The Atmospheres of Titan and Saturn in the Infrared from Cassini: The Interplay Between Observation and Laboratory Studies

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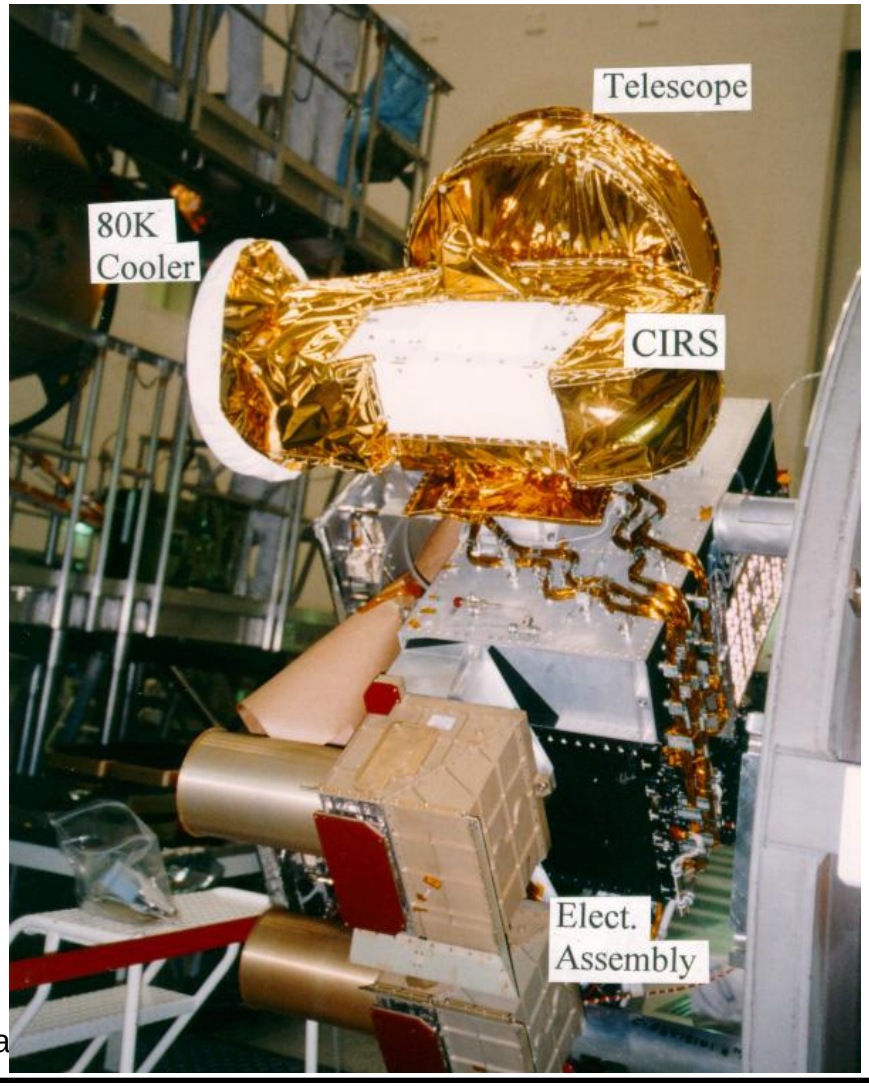
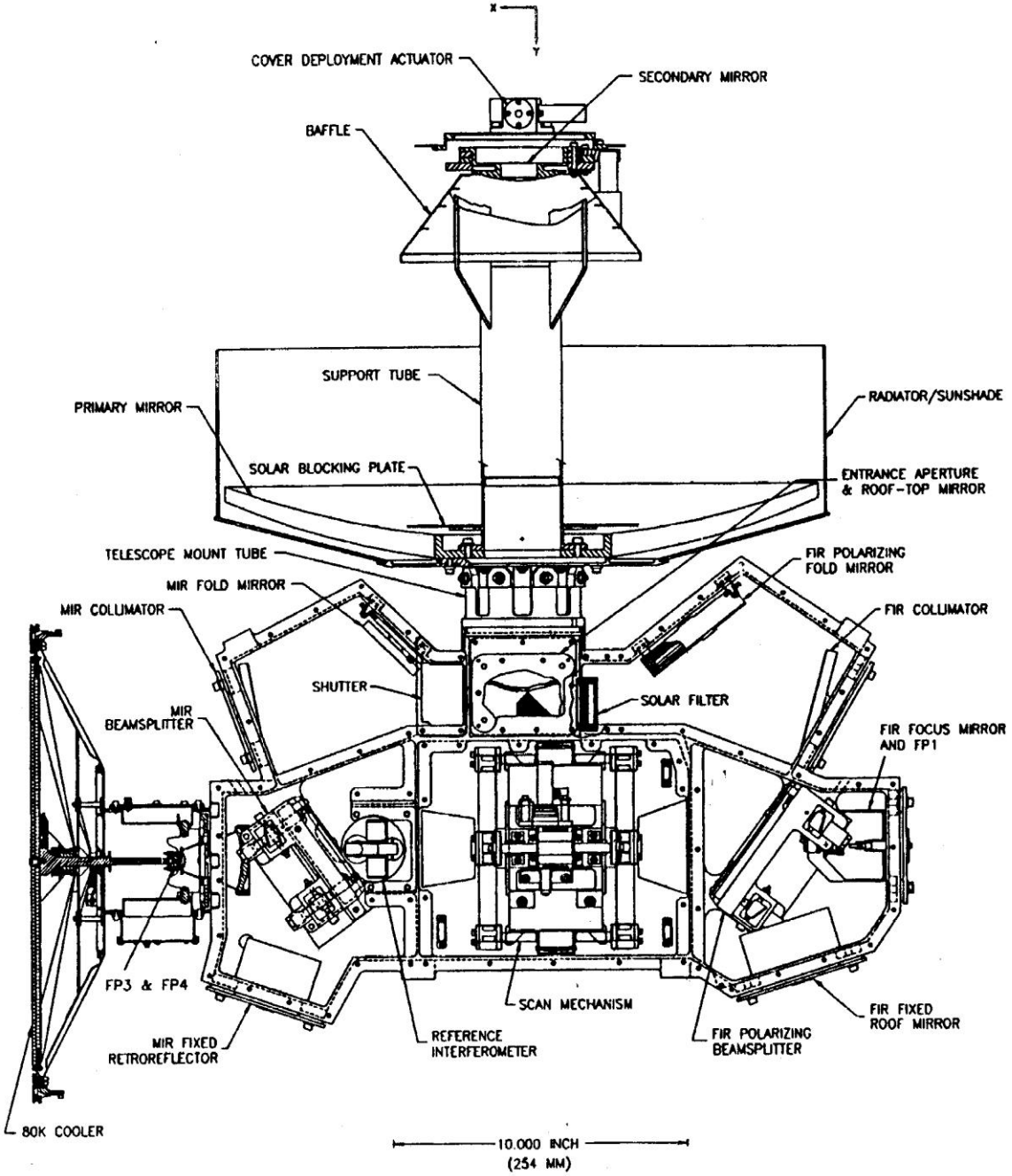
Toledo, Spain 30 May 2011

