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remote sensing of greenhouse gases with solar occultation technique using high resolution near infrared heterodyne spectrometer

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Near infrared heterodyne spectrometer has been developed, which uses a distributed feedback diode laser as a tunable local oscillator, for detecting methane in the atmosphere at 1.65 μm. The main problem of heterodyning in the near infrared range is the stringent requirements to alignment of the incident radiation fronts. Single mode quartz fiber Y-coupler was used as a diplexer to solve this problem. Radiation mixed in a fiber was detected by a balanced couple of InGaAs p-i-n diodes. The amplifier bandpass was $\sim$ 1.75 MHz, close to local oscillator linewith. Wavelength coverage of spectral measurement was provided by sweeping local oscillator frequency in the range of 1.5 cm-1. The spectrometer noise level is demonstrated to be 1.3 of the fundamental shot-noise limit. Using Sun observations, atmospheric methane absorption line has been recorded. Achieved spectral resolution is constrained by local oscillator linewidth and stability, and constitutes about 2 MHz, which corresponds to resolving power of 108.

The simplicity of the proposed scheme opens a perspective to use it for ultra-high resolution spectroscopy in various applications, including TCCON activity. In particular, it allows solar occultation observations of CO_2, C, CH4, H2S, C2H4 and other gases from both spacecraft and ground-based platforms, as well as Doppler measurements of stratospheric winds.