

*Uranus (left, Stromovsky and Fry 2005)
and Neptune (right, Voyager)*

Ice Giant Pre-Decadal Study

OPAG, September 2020

Mark Hofstadter

Jet Propulsion Laboratory/California Institute of Technology

Based on the work of the Ice Giant Science Definition Team:

Amy Simon

Sushil Atreya

Donald Banfield

Jonathan Fortney

Alexander Hayes

Matthew Hedman

George Hospodarsky

Kathleen Mandt

Adam Masters

Mark Showalter

Krista Soderlund

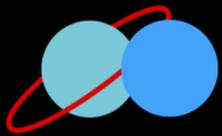
Diego Turrini

Elizabeth Turtle

Predecisional - For planning and discussion purposes only.

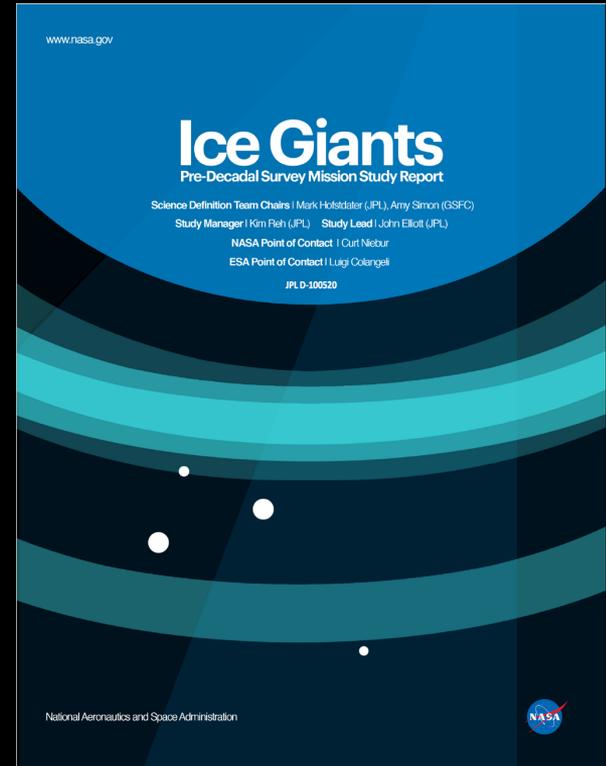
URS CL#20-3868

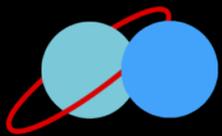
© 2020. California Institute of Technology. Government sponsorship acknowledged.



The SDT Study

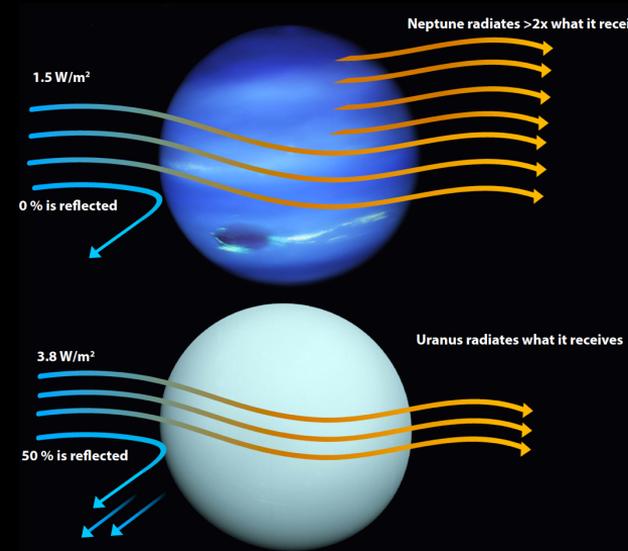
- The study does not identify “The Mission” to fly, but presents options for both the Uranus and Neptune systems.
- Completed in 2017, the full report is available at: http://www.lpi.usra.edu/icegiants/mission_study/
- A summary is published as Hofstadter et al. 2019 in Plan. Sp. Sci. (177), <https://doi.org/10.1016/j.pss.2019.06.004>
- Uranus or Neptune? They are equally compelling, but not equivalent.
- Since you just heard about a Neptune mission.....