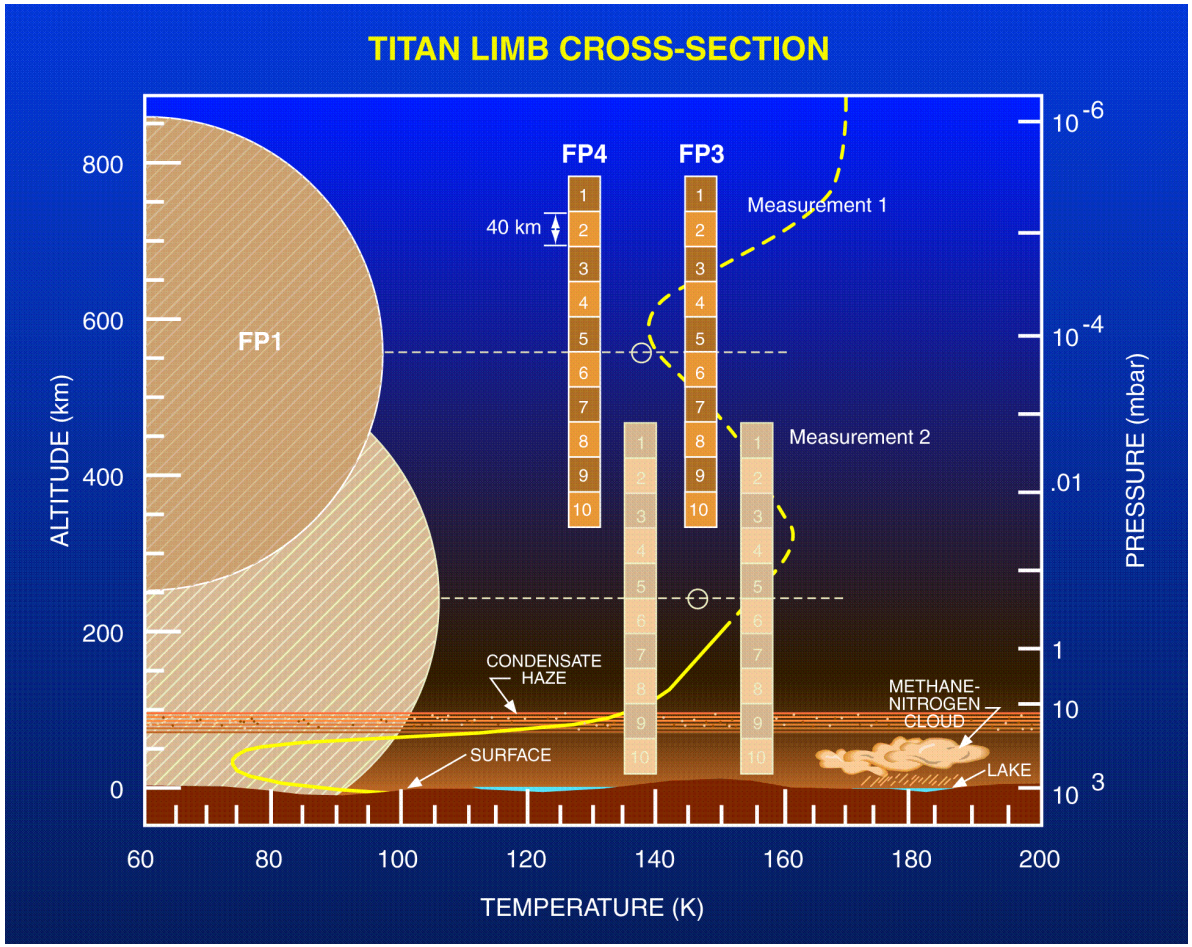
Composite Infrared Spectrometer on Cassini



