

A composite image of Pluto and Charon against a starry background. Pluto is a large, reddish-brown sphere in the lower-left foreground. Charon is a smaller, dark grey sphere in the upper-right. The background is a dense field of stars and a colorful nebula in the top right.

# Pluto and Charon

## From SINFONI Observations

Francesca DeMeo and Christophe Dumas

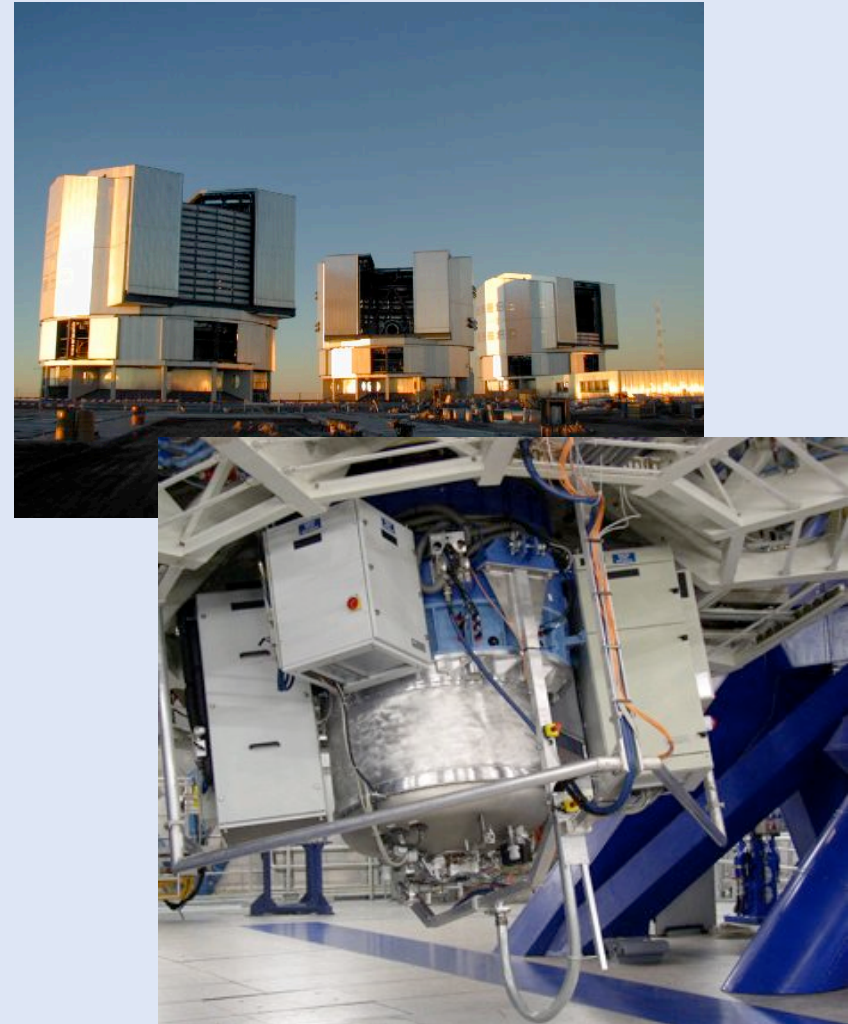
June 17, 2008

# My Project at ESO

- PhD student at the Paris Observatory
- DCDG student at ESO for 3 months to work with Christophe Dumas
  - Model Pluto and Charon spectra over different dates.
  - Extract spectra of hemispheres of Pluto from each data set.

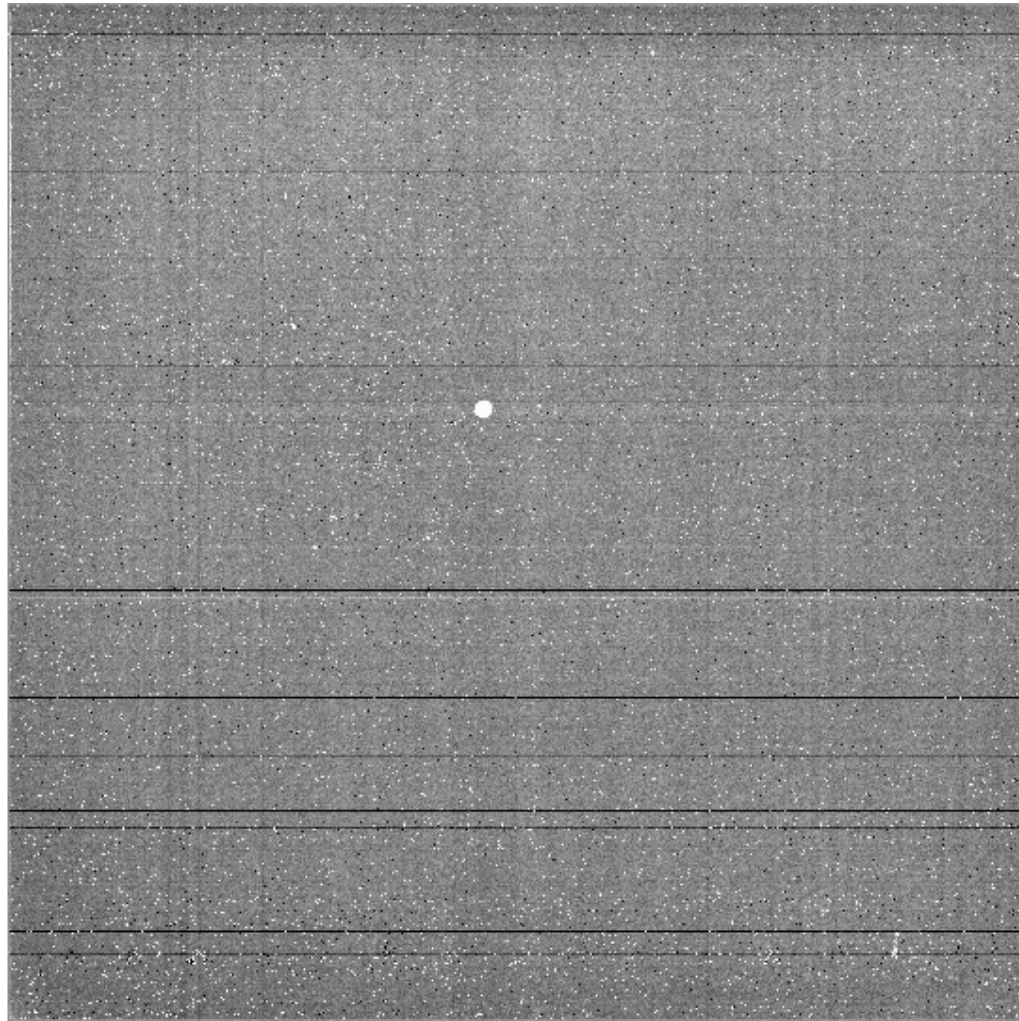
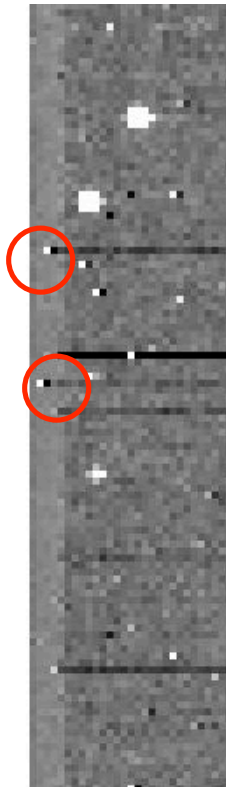
# The Data

