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# High spectral Resolution Observations of $CO_2$ as a Probe for Mars and Venus atmospheric Dynamics

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Mars global circulation models (GCMs) have been developed from observational data acquired by the Mars Global Surveyor (MGS) and Mars Express spacecrafts and are used to predict the structure of the Martian wind field. Observations however, especially from the high atmosphere of Mars are rare.

Non-LTE emission from a narrow layer in the upper atmosphere of Mars (60-80 km) and Venus (100-120 km) is not only an interesting phenomenon by itself but can be used to probe the regions of the atmospheres where the emission occurs. The fairly broad $CO_2$ absorption feature in the lower atmosphere of Mars provides information about lower altitudes. From the Doppler-width of the emission features temperatures in the altitude were the transition occurs can be derived. The Doppler-shift of the emission peaks provide a direct measurement of mesospheric wind speeds to an accuracy of a few m/s.

Mid-infrared high spectral resolution spectroscopy of $CO_2$ offers a unique possibility to probe wind speeds in planetary atmospheres like Mars and Venus. Highest spectral resolution is necessary to fully resolve molecular features and to peek through the many telluric lines that contaminate the spectra and prohibit ground based observations with coarse resolution. By analyzing the shape of emission or absorption lines various information on the physical parameters of the gas can be gathered.

Only heterodyne spectroscopy offers high spectral resolution of better than $10^7$ at 10 $\mu$m. The broadband radiation to be analyzed is superimposed to a monomode local oscillator (LO) and focused to a fast detector. The Cologne Tuneable Heterodyne Infrared Spectrometer (THIS) is at present equipped with quantum-cascade-laser (QCLs) LOs emitting around 10.4 and 9.6 $\mu$m wavelength. As a mixer we use

a mercury-cadmium-telluride (MCT) photovoltaic detector which is optimized for a wavelength between 9 and 12 $\mu$m. The frequency analysis is done by a 2048 channel acousto-optical spectrometer (AOS) with a total bandwidth of 1.4 GHz. THIS is currently the highest spectral resolution IR instrument and perfectly suited to carry out those observations.

A first test of the proposed method was carried out on Mars with THIS during December 2003 at the 1.5 m McMath-Pierce solar telescope on Kitt Peak followed by a detailed observation during December 2005 at the same facility. Venus was also observed in 2005. First results from these observations will be presented.

The first promising results will be followed-up by observations of other seasons of Mars to cover ideally the whole Martian year to verify the predicted variability of the global wind field. Observations will also be extended to Venus in support of the ESA Venus Express mission.