https://ntrs.nasa.gov/search.jsp?R=20100028137 2019-08-30T10:58:04+00:00Z

Hydrocarbons on the Icy Satellites of Saturn

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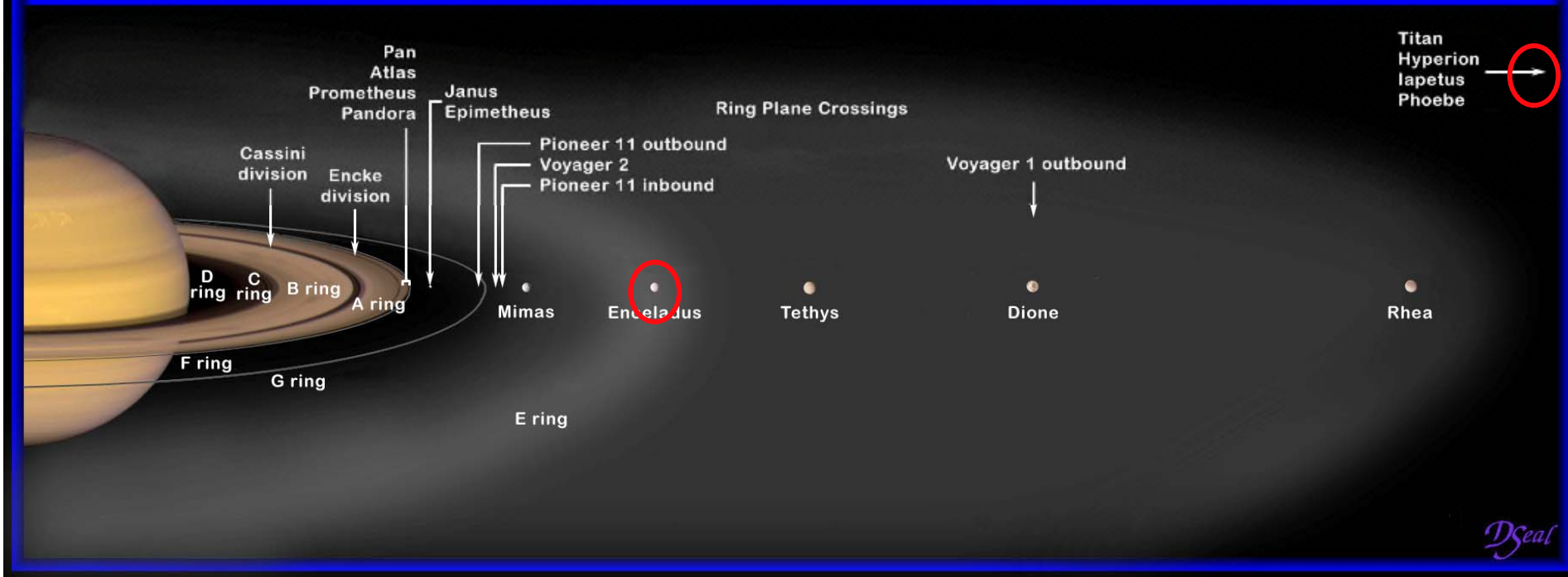
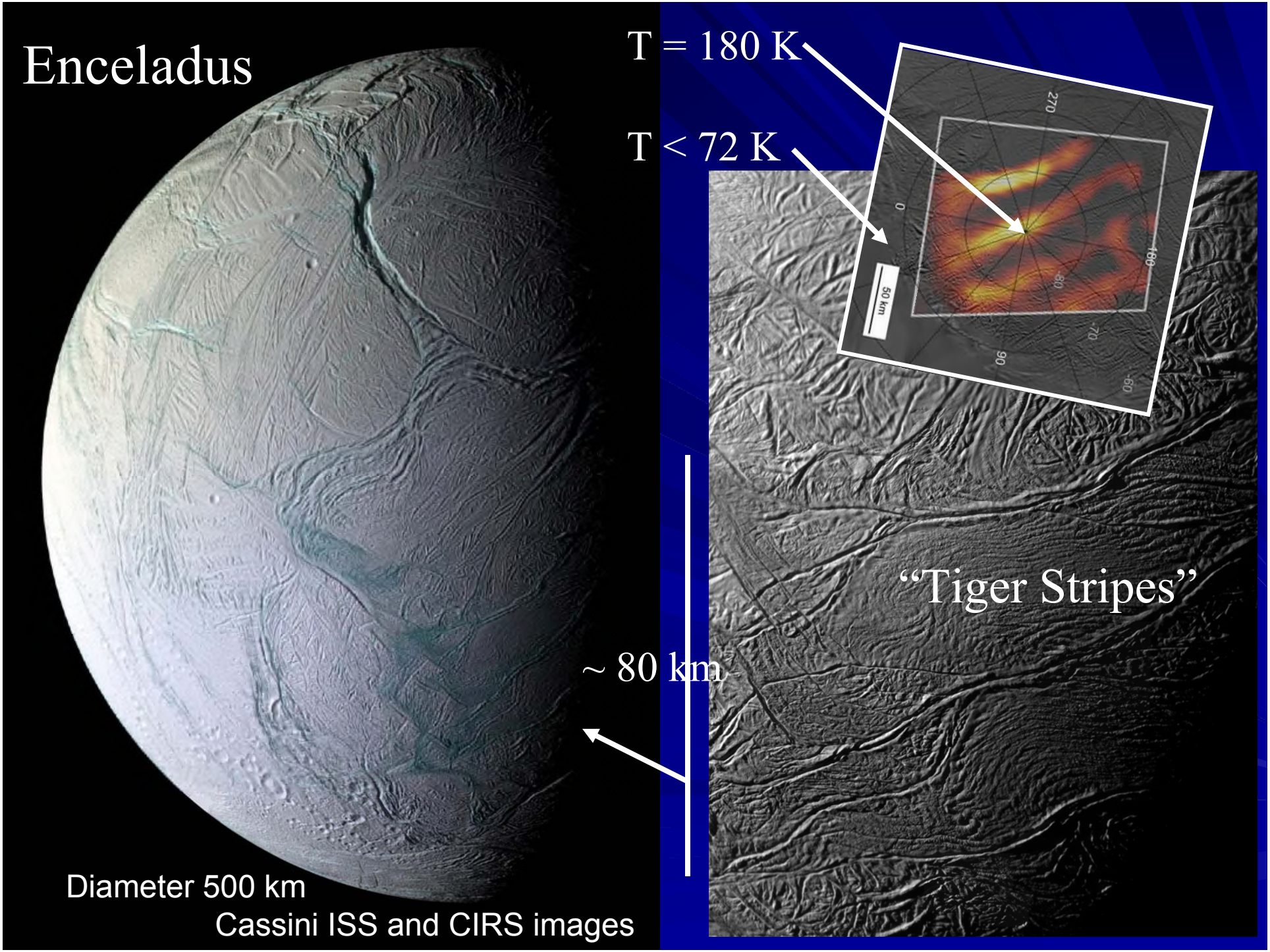
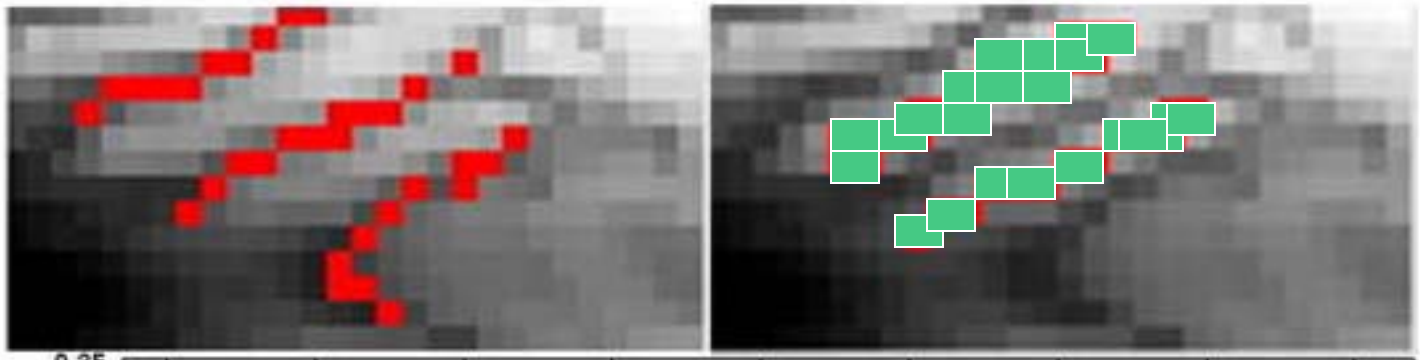
NASA Ames