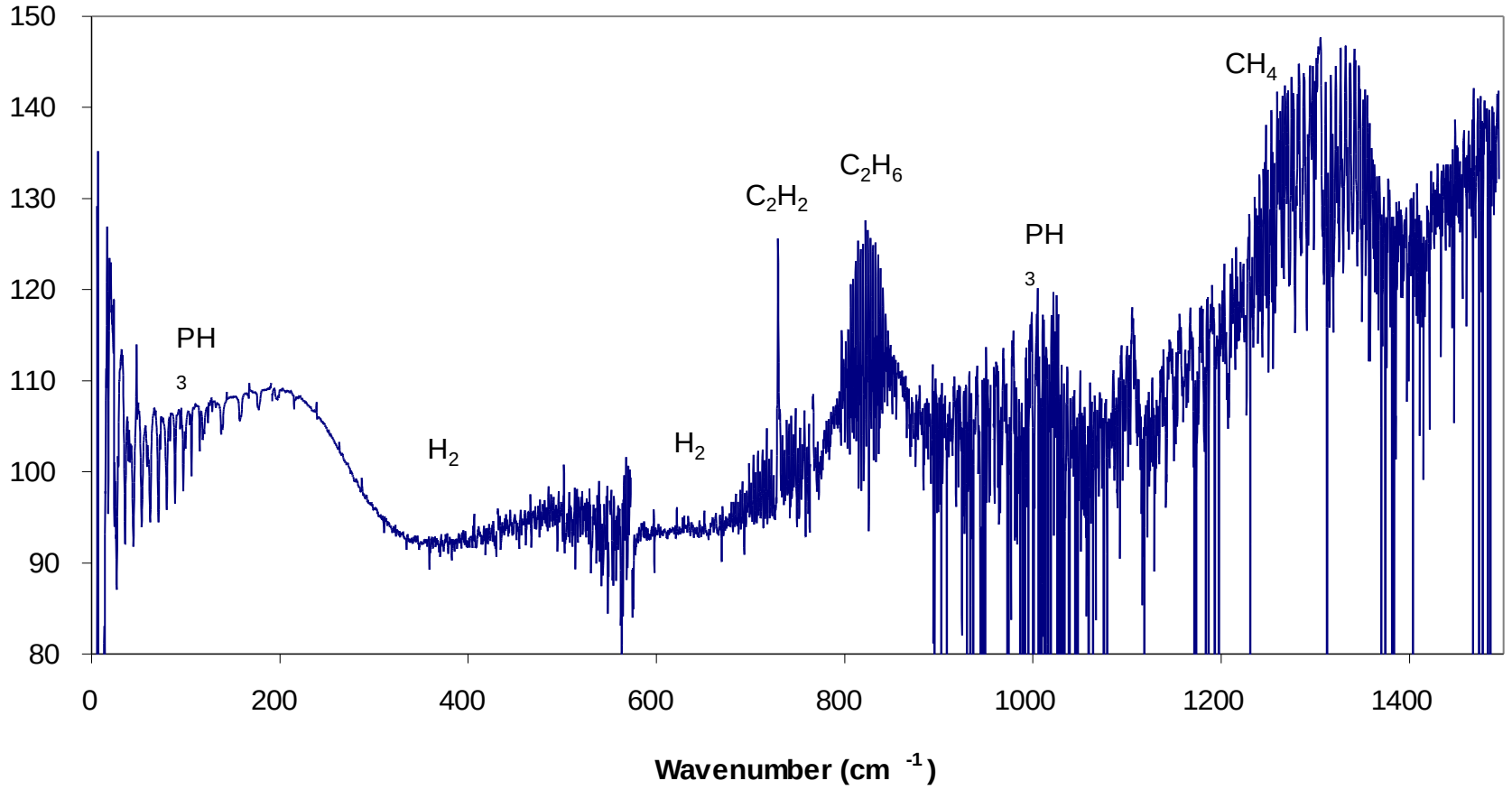
CIRS Mechanical Layout



CIRS FOV's Projected on Titan's Limb



Saturn Brightness Temperature Spectrum



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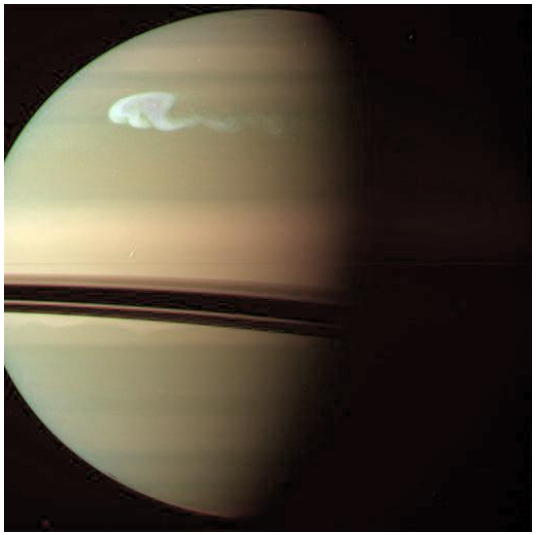
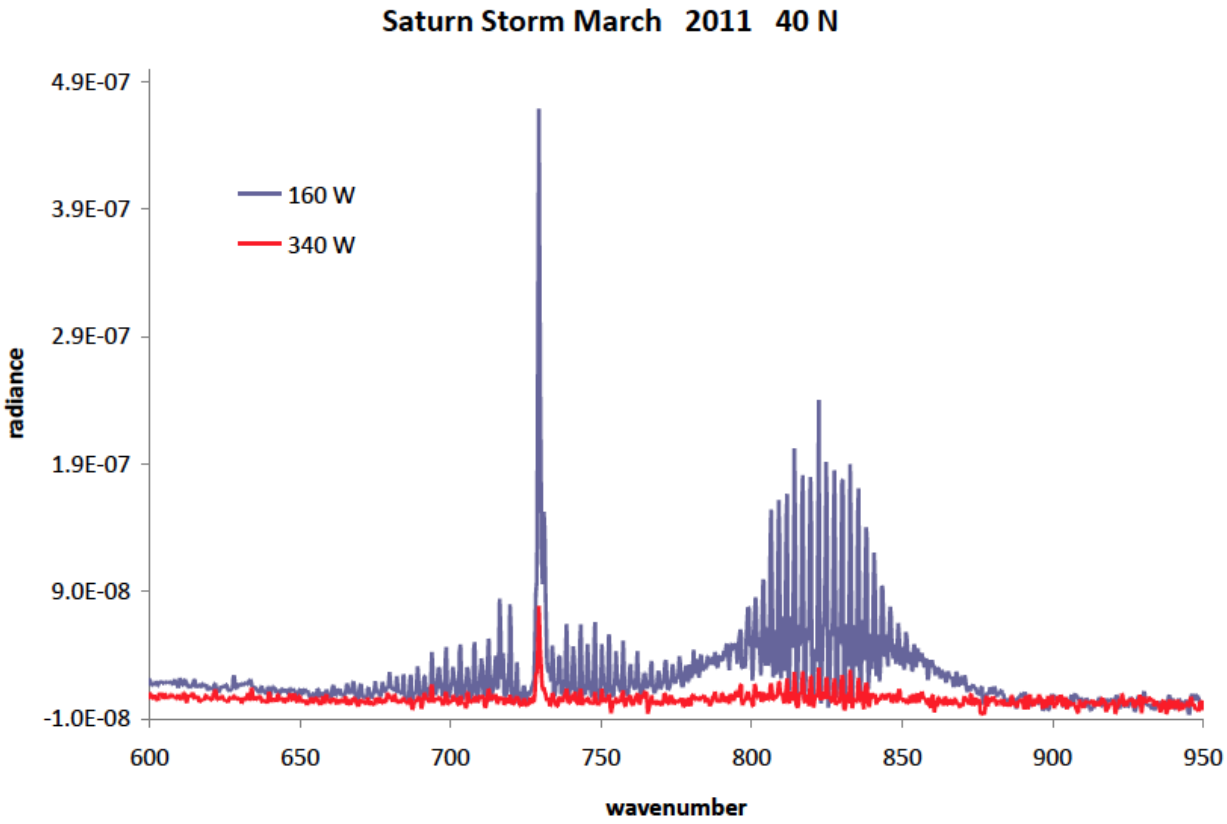
Saturn Storm 2010-11 at 40° N latitude





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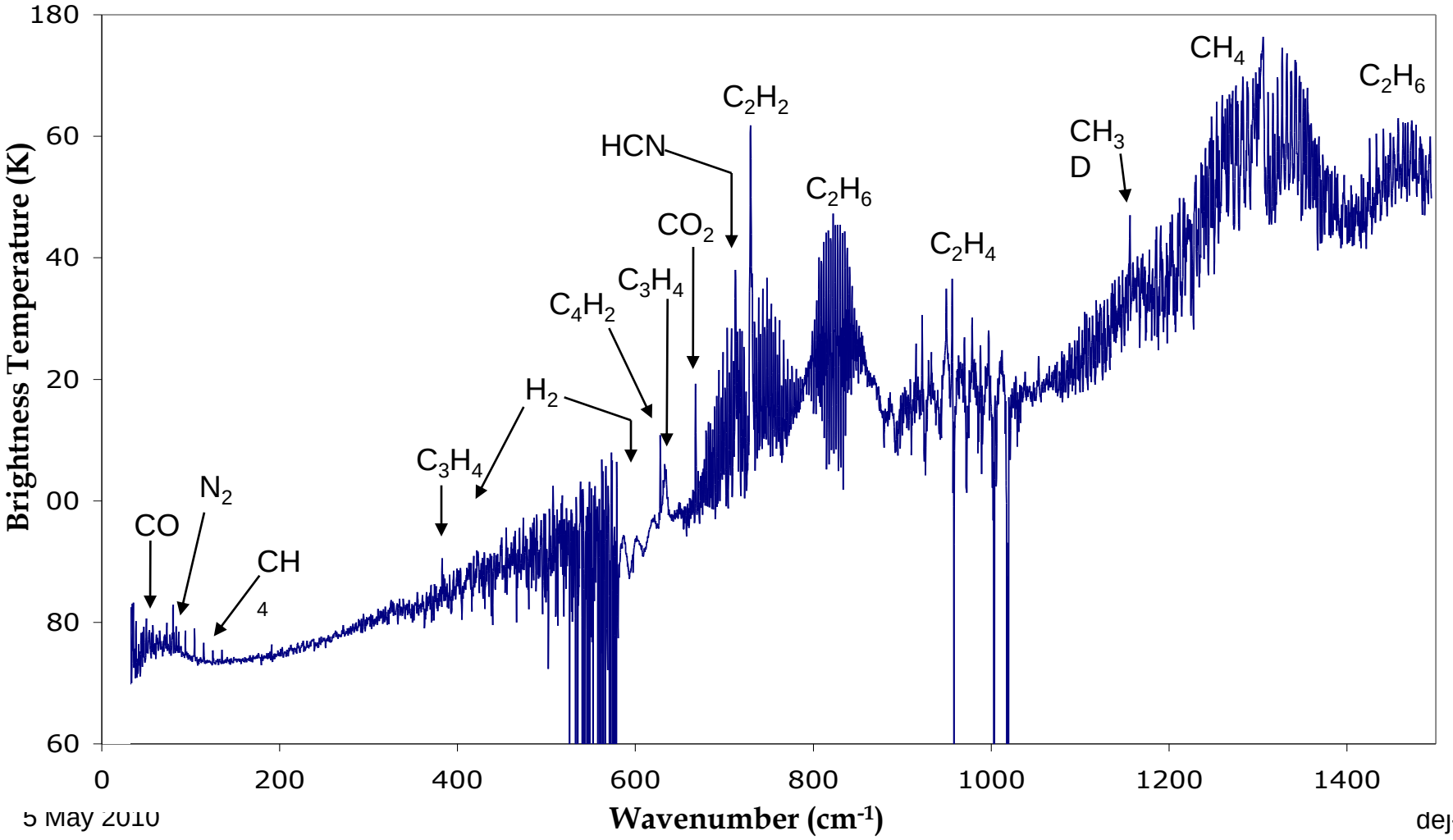
Composite Brightness Temperature of Titan



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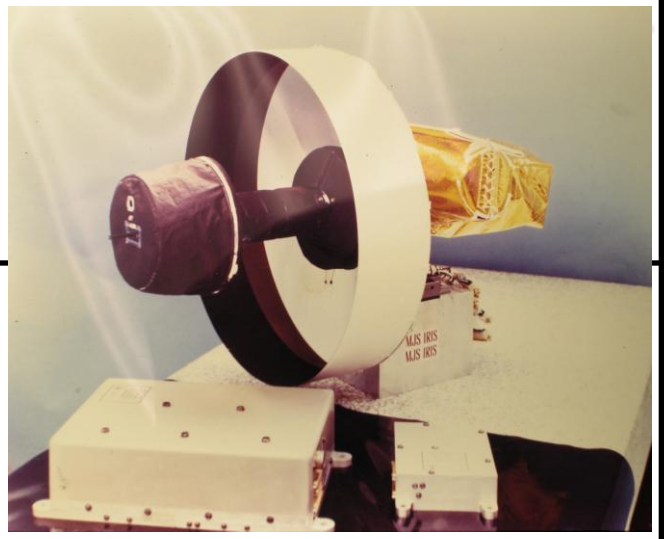
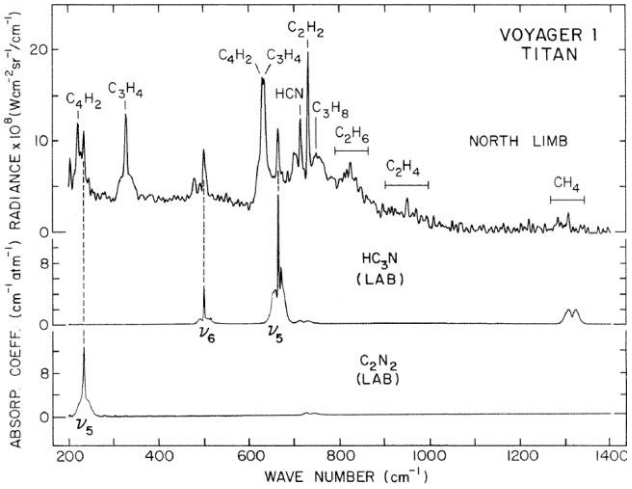
Laboratory spectroscopy and Voyager IRIS