- VLT observations of Pluto and Charon with SINFONI instrument
- Dates: May 13, June 9, and August 9, 2005
- Wavelengths: 1.4-2.4  $\mu\text{m}$
- Field of view: 0.8" x 0.8"
- Exposure times:
  - 5 min for Pluto
  - 25 min for Charon





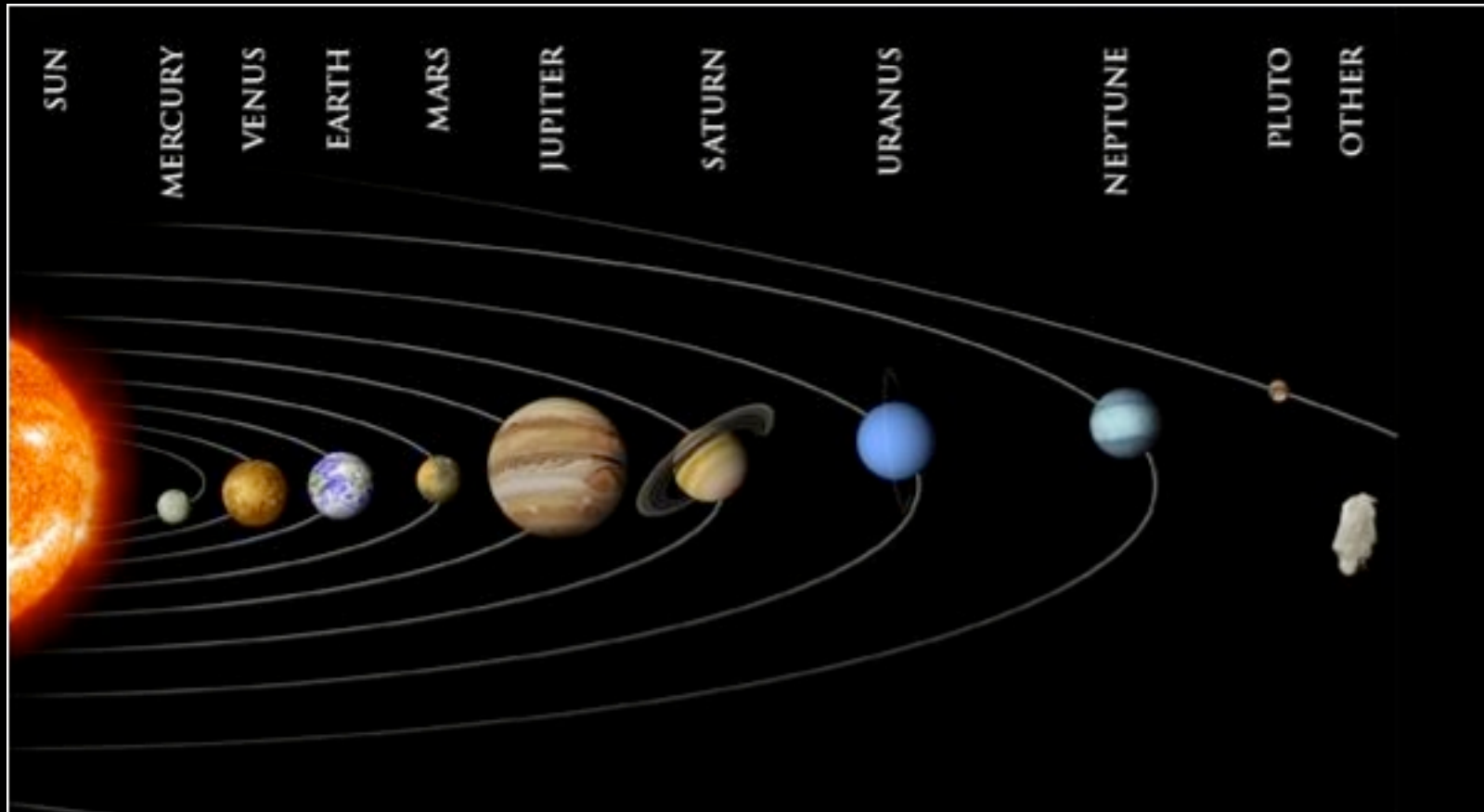
# The Reduction: Bad Line Correction



# Reduction

- SINFONI Pipeline + bad pixel maps from IDL
- IDL routines:
  - second sky subtraction
  - Alignment of object through cube by finding gaussian center and shifting flux maximum to a fixed center value.
- Spectra extracted in qfitsview program
  - Spectra of hemispheres extracted using IDL routine.