Paris Workshop
May, 2010

Saturn's Satellites and Ring Structure



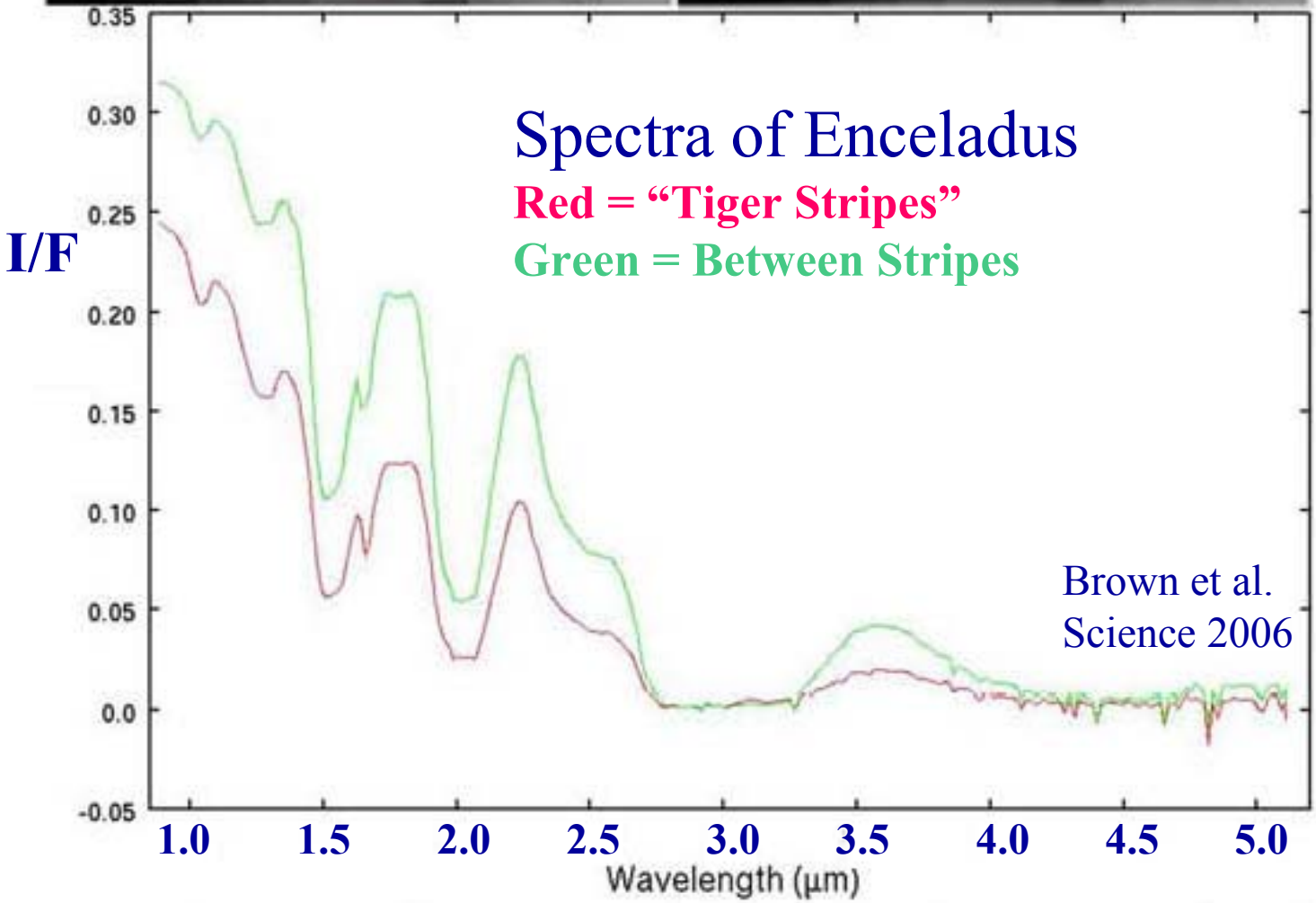

Enceladus
T = 180 K
T < 72 K
270
0
180
90
-90
50 km
“Tiger Stripes”
~ 80 km
Diameter 500 km
Cassini ISS and CIRS images



Spectra of Enceladus

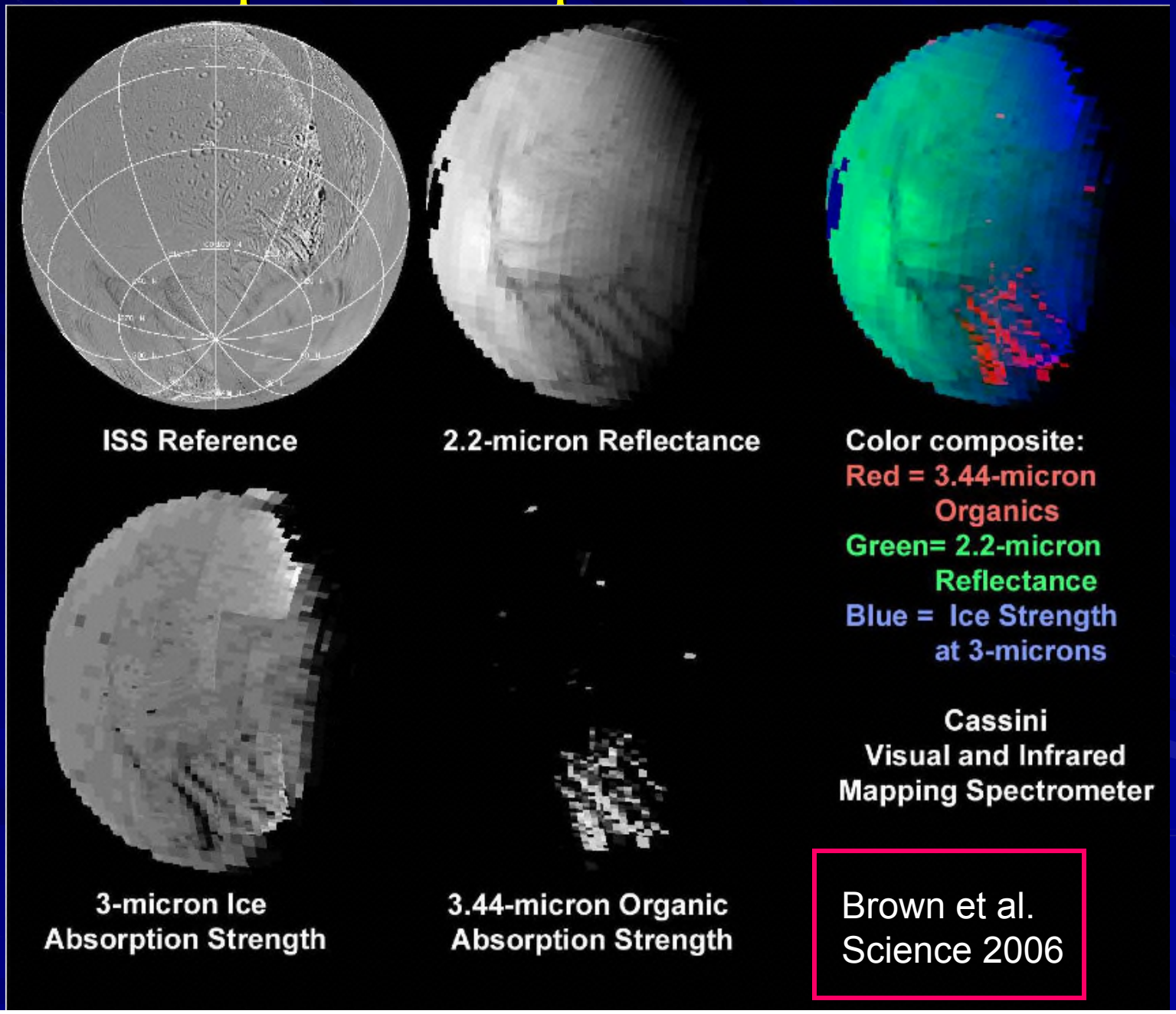
Red = "Tiger Stripes"

