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:

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<th>Target</th>
<th>Missions</th>
<th>Launch *</th>
<th>First Arrival *</th>
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<td>Genesis</td>
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<td>Stardust</td>
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<td>Jan 2, 2004</td>
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<td>Deep Impact</td>
<td>Jan 12, 2005</td>
<td>Jul 4, 2005</td>
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* Note: Only the first in a series is shown
Mercury
Distance from Sun: 0.38 AU  Diameter: 0.38 x Earth’s

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

Mercury Surface Close-up

Mercury Overview
Mercury’s Caloris Basin
Venus

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

- 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

Cloud Top of Venus Taken (Mariner)

Radar Image of Venus Surface (Magellan)

Eistla Regio

Three Craters

Volcano Sapas Mons

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 (Continued)

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

Mars Ancient River Valleys
(Mars Global Surveyor)

Evidence of Liquid Water on Mars
(Mars Global Surveyor)

Evidence of Large Body of Ancient Water
(Mars Exploration Rover – Opportunity)
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 x 23 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
Shoemaker Comet Collided with Jupiter

Impacts on Jupiter
(Taken by Galileo)

Comet Shoemaker-Levy 9
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 Cloud (Voyager)   Moon In-Between Rings (Cassini)

Saturn’s Ring and Spoke Pattern (Voyager)   Saturn’s Ring Close-up (Cassini)

Saturn’s Ring Configuration
More Saturn’s Images from Cassini

“Dragon” Storm 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)

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

Titan Visual Image (Voyager)
Titan Radar Image (Cassini)
Possible Methane Lake
Possible Volcano

Huygan Landing Site
Aerial 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
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
Neptune’s Moons

Triton

Triton’s Thin Atmosphere

Titan’s Southern Hemisphere

Proteus

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