Jet Propulsion Laboratory's Space Explorations

Part 2: Solar System Exploration

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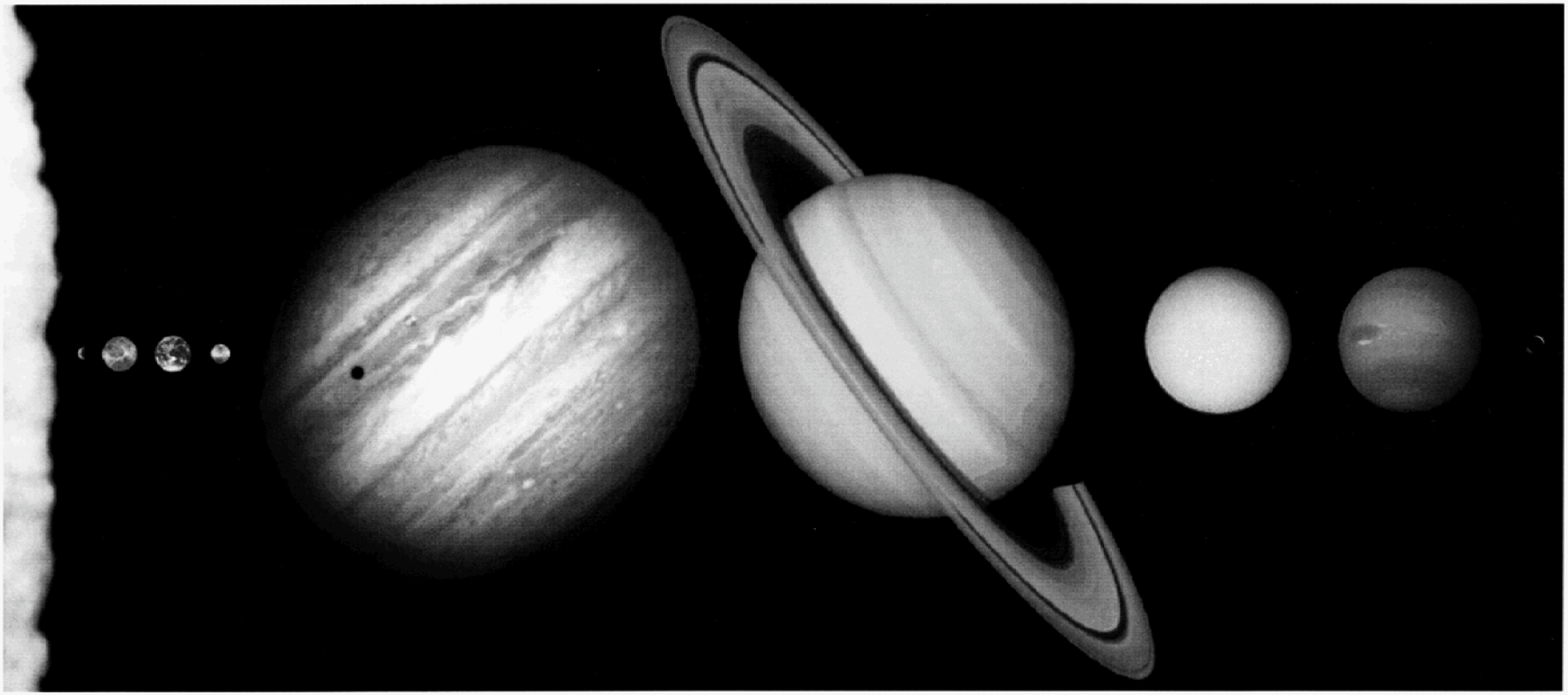
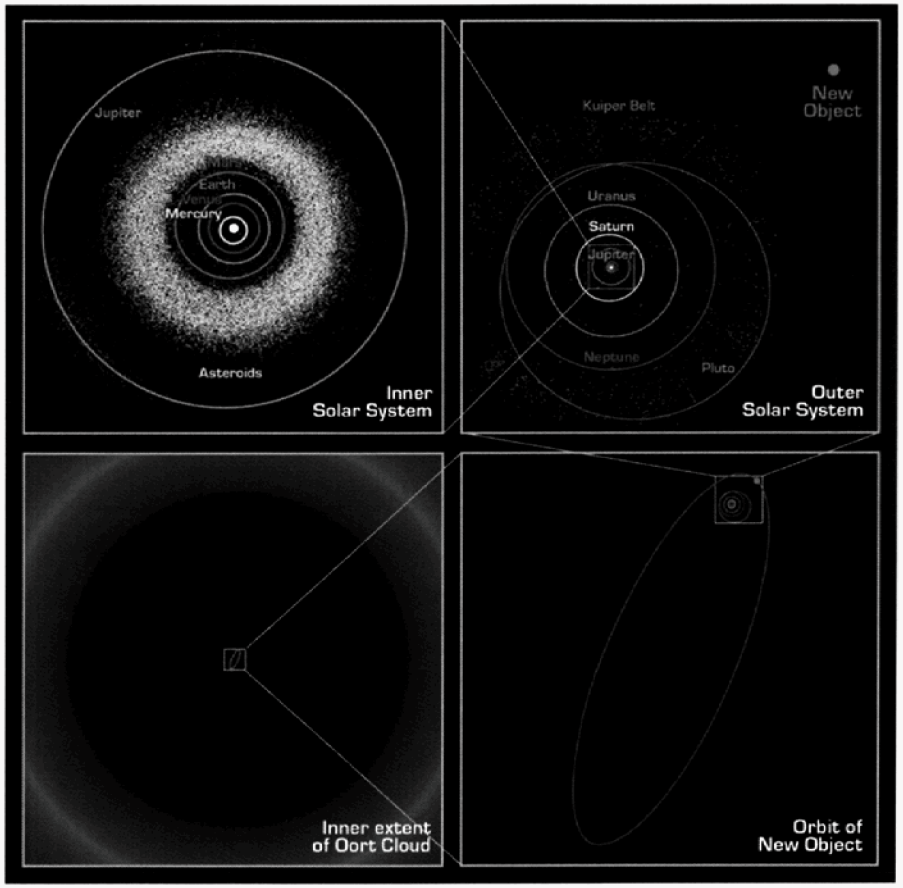
A “Classical” View of Solar System



Sun Venus Mars Jupiter Saturn Uranus Neptune Pluto

Mercury Earth Asteroids

A "Modern" View of Solar System



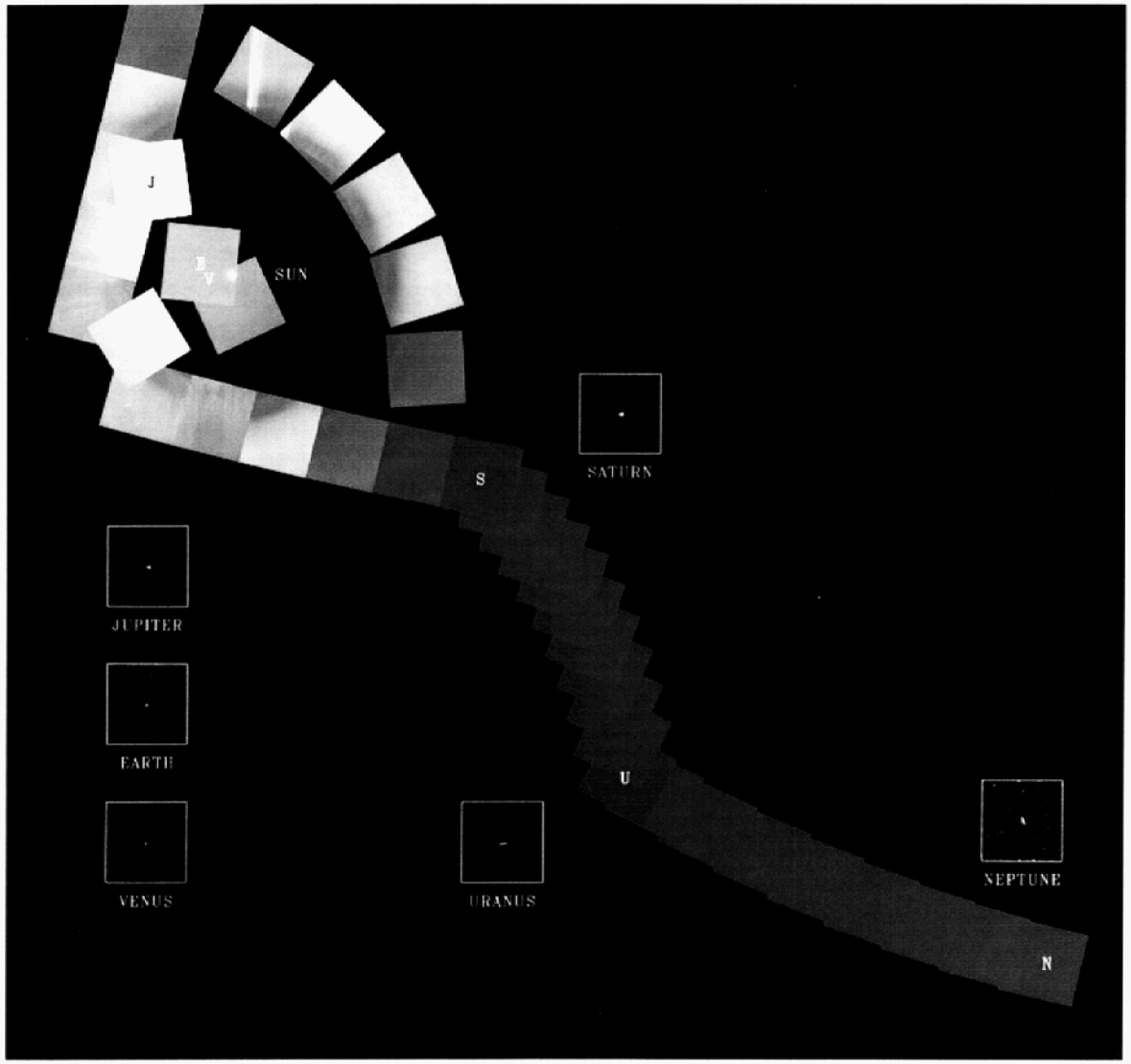
Recently Discovered Objects:

