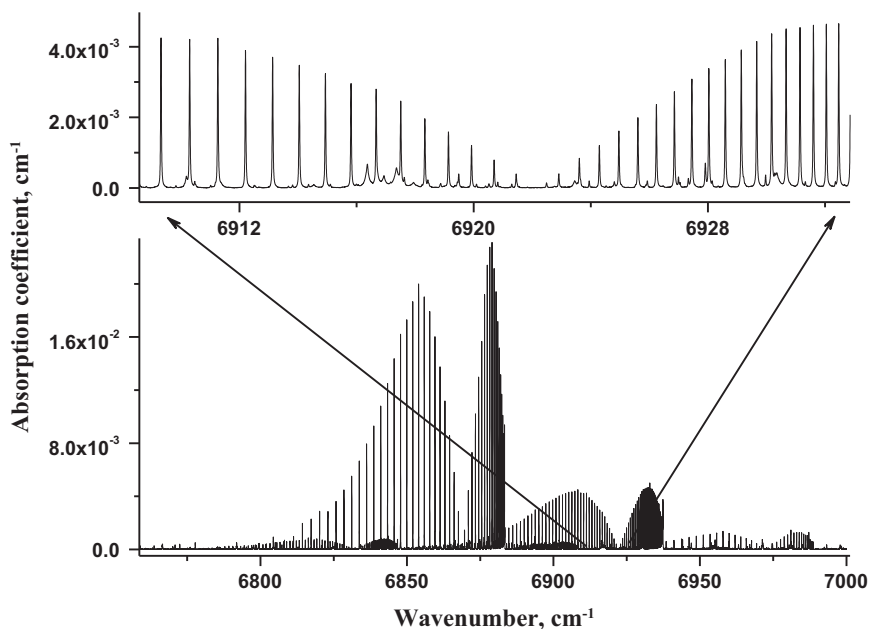


Fig. 2. Spectrum of ^{18}O enriched sample of carbon dioxide in the $6750\text{--}7000\text{ cm}^{-1}$ range.

the line parameters of this band for $^{16}\text{O}^{12}\text{C}^{18}\text{O}$ could be found in the CSD-296 databank [9] and for both isotopologues $^{16}\text{O}^{12}\text{C}^{18}\text{O}$ and $^{12}\text{C}^{18}\text{O}_2$ in the AMES line list [10]. The line positions and intensities of the $^{12}\text{C}^{18}\text{O}_2$ 00051–00001 band could also be calculated using the effective Hamiltonian parameters published by Karlovets et al. [11] and effective dipole moment parameters of the principal isotopologue published by Petrova et al. [12]. The calculated values of the line positions and intensities need to be experimentally validated. The aim of this paper is the

measurements of the line positions and intensities of the 00051–00001 band of $^{16}\text{O}^{12}\text{C}^{18}\text{O}$ and $^{12}\text{C}^{18}\text{O}_2$ isotopologues to validate the calculations.

2. Experimental details

The absorption spectra of the carbon dioxide isotopologues have been recorded using Bruker IFS 125 M Fourier transform spectrometer with 60 cm base length

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