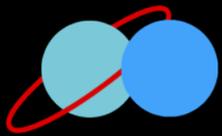




Unique Science at Uranus (1/2)

- Energy Balance: Uranus is the only giant planet not releasing significant amounts of internal heat.
 - Is the energy trapped at depth? This has profound implications for its internal structure.
 - Is Uranus currently in a quiescent phase that all ice giants experience?
- Atmospheric Dynamics.
 - The only giant planet atmosphere not heated from below.
 - Due to its 98° obliquity, has extreme seasonal variations and, on an annual average, the poles receive more sunlight than the equator.
- Magnetospheric Dynamics. Both Uranus and Neptune have complex magnetic fields unlike any others in the solar system. But...
 - Uranus' larger obliquity and larger offset between rotational and magnetic dipole axes creates extreme variations in solar-wind/magnetospheric coupling every 17 hours.





Unique Science at Uranus (2/2)

- Ring/Moon Dynamics.
 - The inner satellites and rings of Uranus are a coupled, complex, and chaotic system.
 - How does the tiny moon Mab create the μ ring? (It looks like Saturn's E-ring, which is formed by the plumes from Enceladus.)
- The Nature of Ice Giant Satellites.
 - The uranian system is the only example of native ice giant satellites in our solar system.
 - The innermost two, Miranda and Ariel, show evidence of recent activity.
 - All 5 large satellites are potential ocean worlds.

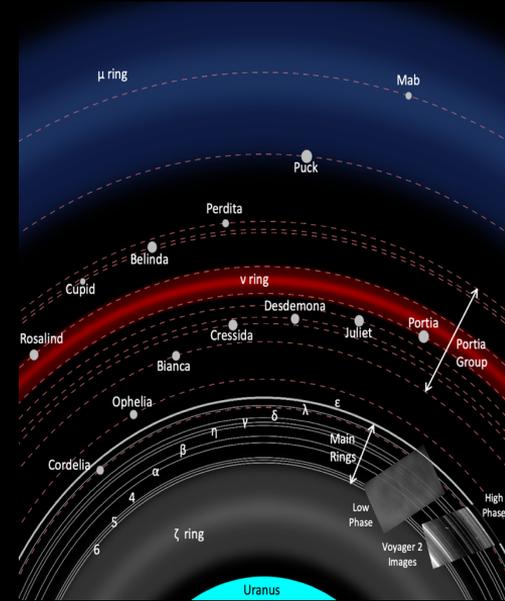
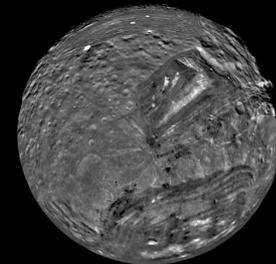
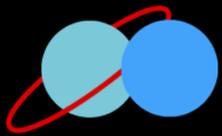


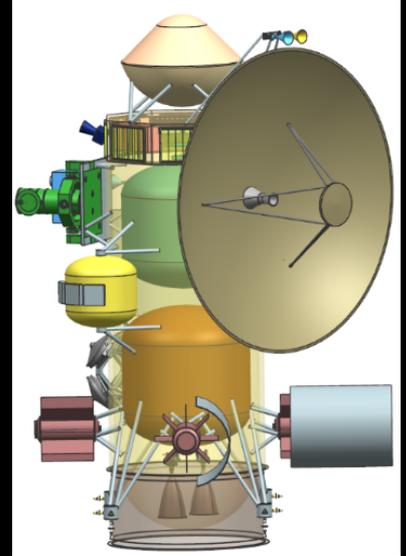
Figure courtesy of Robert Chancia





Conclusions

- The Uranus and Neptune systems are equally compelling, but not equivalent.
- To understand Ice Giants as a class of planet, we need to explore both systems!
- Programmatic factors may decide which to target first with a Flagship.
 - Cost, schedule, risk.
 - Balance among scientific disciplines.



*Notional Uranus mission design
from the referenced study*