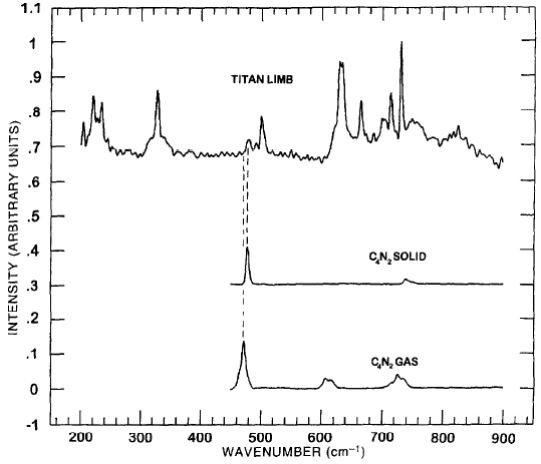


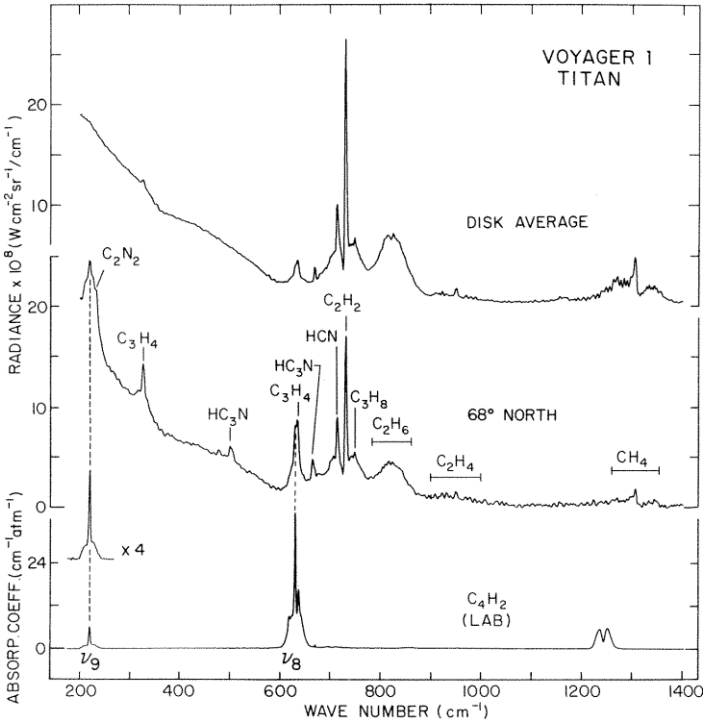
HC_3N

C_2N_2



C_4N_2





C_4H_2

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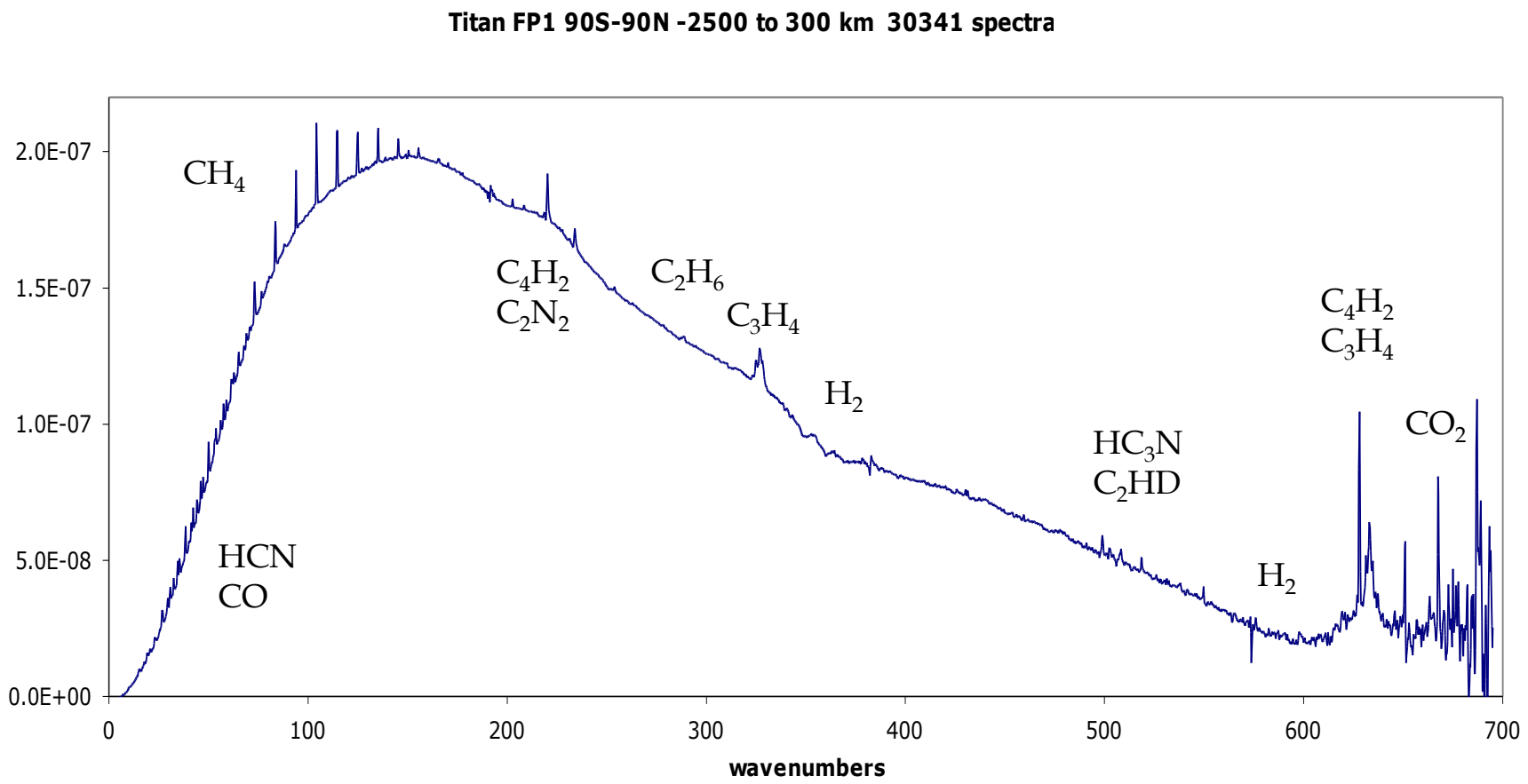
Titan FP1 Large Average