- Quaoar:
  - Discover Date: Jun 2002
  - Diameter: 1280 km
  - Distance from Earth: 42 AU
  - Known moon: 0
- Sedna:
  - Discover Date: Summer 2003
  - Diameter: 1280 – 1800 km
  - Distance from Earth: 90 – 850 AU
  - Known moon: 0
- 2003 UB313
  - Discover Date: Oct 2003
  - Diameter: 2860 km
  - Distance from Earth: 38 – 97 AU
  - Known moon: 1

Notes:
1. Pluto's Diameter is 2240 km
2. 1 AU = 150,000,000 km

A Real Picture of the Solar System

Taken by JPL's Voyager Spacecraft



JPL's Solar System Exploration Missions

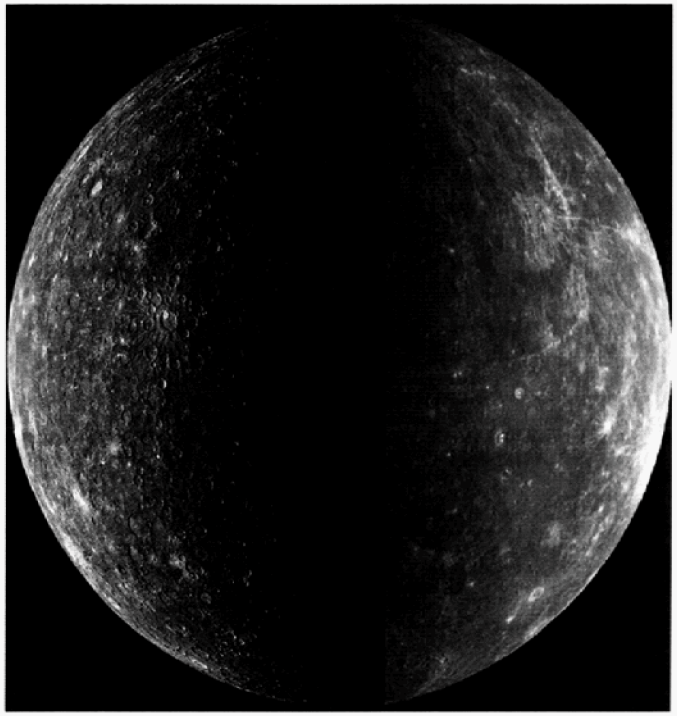
JPL's spacecrafts have visited most of the classical planets except Pluto:

Target	Missions	Launch *	First Arrival *
Sun	Ulysses Genesis	Oct 6, 1990 Aug 8, 2001	Jun–Sep, 1995 Dec 01 – Apr 04
Moon	Ranger 7, 8, 9 Surveyor 1, 3, 5, 7	Jul 28, 1964 May 30, 1966	Jul 31, 1964 Jun 2, 1966
Mercury	Mariner 10	Nov 3, 1973	Mar 29, 1974
Venus	Mariner 2, 5, 10 Magellan	Aug 27, 1962 May 4, 1989	Dec 14, 1962 Aug 10, 1990
Mars	Mariner 4, 6, 7, 9 Viking 1, 2 Mars Global Surveyor Mars Pathfinder Mars Odyssey Mars Exploration rover	Nov 28, 1964 Aug 20, 1975 Nov 7, 1996 Dec 7, 1996 April 7, 2001 Jun 10, 2003	Jul 24, 1965 Jul 20, 1976 Sep 12, 1997 Jul 4, 1997 Oct 24, 2001 Jan 04, 2004
Asteroids	Galileo	Oct 18, 1989	Oct 29, 1991
Jupiter	Voyager 1, 2 Galileo	Sep 5, 1977 Oct 18, 1989	Mar 5, 1979 Dec 7, 1994
Saturn	Voyager 1, 2 Cassini / Huygan	Sep 5, 1977 Oct 15, 1997	Nov 12, 1980 Jul 1, 2004
Uranus	Voyager 2	Aug 20, 1977	Jan 24, 1986
Neptune	Voyager 2	Aug 20, 1977	Aug 25, 1989
Comets	Deep Space 1 Stardust Deep Impact	Oct 24, 1998 Feb 7, 1999 Jan 12, 2005	Sep 25, 2001 Jan 2, 2004 Jul 4, 2005

* Note: Only the first in a series is shown

Mercury

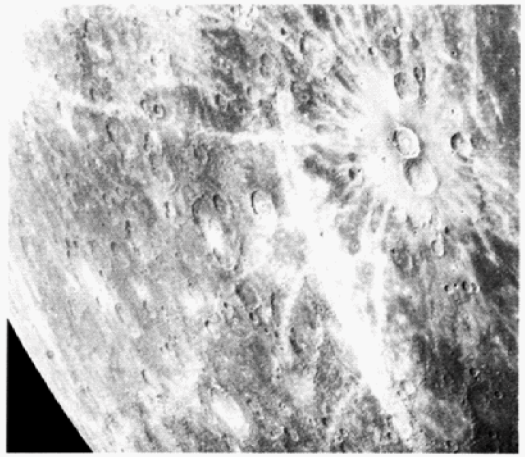
Distance from Sun: 0.38 AU Diameter: 0.38 x Earth's



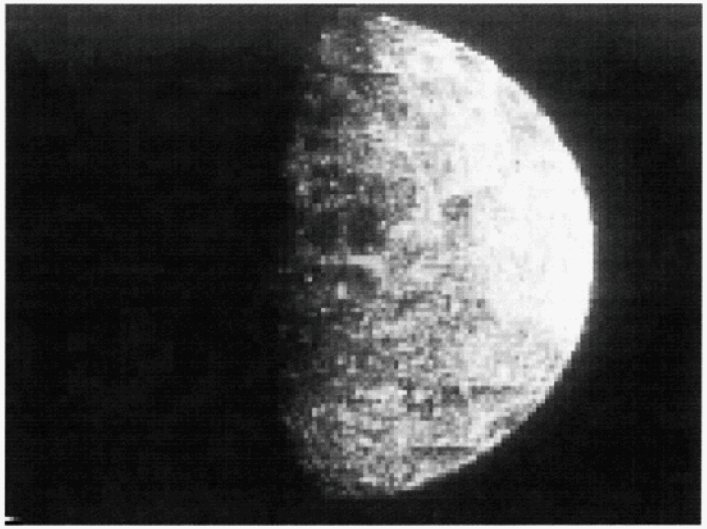
Mercury Overview

- Visited by Mariner 10
- Interesting discoveries
  - Moon like surface
  - A gigantic impact crater, the Caloris Basin

Mercury Surface Close-up



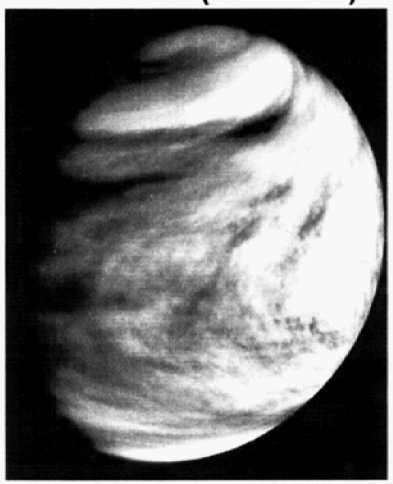
Mercury's Caloris Basin



Venus

Distance from Sun: 0.72 AU Diameter: 0.95 x Earth's

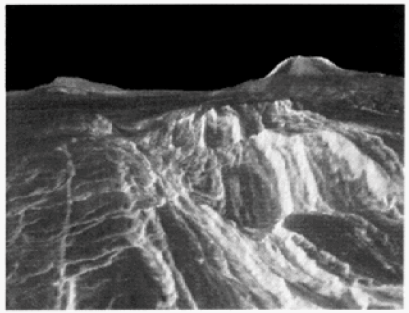
Cloud Top of Venus Taken (Mariner)



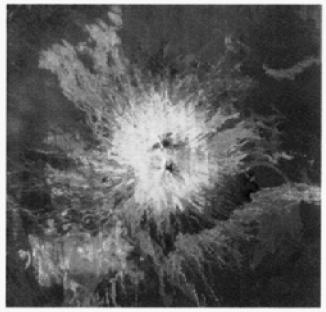
- Visited by Mariner and Magellan spacecrafts
- Highlights of discovery
  - Very complex geological formations under the clouds
  - Recent volcanic activities
  - Tectonic movements

Radar Images of Venus Surface Close-up by Magellan

Eistla Regio

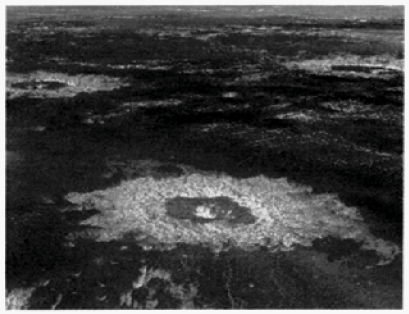


Volcano Sapas Mons



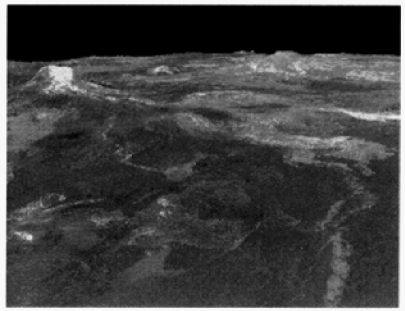
Radar Image of Venus Surface (Magellan)