Green = Between Stripes



Brown et al.
Science 2006

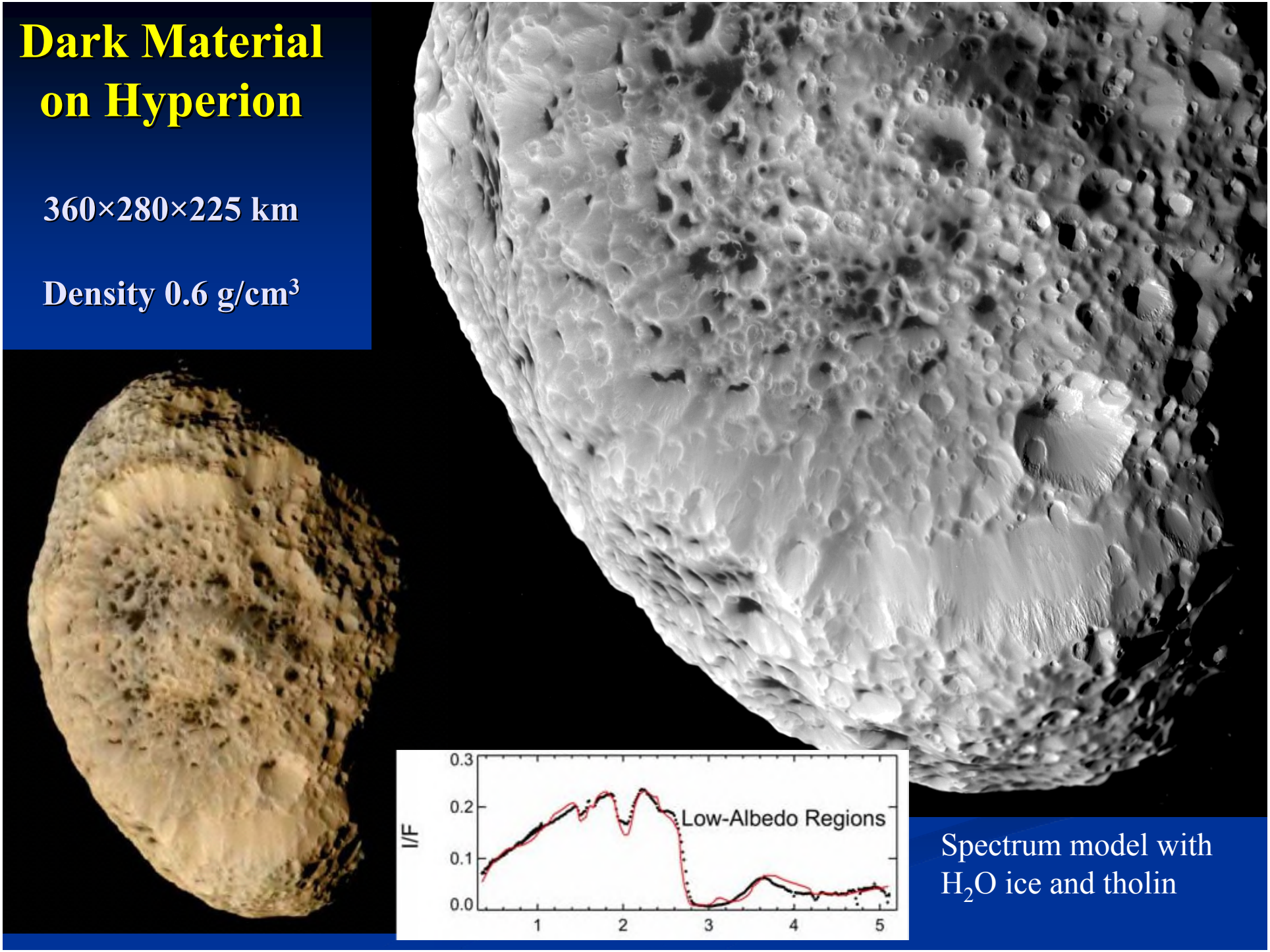
Spectral Maps of Enceladus



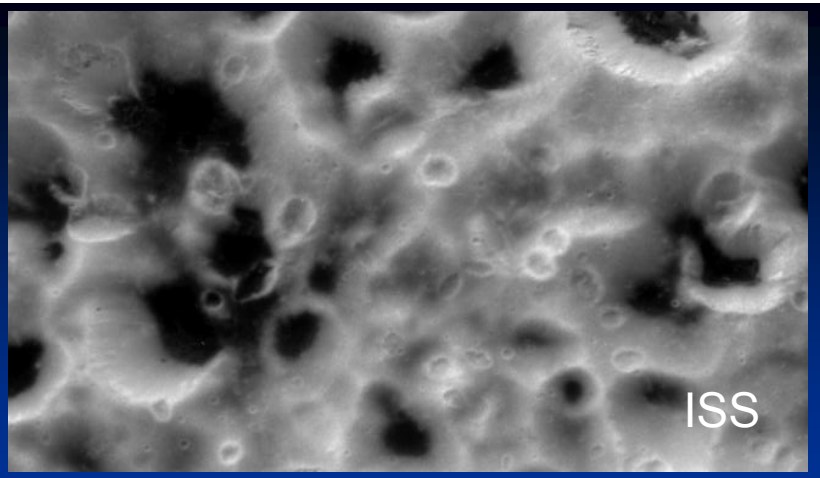
Dark Material on Hyperion

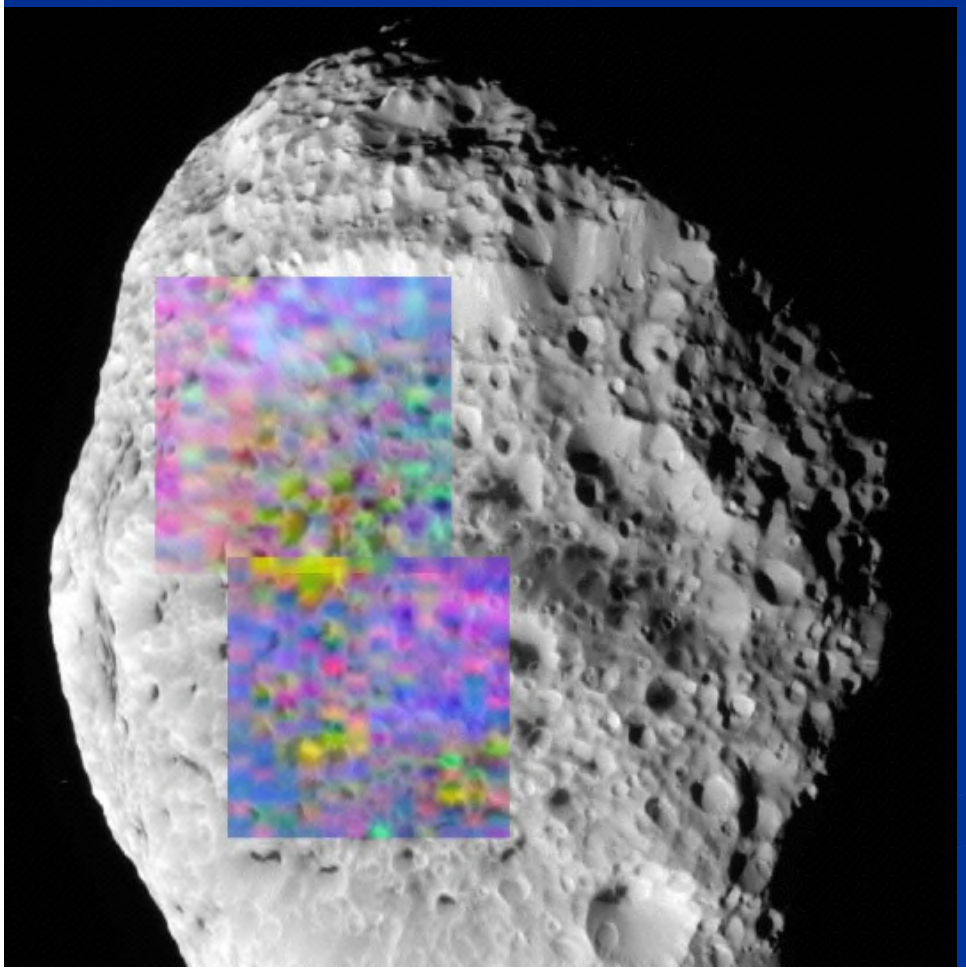
360×280×225 km

Density 0.6 g/cm^3



Spectrum model with H_2O ice and tholin





