

Infrared Heterodyne Spectroscopy of Ozone on Mars from IRTF: 1988-Present

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Fast, K. E. 2005. Mars ozone abundances from infrared heterodyne spectra and their application to the study of the stability of the Martian atmosphere. Ph.D. dissertation, U of MD.

Fast, K. E., T. Kostiuik, F. Espenak, J. Annen, D. Buhl, T. Hewagama, M. F. A'Hearn, D. Zipoy, T. A. Livengood, G. Sonnabend & F. Schmülling, 2005, Icarus, Ozone abundance on Mars from infrared heterodyne spectra I: Acquisition, retrieval, and anticorrelation with water vapor. Submitted.

Fast, K. E., T. Kostiuik, T. Hewagama, M. F. A'Hearn, F. Lefèvre & S. Lebonnois 2005, Icarus, Ozone abundance on Mars from infrared heterodyne spectra II: Validating photochemical models. In preparation.



Why ozone?

- Ozone is destroyed by odd hydrogen (HO_x) species that play key roles in the chemistry and stability of the 95% CO_2 Martian atmosphere.
- Ozone observations can be used to trace the abundance of odd hydrogen species and test predictions of atmospheric models.

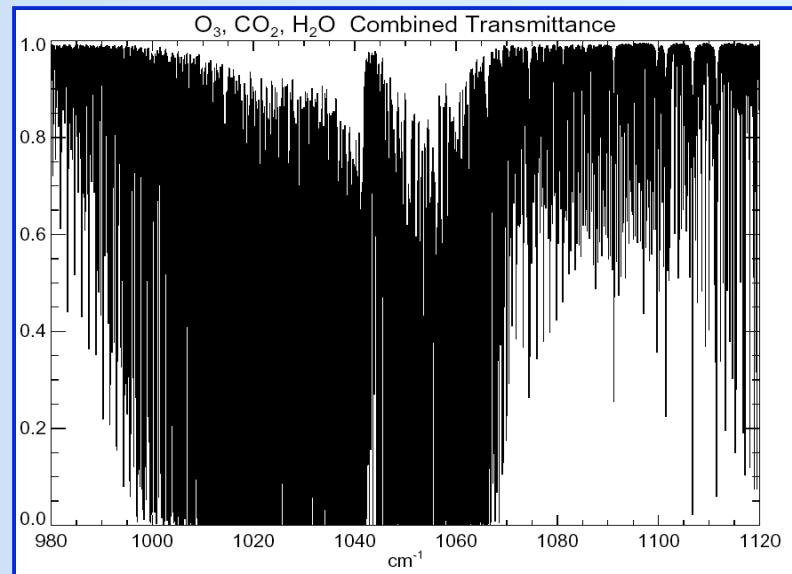
Why IR heterodyne spectroscopy?

- UV Martian ozone observations must be made from space.
- IR heterodyne spectroscopy is the only ground-based technique that provides direct access to Martian ozone absorption features.



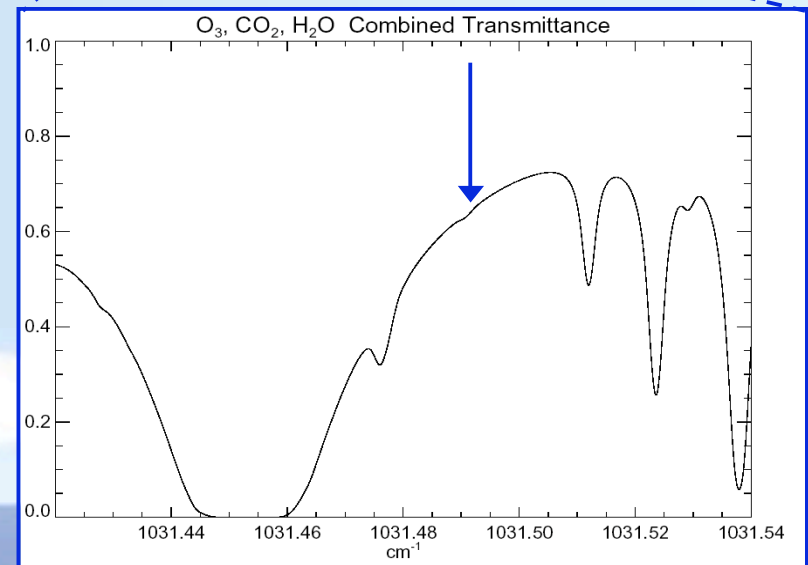
Looking through the Earth's “Picket Fence”

Infrared heterodyne spectroscopy with resolution $\lambda/\Delta\lambda \geq 10^6$ permits direct ground-based observations of Mars ozone absorption features when they are Doppler shifted away from telluric ozone counterparts into regions of higher atmospheric transmittance (arrow).