Three Craters



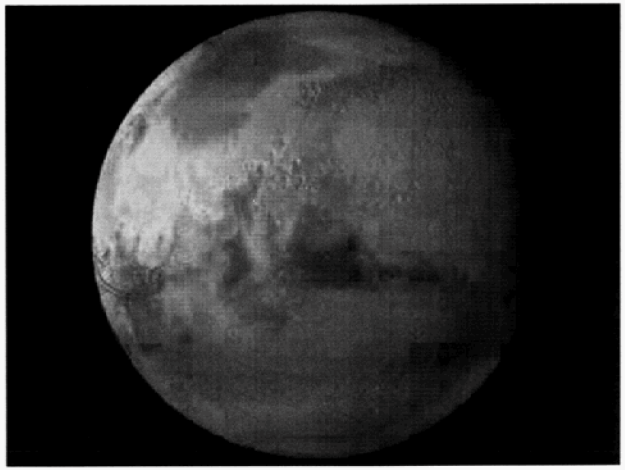
Pancake Domes

Lava Flows

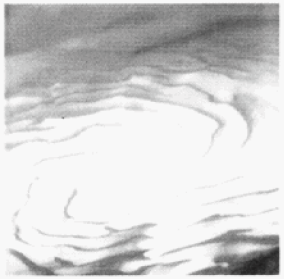


Mars

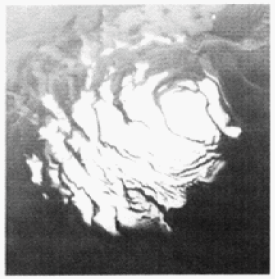
Distance from Sun: 1.52 AU Diameter: 0.53 x Earth's



- Visited by Mariners, Vikings, Mars Pathfinder, Mars Exploration Rovers
- Highlights of discovery
  - Evidence of abundant of water in ancient time



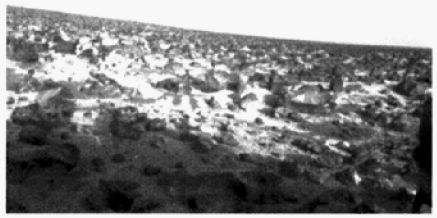
Mars North Pole (Mariner)



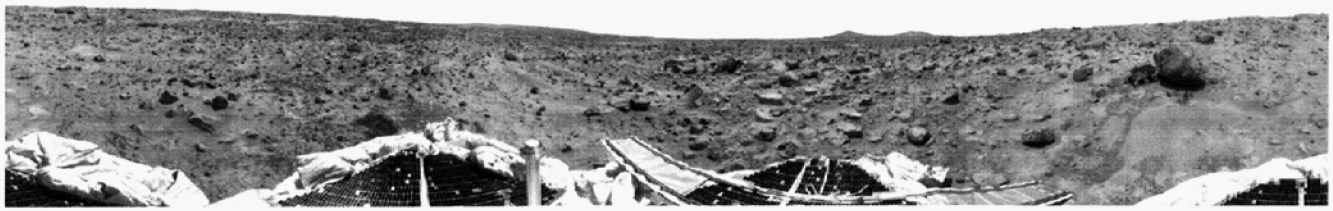
Mars South Pole (Mariner)

Mars Pathfinder Rover

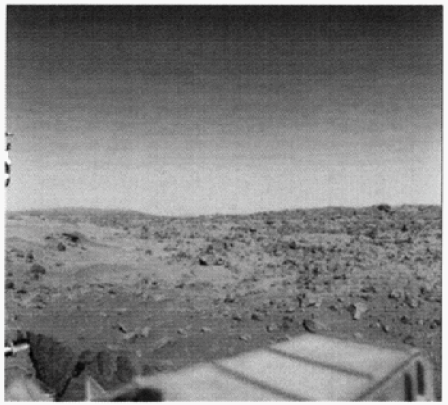
Mars Sunset & Clouds (Pathfinder)



Mars Frost (Viking)



Mars Pathfinder Landing Site

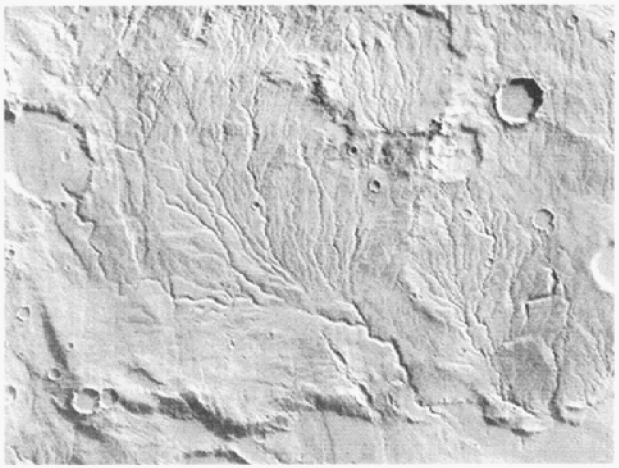


Viking Landing Site

Mars (Continued)

Distance from Sun: 1.52 AU Diameter: 0.53 x Earth's

Mars Ancient River Valleys
(Mars Global Surveyor)

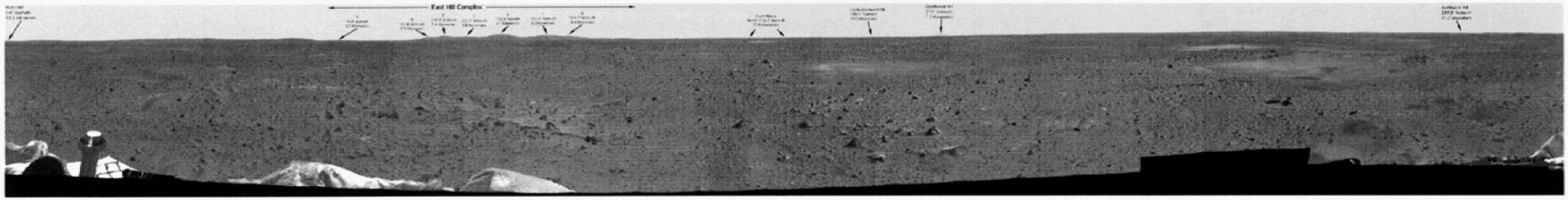


Evidence of Large Body of Ancient Water
(Mars Exploration Rover – Opportunity)

Evidence of Liquid Water on Mars
(Mars Global Surveyor)

Mars (Continued)

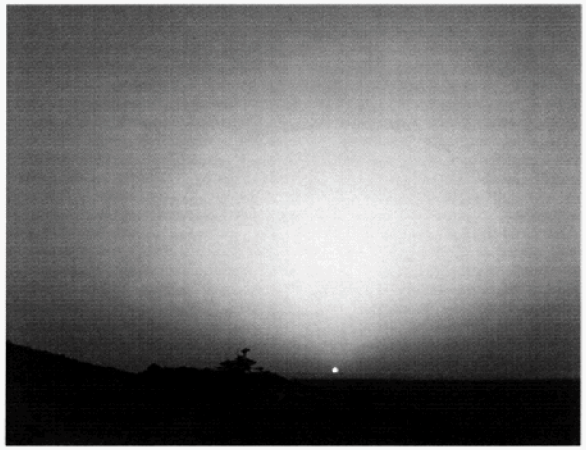
Distance from Sun: 1.52 AU Diameter: 0.53 x Earth's



Mars Exploration Rover (Spirit) Landing Site

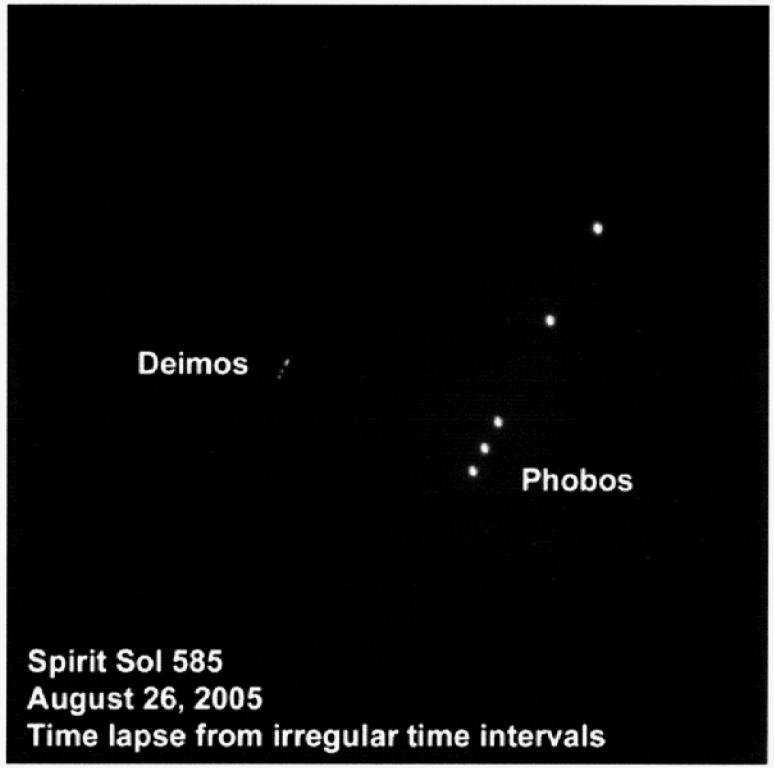
Aerial view of MER Landing Site

MER Animation

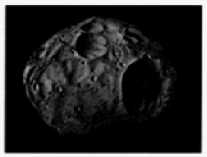


Special-Effects Spirit Silhouetted

Moons of Mars



Deimos
Diameter: 12.6 km
Composition: Carbon-rich rocks



Phobos (with Stickney Crater)
Diameter: 22.2 km
Composition: Carbon-rich rocks

Notes:

Mars' Satellites are believed to be captured satellites. Phobos will crash into Mars in 50 millions years

Asteroids

- Gaspra and Ida were visited by Galileo
- Interesting discoveries
  - Irregular asteroid can also have satellite

Ida and Dactyl

Ida Size: 58 x23 km
Dactyl Size: 1.6 x 1.2 km

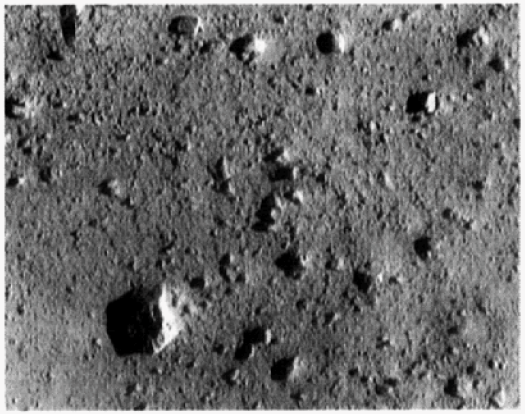
Gaspra

Size: 19 x 12 x 11 kilometers

Asteroids (Continued)

