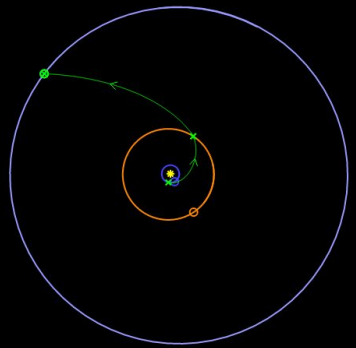
URANUS-MIRANDA SCIENCE MISSION CONCEPT

Background

Uranus' moon Miranda has previously only been visited by Voyager 2 when it conducted a flyby in 1986. This limited encounter revealed complex surface features produced by intense geological activity. 60% water-ice in composition, Miranda is dotted with canyons and coronae, which may be evidence for cryovolcanism. Miranda has a diameter of only 470km, but it is also home to Verona Rupes, a 20km high cliff and the tallest in our solar system. The origin and evolution of Miranda's varied topology is a mystery. A probe orbiting around Miranda would be in a good position to investigate Uranus' rings.
Sending a probe to Uranus has been studied as part of the Planetary Science Decadal Survey [1], and feasible New Frontiers class mission concepts have been explored [3]. However, no missions exist for the specific purpose of the study of Miranda.



Mission Timeline

For a 2034 launch date, the Uranus-Miranda spacecraft will require a launch ΔV of 6.6km/s and will take advantage of a Jupiter flyby to reach Uranus in 10.12 years. Following an initial observation of Uranus and its rings, the spacecraft will perform a Miranda orbit insertion and take measurements from that location. A two-year tour would be sufficient for data collection purposes [2]. The Uranus-Miranda spacecraft is designed for a mission lifetime of 12 years, although this may be extended to conduct further research on Uranus and its moons.

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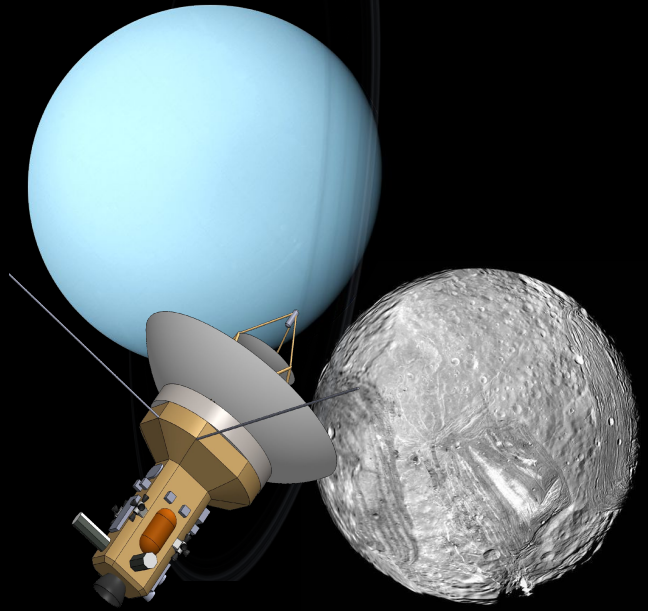
Science Objectives

The primary scientific objective of the Uranus-Miranda Science Mission is to determine the origin and evolutionary processes behind Miranda's unique geology. The secondary objective is to study the dynamics behind the formation and preservation of Uranus' narrow rings.

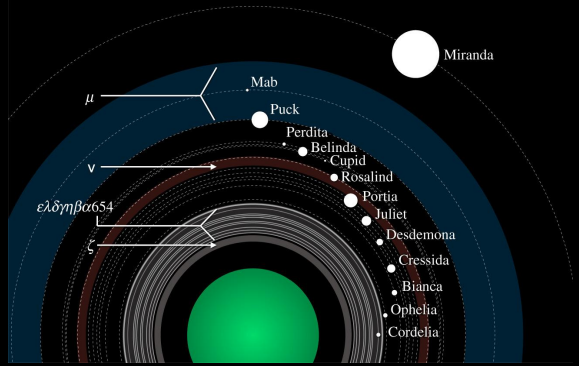


Instruments

Imaging Science Subsystem: Wide and narrow angle cameras for high resolution pictures of Uranus and Miranda
Ultraviolet Spectrograph: Studies the composition of Uranus' rings, Miranda surface features and cryovolcanic ejecta
Visible and Infrared Spectrometer: Used to determine the composition and temperature of Miranda's surface
Ice Penetrating RADAR: Studies the geology beneath Miranda's surface
Orbital Laser Altimeter: Maps Miranda's unusual topography
Magnetometer: Determines how Uranus' magnetosphere influences its moons and rings

Spacecraft Design

Propulsion: A variety of chemical and electric propulsion systems are considered in a trade study. A high impulse electric propulsion system is the most appropriate for this mission.
Power: Radioisotope thermoelectric generators (RTG) are selected for their long lifespan. Multiple RTGs are included for redundancy.
ADCS: A combination of reaction wheels and monopropellant thrusters are used for attitude control. Guidance and navigation is handled using IMUs, star trackers, and a sun sensor.
Telemetry: The spacecraft will communicate with Earth via the Deep Space Network. Both high and low gain antennas are used.
CDH: A future derivative of a radiation hardened flight computer such as the RAD750 will be used. Multiple units and extra rad-hardened storage devices are included for redundancy.
Structure: The spacecraft structure will be a welded square cylindrical frame with honeycomb cores.
Thermal: The spacecraft will regulate the temperature of flight systems and provide shielding from the radiation environment.
Payload: The spacecraft will carry several scientific instruments to conduct a detailed study of Miranda and Uranus.
Launch: The mission will be launched from Cape Canaveral onboard a Falcon 9 rocket on June 7, 2034.



Miranda in relation to Uranus' ring system and other satellites [4].

References

[1] Hofstadter et al, Uranus and Neptune missions: A study in advance of the next Planetary Science Decadal Survey, Planetary and Space Science,Volume 177,2019,104680, ISSN 0032-0633.
[2] Hubbard, W. Ice Giants Decadal Study: Mission Concept Study Final Report. NASA, 2010
[3] Jarmak et al, QUEST: A New Frontiers Uranus orbiter mission concept study, Acta Astronautica, Volume 170,2020, ISSN 0094-5765.
[4] Showalter Mark R. 9 Nov 2020. The rings and small moons of Uranus and Neptune. Phil. Trans. R. Soc. A. 378:20190482. 20190482