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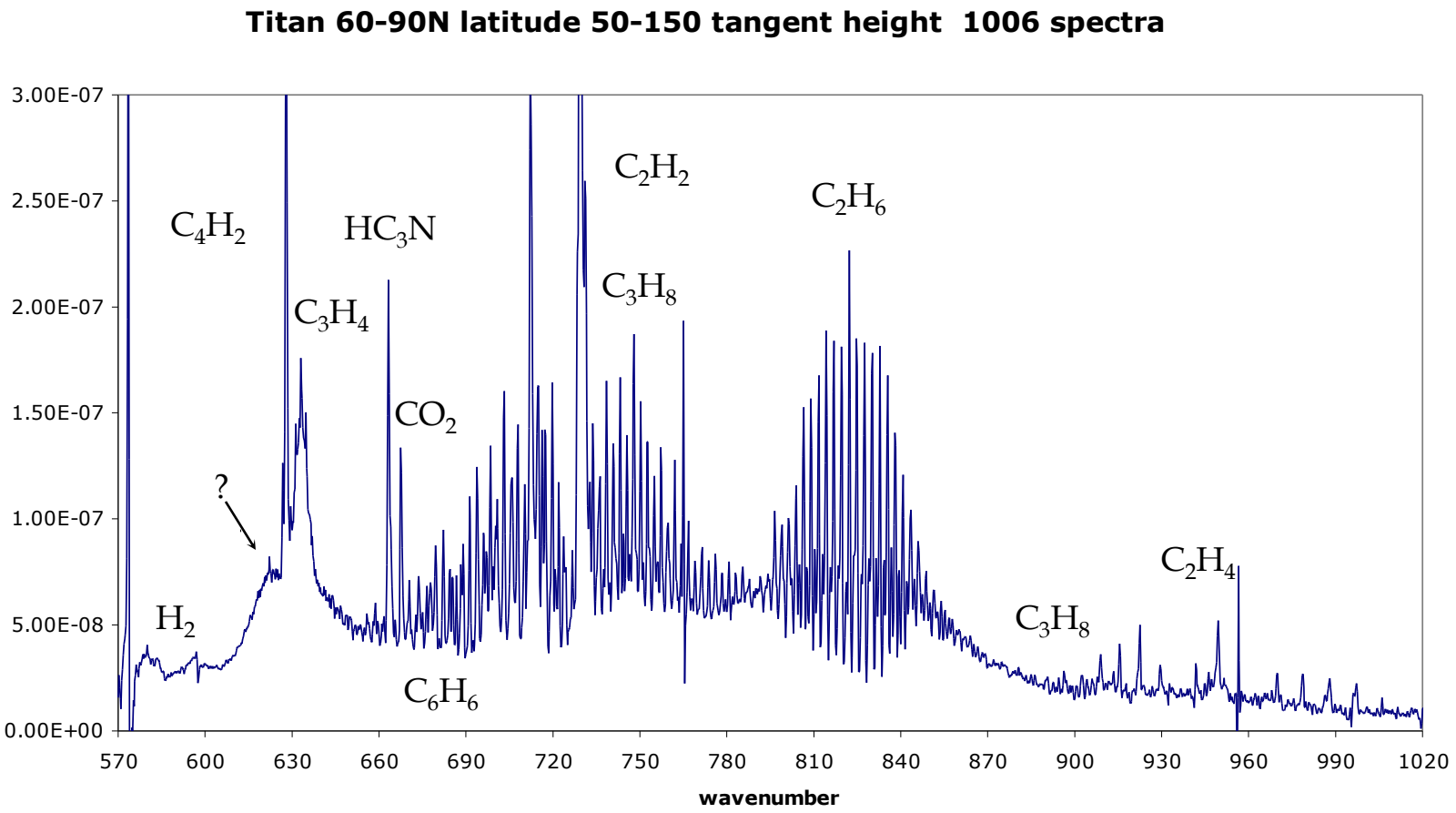
Titan FP3 Large Average



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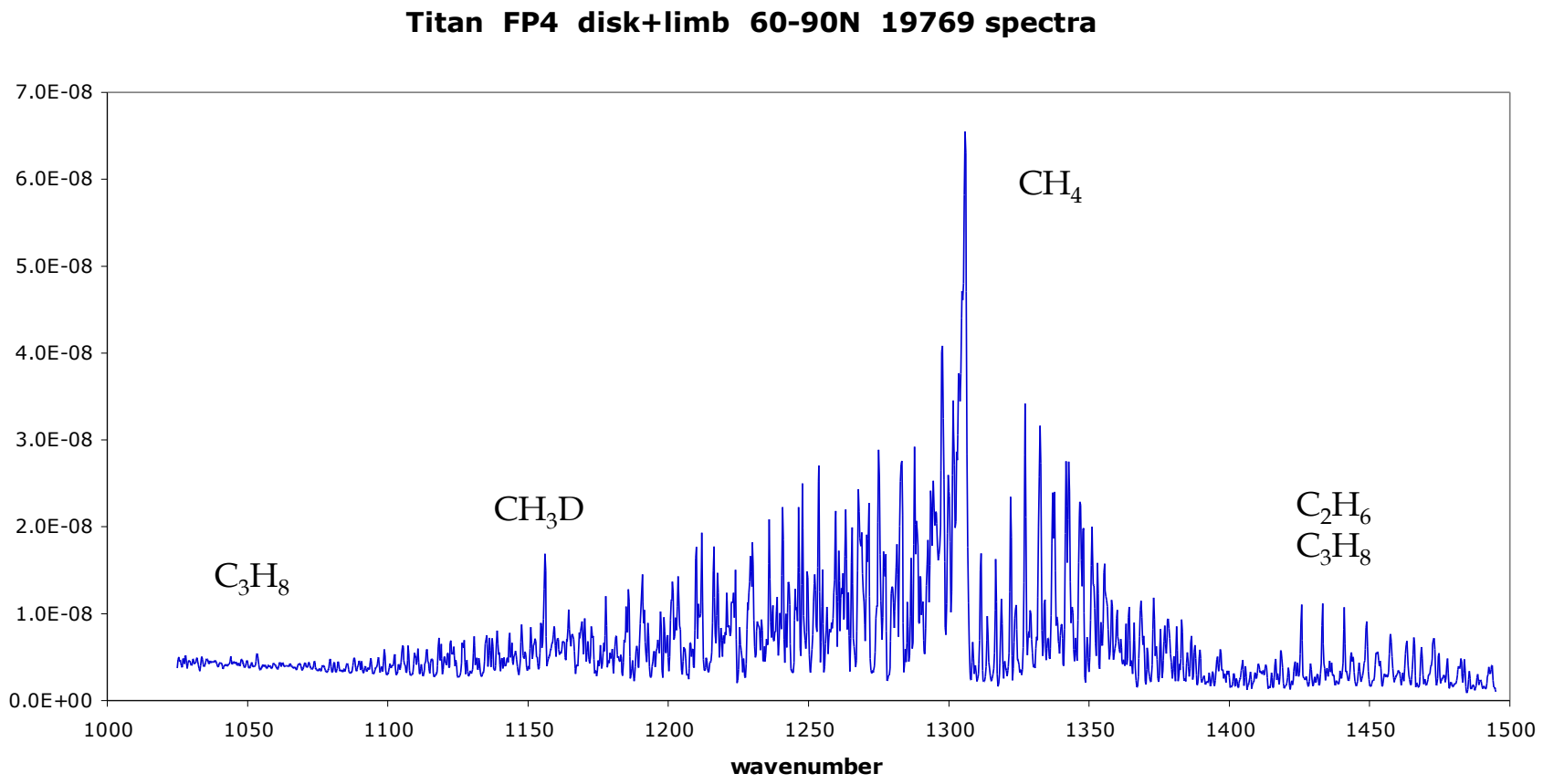
Titan FP4 Large Average



