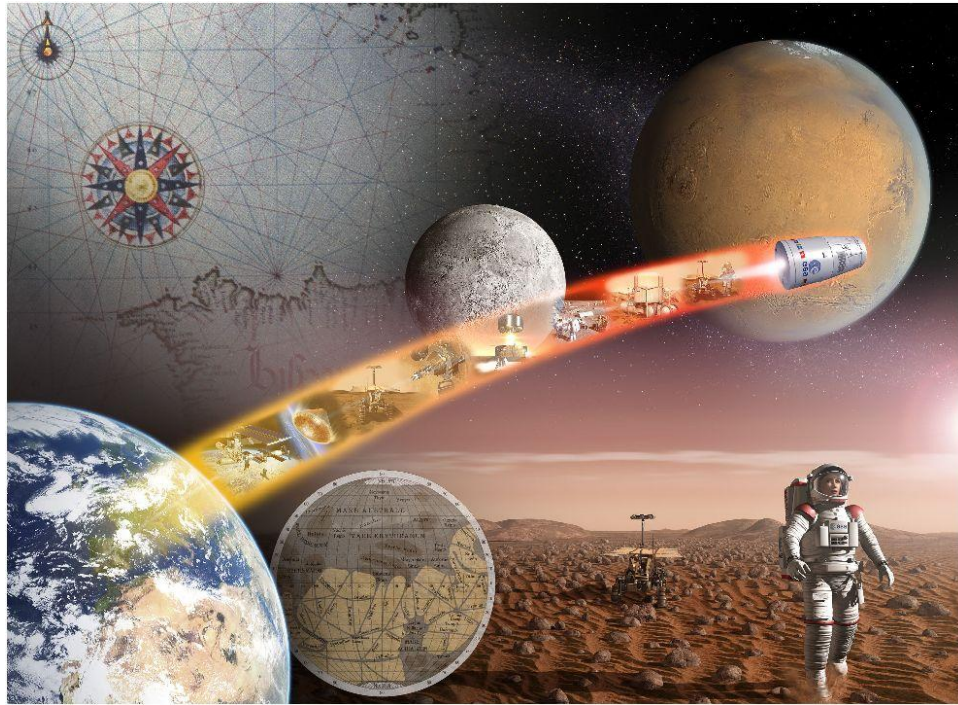# Classification of the Spacecraft and Space Exploration

Dr. Alka Misra
Department of Mathematics & Astronomy
University of Lucknow
Lucknow[Type text]

Spacecraft Classification

Robotic spacecraft are specially designed and constructed systems that can function in specific hostile environments. Their complexity and capabilities vary greatly and their purposes are diverse. To make some sense of all these variables, this chapter arbitrarily designates eight broad classes of robotic spacecraft according to the missions the spacecraft are intended to perform:

1. **Flyby spacecraft**
2. **Orbiter spacecraft**
3. **Atmospheric spacecraft**
4. **Lander spacecraft**
5. **Rover spacecraft**
6. **Penetrator spacecraft**
7. **Observatory spacecraft**
8. **Communications spacecraft**

we illustrate these eight classes.
(Also please refer the JPL public website has an up-to-date listing of all past, current, future and proposed JPL robotic spacecraft missions)

1. Flyby Spacecraft

Flyby spacecraft conducted the initial reconnaissance phase of solar system exploration. They follow a continuous solar orbit or escape trajectory, never to be captured into a planetary orbit. They must have the capability of using their instruments to observe targets they pass. Ideally, they can pan to compensate for the target's apparent motion in optical instruments' field of view. They must downlink data to Earth, storing data onboard during the periods when their antennas are off Earth point. They

Voyager 2

must be able to survive long periods of interplanetary cruise. Flyby spacecraft may be designed to be stabilized in 3 axes using thrusters or reaction wheels or to spin continuously for stabilization. Our prime example of the flyby spacecraft category is Voyager 2, which conducted encounters in the Jupiter, Saturn, Uranus, and Neptune systems. Other examples of flyby spacecraft include:
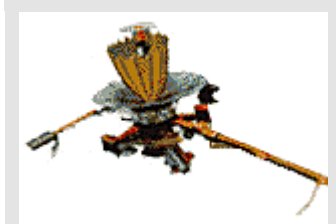
- **Stardust Cometary Sample Return**
- **Mariner 2 to Venus**
- **Mariner 4 to Mars**
- **Mariner 5 to Venus**
- **Mariner 6 and 7 to Mars**