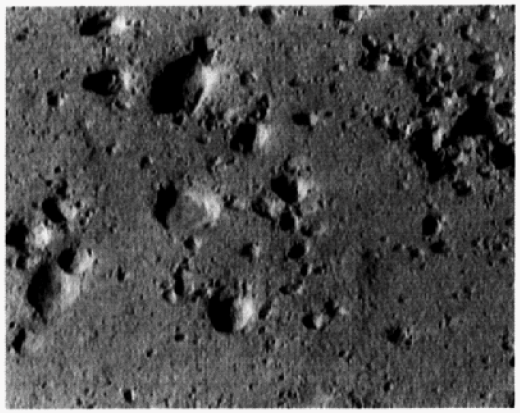
JPL has landed the NEAR spacecraft (APL) on Asteroid Eros

Eros Size: 33x13x13 km

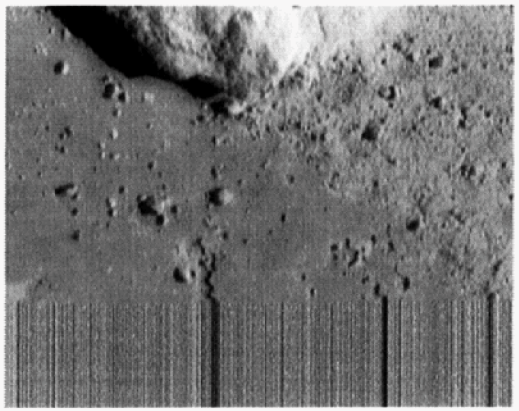


1150 m above Eros

750 m above Eros



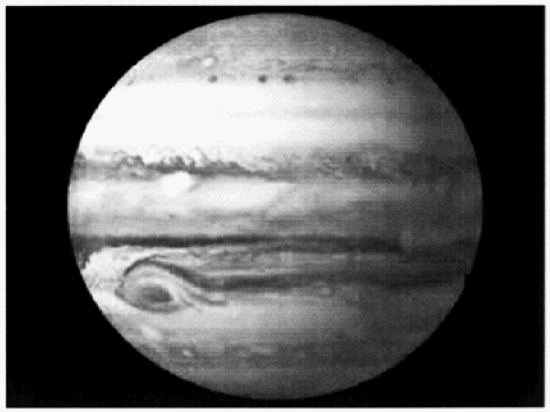
250 m above Eros



120 m above Eros

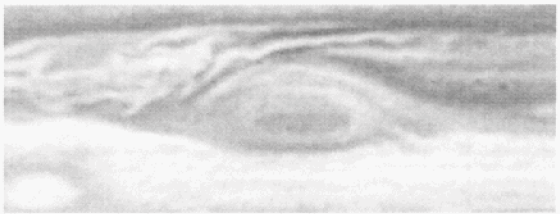
Jupiter

Distance from Sun: 5.20 AU Diameter: 11 x Earth's

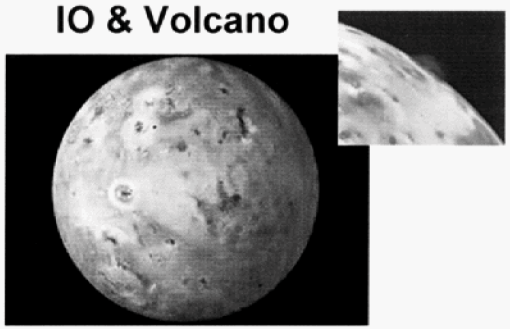


- Visited by Voyagers, Galileo, Cassini / Huygan
- Highlights of discovery
  - The Great Red Spot is a turbulence
  - Jupiter has a ring
  - Its satellite IO has active volcanoes
  - Its satellites Europa, Ganymede, Caliisto are icy moons
  - Europa may have a large liquid water ocean below ice surface

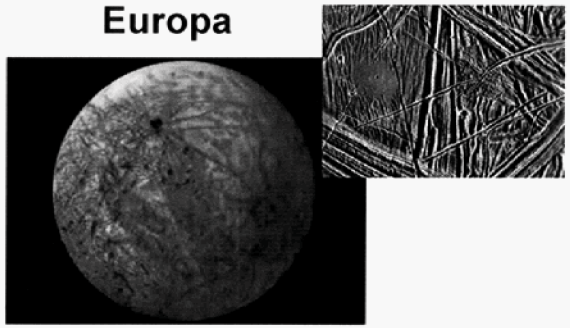
Jupiter's Great Red Spot



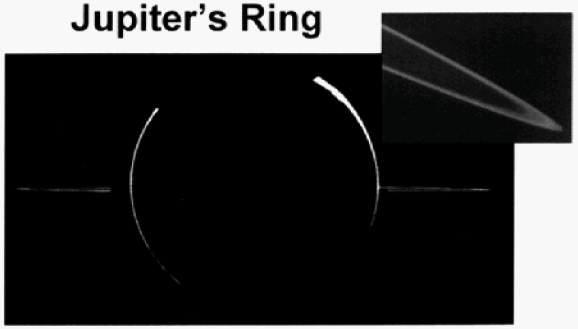
IO & Volcano



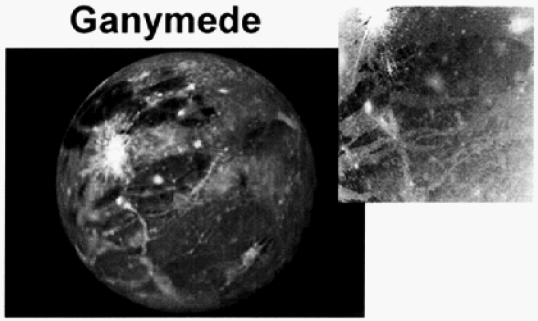
Europa



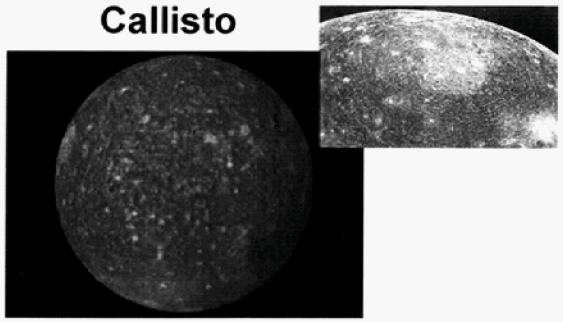
Jupiter's Ring



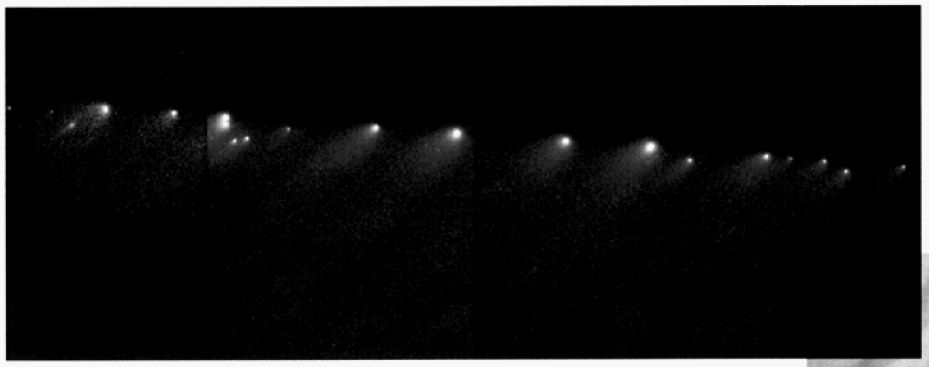
Ganymede



Callisto



Shoemaker Comet Collided with Jupiter



Comet Shoemaker-Levy 9

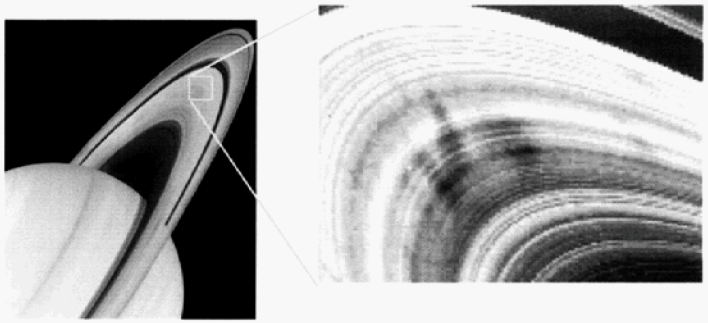
Impacts on Jupiter
(Taken by Galileo)

Saturn

Distance from Sun: 9.54 AU Diameter: 9 x Earth's

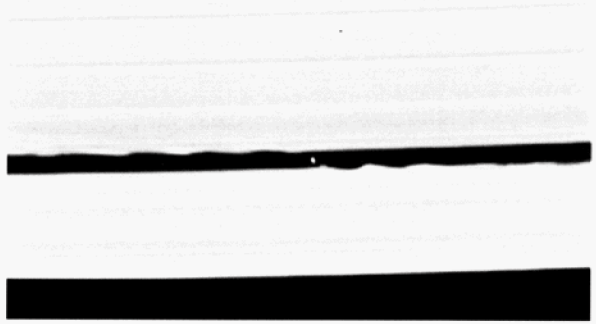
- Visited by Voyagers, Cassini/Huygan
- Highlights of discovery
  - Rings are made up of thousands of small rings and has rotating "spoke" pattern
  - Moons inside the rings

Saturn's Ring and Spoke Pattern (Voyager)

