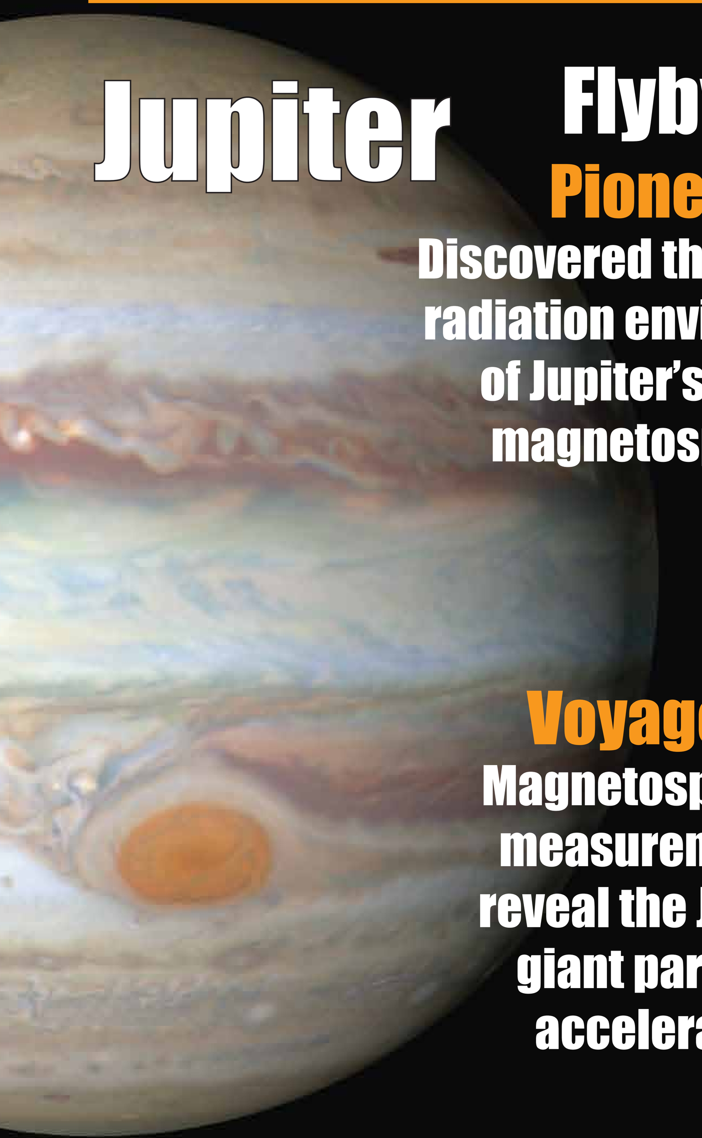
Magnetospheric Science Discoveries

Missions in the Queue

Planetary Magnetospheres Science Vision for 2050

Jupiter



Flyby

Pioneer

Discovered the intense radiation environment of Jupiter's inner magnetosphere

Voyagers

Magnetospheric measurements reveal the Jovian giant particle accelerator

Orbit

Galileo

Induction measurements reveal ocean worlds at Jupiter and characterize the dynamics of the giant particle accelerator

Juno

Is the first mission to explore the auroral regions of Jupiter

Orbit

Europa Clipper

Induction measurements will determine Europa's ocean depth, ice shell thickness, and ocean salinity

JUICE

Will reveal the giant particle accelerator, dynamically image the magnetosphere, and reveal the Ganymede magnetosphere

Land

Europa Lander

Can the surface and subsurface support life in the Europa radiation environment?

