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High-resolution mid-infrared spectroscopy using laser difference-frequency spectrometer

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In this paper, we report on development of a continuous-wave (CW) laser spectrometer based on difference-frequency generation (DFG) in nonlinear optical crystal. The CW DFG-based laser spectrometer is continuously tunable (without any "mode hop") in the mid-infrared spectral region of 3.4 - 20 μm with a Doppler linewidth limited spectral resolution.

Two CW Ti:Sapphire lasers operating at 710-810 nm and 800-915 nm respectively were used as difference-frequency mixing sources. The following crystals were used as frequency conversion component for different infrared wavelength regions :

(1) 3.4 - 4.4 μm : quasi-phase-matched (QPM) PPRTA (periodically poled $RbTiOAsO_4$) crystal [1] ;

(2) 4 - 10 μm : $AgGaS_2$, $LiInS_2$ or $LiInSe_2$ crystal in birefringent phase-matching configuration [2,3] ;

(3) 9 - 20 μm [4] : birefringently phase-matched GaSe crystal.

DFG absorption spectra of various atmospheric species (CH_4, CO_2, SO_2, ...) and volatile organic compounds (VOCs, such as C_2H_2, C_2H_4, C_6H_6, C_7H_8, ...) were recorded for study of the spectral line parameters (absorption frequency, line strength, pressure-broadening coefficient, ...). Isotopic composition measurements of CH_4 were performed as well based on laser DFG absorption spectroscopy.

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References

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