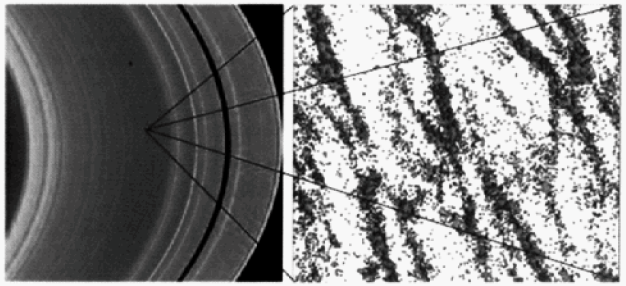


Saturn's Cloud (Voyager)

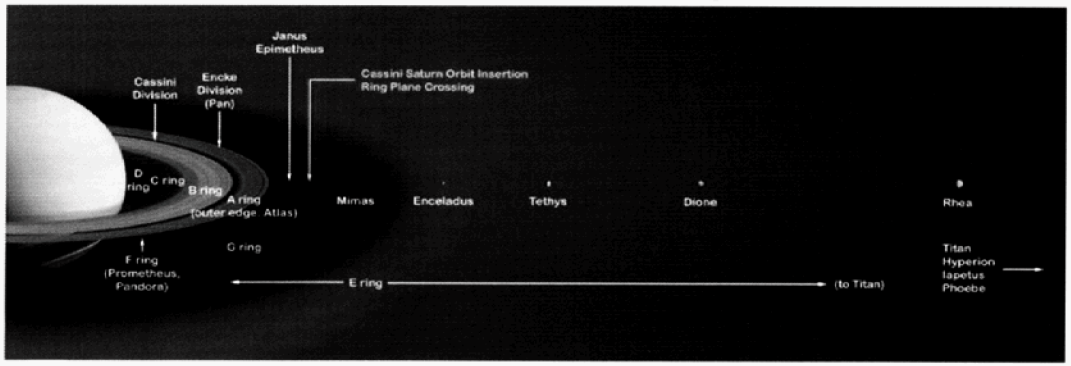
Moon In-Between Rings (Cassini)



Saturn's Ring Close-up (Cassini)

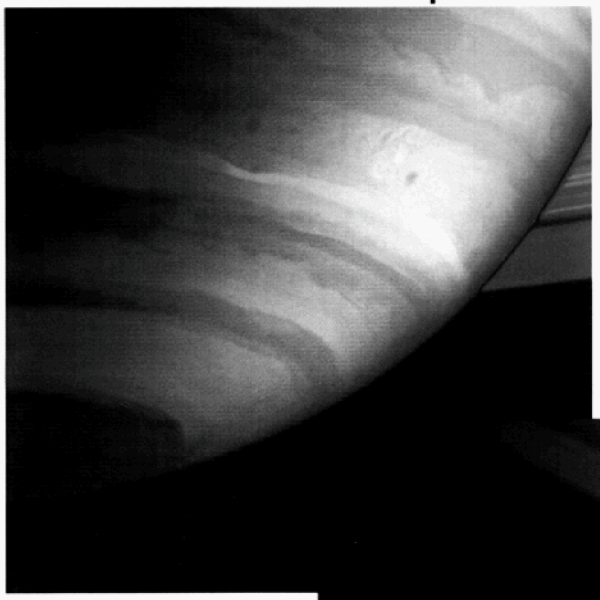


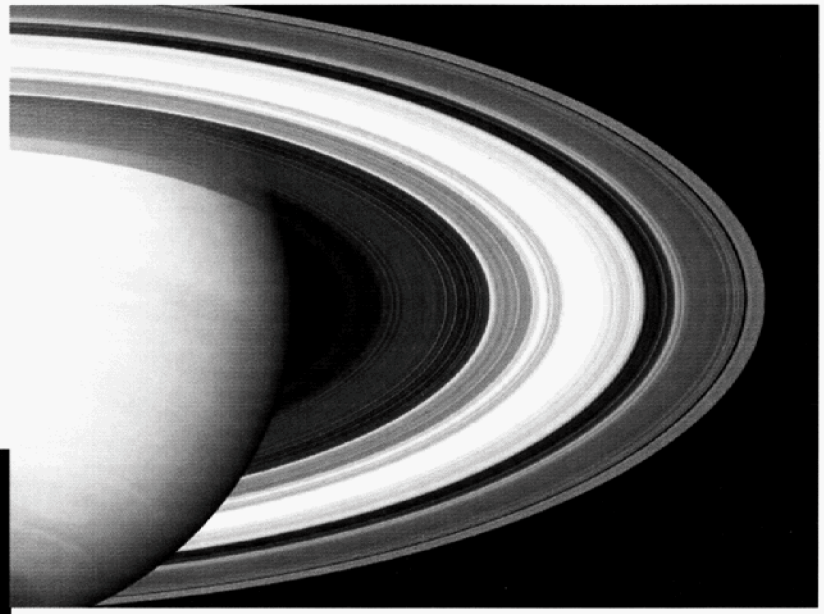
Saturn's Ring Configuration



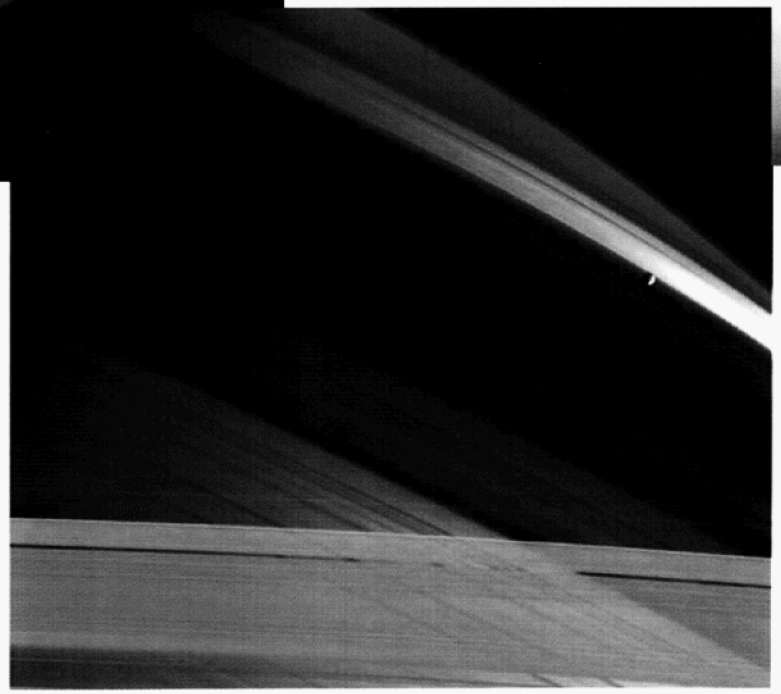
More Saturn's Images from Cassini

"Dragon" Strom in
Southern Hemisphere



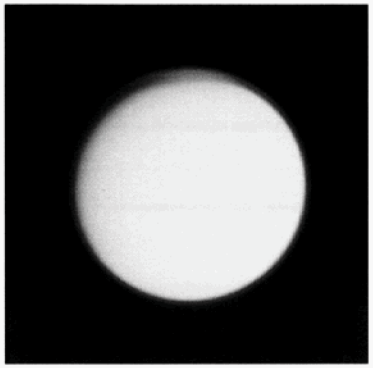


View of Rings from
Southern Hemisphere

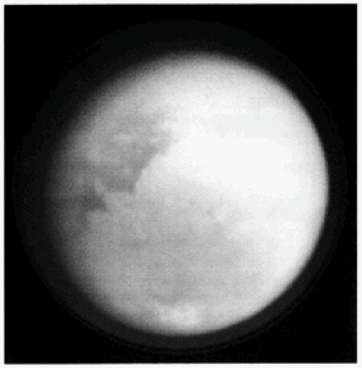


Saturn's Moon Mimas
and Shadow of the Rings

Saturn Moon Titan
(The only satellite has significant atmosphere)



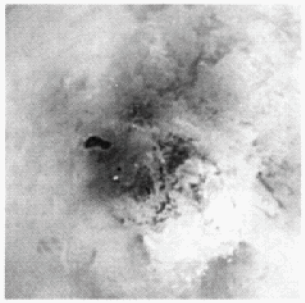
Titan Visual Image
(Voyager)



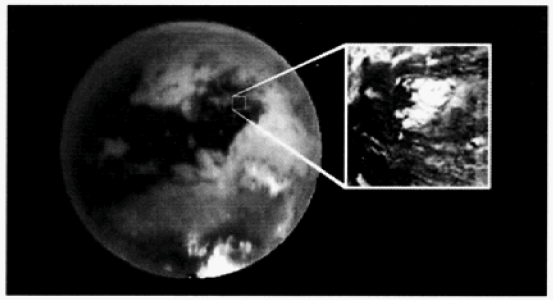
Titan Radar Image
(Cassini)

- Visited by Cassini and landed on by Huygan
- Highlights of discovery
  - Earth-like geological features
  - Possible methane lake
  - Possible methane volcano

Possible Methane Lake

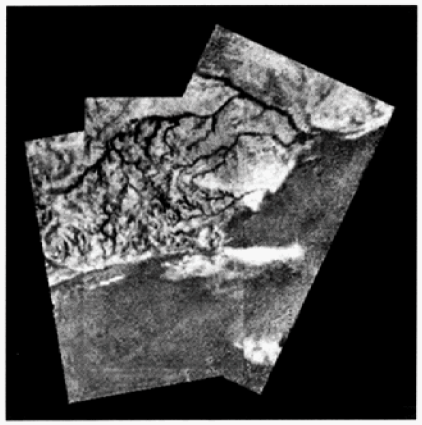


Possible Volcano



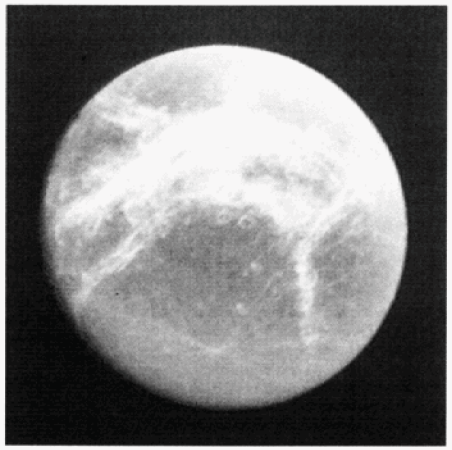
Huygan
Landing Site

Arial View of Titan
(Huygan)