# Pluto in the Solar System



# Largest known trans-Neptunian objects (TNOs)



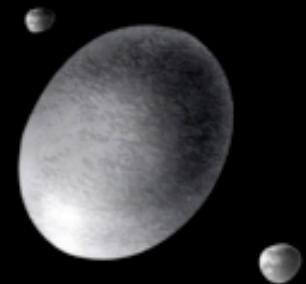
**Eris**



**Pluto**



**2005 FY<sub>9</sub>**



**2003 EL<sub>61</sub>**



**Sedna**



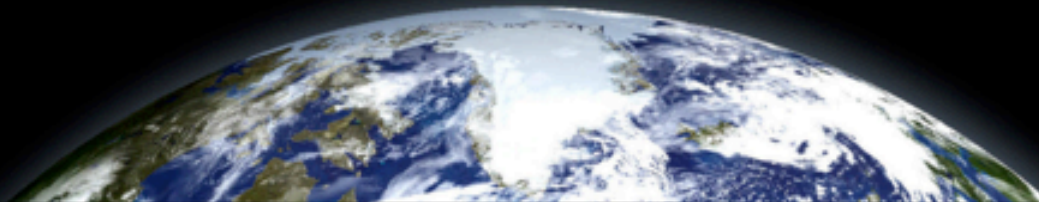
**Orcus**



**Quaoar**



**Varuna**



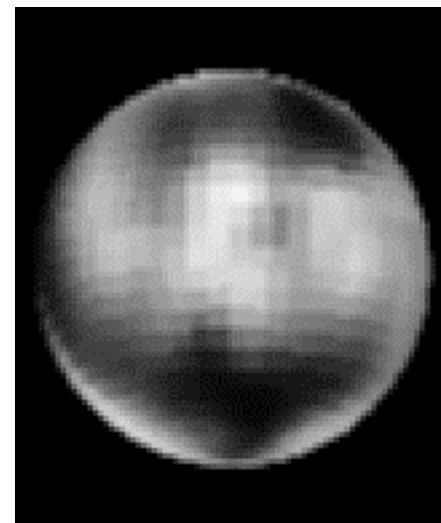
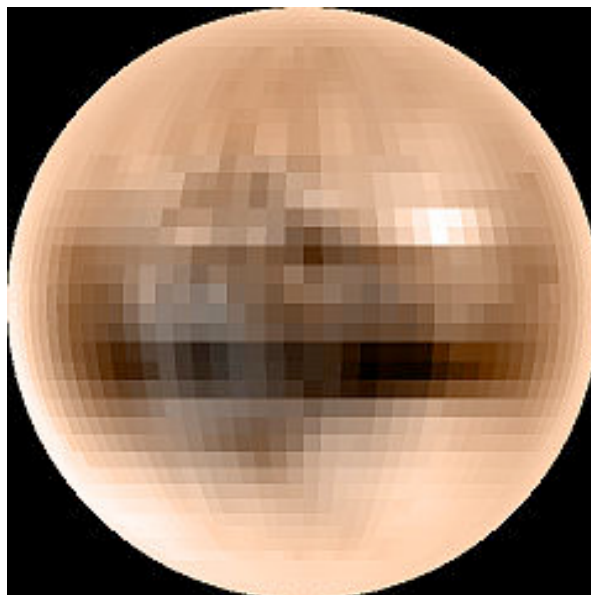
# Pluto has 3 Moons





Table 1: Basic Facts

	Pluto	Charon
Discovery	February 18, 1930	June 22, 1978
Diameter (km)	1200	600
Mass (kg)	$1.3 \times 10^{22}$	$1.52 \times 10^{21}$
Density (g/cm <sup>3</sup> )	2.03	1.65
Period	248 years	6.39 days
Albedo	0.51 - 0.71	0.35 - 0.4
Semi-major axis	39 AU	



# Definition of a Planet

- A planet is a celestial body that:
  - is in orbit around the Sun
  - has a nearly round shape
  - has cleared the neighborhood around its orbit.
- A dwarf planet is a celestial body that:
  - is in orbit around the Sun,
  - has a nearly round shape
  - has NOT cleared area around its orbit
  - is not a satellite.
- All other objects except satellites shall be referred to as Small Solar System Bodies.

# The Model

- Radiative Transfer Model based on Hapke Theory
- Creates intimate mixtures of input materials
- Finds the “best fit” amounts of each input by minimizing  $X^2$

# Materials Modeled

## Charon

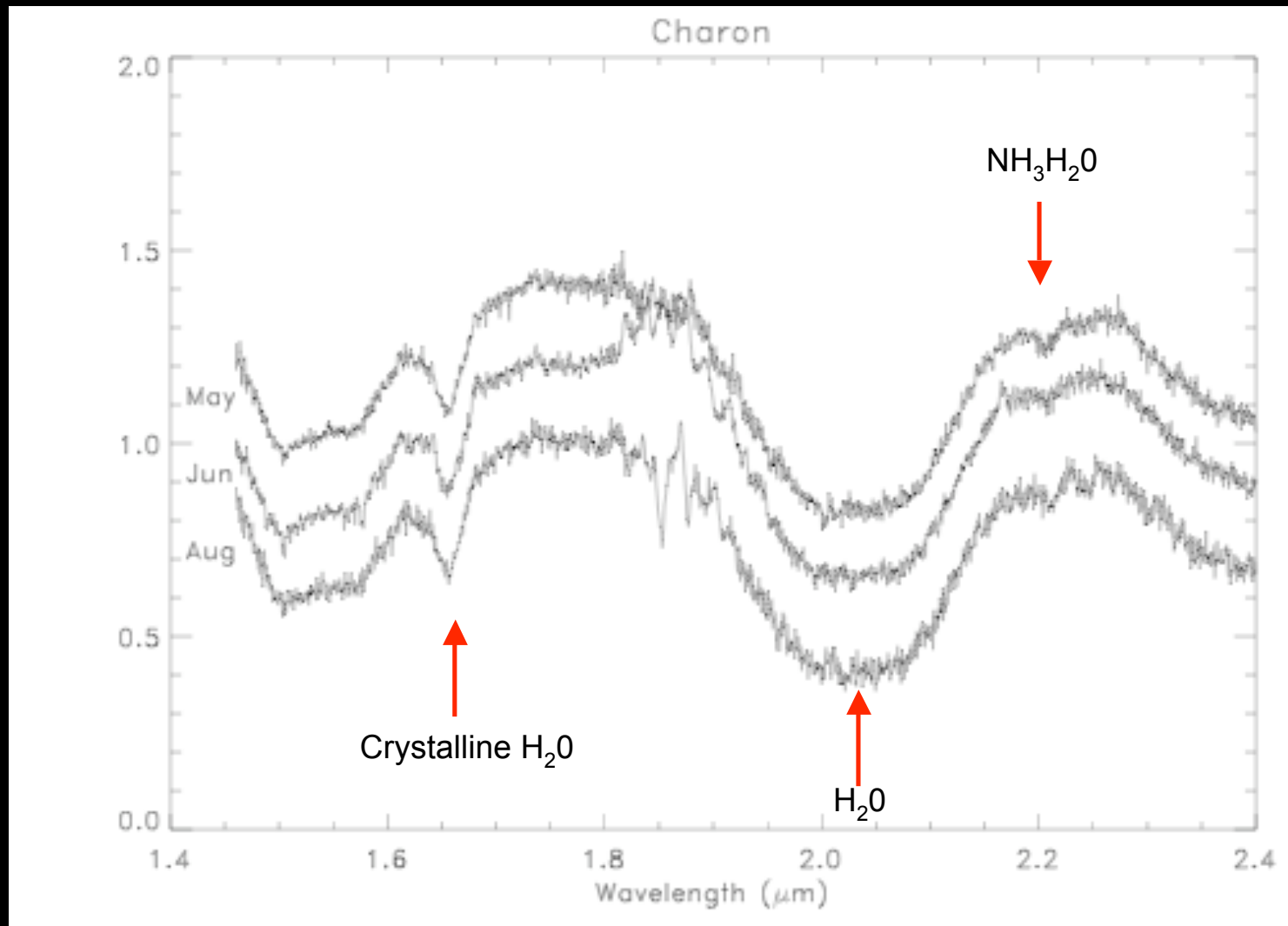
- Crystalline H<sub>2</sub>O ice
- Amorphous H<sub>2</sub>O ice
- Carbon
- Titan Tholin

