Tytuł projektu

Badania doświadczalne widma tlenu w obszarze widmowym około 1.27 μm.

Project title

Experimental investigation of the oxygen spectrum around 1.27 μm.

Dyscyplina /Area of science

Nauki fizyczne

PROJECT DESCRIPTION

Preliminary goals

This project is aimed to an experimental investigation of the oxygen band around 1.27 μm (also referred as 7885 cm^{-1}) due to the $a^1\Delta_g$ - $X^3\Sigma_g^-$ transitions.

The knowledge of accurate spectroscopic parameters for lines in this oxygen band is very important in the remote sensing domain for high-accuracy measurements of atmospheric greenhouse gases (GHG) such as CO_2, CH_4, N_2O and others. Due to the uniform mixing of oxygen throughout the atmosphere, the oxygen lines are often used as a reference for intensity calibration of atmospheric spectra recorded by ground-based or satellite instruments. For instance, Total Carbon Column Observing Network (TCCON) is a worldwide network of ground-based Fourier Transform Spectrometers which record direct solar spectra in the near-infrared to measure GHGs. Airmass column calibration in the TCCON is obtained exclusively from the spectra of the 7885 cm^{-1} oxygen band which is the subject of the present proposal. TCCON data are essential for validating satellite observation and carbon cycle modeling. Both validations require accuracy of 0.3% on TCCON GHGs column retrievals. However, the current accuracy is only around 1-2% and additional aircraft calibration is required to realize the 0.3% accuracy. A significant part of the uncertainties related to TCCON retrieval is associated with available accuracy of spectral line data of O_2. Data available in the HITRAN database, which is the main database for atmospheric purposes, mostly come from calculations and present large uncertainties. Also, laboratory data for the transitions of this band are mainly limited to center frequencies and intensity factors, resulting from the analysis of FTIR spectra by means of the Voigt line-shape model.

Experimental data will be collected using the frequency-stabilized cavity ring-down spectrometer (FS-CRDS) which is currently one of the most sensitive and widely recognized methods for trace gas detection and precise measurements of weak absorption spectra.

An important part of this project is the adoption of more sophisticated line-shape models to fit high-quality CRDS spectra, taking into account speed-dependent and Dicke-narrowing effects as well as correlations between velocity-changing and dephasing collisions. Data analysis will be performed with multispectrum fitting technique, that is the simultaneous fitting of spectra acquired in a range of parameters such as pressure and/or temperature.

Research plan:

- testing of the new experimental setup,
- modification of the control and fitting software,
- measuring the oxygen spectrum at the 1.27 μm region,
- fitting data with the advanced line-shape functions,
- measuring and fitting the spectrum of the oxygen perturbed by nitrogen.

As a result very accurate data for line positions, intensities and other line shape parameters for investigated band will be provided, which can be used for both fundamental research and applications. Determined line positions should be at least an order of magnitude better than available data for investigated transitions. Such data would be valuable for improving molecular constants and for compilation of new generation spectroscopic databases.

PhD student will learn the advanced high sensitivity and high resolution experimental technique using the state-of-the art instrumentation together with advance theory for atomic and molecular interactions and theory of the spectral line shapes. Also the extensive knowledge of LabView programming and data analysis at advanced level will be the outcome.

Zgłaszający projekt/ Author of the project

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Proponowani promotorzy i mentorzy/prospective supervisors

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