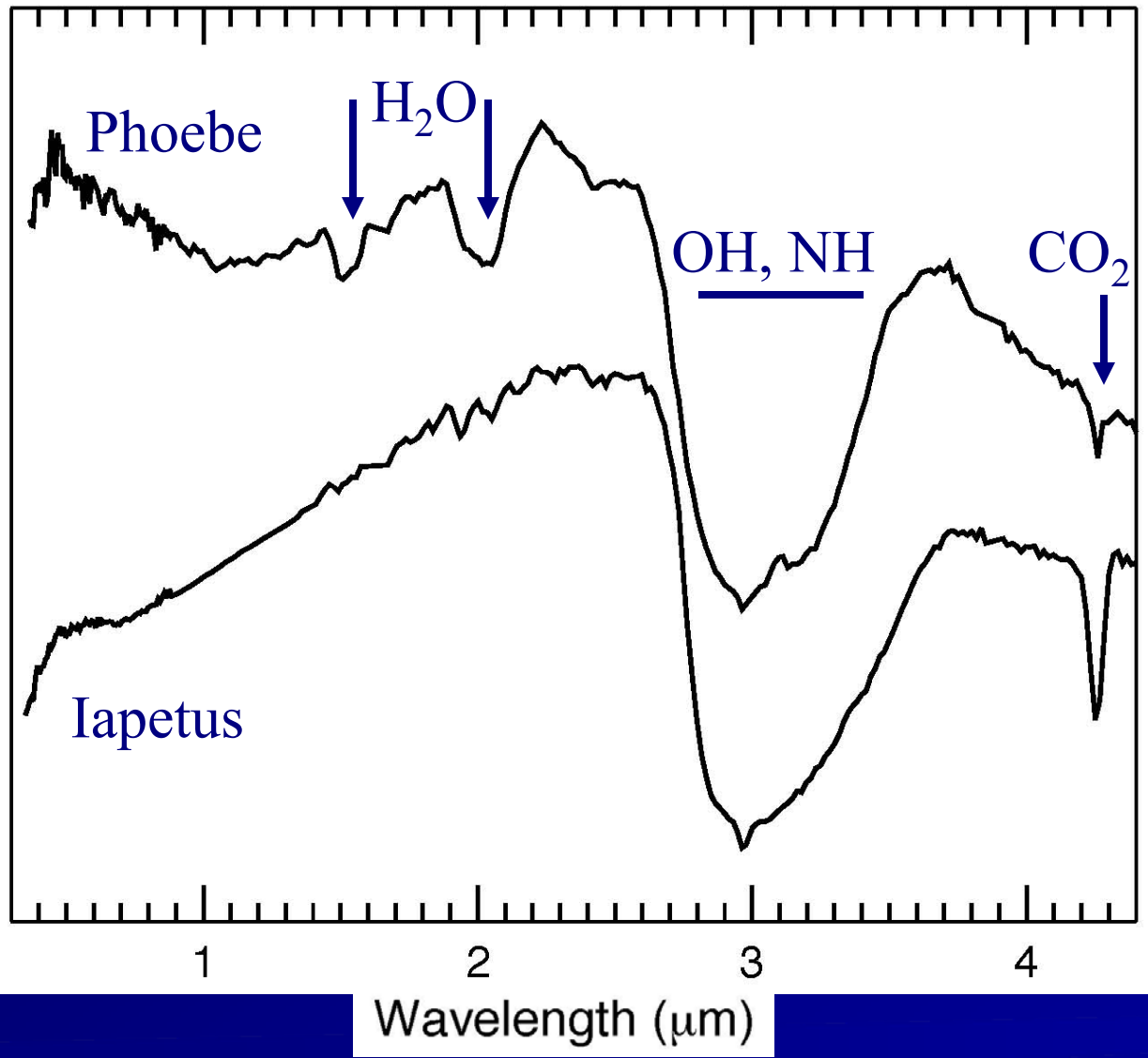
Hyperion Composition Map

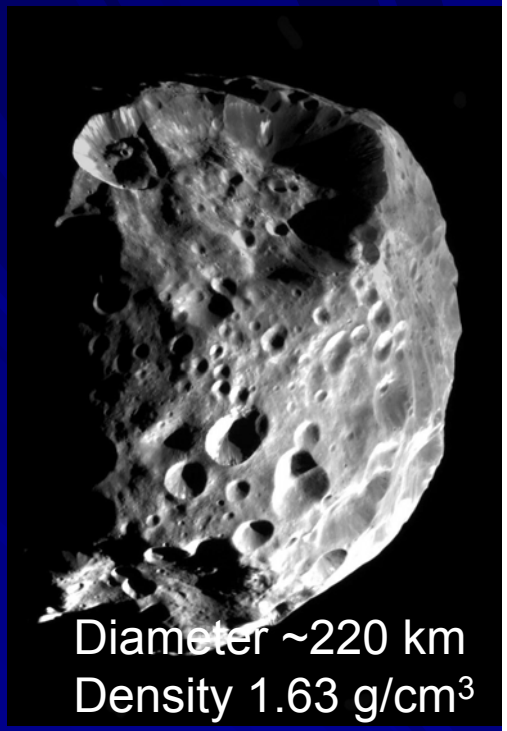
Color code:

Blue = H_2O band depth
Red = CO_2 band depth
Green = 2.42 µm band
Yellow = CO_2 + 2.42 µm
Magenta = H_2O + CO_2

Cruikshank et al. 2007. Nature 448, 54.