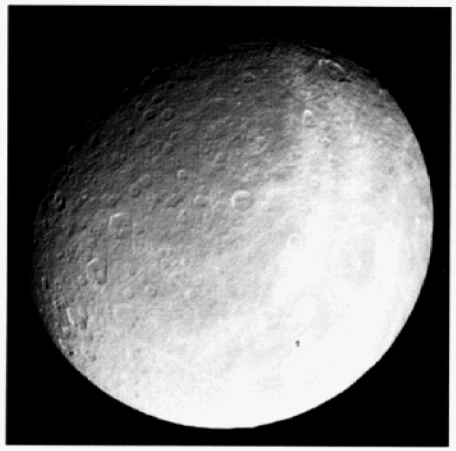
Titan Panoramic View (Huygan)

Other Satellites of Saturn

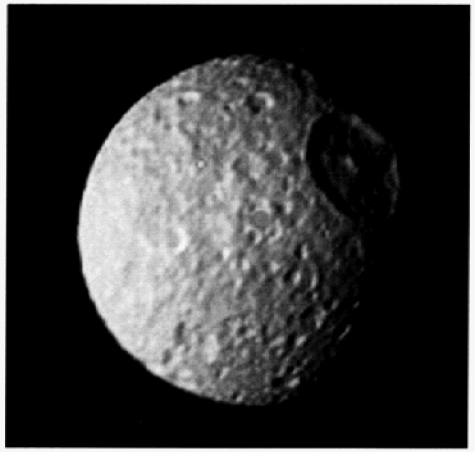


Dione (Voyager)

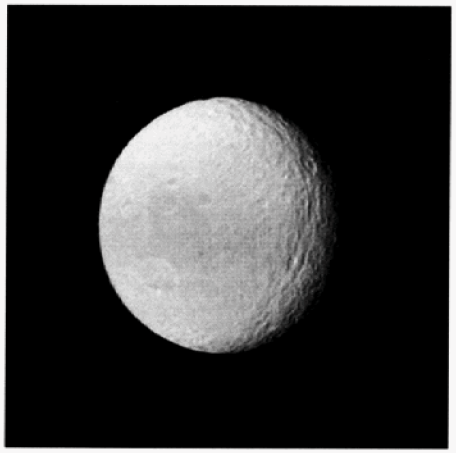
Enceladus (Cassini)



Rhea (Cassini)



Mimas & Herschel crater (Voyager)

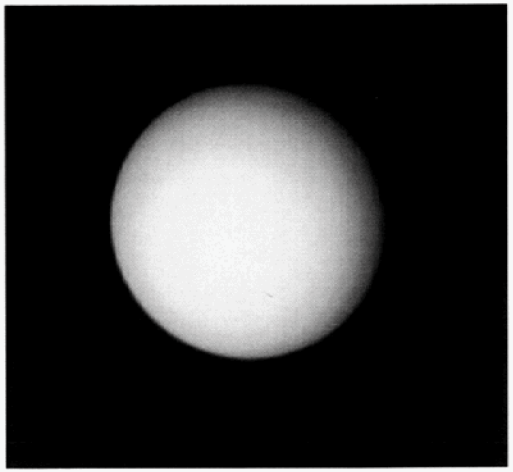


Tethys (Voyager)

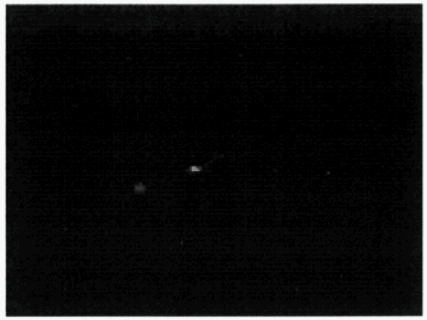
Hyperion (Cassini)

Uranus

Distance from Sun: 19.2 AU Diameter: 4 x Earth's

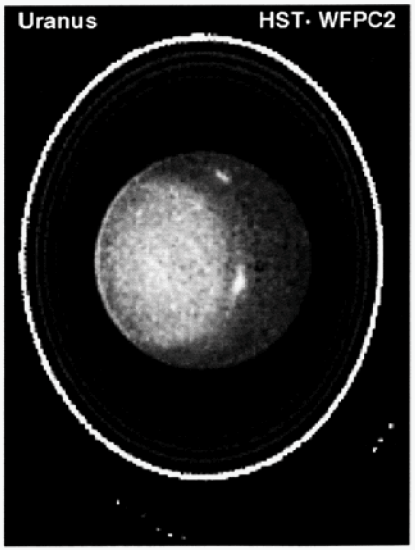


- Visited by Voyagers
- Highlights of discovery
  - Almost featureless surface
  - Complex ring system
  - Dramatic geological features on Miranda

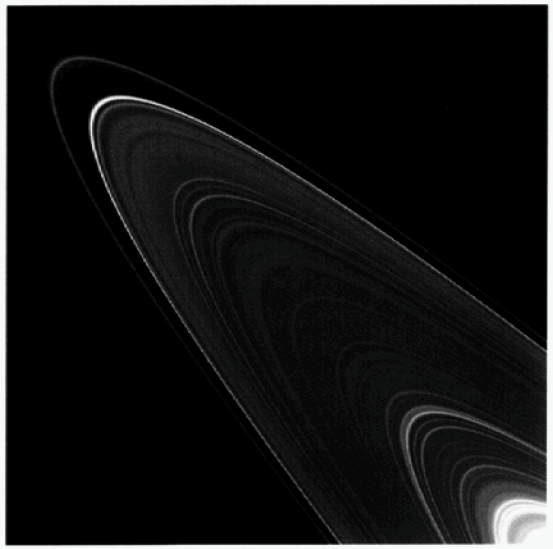


Traversing Miranda's Surface Animation

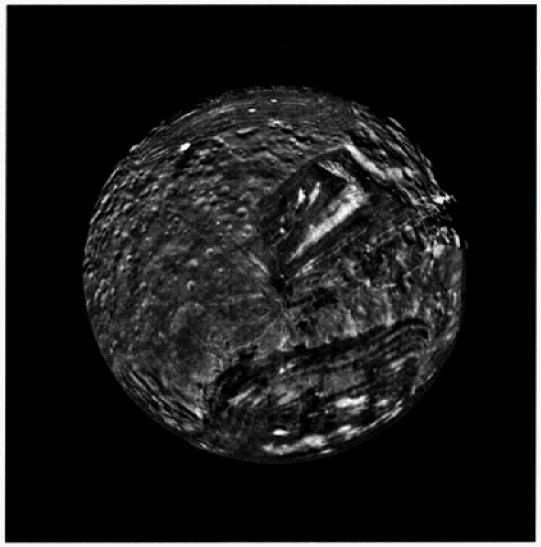
Uranus and Its Rings (Hubble)



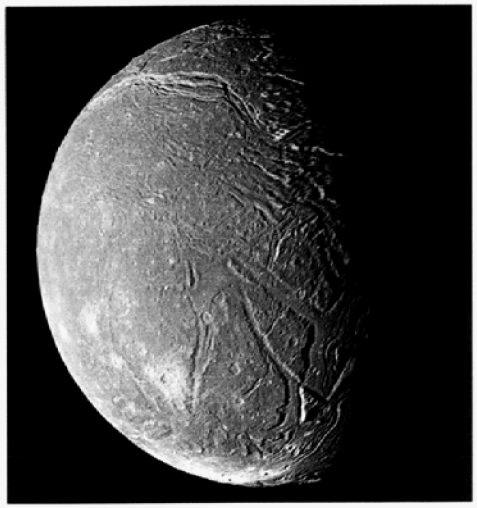
Uranus' Ring System (Voyager)



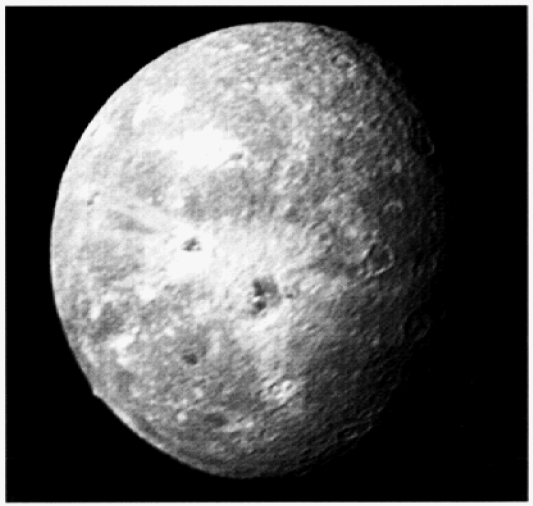
Uranus' Moon Miranda (Voyager)



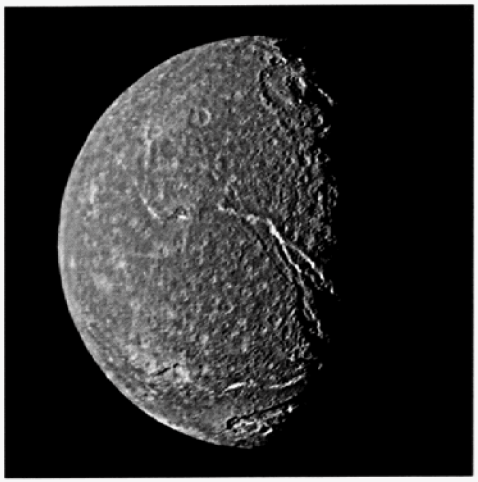
Other Moons of Uranus



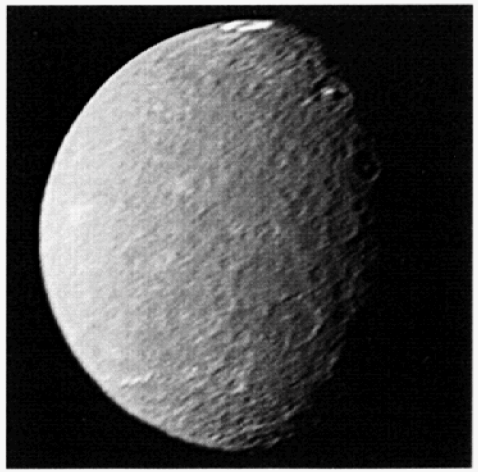
Ariel (Voyager)



