NEPTUNE ODYSSEY: MISSION TO THE NEPTUNE-TRITON SYSTEM.

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The Neptune Odyssey mission concept is a Flagship-class orbiter and atmospheric probe to the Neptune-Triton system. This bold mission of exploration would be the first to orbit an ice giant planet to study the planet, its rings, small satellites, space environment, and the planet-sized moon, Triton. Triton is, itself a captured dwarf planet from the Kuiper Belt and a geophysically reactivated twin of Pluto. Odyssey addresses Neptune system-level science, with equal priorities placed on Neptune, its rings, moons, space environment, and Triton. Between Uranus and Neptune, the latter is unique in providing simultaneous access to both an ice giant and a Kuiper Belt dwarf planet. The spacecraft—in a class with Cassini—would launch in 2033 on a Space Launch System (SLS) or equivalent launch vehicle on a 16-year cruise to Neptune for a 4-year prime orbital mission. Our solution provides annual launch opportunities and allows for easy upgrade to a shorter (12-year) cruise phase that can utilize a Jupiter gravity assist (JGA), if NASA chooses to stand up this mission in time for a launch before 2032. Odyssey would orbit Neptune retrograde (prograde with respect to Triton), providing New Horizons-quality science from Triton every month, using the moon's gravity to shape the orbital tour and allow coverage of a range of latitudes and longitudes on Triton, on Neptune, and in the space environment. The atmospheric entry probe would descend in ~37 minutes to the 10-bar pressure level in Neptune's atmosphere just before Odyssey's orbit-insertion engine burn. Odyssey's mission would end by conducting a Cassini-like Grand Finale tour, passing inside the rings very close to the giant planet, and ultimately taking a final great plunge into Neptune's atmosphere.

As part of defining the science traceability matrix (STM) a family of instruments for both the orbiter and the probe were selected, drawing from proven flight heritage designs. Broadly, the STM addresses the following questions: (1) How do the interiors and atmospheres of ice giant (exo)planets form and evolve? (2) What causes Neptune's strange magnetic field, and how do its magnetosphere and aurora work? (3) Is Triton an ocean world? What causes its plumes? What is the nature of its atmosphere? (4) How can Triton's geophysics and composition expand our knowledge of dwarf planets like Pluto? (5) What are the connections between Neptune's rings, arcs, surface weathering, and small moons (some of which are captured from the Kuiper Belt or the protoplanetary disk).

We present our mission concept as a "shovel-ready," concept maturity level of 4 and a total modeled cost (including 50% margin) of less than \$3.4B; this is a mission NASA could choose to stand up now without waiting for significant advances in technology. An SLS rocket with a Centaur upper stage (fitting in the payload fairing) allows direct-to-Neptune launch opportunities every calendar year. Our example spacecraft will launch with 3520 kg to Neptune orbit and utilize three RTGs (radioisotope thermoelectric generators), requiring 28.8 kg of plutonium. A JGA, although enhancing, is not required. If NASA selects a mission like Odyssey for a new start and an SLS-class vehicle is not available, a Falcon Heavy-class vehicle could deliver the same payload mass using a solar electric propulsion kickstage.

From the start of this long mission, preserving knowledge and cultural continuity would be a priority. Observations along the way (for example, stereo observations of the edges of our heliosphere, asteroid and Centaur flybys, and using Odyssey's cameras for a rear-view look back at our solar system) will sustain interest and provide unprecedented opportunities for discovery. Finally, equipping both the orbiter and probe with cameras specially purposed for public engagement will help to share the joy of exploration and discovery with those who help make space exploration possible—the general public.

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NEPTUNE ODYSSEY

ICE GIANT KUIPER BELT SYSTEM SCIENCE

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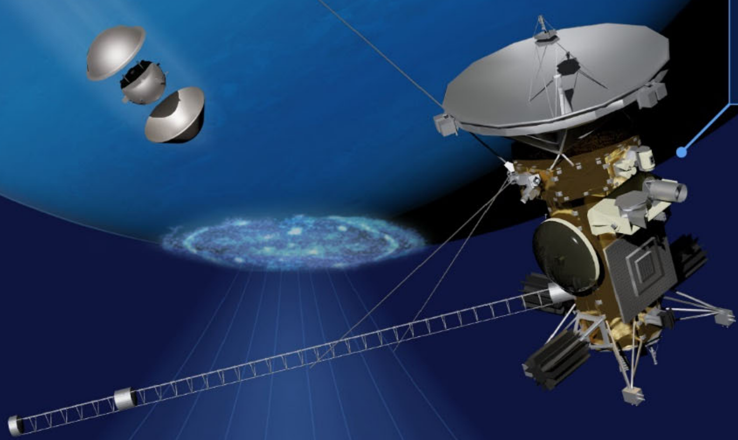
2. What causes Neptune's strange magnetic field and how do its aurorae work?
3. Is Triton an ocean world? What causes its plumes? What is the nature of its atmosphere?
4. How can Triton's geophysics and composition expand our knowledge of dwarf planets like Pluto?
5. What are the connections between Neptune's rings, arcs, space weather, and small moons?

PROTEUS



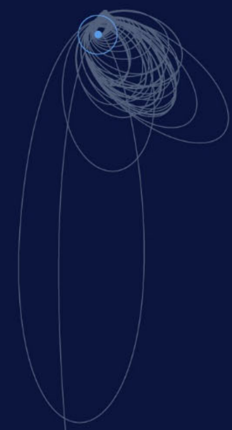
COST:
<$3.5 Billion

POWER AT LAUNCH:
1087 W from 3 Next Gen RTGs

WET MASS AT LAUNCH
3520 kg

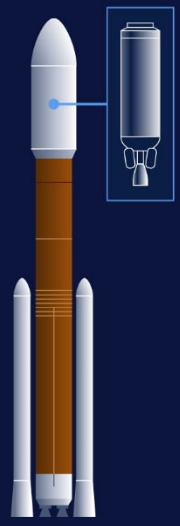
TRITON

ORBITING
2049-2053



16 YEARS
DIRECT TO NEPTUNE

Small Body Observations
Heliospheric Science



SLS BLOCK 2
LAUNCH 2033

SCIENCE INSTRUMENTS

ORBITER

- UV Imaging Spectrograph
- Color Narrow Angle Camera
- Vis-NIR Imaging Spectrometer
- Thermal IR Imager
- Ion and Neutral Mass Spectrometer
- Laser Altimeter
- Thermal Plasma Spectrometer
- Energetic Charged Particle Detector
- Energetic Neutral Atom Imager
- Radio & Plasma Wave Detector
- Magnetometer
- Microwave Radiometer
- Public Engagement Camera
- Dust Detector
- Gravity Investigation

ENTRY PROBE

- Mass Spectrometer
- Atmospheric Structure Instrument
- Helium Abundance Detector
- Ortho-Para H_2 Detector
- Nephelometer
- Net Flux Radiometer
- Doppler Wind Experiment
- Public Engagement Camera