Cassini VIMS spectra of Phoebe and Iapetus

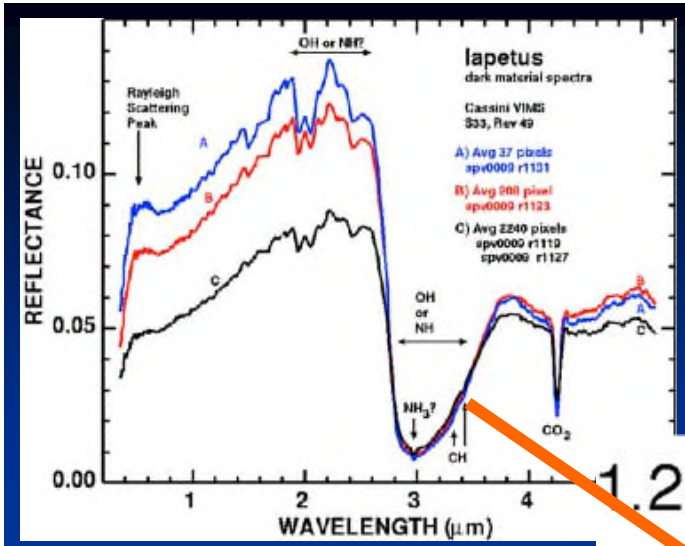




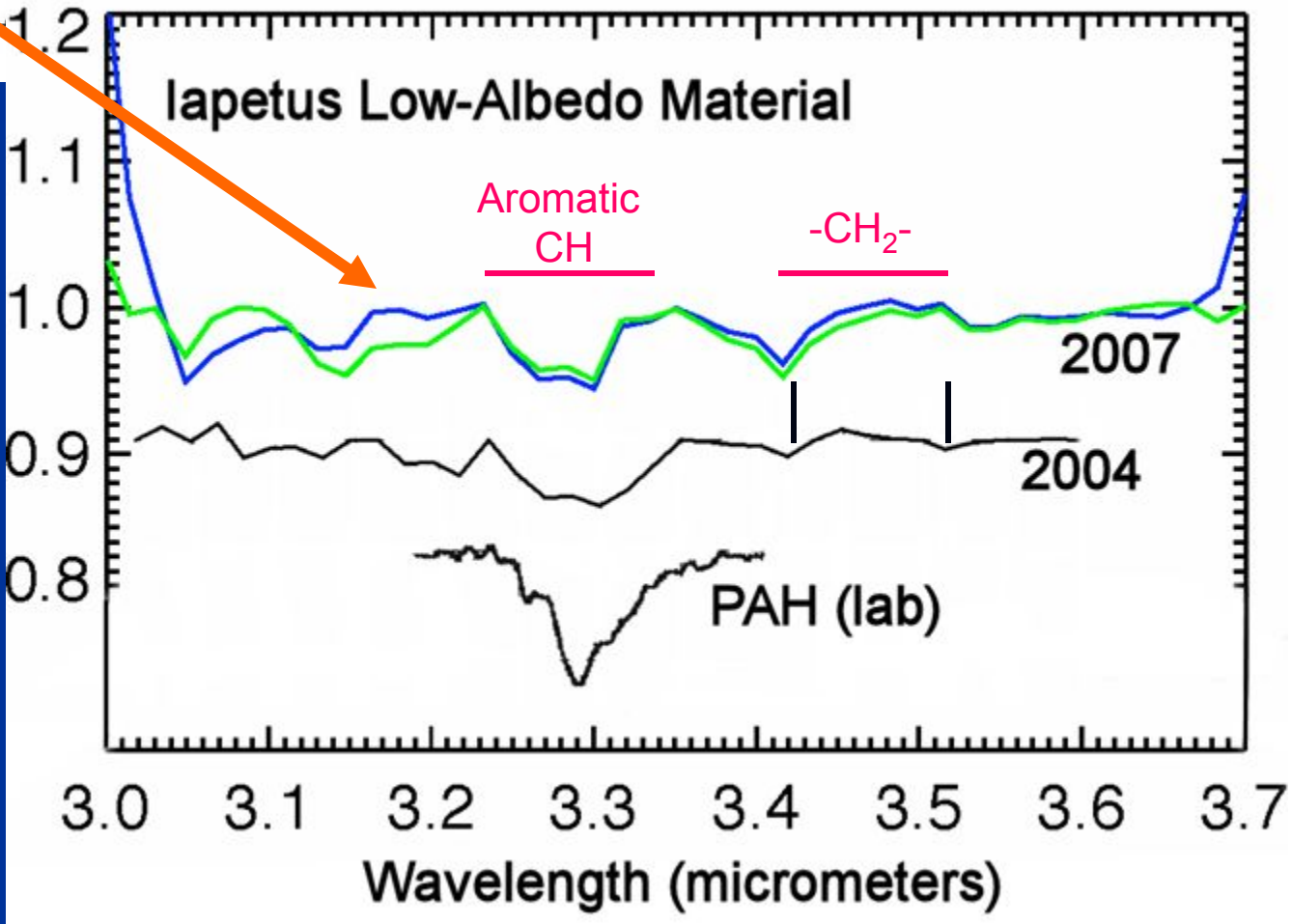
Diameter ~220 km
Density 1.63 g/cm^3

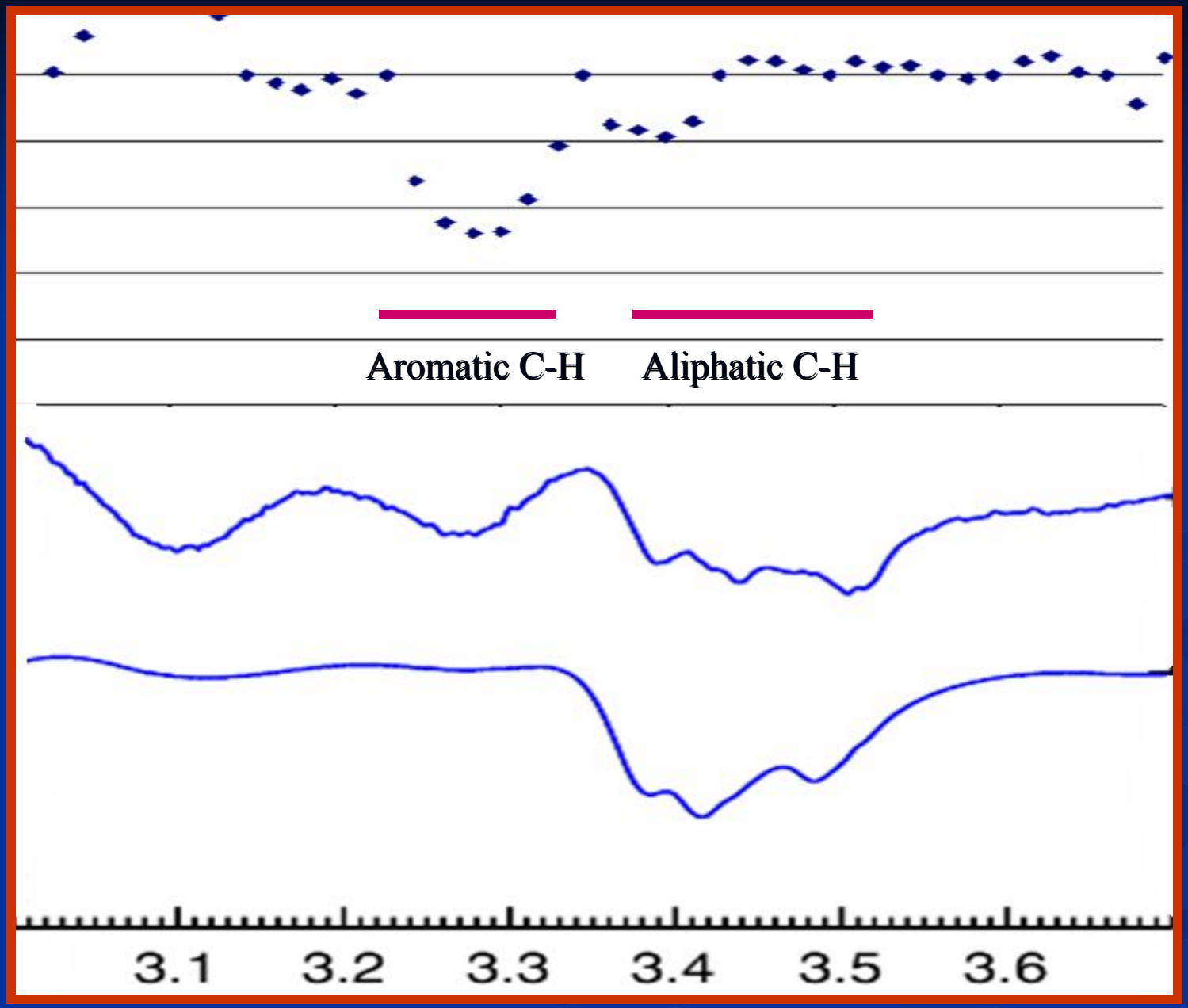
Diameter 1440 km
Density 1.08 g/cm^3

VIMS Spectral Study of Iapetus