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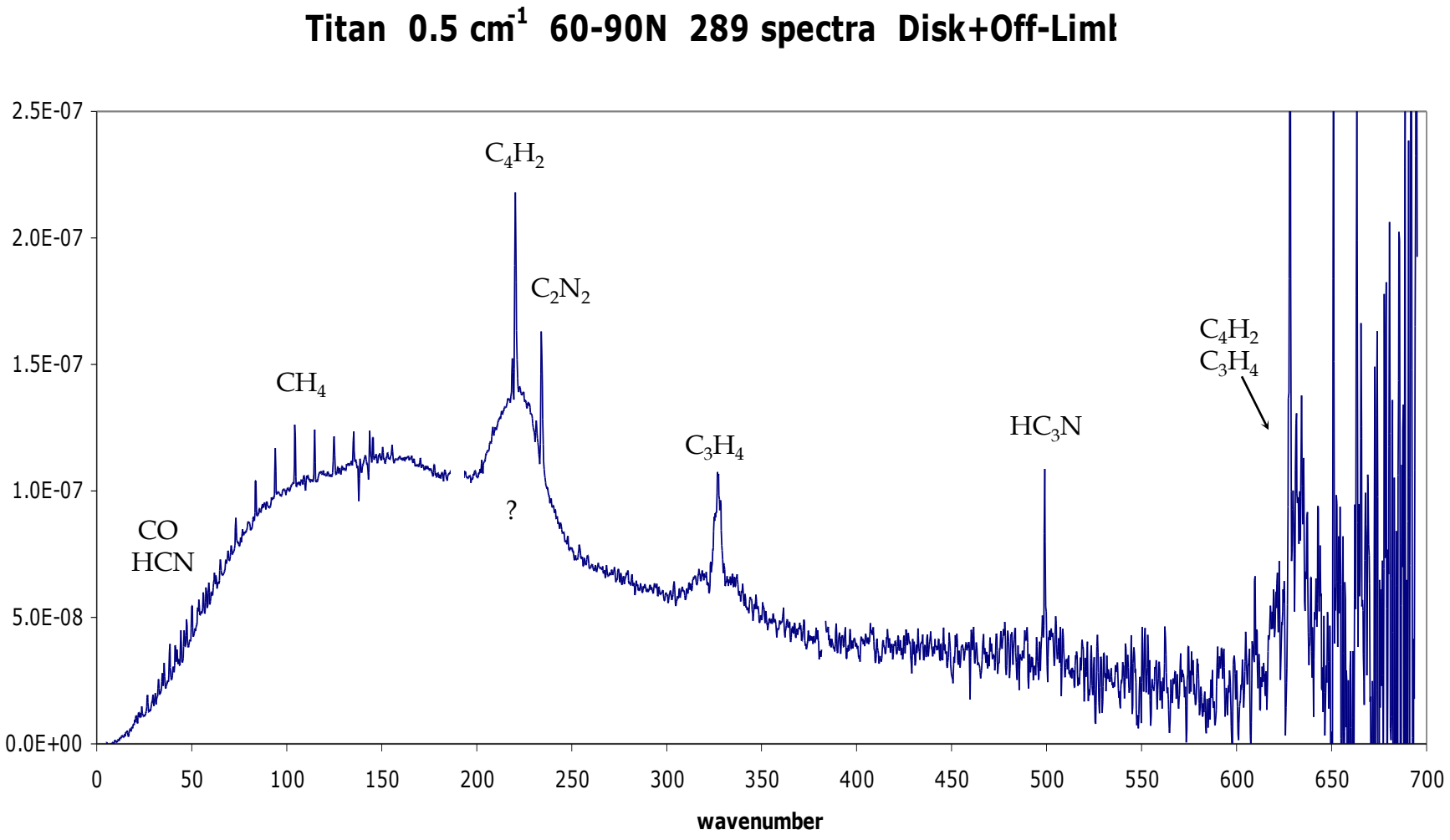
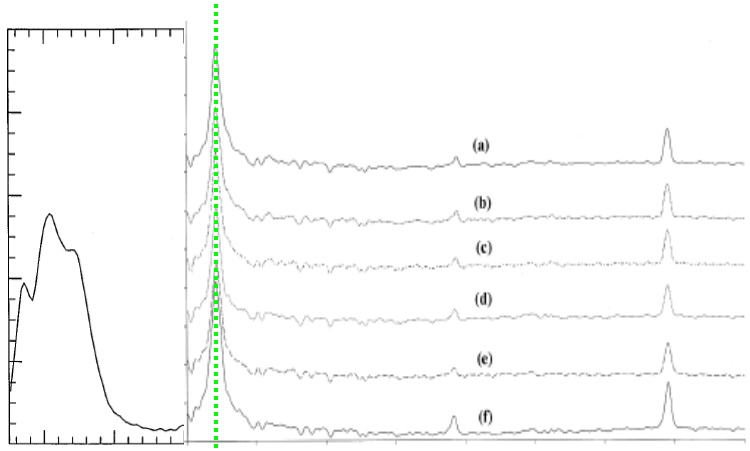
Titan's Atmospheric Haze

CIRS FP1 spectrum at 0.5 cm^{-1} resolution

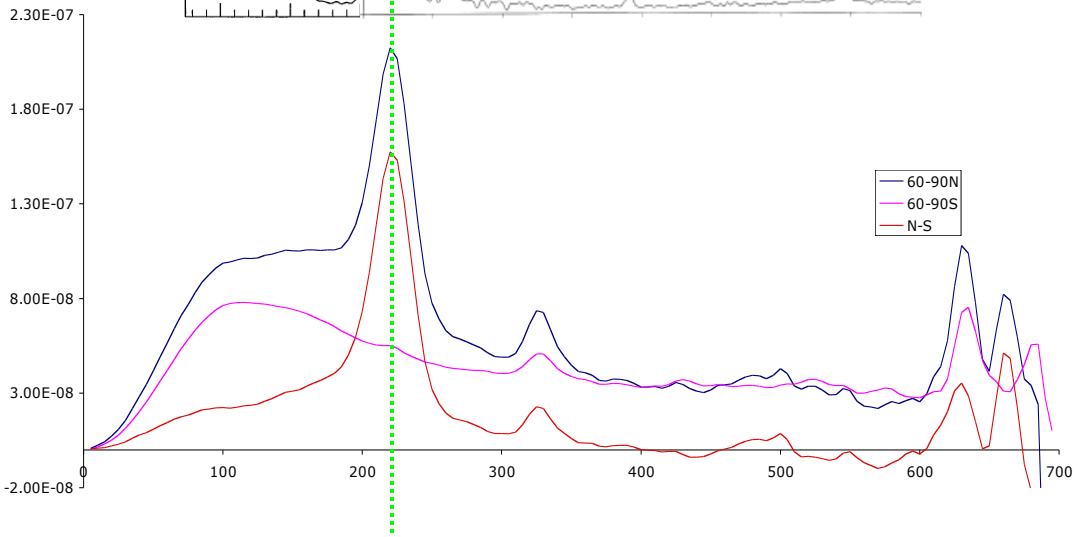


Solid Propionitrile as a candidate for 200 cm^{-1} feature

Laboratory
Crystalline CH_3CH_2CN
DelloRusso & Khanna, Icarus 123, 366 (1996)
Khanna, Icarus 177, 116 (2005)



Titan
CIRS



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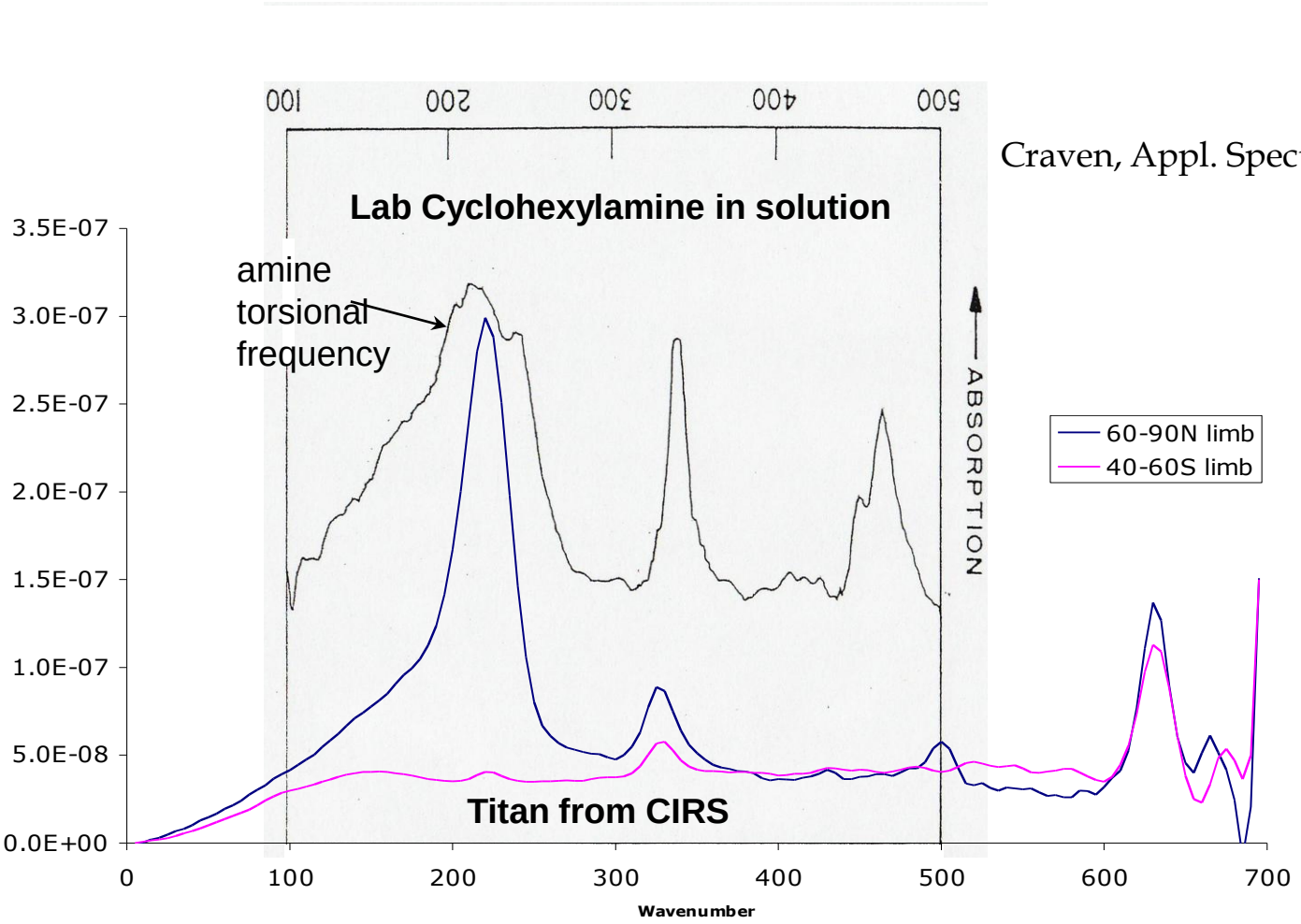
Amine torsional group frequency as a candidate for 225 cm^{-1} emission feature