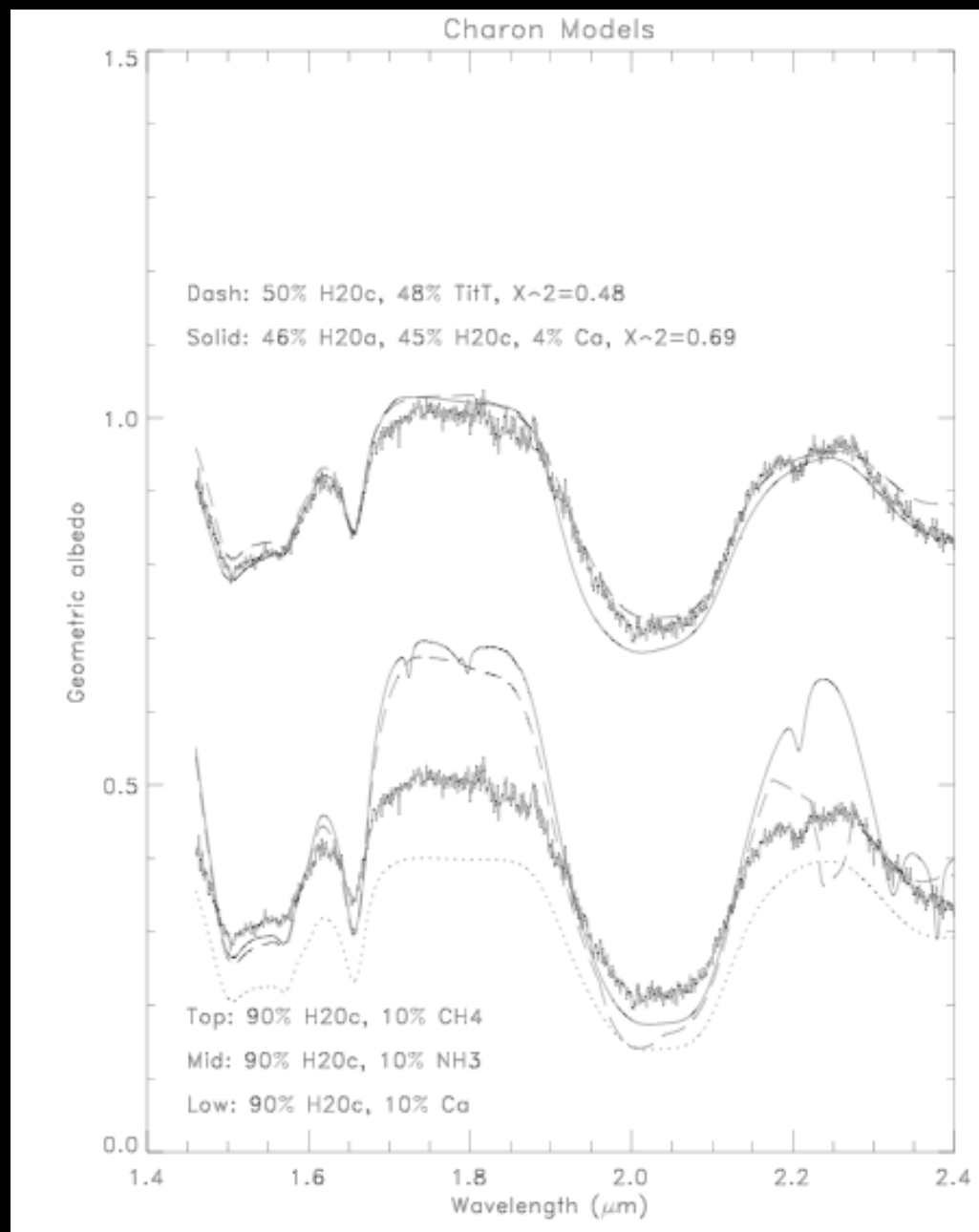
## Pluto

- Methane
- Nitrogen
- Titan Tholin

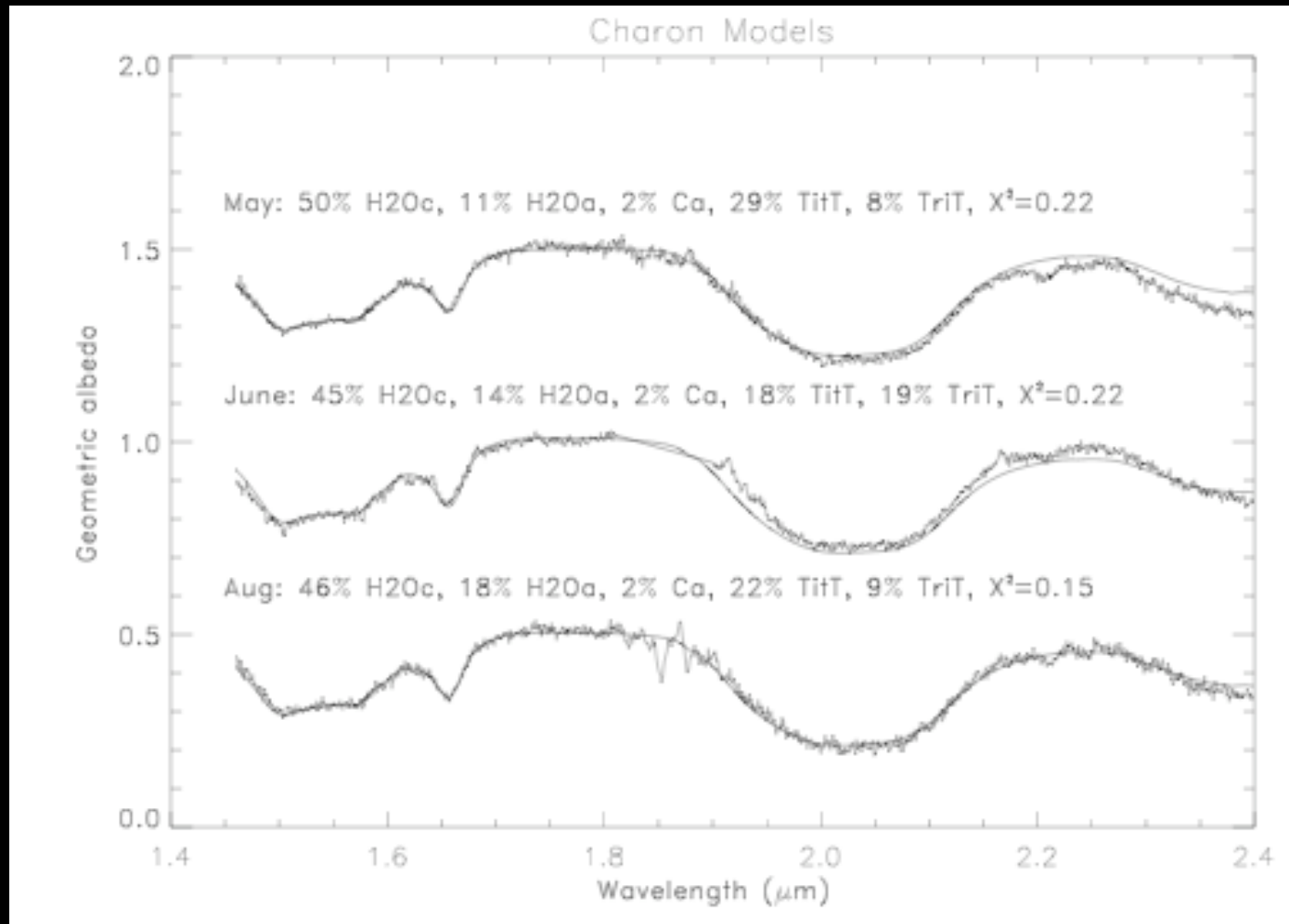


# Charon

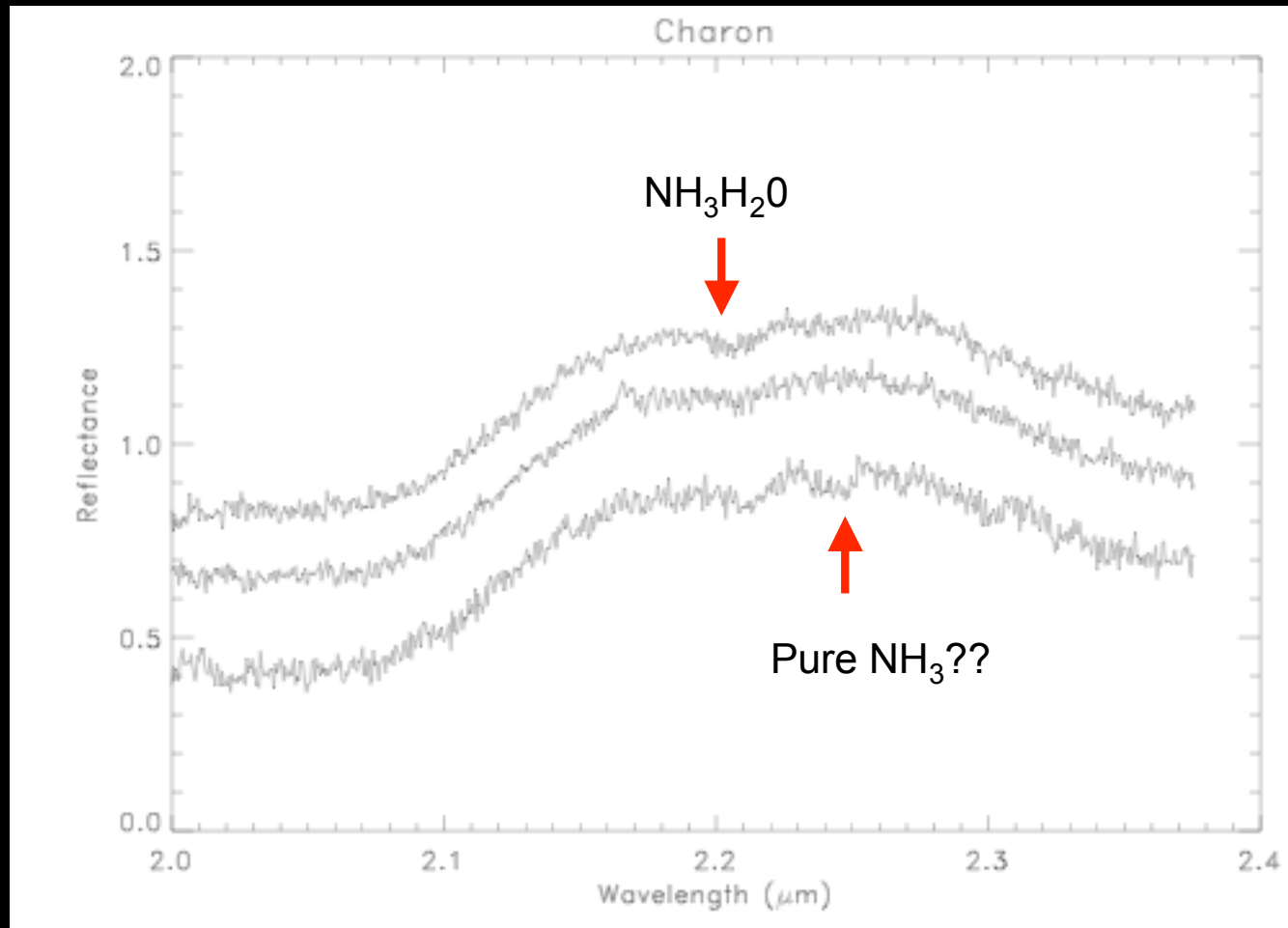