Organic solids on Iapetus. Cruikshank et al. Icarus 2008



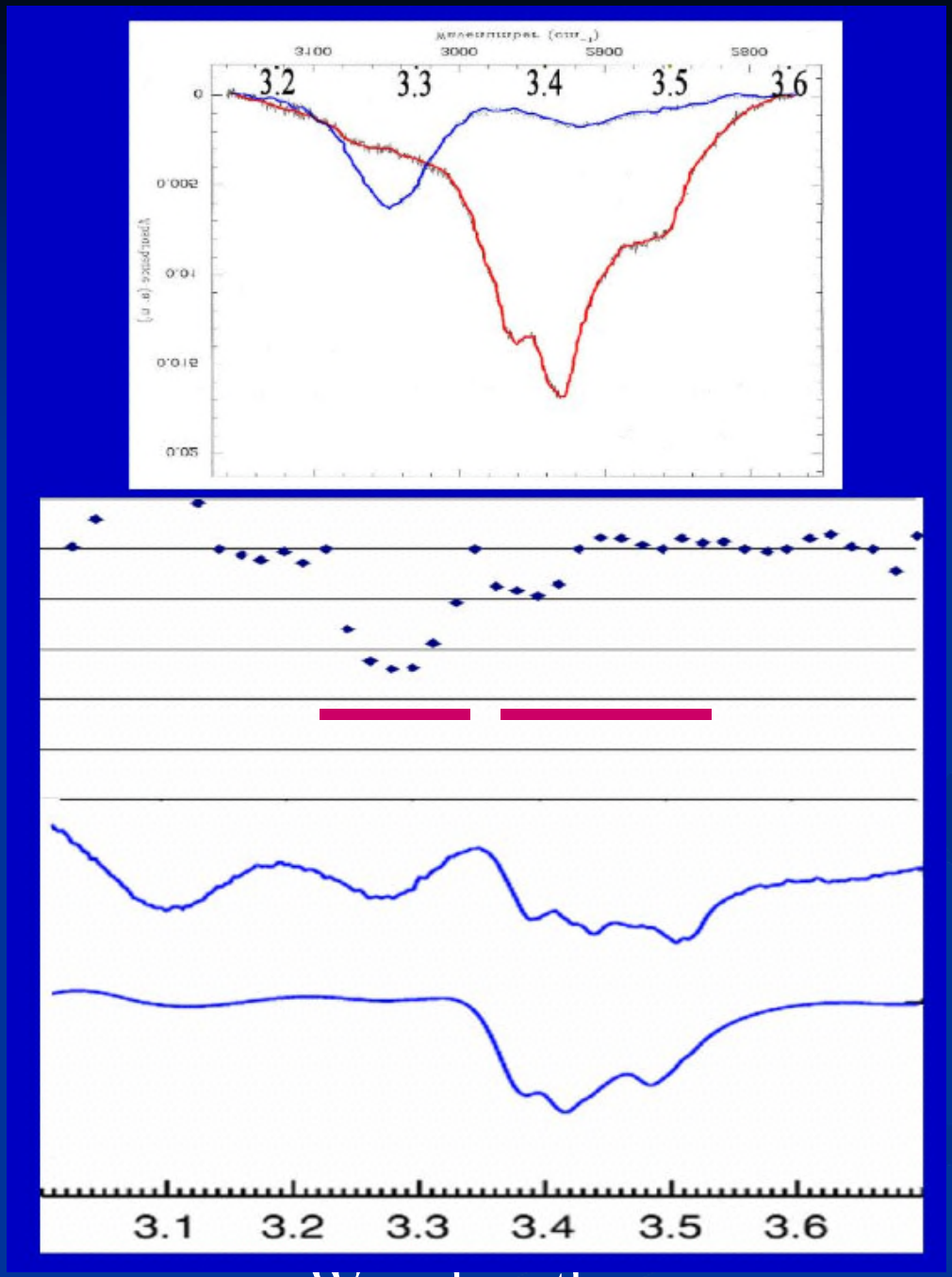


Iapetus Low-Albedo Material

Tagish Lake IOM

Murchison IOM

Meteorite transmission data from C. Alexander & G. Cody



Hydrogenated Amorphous Carbon (Mennella et al.)