Oberon (Voyager)



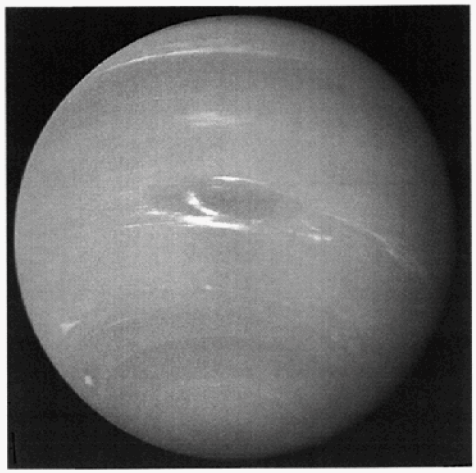
Titania (Voyager)



Umbriel (Voyager)

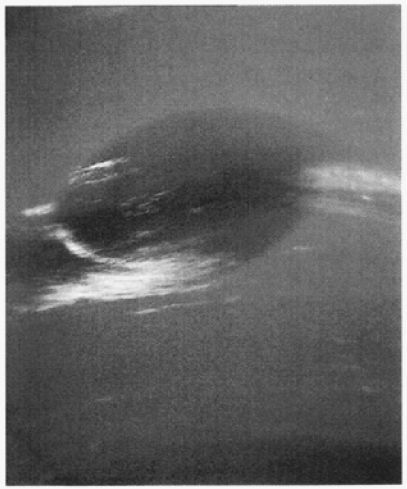
Neptune

Distance from Sun: 30 AU Diameter: 4 x Earth's

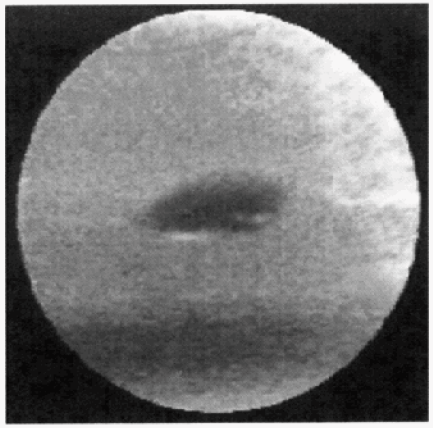


- Visited by Voyagers
- Highlights of discovery
  - Great Dark Spot
  - Very high speed wind
  - Complex ring system
  - Ice volcano on Neptune's moon Tritan

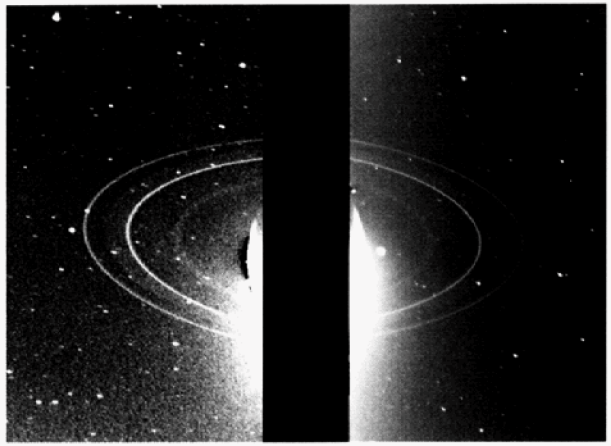
Great Dark Spot



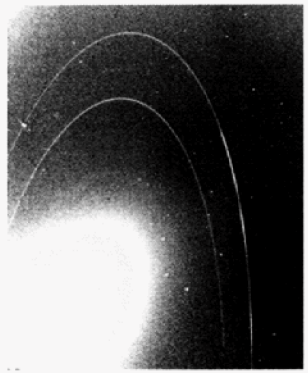
Neptune's Turbulence Atmosphere



Neptune's Ring System

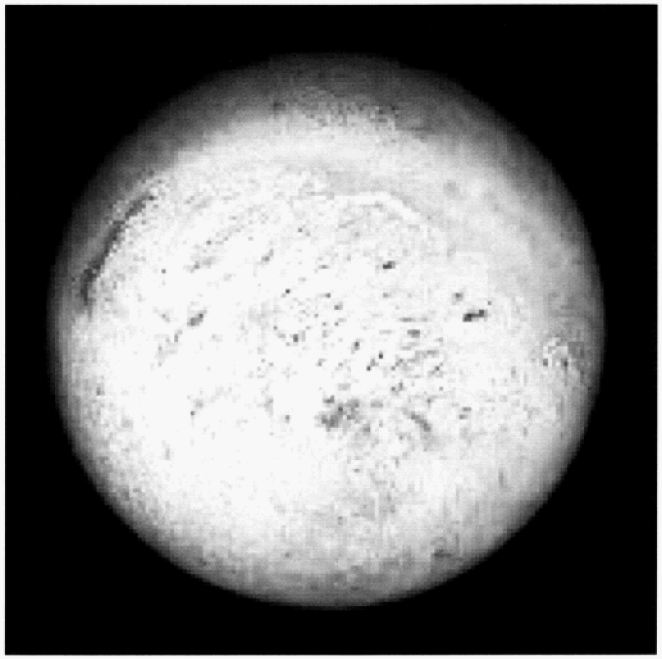


Uneven Ring

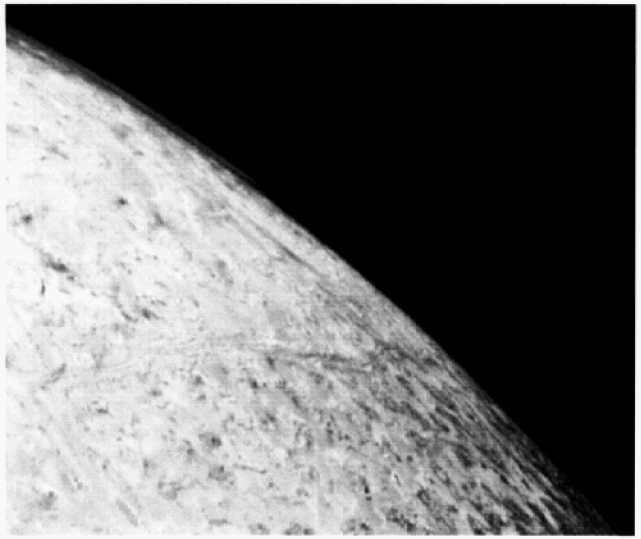


Neptune's Moons

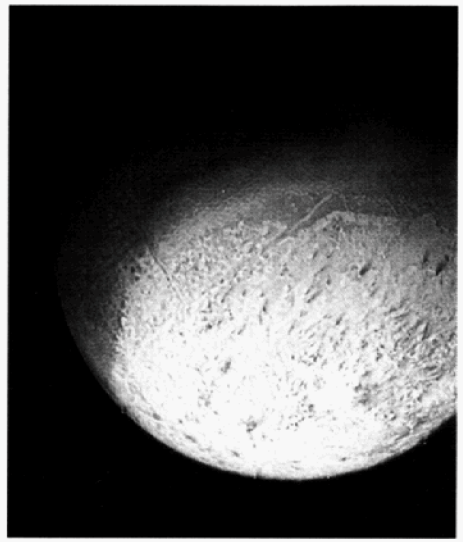
Triton



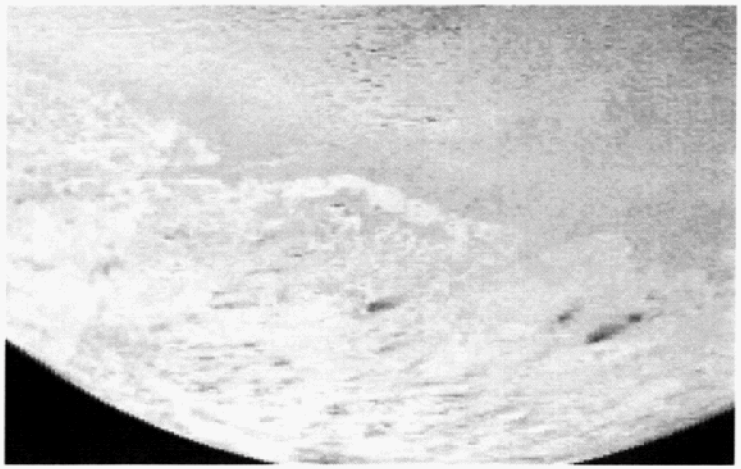
Triton's Thin Atmosphere



Titan's Southern Hemisphere



Ice Volcano Animation

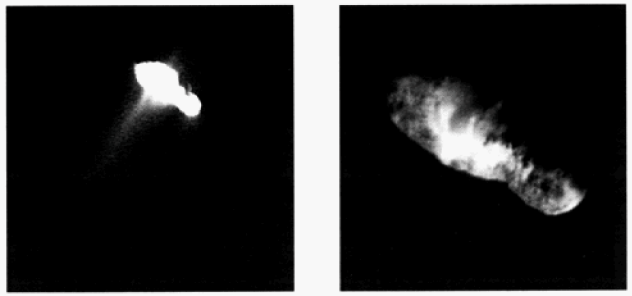


Proteus

Comets

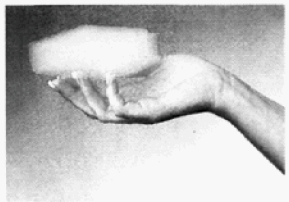
Three comets has been visited by JPL's spacecrafts:
Comet Borrelly, Comet Wild 2, Comet Tempel 1

- Comet Borrelly
  - Visited by Deep Space 1
  - Highlights of discovery
    - Most detailed image of a comet up to that time

