

Studying Planetary Atmospheres with High Resolution Infrared Heterodyne Spectroscopy: Results, Projects and Future Possibilities

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Infrared heterodyne spectroscopy offers the capability of very high spectral resolving power (greater than 10^7) combined with relatively high sensitivity. In addition the spatial resolution is inherently higher when compared to heterodyne observations at mm and sub-mm wavelength. This high spectral and spatial resolution enables unique high sensitivity studies of the physical and chemical processes in planetary atmospheres through measurement of fully resolved lineshapes of transitions of molecular species.

The Cologne Tunable Heterodyne Infrared Spectrometer (THIS) offers for the first time the possibility to study the whole mid-IR (7-14 μ m) by heterodyne techniques. The high spectral resolution and precision of heterodyne detection enables the retrieval of atmospheric parameters like abundance, temperature, pressure or wind velocity.

Dynamics in planetary atmospheres can be studied by observing molecular lines Doppler-shifted due to winds such as on Titan, Venus and Mars, for the latter two with an accuracy of better than 10 m/s. Results from such measurements with sufficiently high spatial resolution are especially useful for validation of GCMs (General Circulation Models) and an improved understanding of the current state and evolution of planetary atmospheres.

Unique enhanced emissions from low-pressure regions of planetary atmospheres also require ultra-high spectral resolution. The non-LTE emission lines of CO₂ from Mars and Venus having linewidth <40 MHz (0.0013 cm⁻¹) require heterodyne spectral resolution to be observed, as do C₂H₆ emissions from polar regions of Jupiter and Saturn, which probe physical and thermal changes caused by solar activity and seasonal ef-

fects.

Current and future projects will be presented including wind measurements on Mars and Venus, mesospheric features of Methane on Jupiter, and mid-IR studies of SO₂ on Io to probe the interaction between Io's atmosphere and Jupiter.