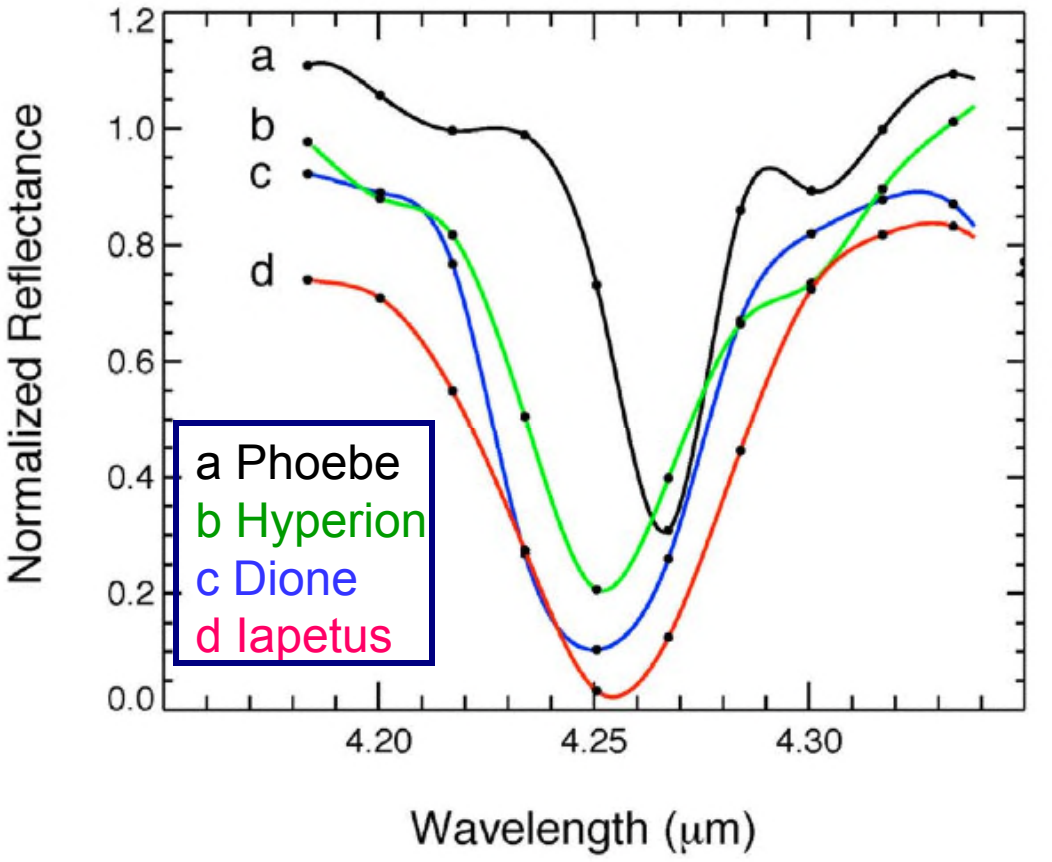
Iapetus Low-Albedo Material

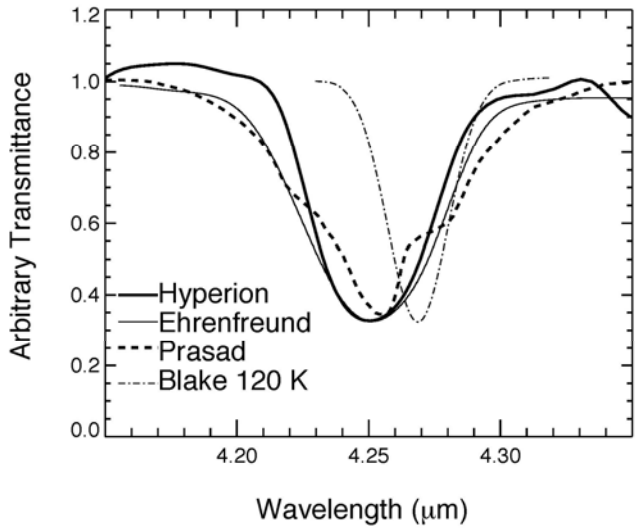
Tagish Lake IOM

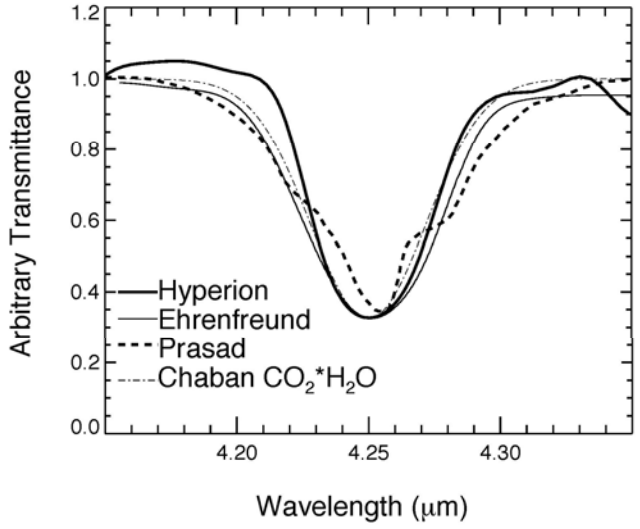
Murchison IOM

Varieties of CO_2 on Saturn's Satellites—Variations in ν_3

Compared to pure CO_2 ice at $\lambda = 4.628$ μm, CO_2 is shifted to shorter wavelengths and the band is broadened. Phoebe's CO_2 is <u>not</u> shifted.