Jupiter:

Understand the constraints on habitable environments by characterizing giant particle accelerators. Understand stellar-planetary interactions and implications in light of exoplanetary radio emissions

Io:

Understand atmospheric loss processes from non-magnetized bodies

Europa:

Understand how the radiation environment imposes constraints on habitability

Ganymede:

Ganymede as a template for exotic interactions. Discover the origins of its mini-magnetosphere

Callisto:

Explore Callisto's ionosphere and discover the characteristics of its subsurface Ocean

Technology Infusion

Regular Missions to Jupiter:

Much like the progress that has been made in understanding Mars, humanity's grasp of the plethora of planetary environments will benefit from regular innovative and focused missions

Jovian Laboratory Provides:

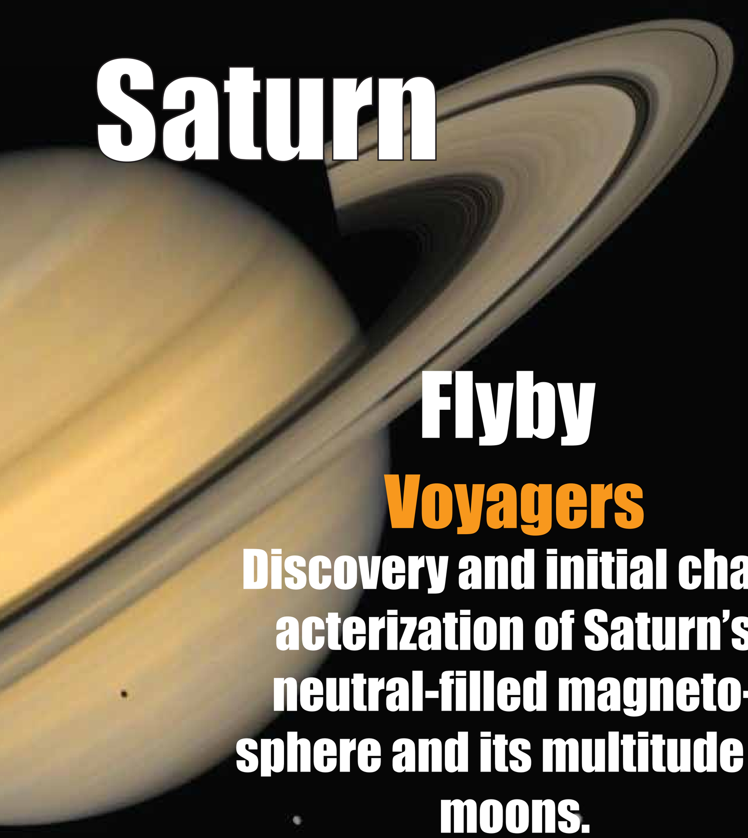
The Giant Particle Accelerator:

Jovian electrons are accelerated to high energies producing radiation that is

Ocean Worlds Environments:

The surfaces and subsurfaces of the ocean worlds cannot currently be fully simulated in the laboratory.

Saturn



Flyby

Voyagers

Discovery and initial characterization of Saturn's neutral-filled magnetosphere and its multitude of moons.

Orbit

Cassini

Magnetometer measurements discover Enceladus plume

Numerous magnetospheric breakthroughs in the Saturnian system

Orbit?/Land?

New Frontiers Enceladus

New Frontiers Saturn Probe

New Frontiers Titan

Saturn:

What is the rotation rate and internal structure of Saturn, and is it the ionosphere or the magnetosphere that forces this rate into the observed periodicities?

Enceladus:

Discover the composition of the subsurface ocean and how this material propagates through Saturn's magnetosphere

Titan:

Discover whether Titan's atmosphere produces biomolecules either through the introduction of oxygen from Enceladus or upper atmospheric chemistry

Toolbox Improvements

Capable Low Size, Weight, & Power Instrumentation

Instrumentation that maintains quality measurements at low SWAP enables outer planet exploration

Saturn Laboratory Provides:

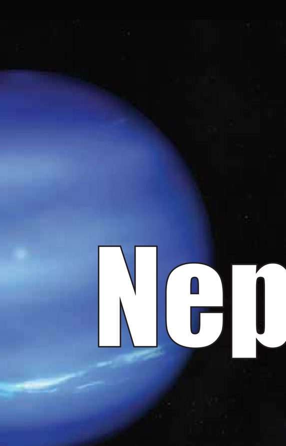
Atmospheric Chemistry & Access to Ocean Samples

The Titan atmospheric chemistry experiment cannot be replicated in Earth laboratories, and the Enceladus ocean provides delivery of ocean samples direct to space.

