NEPTUNE-ODYSSEY, NASA Flagship mission concept study for the Neptune Triton system

*Abigail M Rymer[1], Brenda Clyde[1], Kirby Runyon[1], Group the Neptune Odyssey Study team

1. Johns Hopkins University Applied Physics Laboratory

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. 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 (as we hope) 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. 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. 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 specifically 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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