



## 3 Methods of Exploration of Mars

- Flybys
- Orbiters
- Landers and Rovers

## Spacecraft Flybys

MARINER 3 & 4

MARINER 6 & 7

## Mariner Project

- To explore the inner solar system, visiting the planets Venus, Mars and Mercury for the 1<sup>st</sup> time.
- Between 1962 and 1973.
- The 10 Mariners were all relatively small robotic explorers, each launched on an Atlas rocket with either an Agena or Centaur upper-stage booster.

## Mariner 3 & 4

- Mariner 3 and 4 were identical spacecrafts designed to carry out the first flybys of Mars.
- Mariner 3 was launched on November 5, 1964, but the shroud encasing the spacecraft atop its rocket failed to open properly, and Mariner 3 did not get to Mars.
- November 28, 1964, Mariner 4 was launched successfully on an eight-month voyage to the red planet.

## Importance of Mariner 4

- Collected the first close-up photographs of another planet.
- Not expected to survive much longer than the eight months.
- Lasted about three years in solar orbit, continuing long-term studies of the solar wind environment and making coordinated measurements with Mariner 5, a sister ship launched to Venus in 1967.


## Mariner 6 & 7

- ❑ Mariner 6 and 7 were the second pair of Mars missions in NASA's Mariner series.
- ❑ 1969, Mariner 6 and Mariner 7 completed the first dual mission to Mars.
- ❑ Flew by over the equator and south polar regions and analyzing the Martian atmosphere and surface with remote sensors.
- ❑ Showed that the dark features on the surface seen from Earth were not canals, as once thought in the 1800s.

## Mars Orbiters


- Mariner 8-9
- Viking 1-2
- Mars Observer
- Climate Orbiter
- Mars Global Surveyor

Past



- 2001 Mars Odyssey
- Mars Express
- Mars Reconnaissance Orbiter

Current



## Mariners 8 & 9


Mariner 8 and 9 were the third and final pair of Mars missions in NASA's Mariner series.

Both were designed to be the first Mars orbiters.

Mariner 8 failed during launch on May 8, 1971.

Mariner 9 was launched successfully and became the first artificial satellite of Mars.

## Importance of Mariner 9



- Mariner 9 proceeded to reveal Mars to be a very different planet than expected.
- Gigantic Volcanoes
- A GRAND Canyon stretching 3,000 miles
- Ancient Riverbeds
- Mapped 100% of the Surface.
- Revealed Two Moons.
- Phobos and Deimos

## Viking 1 & 2

Became the first U.S. mission to land a spacecraft safely on the surface of Mars and return images of the surface.

Two identical spacecraft, each consisting of a lander and an orbiter, were built.

The two landers conducted 3 biology experiments designed to look for possible signs of life.

## Mars Observer

Represents a renewed interest in Mars after a 17 year gap since the last Mars mission.

Launched Mars Observer on September 25, 1992.

The spacecraft was based on a commercial Earth-orbiting communications satellite that had been converted into an orbiter for Mars.

## Mars Climate Orbiter

Designed to function as an interplanetary weather satellite.

Carried 2 instruments: a copy of an atmospheric sounder lost on the Mars Observer and a new, lightweight color imager combining wide- and medium-angle cameras.

## Mars Global Surveyor

1<sup>st</sup> successful mission to Mars in 20 years!

Most exciting observations of the spacecraft's wide-angle camera system is that Mars has very repeatable weather patterns.

Has found gullies and debris flows suggesting sources of liquid water, similar to an aquifer, were once present at or near the surface of the planet.

## 2001 Mars Odyssey

Collected more than 130,000 images and continues to send information to Earth about Martian geology, climate, and mineralogy.

Enabled scientists to create maps of minerals and chemical elements and identify regions with buried water ice.

Determined that radiation exists in low-Mars orbit, an essential piece of information for eventual human exploration

Odyssey is currently supporting landing site selection for the Phoenix Scout Mission

## Mars Express

Joint Mission with ESA and the Italian Space Agency.

Objective is to search for sub-surface water from orbit.


NASA's involvement with the mission includes joint development of a radar instrument called MARSIS

## Mars Reconnaissance Orbiter

Carries the most powerful camera ever flown on a planetary exploration mission.

Carries a sounder to find subsurface water

## Mars Landers

|   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• Viking 1 &amp; 2</li> <li>• Pathfinder</li> <li>• Polar Lander/Deep Space 2</li> </ul> | <ul style="list-style-type: none"> <li>• Mars Exploration Rovers</li> </ul>                          |
| <p>Past </p>                               | <p>Current </p> |

## Pathfinder

Returned 2.3 billion bits of information, including more than 16,500 images from the lander and 550 images from the rover

Findings suggest that Mars was at one time in its past warm and wet, with water existing in its liquid state and a thicker atmosphere.

## Polar Lander/Deep Space 2

Mission was to dig for water ice with a robotic arm. Piggybacking on the lander were two small probes called Deep Space 2 designed to impact the Martian surface to test new technologies.

Both were lost upon arrival.

## Mars Rovers

2 robots on the opposite sides of Mars: Spirit and Opportunity

Both rovers have found evidence of ancient Martian environments where intermittently wet and habitable conditions existed.

The twin rovers have sent more than 100,000 spectacular, high-resolution, full-color images of Martian terrain as well as detailed microscopic images of rocks and soil surfaces to Earth.

## What we have learnt so far!

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|--|---|--|--|
| <b>Mariner 6 &amp; 7</b><br>• There's no canals on Mars        | <b>Mariner 9</b><br>• Discovery of Volcanoes, Canyons, Ancient Riverbeds, & 2 Moons                             | <b>Viking 1 &amp; 2</b><br>• Life could not exist on Mars now. | <b>Mars Global Surveyor</b><br>• Found gullies suggesting sources of liquid water. |
| <b>Mars Odyssey</b><br>• Mapped regions with buried water ice. | <b>Pathfinder</b><br>• Past was warm and wet, with water existing in its liquid state and a thicker atmosphere. | <b>Mars Rovers</b><br>• Early Mars had habitable conditions.   |  |

## Questions Answered

- We know there is no intelligent life on Mars.
- We know Mars can not support human life.
- We know Mars was a very Earth-like Planet in its past.

## Questions Not Answered

- Possibility of any kind of life now or in the past.
- Can we get there safely.
- Possibility of liquid water now.
- How Abundant if Life?

## What's to come in the Future?

Lets Leave That To Guest Lecturer Professor Brian Hynek