10.2 μm

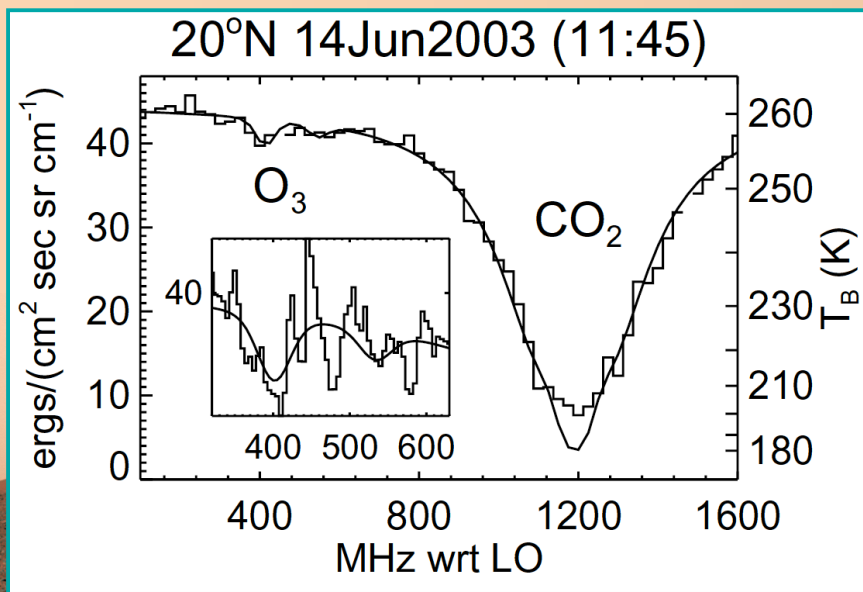
8.9 μm



9.7 μm

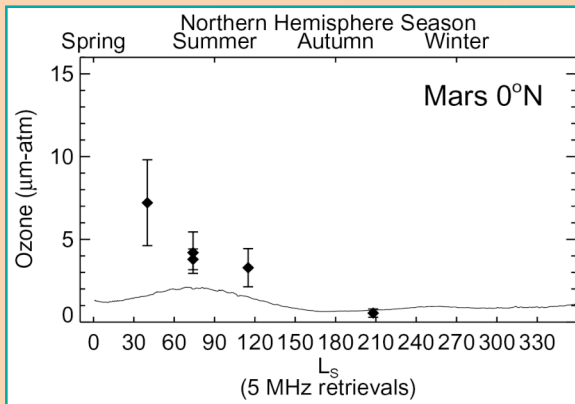
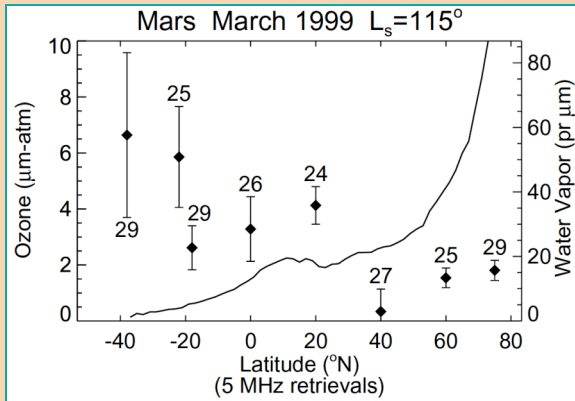
Observations of ozone on Mars from IRTF

- 1988-1999 : GSFC's Infrared Heterodyne Spectrometer (IRHS) at IRTF Coudé focus.
- 2003-present: GSFC's Heterodyne Instrument for Planetary Wind and Composition (HIPWAC) at IRTF Cassegrain focus.
- Spatial and temporal behavior of ozone measured at a variety of Martian seasons.



Example heterodyne spectrum of Mars from IRTF in June 2003. Filter banks provide 25 MHz-resolution of ozone and CO₂ and 5 MHz-resolution of ozone (inset). An acousto-optic spectrometer (AOS) now provides HIPWAC with 1 MHz-resolution.

Results



- *upper panel*: Observed anticorrelation of IR heterodyne ozone abundance (points) and water vapor abundance (curve, MGS) tests predictions of photochemistry .
- *lower panel*: Disagreement between IR heterodyne ozone measurements (points) and a photochemical model (curve, Lefèvre *et al.* 2004) points to additional chemistry needed in the model.
- IR heterodyne ozone measurements have the potential to probe the vertical distribution of ozone down to the surface, which is not possible from current spacecraft, and is important for refining photochemical models.

IR heterodyne measurements of Mars from IRTF provide long-term monitoring of atmospheric ozone, validate and complement spacecraft data, and test predictions made by models of Martian atmospheric chemistry and circulation.