Ice Giants

Uranus

Neptune



Flyby

Voyagers

Discover a highly tilted magnetosphere

Ion dominated magnetosphere with several relatively darkened icy moons (space weathering?)

Voyagers

Magnetometer measurements discover a highly tilted magnetosphere

Orbit

Ice Giants Flagship

What is the nature of the displaced and tilted magnetospheres of Uranus and Neptune and how do conditions vary with the pronounced seasonal changes on each planet?

What is the detailed plasma composition in any of these systems, particularly for ice giants?

What causes the enormous differences in the ion to neutral ratios in these systems?

What can our understanding of these magnetospheres tell us about the conditions to be expected at exoplanets?

Uranus and Neptune:

Characterize ice giant magnetospheres to fill in the knowledge gap in planetary evolution

Extend this knowledge to gain understanding of the multitude of exoplanetary systems and to tie to the nature of exoplanetary radio emissions

Icy Moons:

Discover whether any of these moons are Ocean Worlds, possibly through magnetic induction measurements

Explore the effects of radiation processing of surface ices and CO_2 ices to explore organic production

Uranus Laboratory Provides:

A Highly Tilted, Ion Dominated Magnetosphere:

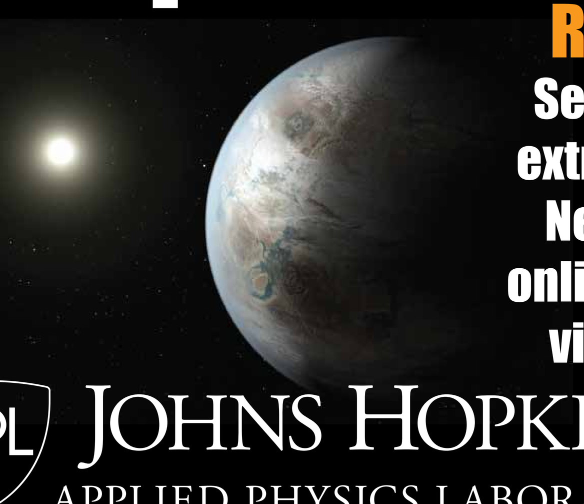
This magnetosphere is unique in our solar system, yet it may be quite common for extrasolar planets. How does this magnetosphere function? Does it provide the same level of protection for its icy moons as the Earth's magnetosphere provides to support life?

Neptune Laboratory Provides:

A Large, Captured Moon

How has Triton evolved in the Neptune system, and can we use the tilted magnetic field of Neptune to discover its internal structure?

Exoplanets



Ground Based Radio Telescopes:

Several non-detections of extrasolar radio emissions. New capabilities coming online from LOFAR could provide the first detections.

Exoplanets Vision

Constrain Habitability:

Planetary environments with magnetospheres can shield the surface from radiation or such as the case for Europa provide more radiation

Use radio emissions to characterize the stellar-planet interactions and discover exoplanetary magnetospheres

Technology Infusion

High Capability Radio Telescopes:

From radio quiet environments such as the far-side of the Moon enables magnetospheric observations from exoplanetary systems

THE PLANETARY MAGNETOSPHERES IN OUR SOLAR SYSTEM PROVIDE A NATURAL LABORATORY TO INVESTIGATE UNIVERSAL ASTROPHYSICAL PROCESSES

J. H. Westlake, P.C. Brandt, I.J. Cohen, R.L. McNutt, D.G. Mitchell, and A.M. Rymer
(Johns Hopkins University Applied Physics Laboratory)

APL JOHNS HOPKINS APPLIED PHYSICS LABORATORY