HIGH PRECISION MID-IR SPECTROSCOPY OF $^{12}C^{16}O_2$: $00^01 \leftarrow 00^00$ BAND NEAR 4.3 $\mu$m

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We have observed the sub-Doppler saturation spectra of the 4.3 $\mu$m fundamental band transitions of $^{12}C^{16}O_2$ using a mW-level DFG (Difference Frequency Generation) source. The DFG radiation is generated by a 1-W Ti:sapphire laser and a Nd:YAG laser amplified by a 10-W fiber amplifier in a 50-mm long MgO:PPLN (Magnesium doped Periodically-Poled Lithium Niobate) crystal. We are able to generate 3 mW DFG power at 4.3 $\mu$m. The saturation spectrum is observed by a conventional arrangement using the third harmonic demodulation technique. The FWHM is about 1 MHz and the signal-to-noise ratio is $> 1000$.
To measure the center frequency of a fundamental band transition, the Nd:YAG laser is frequency stabilized to the a10 hyperfine peak R(56) 32-0 transition of $^{127}I_2$ molecule and the Ti:sapphire laser is locked to its center. Then we can determine the center frequency after measuring the Ti:sapphire laser frequency using an OFC (Optical Frequency Comb). Up to now, the absolute frequencies of 56 transitions have been measured to an accuracy of 30 kHz. Using the accurate molecular constant of $00^01$ level available from the precision frequency measurement of the regular band $CO_2$ laser transitions, precise molecular constants of the ground vibrational level are determined and the constant $L$ is determined for the first time.