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Highly sensitive laser heterodyne radiometer based on a balanced photodetector for carbon dioxide measurement in the atmospheric column

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An all-fiber coupled laser heterodyne radiometer (LHR), using a wideband tunable external cavity diode laser (1500–1640 nm) as local oscillator laser, was developed for ground-based remote sensing of carbon dioxide. Optimal absorption lines and transmission spectra of carbon dioxide in this wavelength range were determined. High sensitivity of the LHR was achieved by using a balanced photodetector to suppress the relative intensity noise of the local oscillator laser. The noise model of the highly sensitive LHR was analyzed and compared with the traditional LHR using single photodetector [1-2]. Finally, field campaigns were performed on the roof of the platform of IRENE building in Dunkerque (51.05°N/2.34°E). The measured LHR spectra in the atmospheric column are compared, in good agreement, with referenced Fourier-transform infrared spectra from the TCCON observation network and with the simulation spectra resulting from an atmospheric transmission modeling. Experimental details including noise analysis and LHR spectra will be discussed and presented.

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References

[1] T. G. Blaney. "Signal-to-noise ratio and other characteristics of heterodyne radiation receivers",

Space Science Reviews **17** (1975) 691-702.

[2] F. Shen, G. Wang, J. Wang, T. Tan, G. Wang, P. Jeseck, Y.-V. Te, X. Gao, W. Chen. "A transportable mid-infrared laser heterodyne radiometer operating in the shot-noise dominated regime", Opt. Lett.**46** (2021) 3171-3174.