# Best Fits



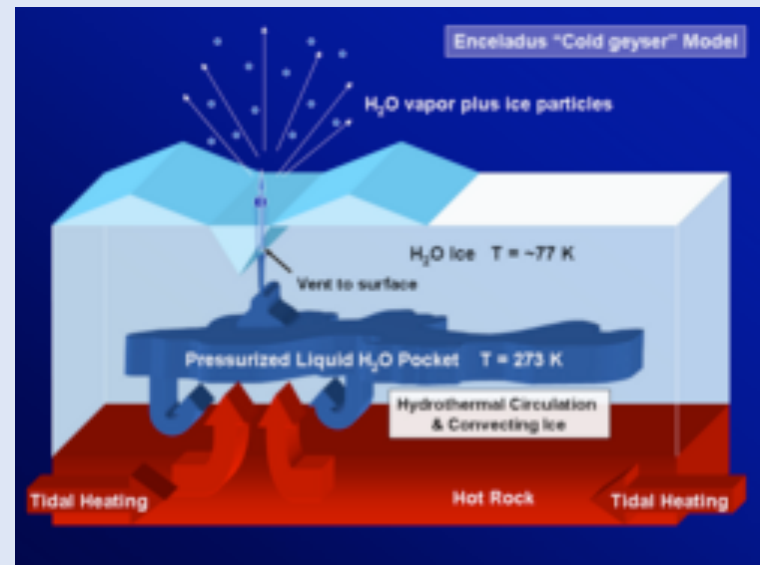
# Close Up



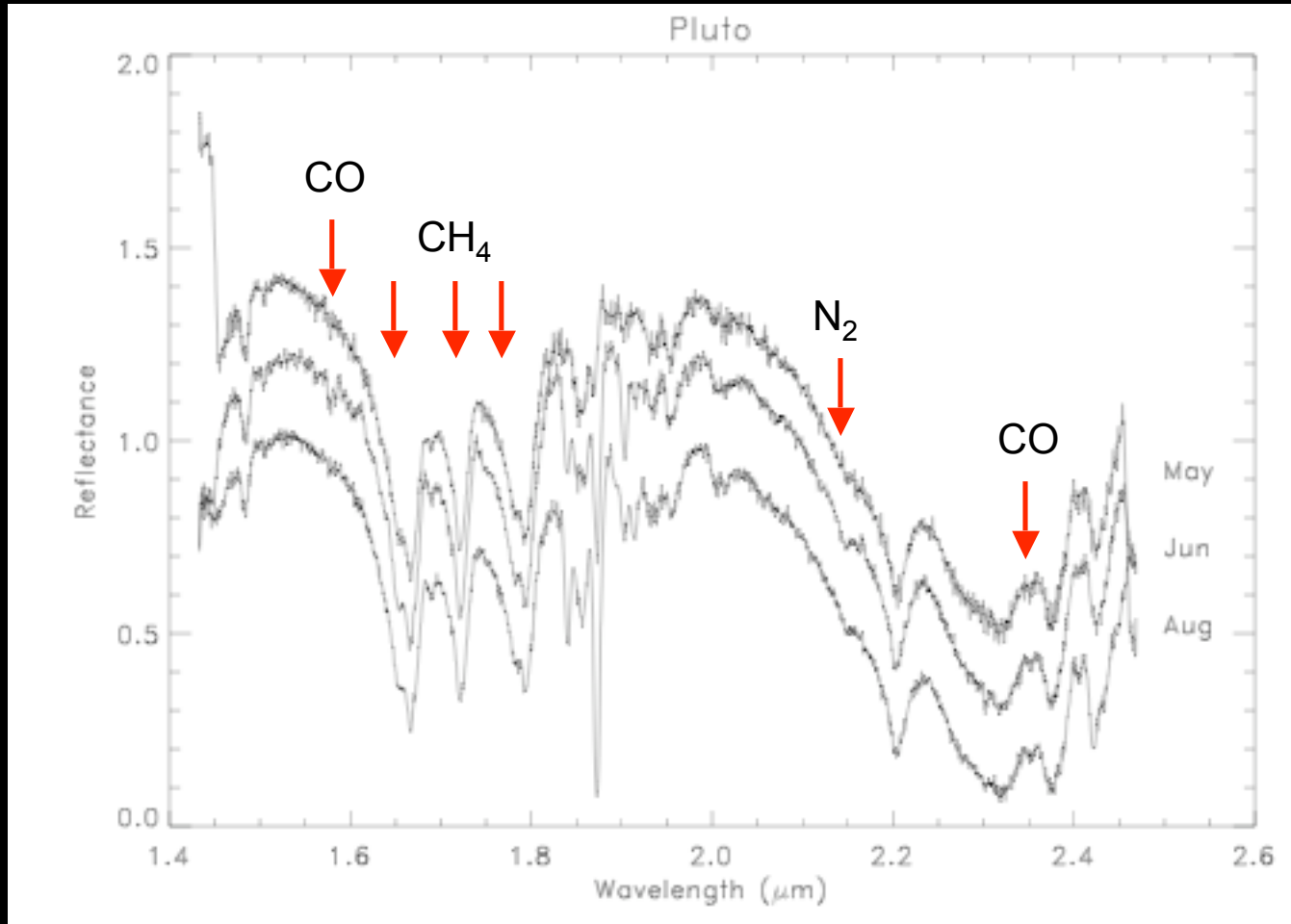


# Cryovolcanism

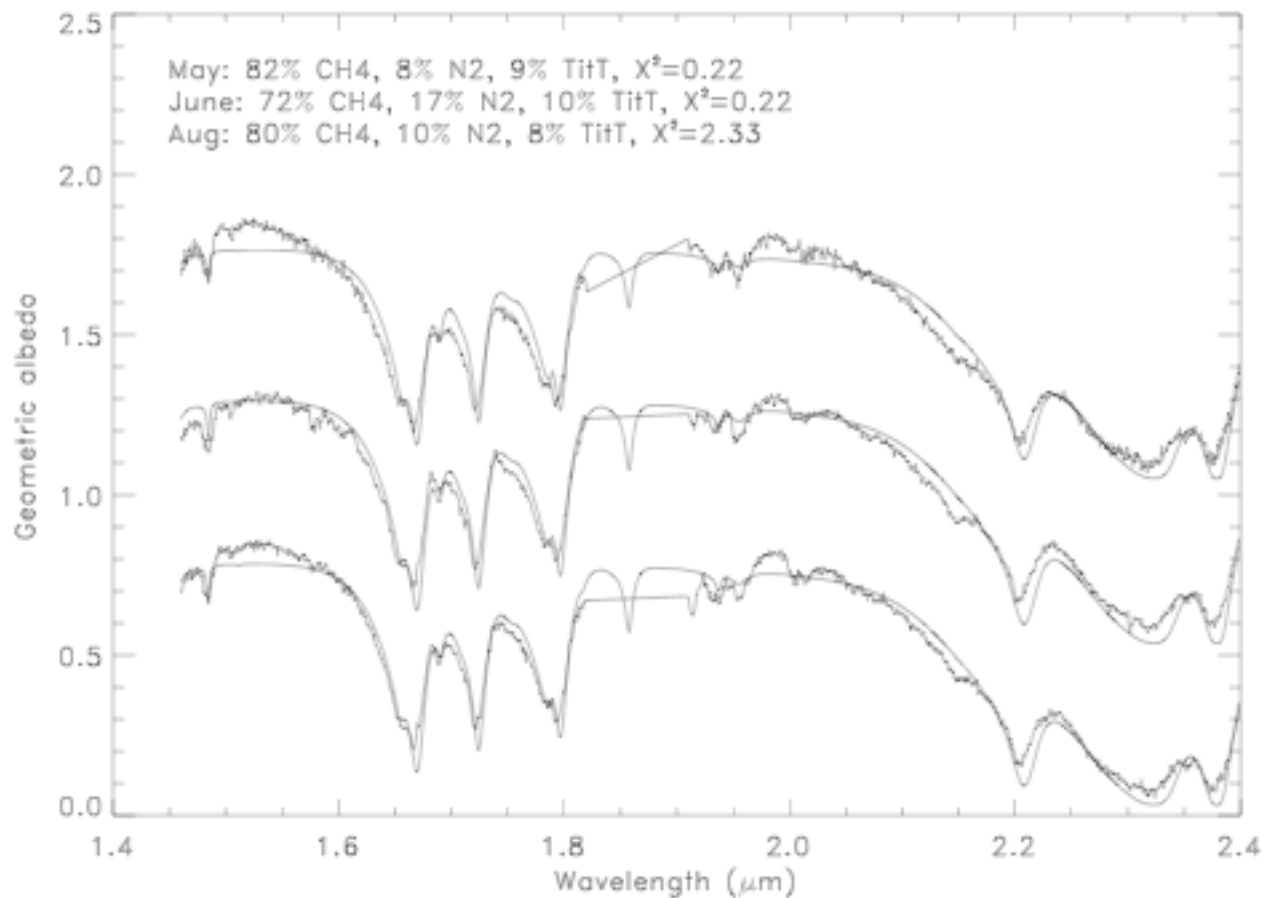
- Cryovolcanoes are icy volcanoes.
- Rather than molten rock, these volcanoes erupt volatiles such as water, ammonia, or methane.
- Heat source comes from tidal heating or radioactive decay.
- It is thought to exist on: Europa, Ganymede, Enceladus, Titan, Triton, Charon