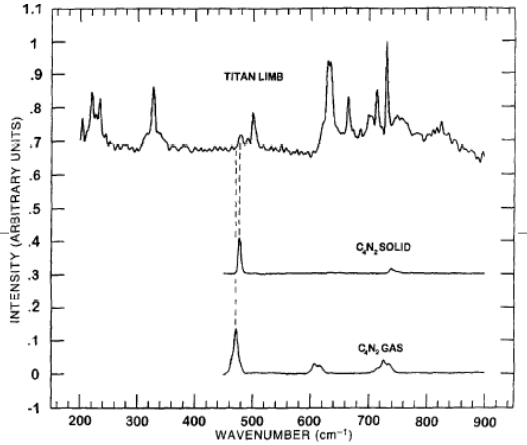


Craven, Appl. Spect. 26, 449 (1972

Identifications of condensed species in Titan from laboratory studies

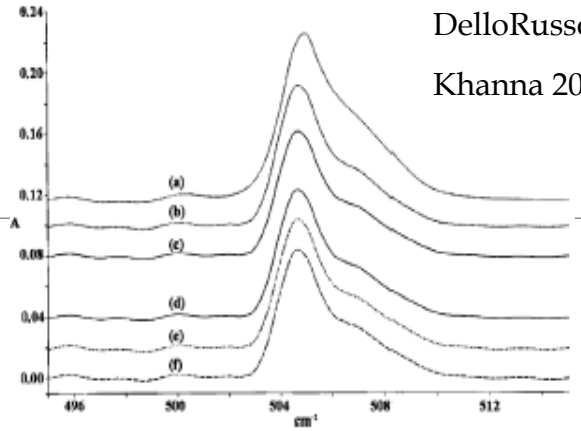
Khanna *et al.* 1987

Samuelson *et al.* 1997



DelloRusso & Khanna 1996

Khanna 2005



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Carbon isotope enrichment on Titan varies among molecular species

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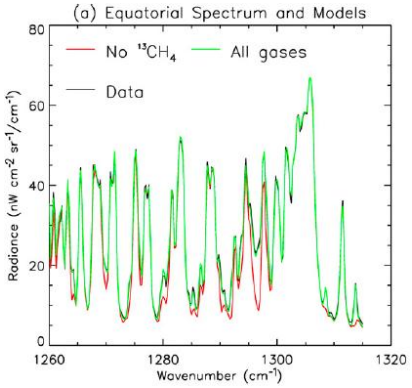
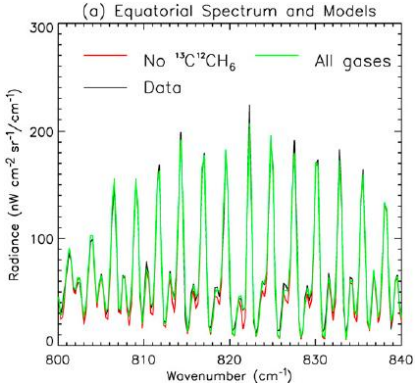
Isotopic intensities and Kinetic Isotope Effects need to be known

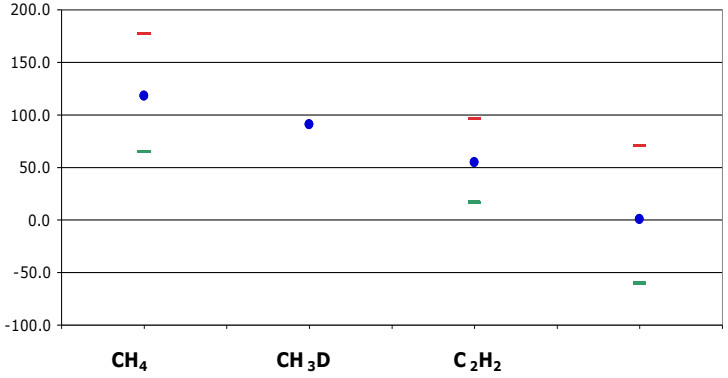
Methane from CIRS



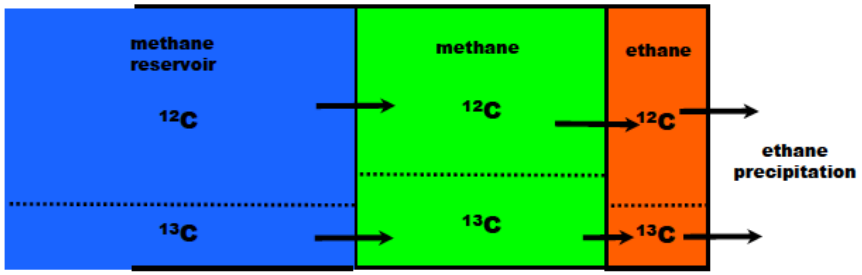


Ethane from CIRS

C-13 Enrichment in Titan' Stratosphere



Can C-13 fractionation tell us about the origin of CH_4?



$$\left.\frac{^{12}C}{^{13}C}\right|_{\substack{reservoir\\methane}} \approx KIE \bullet \left.\frac{^{12}C}{^{13}C}\right|_{\substack{atmosphere\\methane}} \approx \left.\frac{^{12}C}{^{13}C}\right|_{\substack{atmosphere\\ethane}}$$

- Ethane is the main product of the destruction of methane.
- Ethane appears to be depleted in ^{13}C compared to methane.
- Ethane's $\delta^{13}C \sim 0$ is close to telluric and Solar System values.

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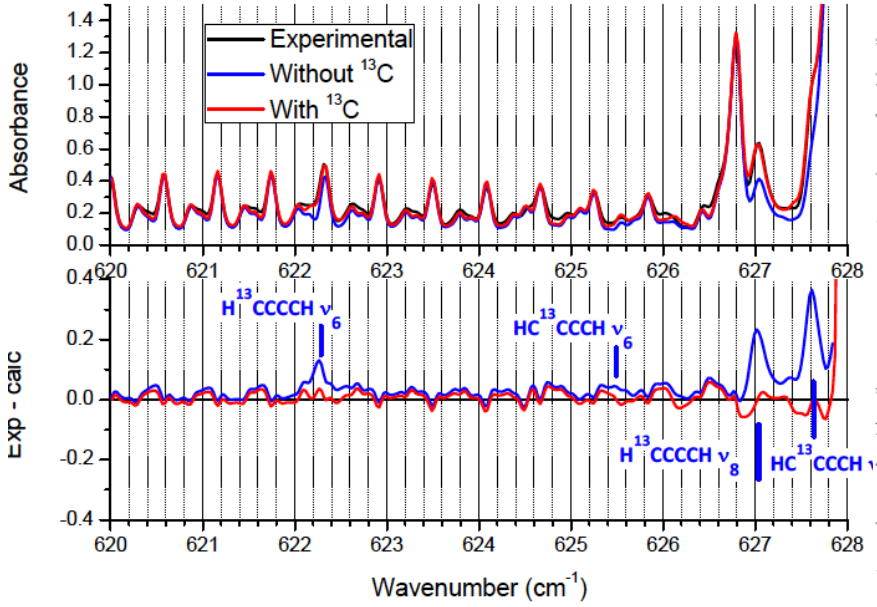
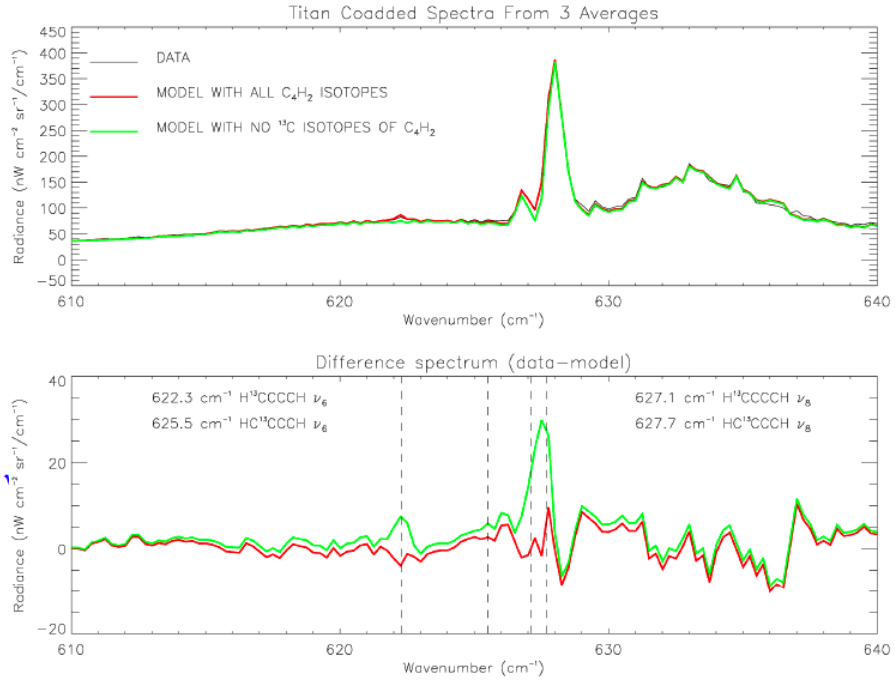
Isotopic species: identification of ^{13}C-diacetylene in Titan from laboratory measurements