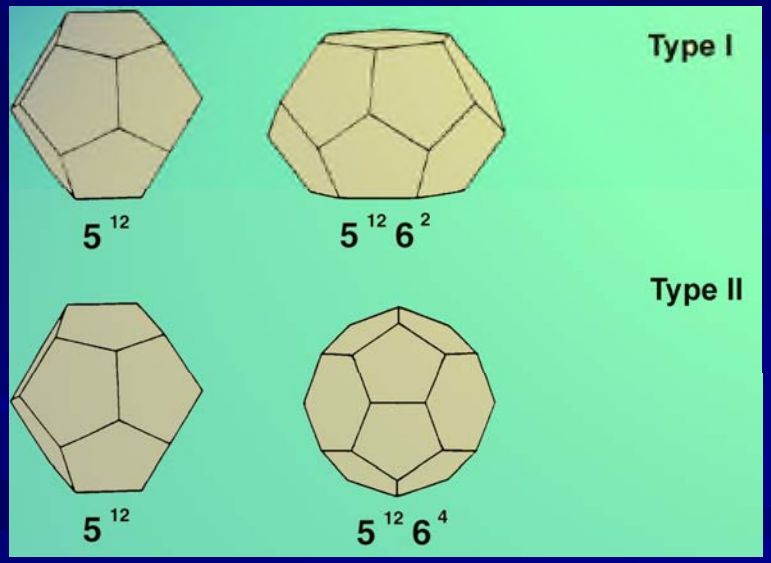




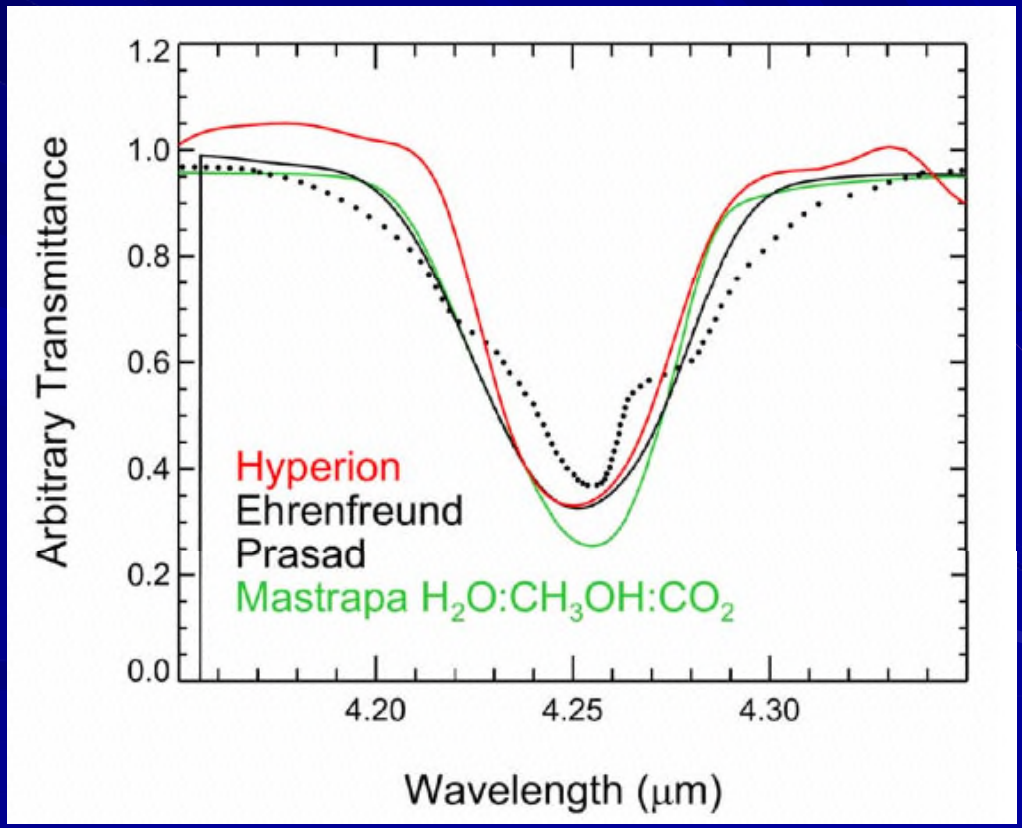


Hyperion conclusion: Wavelength and band shape matched with Prasad clathrate, Ehrenfreund & Mastrapa/Sandford 1:1:1 mixtures, and Chaban et al. $CO_2 \cdot 2H_2O$ calculations.

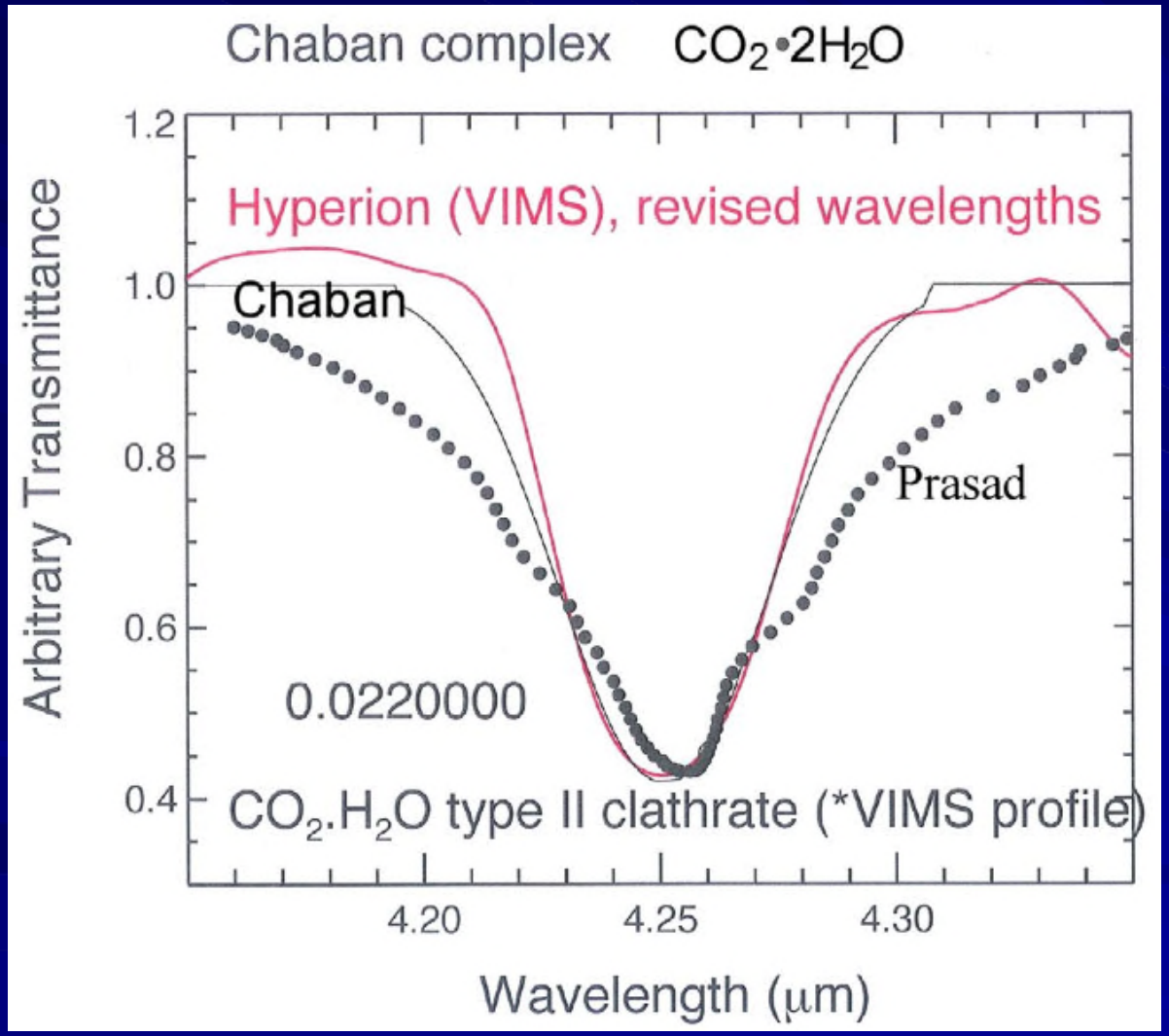
=> <u>CO_2 is complexed with H_2O and/or other molecules</u>



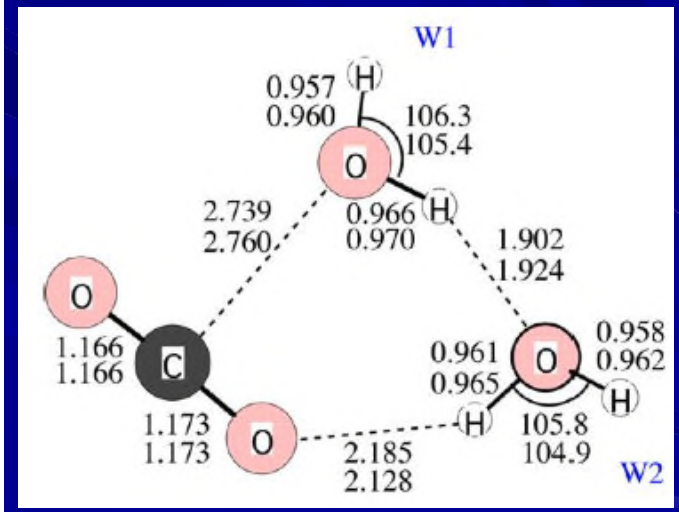
Lab spectra needed for clathrates with verified structure



Chaban theoretical spectrum



The *ab initio* calculation of one CO_2 with two H_2O molecules (plotted as a Gaussian with the VIMS resolution element) fits the Hyperion data well.



Calculations with two levels of molecular theory.
Chaban et al. 2007, Icarus

Laboratory Work

- Optical constants in extended wavelength regions
  - Ices in different phases, organic solids (synthetic and natural)
- Ice mixtures--spectroscopy
  - Matrix isolated hydrocarbons and nitriles
  - Clathrates and other complexes
  - Other mixtures
- Organic solids
  - Analysis and optical constants for complex macromolecular carbonaceous materials (synthetic tholins, meteoritic organic materials (soluble and insoluble)
- Nanoscale metal particles
  - Optical and scattering properties
- Special circumstances
  - Irradiated materials and mixtures
  - Irradiated ice and organic solids mixtures
  - Surface reactions on ice grains

The End