Dr. Alka Misra
Department of Mathematics & Astronomy
University of Lucknow
Lucknow[Type text]

- **Mariner 10 to Mercury**
- **Pioneers 10 and 11 to Jupiter and Saturn**
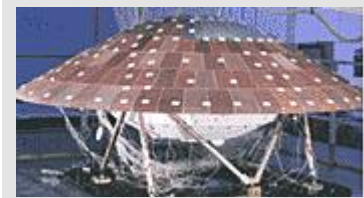
2. Orbiter Spacecraft

Galileo

A spacecraft designed to travel to a distant planet and enter into orbit about it must carry with it a substantial propulsive capability to decelerate it at the right moment to achieve orbit insertion. It has to be designed to live with the fact that solar occultations will occur, wherein the planet shadows the spacecraft, cutting off any solar panels' production of electrical power and subjecting the vehicle to extreme thermal variation. Earth occultations will also occur, cutting off uplink and downlink communications with Earth. Orbiter spacecraft are carrying out the second phase of solar system exploration, following up the initial reconnaissance with in-depth study of each of the planets. These include Magellan, Galileo, Mars Global Surveyor, and Cassini. Our prime example of the orbiter spacecraft category is Galileo which entered orbit about Jupiter in 1995 to carry out a highly successful study of the Jovian system. Click the Galileo image for details of the Galileo spacecraft. Other examples of orbiter spacecraft include:

- **Mariner 9 Mars Orbiter**
- **Cassini Saturn Orbiter**
- **Mars Global Surveyor**
- **TOPEX/Poseidon Earth Orbiter**
- **Ulysses Solar Polar Orbiter**
- **Jason Earth Orbiter**
- **Mars '01 Orbiter**
- **Magellan Venus Orbiter**
- **Mars Observer a spacecraft lost**

3. Atmospheric Spacecraft

Atmospheric spacecraft are designed for a relatively short mission to collect data about the atmosphere of a planet or satellite. One typically has a limited complement of spacecraft subsystems. For example, an atmospheric spacecraft may have no need for propulsion subsystems or attitude and articulation control system subsystems at all. It does require an electric power supply, which may simply be batteries, and telecommunications equipment for tracking and data relay. Its

Huygens

scientific instruments may take direct measurements of an atmosphere's composition, temperature, pressure, density, cloud content and lightning.

Typically, atmospheric spacecraft are carried to their destination by another spacecraft. Galileo carried its atmospheric probe on an impact trajectory with Jupiter in 1995 and increased its spin rate to stabilize the probe's attitude for atmospheric entry. After probe release Galileo maneuvered to change from an impact trajectory to a Jupiter Orbit Insertion trajectory. An aeroshell protected the probe from the thousands of degrees of heat created by atmospheric friction during atmospheric entry, then parachutes deployed after the aeroshell was jettisoned. The probe completed its mission on battery power, and the orbiter relayed the data to Earth. The Pioneer 13 Venus Multiprobe Mission deployed four atmospheric probes that returned data directly to Earth during descent into the Venusian atmosphere in 1978.

Balloon packages are atmospheric probes designed for suspension from a buoyant gas bag to float and travel with the wind. The Soviet Vega 1 and Vega 2 missions to Comet Halley in 1986 deployed atmospheric balloons in Venus' atmosphere en route to the comet. DSN tracked the instrumented balloons to investigate winds in the Venusian atmosphere. (The Vega missions also deployed Venus landers.) Our prime example of the atmospheric spacecraft category is Huygens, which is being carried to Saturn's moon Titan by the Cassini spacecraft. Click the Huygens image for details of the Huygens spacecraft. Other examples of atmospheric spacecraft include:

- **Galileo Atmospheric Probe**
- **Mars Balloon**
- **Titan "Aerover" Blimp**
- **Vega 1 Venus Balloon**
- **Vega 2 Venus Balloon**
- **JPL Planetary Aerovehicles Development**
- **Pioneer 13 Venus Multiprobe Mission**

4. Lander Spacecraft

Pathfinder

Lander spacecraft are designed to reach the surface of a planet and survive long enough to telemeter data back to Earth. Examples have been the highly successful Soviet Venera landers which survived the harsh conditions on Venus while carrying out chemical composition analyses of the rocks and relaying color images, JPL's Viking landers at Mars, and the Surveyor series of landers at Earth's moon, which carried out similar experiments. The Mars Pathfinder project, which landed on Mars on July 4, 1997, and deployed a rover, was intended to be the first in a series of landers on the surface of Mars at widely distributed locations to study the planet's atmosphere, interior, and soil. A system of actively-cooled, long-lived Venus

landers designed for seismology investigations, is being envisioned for a possible future mission.

