Diode laser spectroscopy of methane at 1.65 µm for the Merlin lidar mission

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In the framework of the MERLIN research program, a high-resolution spectroscopic study is developed on methane around 1.6 µm. MERLIN that means "MEthane Remote sensing LIdar missioN" is a Franco-German Lidar mission for Methane monitoring from space. The two national space agencies CNES and DLR are responsible for mission programmatic and satellite development. The space segment is a micro-sat e.g. 100 kg & 100 W, embarking a pulsed Lidar operating in "Integrated Path Differential Absorption technique" using surface scattering. CNES provides the spacecraft (e.g. Evolutions platform) and is responsible for overall mission integration. DLR provides the Lidar payload that is based on a pulsed Optical Parametric Oscillator laser emitting at 2 wavelengths around 1.645 µm. One of these wavelengths is called "on". In this case the target of this laser source is the R6 manifold of the $2\nu_3$ band of methane. The second wavelength is called "off" and neither methane nor water vapor may absorb at this wavelength.

Molecular spectroscopy of methane in the targeted region is crucial. First the "off" wavelength may be clear of methane and water vapor. At the moment when looking at standard databases such as HITRAN the region seems free of these gases. Preliminary results obtained with a tunable diode laser spectrometer will demonstrate that this region contains a lot of weak methane lines that may perturb the measurement if the wavelength is chosen for "off".

In a second part, there is a key role of spectroscopic information on Weighting Function (*WF*):

$$WF(p,T) = \frac{\sigma_{on}(p,T) - \sigma_{off}(p,T)}{\left(1 + \frac{M_{H_2O}}{M_{air}}\rho_{H_2O}(p,T)\right) \cdot g \cdot M_{air}}$$

Thus, accurate absorption cross sections at 2 wavelengths is necessary. The CH_4 R6 manifold permits to obtain substantial relaxation of requirements on laser frequency and platform stability but requires accurate knowledge in all pressure & temperature conditions to avoid bias. First spectroscopic results obtained for R6 manifold of methane at 1.6 µm will be presented.

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