CIRS



Laboratory spectra of $H^{13}CCCCH$ and $HC^{13}CCCH$



Titan from CIRS observations

Jolly *et al., Astrophys. J.* 714, 852 (2010).

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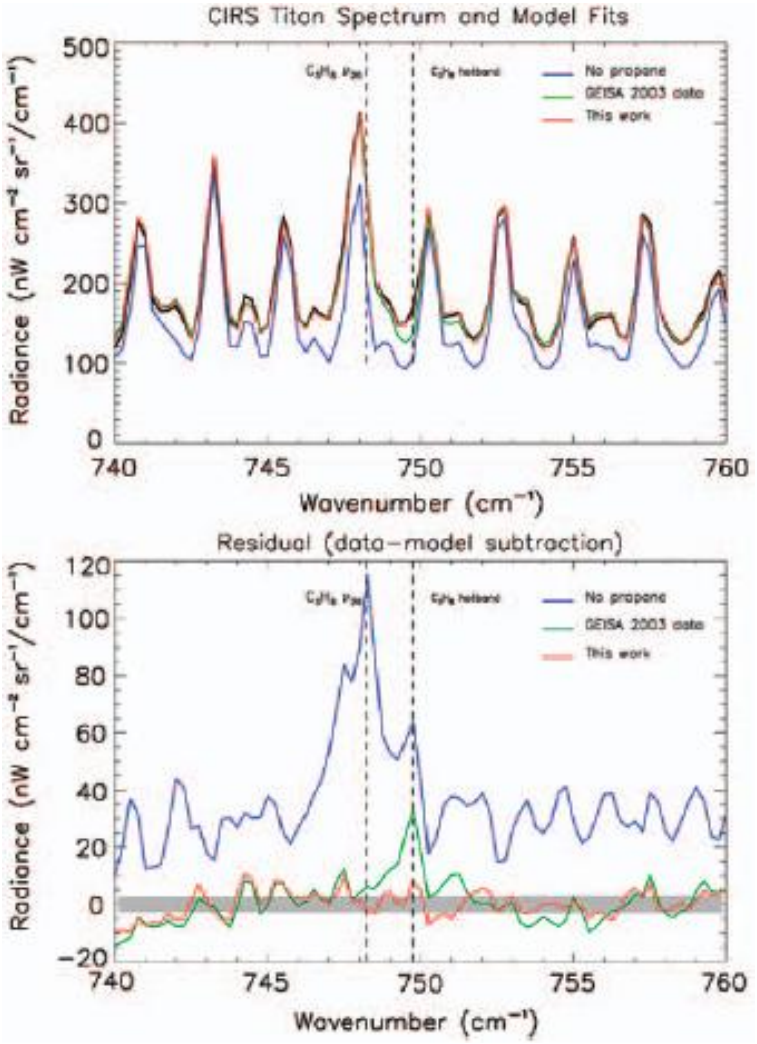
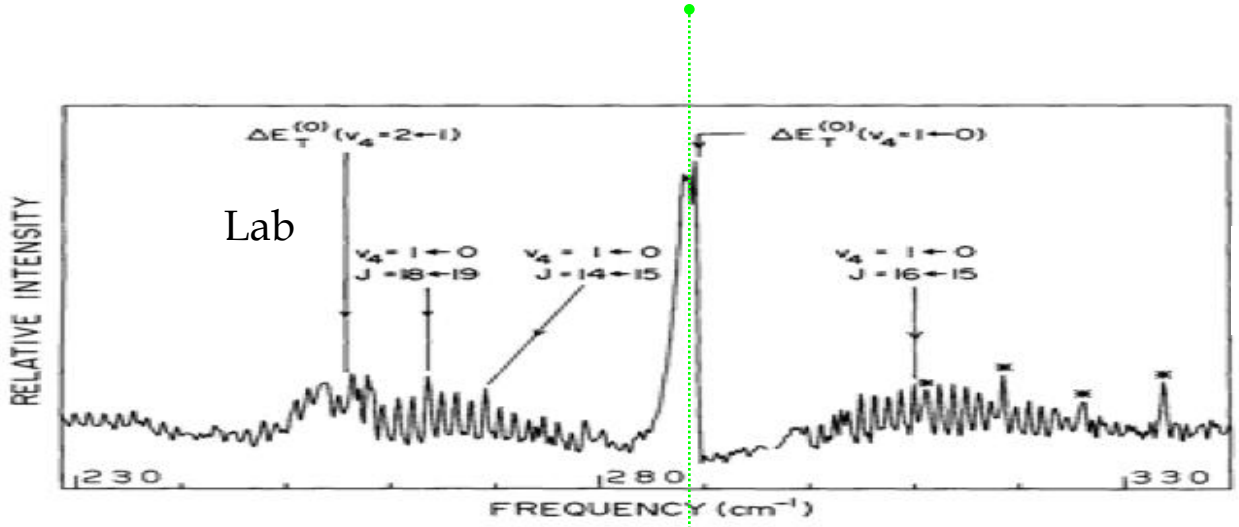
Modeling Titan's spectrum requires improved molecular parameters

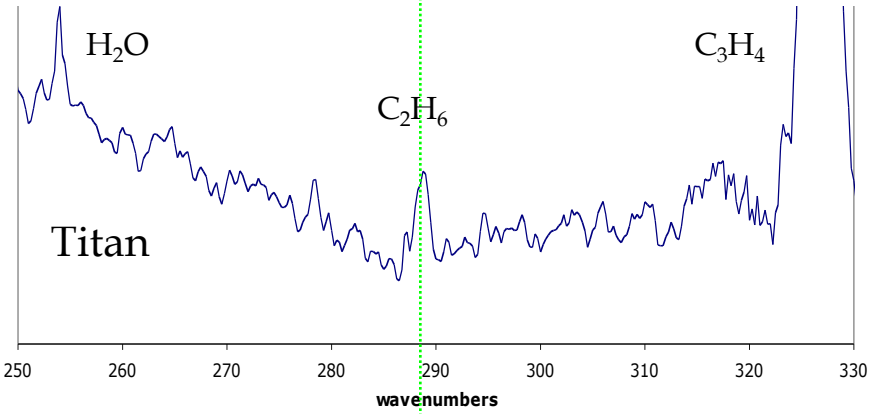


Missing C_3H_8 hot band in earlier model later fit with improved linelist from laboratory spectroscopy.

Flaud *et al., Molec. Phys.* in press, (2010)

Ethane ν_4 Torsional Band at 288 cm^{-1} in Titan





Moazzen-Ahmadi *et al.* 1988, JCP, 88, 563.


COMPOSITE INFRARED SPECTROMETER
CASSINI CIRS
NASA/GSFC
OBS. PARIS-MEUDON
QMW-LONDON
UNIV. OF OXFORD
CEA/ASTROPHYSIQUE