Development of a 4.3 μm quantum cascade laser based $^{13}CO2/^{12}CO2$ isotopic ratio sensor

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High precision measurements of $^{13}CO_2/^{12}CO_2$ are needed in a wide range of fields that includes: atmospheric chemistry, volcano emission studies, combustion diagnostics, medical diagnostics and biology. Currently we are developing a compact, field deployable quantum cascade laser based sensor to perform real time measurements with a precision of δ~0.1‰, using absorption spectroscopy. The initial design of this analyser will target the prediction of potential volcano activities, but can be useful in other applications.
A thermoelectrically cooled pulsed, single frequency quantum cascade laser is used as spectroscopic source. Besides, the use of thermoelectrically cooled mid infrared fast detectors allows a complete liquid nitrogen free operation of the sensor, which is required for field deployment. The laser is planned to operate at 4.33 μm, where P-branch of $^{12}CO_2$ overlaps R-branch of $^{13}CO_2$ of the 00^01-00^00 transition. As the instrument sensitivity depends on the judicious choice of appropriate absorption lines we will review the different approaches made in the mid infrared for this selection. To reach a high precision delta value, influences of temperature and pressure stabilities must be taken into account, as well as the water vapor collision broadening.
We will report a new, simplified quantum cascade based sensor architecture, which has benefited from previous feasibility studies performed with an isotopic ratio analyser that used difference frequency generation (DFG) [*Richter et al.* 2002, *Erdélyi et al.* 2002].

References:

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