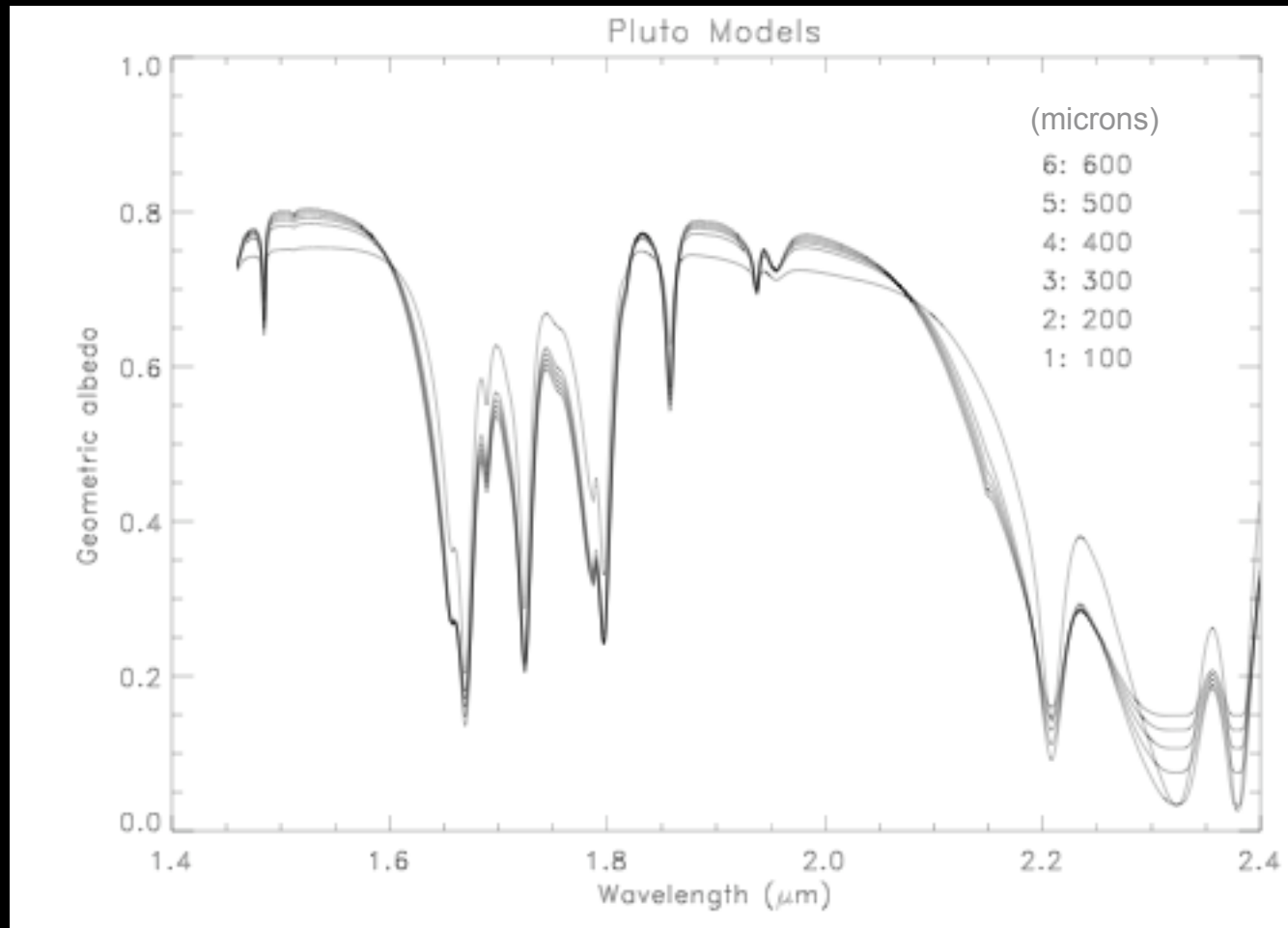
# Pluto



# Pluto Models

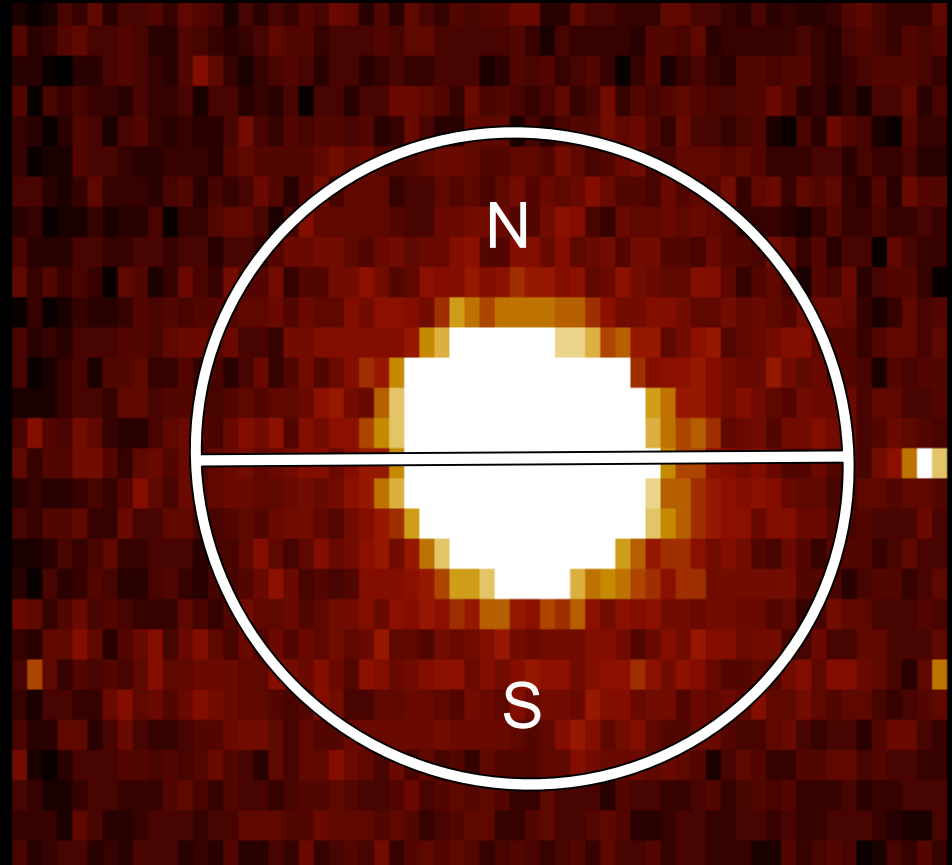


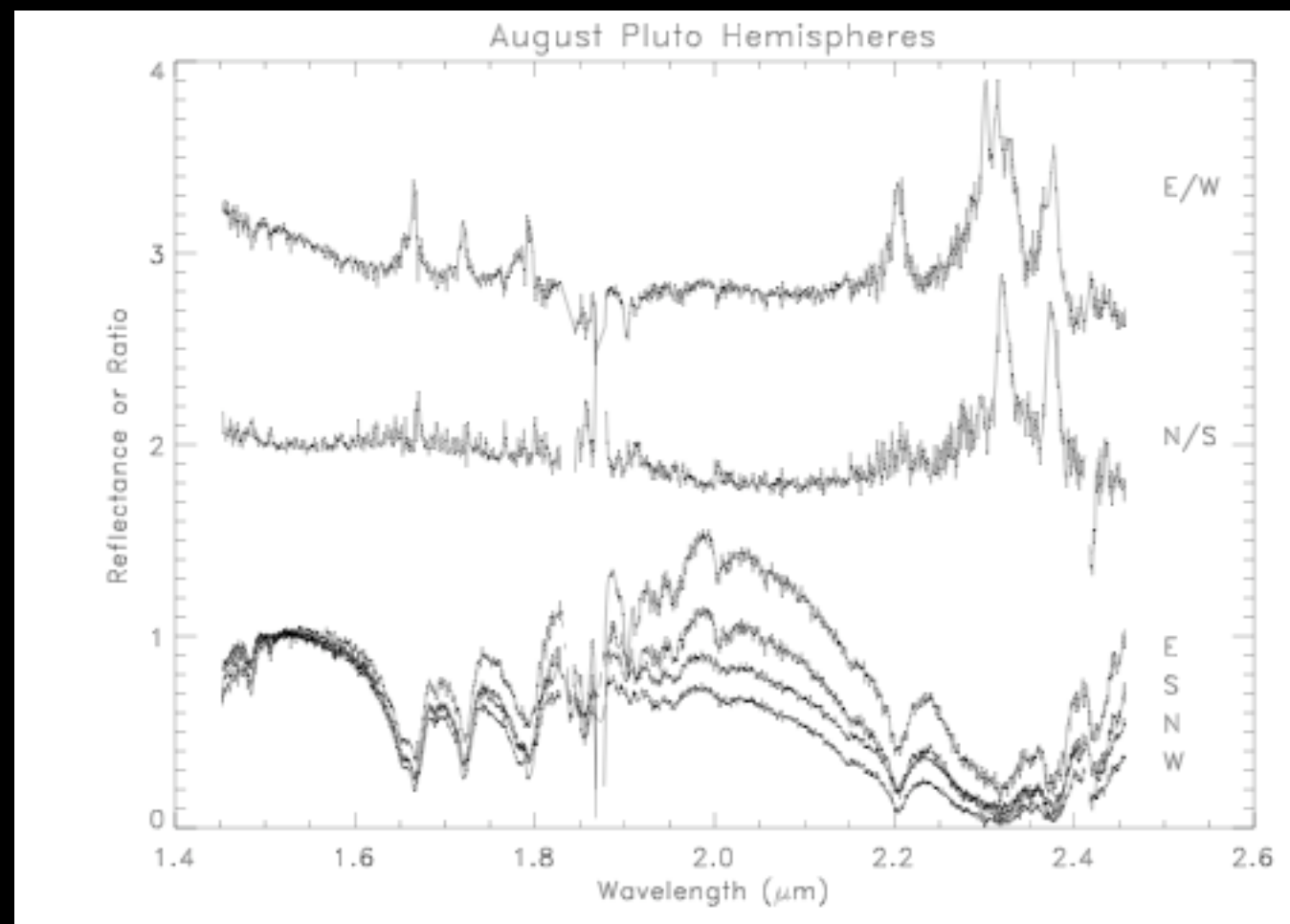
# Increasing Grain Size





# Separating Pluto's Hemispheres

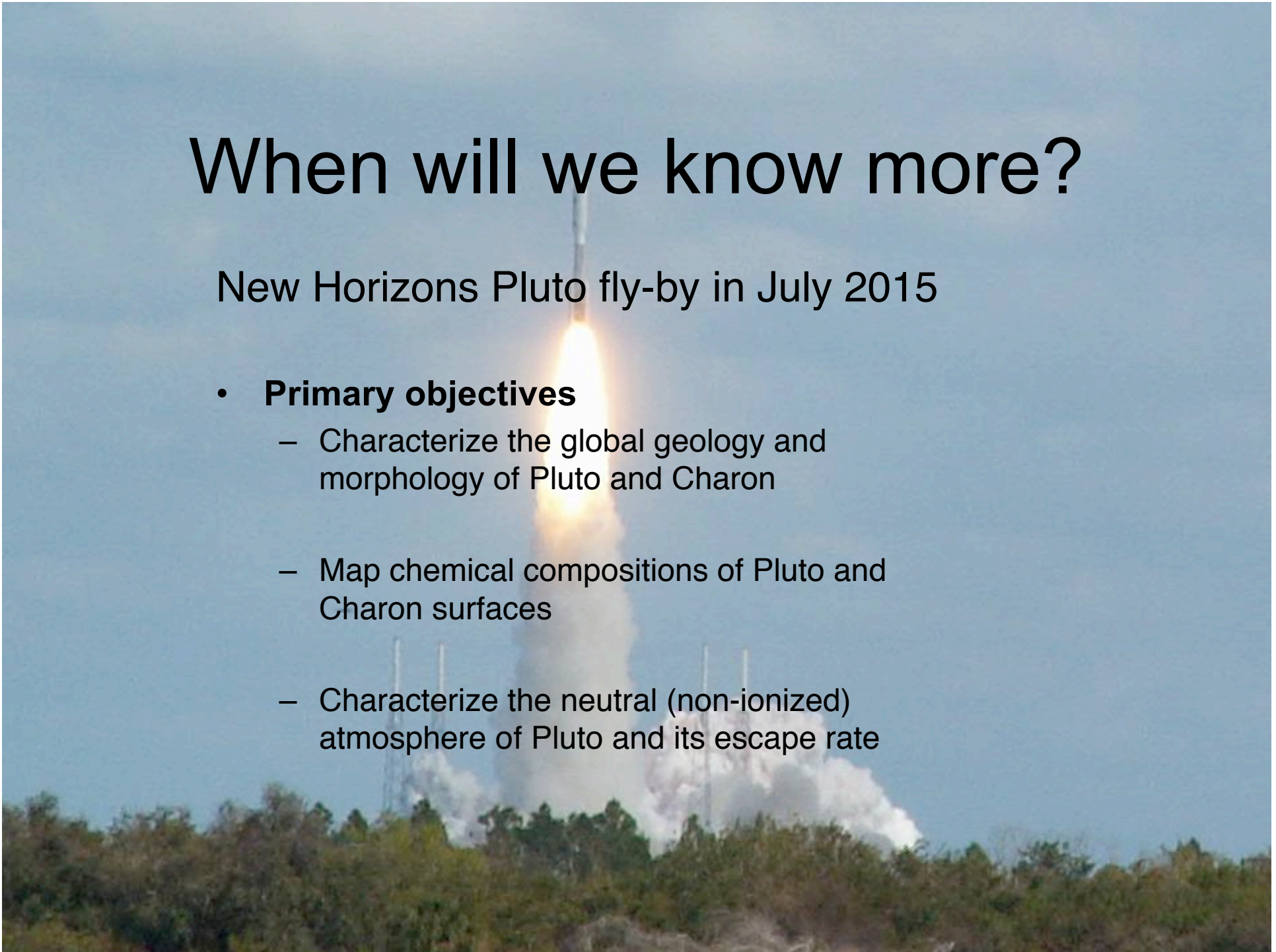




# When will we know more?

New Horizons Pluto fly-by in July 2015

- **Primary objectives**
  - Characterize the global geology and morphology of Pluto and Charon
  - Map chemical compositions of Pluto and Charon surfaces
  - Characterize the neutral (non-ionized) atmosphere of Pluto and its escape rate



The image features a large orange sphere on the left and a smaller grey sphere on the right, both set against a solid black background. The orange sphere has a pixelated texture and a bright highlight at the top. The grey sphere also has a pixelated texture and a bright highlight at the top. The text "Thank You" is written in a white, serif font, centered between the two spheres.

Thank You