Our prime example of the lander spacecraft category is Mars Pathfinder. Click the Pathfinder image for details of the Pathfinder spacecraft. Other examples of lander spacecraft-include:

- **Viking Mars Landers**
- **Venera 13 Venus Lander**
- **Surveyor Moon Landers**

5. Penetrator Spacecraft

Surface penetrators have been designed for entering the surface of a body, such as a comet, surviving an impact of hundreds of Gs, measuring, and telemetering the properties of the penetrated surface. As of November 2000, no Penetrator spacecraft have been successfully operated. Penetrator data would typically be telemetered to an orbiter craft for re-transmission to Earth. The Comet Rendezvous / Asteroid Flyby (CRAF) mission included a cometary penetrator, but the mission was cancelled in 1992 due to budget-constraints.

Our prime example of a penetrator spacecraft is the twin Deep Space 2 penetrators which piggybacked to Mars aboard the Mars Polar Lander and were to slam into Martian soil December 3, 1999. They were never heard from. Click the Deep Space 2 image for details of the penetrator spacecraft. Another example of penetrator spacecraft include:
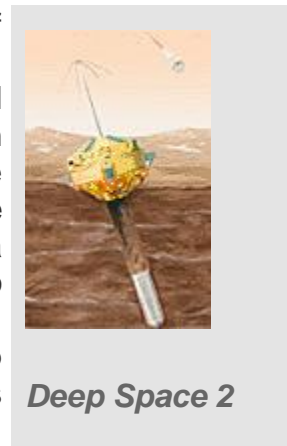
Deep Space 2

- **Deep Impact Mission to a comet**

6. Rover Spacecraft

Electrically-powered rover spacecraft are being designed and tested by JPL as part of Mars exploration effort. The Mars Pathfinder project included a small, highly successful mobile system referred to as a micro-rover by the name of Sojourner. Mars rovers are also being developed by Russia with a measure of support from The Planetary Society. Rover craft need to be semi-autonomous. They are steerable from Earth. Their purposes range from taking images and soil analyses to collecting samples for return to Earth.

Sojourner

Our prime example of a rover spacecraft is of course the famous Sojourner Rover, shown here in an image from the surface of Mars. Click the Sojourner image for details of the rover spacecraft.

7. Observatory Spacecraft

An observatory spacecraft does not travel to a destination to explore it. Instead, it occupies an Earth orbit or a solar orbit from where it can observe distant targets free of the obscuring and blurring effects of Earth's atmosphere.

SIRTF

NASA's Great Observatories program studies the universe at wavelengths from visible light to gamma-rays. The program includes four Observatory Spacecraft: the familiar Hubble Space Telescope (HST), the Chandra X-Ray Observatory (CXO -- previously known as AXAF), the Compton Gamma Ray Observatory (GRO), and the Space Infrared Telescope Facility (SIRTF). The HST is still operating as of November 2000. GRO has completed its mission and was de-orbited in June 2000. CXO was launched in July 1999 and continues to operate. SIRTF is set to launch in January 2003. In the coming decades many new kinds of observatory spacecraft will be deployed to take advantage of the tremendous gains available from operating in space.

Our prime example of an observatory spacecraft is the JPL SIRTF Project. Click the SIRTF image for details of the observatory spacecraft. Other examples of observatory spacecraft-include:
- **HST Hubble Space Telescope**
- **Chandra X-ray Observatory**
- **Compton Gamma-ray Observatory**
- **TPF Terrestrial Planet Finder**
- **NGST Next-Generation Space Telescope**
- **SIM Space Interferometry Mission**

8. Communications Spacecraft
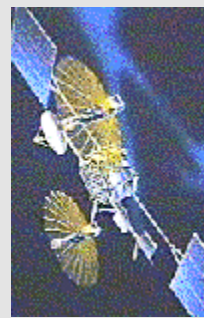
TDRSS

Communications spacecraft are abundant in Earth orbit, but they are largely incidental to JPL's missions. The Deep Space Network's Ground Communications Facility does make use of Earth-orbiting communications spacecraft to transfer data among its sites in Spain, Australia, California, and JPL.
In the future, communications spacecraft may be deployed at Mars, Venus, or other planets to communicate with orbiters, rovers, penetrators, and atmospheric spacecraft operating in their vicinity. Their purpose would be to augment the Deep Space Network's capabilities to communicate with the resident spacecraft.