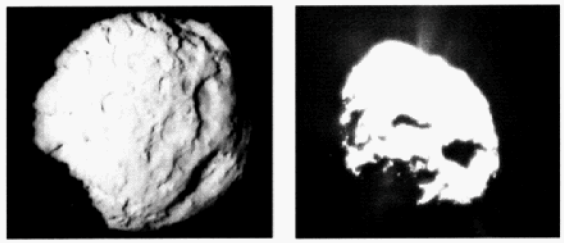


Comet Borrelly (Deep Space 1)

- Comet Wild 2
  - Visited by Stardust
  - Highlights of discovery
    - Captured samples from tail of the comet
    - Samples will return to Earth in 2006



Aerogel used for comet sample capture

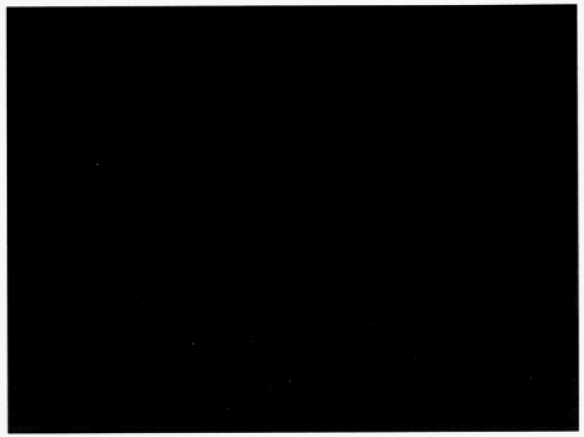


Comet Wild 2 & Jets (Stardust)

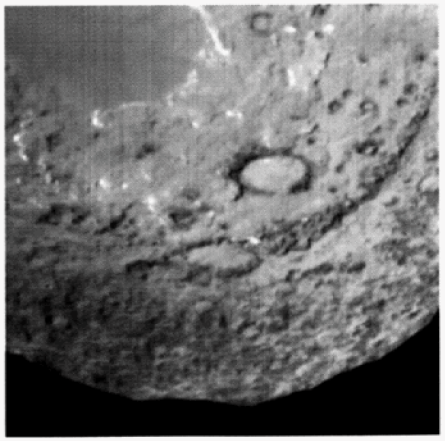
Stardust Fly-by Wild 2

Comets (Continued)

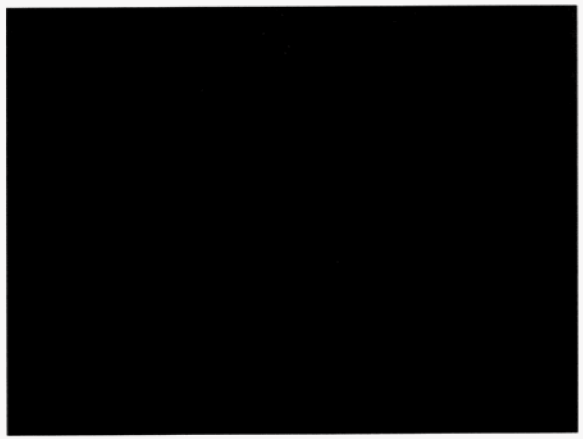
- Comet Tempel 1
  - Visited by Deep Impact
  - Highlights of discovery
    - Internal materials exposed by impact
    - Surface of the comet appears to be soft materials



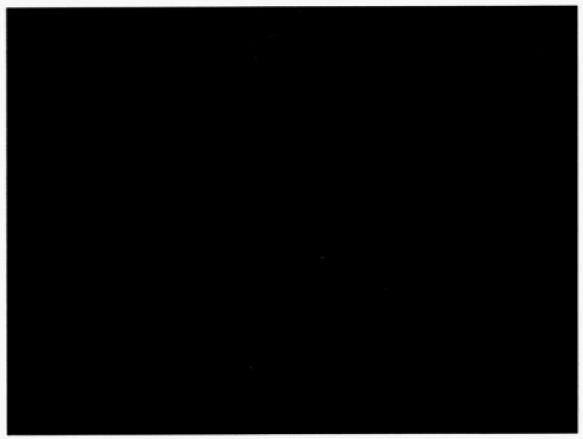
Deep Impact Trajectory



Comet Tempel 1 (Deep Impact)

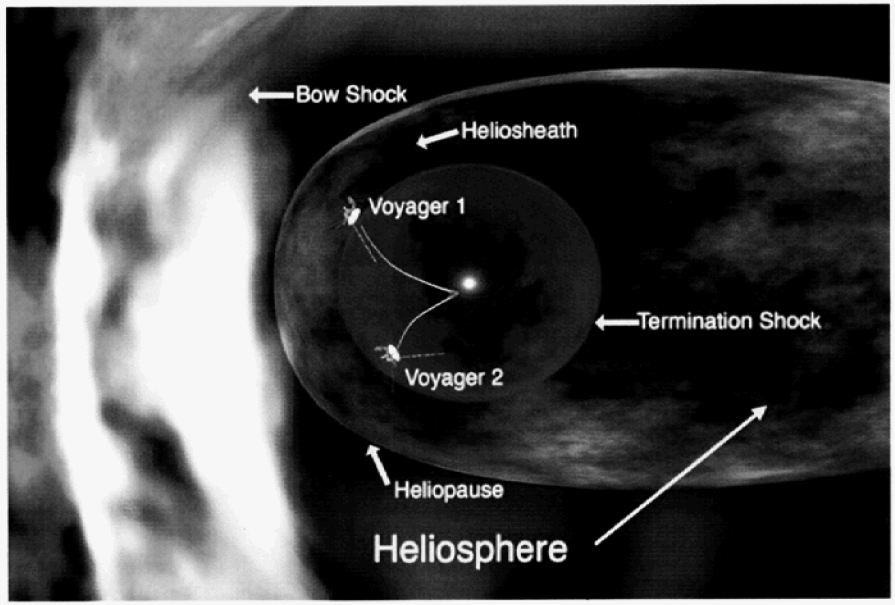


Impactor Approaching Comet Tempel 1 (Deep Impact)

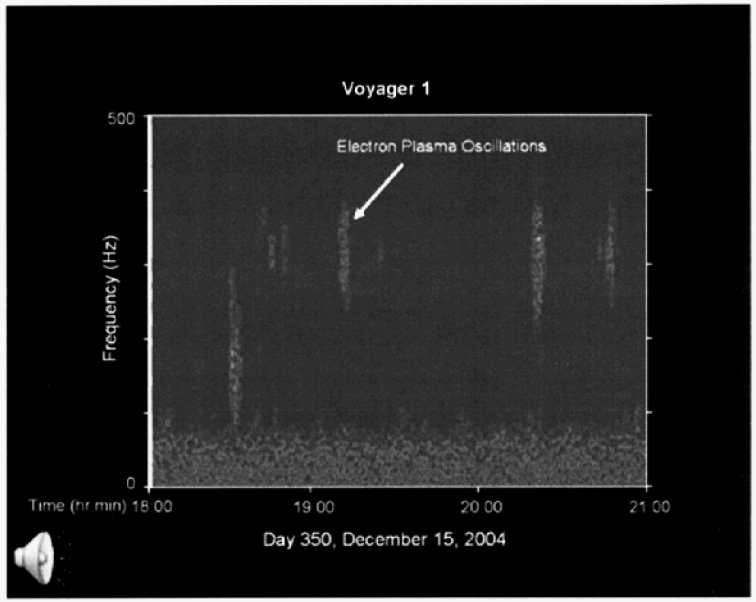


Comet Tempel 1 Impact Sequence (Deep Impact)

To the Edge of the Solar System



Voyager 1 Existing Solar System



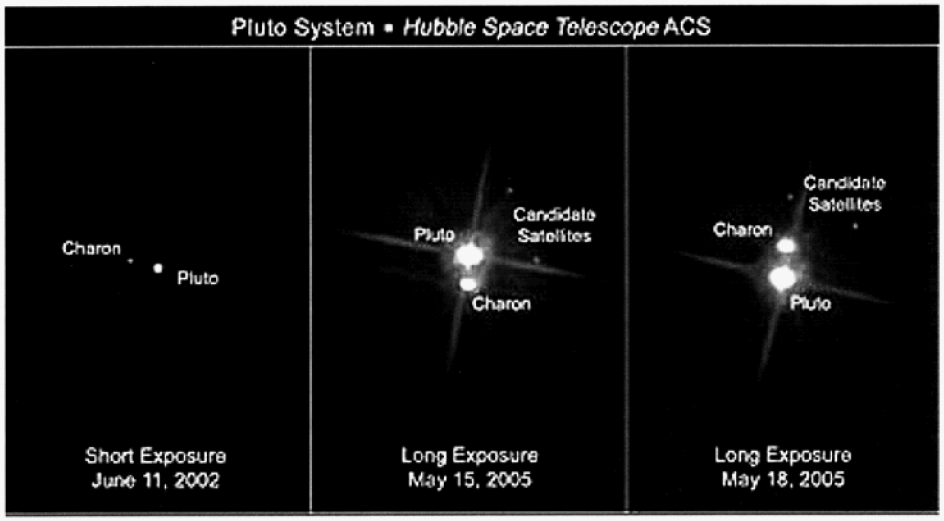
Sound of Solar Wind at Heliosheath Boundary

Preview of Pluto Mission

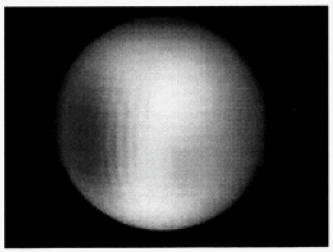
Distance from Sun: 39.44 AU Diameter: 0.24 x Earth's

Pluto will be visited by the New Horizon spacecraft (managed by APL)

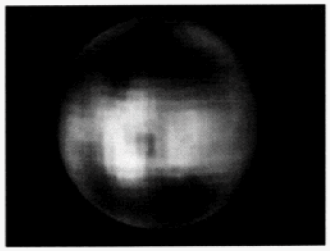
Pluto and Charon
(Hubble Space Telescope)



Two new moons found



Pluto



Charon