The Uranus System Explorer (USE)  Unveiling the evolution and formation of icy giants


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INTRODUCING USE The Uranus System Explorer

Many fundamental aspects of the Uranian system remain unknown or poorly constrained as no in-depth study of this system has been carried out thus far. Our knowledge of Uranus relies solely on the Voyager 2 flyby in 1986, as well as remote sensing from near Earth by the Hubble Space Telescope. Studying the Uranian system would allow a better understanding on how the icy giant planets formed, provide an archetype for similar exoplanets, and constrain current solar system formation models. Uranus System Explorer (USE) will investigate the Uranian planetary system and gain new insights into the formation and evolution of icy giants. This mission will perform highly accurate measurements of the Uranian System gravity and magnetic fields, as well as a number of in-situ and remote sensing investigations [1]. The mission concept presented here is the result of a student exercise during the Alpbach Summer School 2012 [2].

SCIENCE OBJECTIVES with an Orbiter and a Probe

Answering fundamental questions about formation and evolution of the icy giants by placing them in the planetary system formation models [3].

- **INTERIOR**: Why is the heat flux lower than expected? What are the implications for the interior and thermal evolution of the planet? Why does Uranus have such a strong intrinsic magnetic field? How do its characteristics constrain the interior? Is there a rocky silicate core?

- **ATMOSPHERE**: What is the composition of the atmosphere? Which are the drivers of atmospheric chemistry? What are the atmosphere dynamics?

- **MAGNETOSPHERE**: How is plasma transported in the magnetosphere? Is there significant plasma source in Uranus? Insight into Earth’s magnetosphere during magnetic reversals.

PAYLOAD

 Imaging Camera (CAM)
 Visible and Infrared Spectrometer (VIS-V & IRIS)
 Thermal IR Spectrometer (TIR)
 UV-Spectrometer (LVS)
 Microwave Radiometer (MR)
 Electron and ion spectrometer (EIS)
 Scalar and Vector Magnetometer (SCM & MAG)
 Energetic Particle Detector (EPD)
 Radio and Plasma Wave Instrument (RPWI)
 Ion composition instrument (ICI)

Atmospheric Probe

 Mass Spectrometer (ASS & GCMS)
 Nephelometer (NEP)
 Doppler wind instrument (DWI)
 Atmospheric Physical Properties Package (AP3)

SYSTEM DESIGN

The Spacecraft design strongly driven by the unique operational profile of the mission. In order to achieve acceptable telemetry rates at Uranus, the spacecraft carries a 4m High Gain Antenna for Ka-band downlink and X-band uplink. Electrical power is provided by three Advanced Stirling Radioisotope Generators, providing 140 W of electrical power at beginning of life. The two large side panels of the spacecraft house the remote sensing instruments and the atmospheric probe, respectively, while the smaller side panels house the plasma instrument package. The magnetometer payload is housed at the end of a deployable 10m boom to minimize the influence of spacecraft fields. Primary propulsion is provided by an NTO/Hydrazine bipropellant main engine, providing a specific impulse of 315s and a nominal thrust of 845N.


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SUMMARY

The USE mission represents a unique opportunity to study the Uranian system in unprecedented detail and to gain new insights into the formation and evolution of icy giant systems. The knowledge gained from this investigation would provide crucial constraints to current models for planetary formation and evolution, and would address a significant gap in current understanding of Solar System formation.