A glimpse:

The evolution goes something like this:

1. **Flyby.** Initial reconnaissance of a planet. Gather information on e.g. the local radiation environment and other potential obstacles for an orbiter mission.
2. **Orbiter.** Detailed surface mapping to help plan a lander mission.
3. **Lander.** More details on surface composition to help plan a rover mission.
4. **Rover.**

Each step costs more than the previous one. So only the most interesting targets have rovers sent to them.

What is the difference between a rover, a lander, and an orbiter?

Rover: Is a vehicle that moves around in the planet or astronomical object.

Lander: A space craft that lands softly and then stays there at rest and does all other functions which it has to do.
Orbiter: Orbits plants or astronomical objects.

- Rovers have wheels.
- Landers have feet.
- Orbiters have neither.

Lunar and Planetary Exploration

Missions Timeline:

1957

- 🚩 **Sputnik 1** - **4 October 1957 - Earth Orbiter**
- 🚩 **Sputnik 2** - **3 November 1957 - Earth Orbiter**
- 🇺🇸 **Vanguard TV3** - **6 December 1957 - Attempted Earth Orbiter (Launch Failure)**

1958

- 🇺🇸 **Explorer 1** - **1 February 1958 - Earth Orbiter**
- 🇺🇸 **Vanguard 1** - **17 March 1958 - Earth Orbiter**
- 🇺🇸 **Pioneer 0** - **17 August 1958 - Attempted Lunar Orbit (Launch Failure)**
- 🚩 **Luna 1958A** - **23 September 1958 - Attempted Lunar Impact? (Launch Failure)**
- 🇺🇸 **Pioneer 1** - **11 October 1958 - Attempted Lunar Orbit (Launch Failure)**
- 🚩 **Luna 1958B** - **12 October 1958 - Attempted Lunar Impact? (Launch Failure)**
- 🇺🇸 **Pioneer 2** - **8 November 1958 - Attempted Lunar Orbit (Launch Failure)**
- 🚩 **Luna 1958C** - **4 December 1958 - Attempted Lunar Impact? (Launch Failure)**
- 🇺🇸 **Pioneer 3** - **6 December 1958 - Attempted Lunar Flyby (Launch Failure)**

1959

- 🚩 **Luna 1** - **2 January 1959 - Lunar Flyby (Attempted Lunar Impact?)**
- 🇺🇸 **Pioneer 4** - **3 March 1959 - Lunar Flyby**
- 🚩 **Luna 1959A** - **16 June 1959 - Attempted Lunar Impact? (Launch Failure)**
- 🚩 **Luna 2** - **12 September 1959 - Lunar Impact**
- 🚩 **Luna 3** - **4 October 1959 - Lunar Flyby**
- 🇺🇸 **Pioneer P-3** - **26 November 1959 - Attempted Lunar Orbiter (Launch Failure)**

1960

- **Luna 1960A** - 15 April 1960 - Attempted Lunar Flyby **(Launch Failure)**
- **Luna 1960B** - 18 April 1960 - Attempted Lunar Flyby **(Launch Failure)**
- **Pioneer P-30** - 25 Sept 1960 - Attempted Lunar Orbiter **(Launch Failure)**
- **Marsnik 1 (Mars 1960A)** - 10 October 1960 - Attempted Mars Flyby **(Launch Failure)**
- **Marsnik 2 (Mars 1960B)** - 14 October 1960 - Attempted Mars Flyby **(Launch Failure)**
- **Pioneer P-31** - 15 December 1960 - Attempted Lunar Orbiter **(Launch Failure)**

1961

- **Sputnik 7** - 4 February 1961 - Attempted Venus Impact
- **Venera 1** - 12 February 1961 - Venus Flyby (Contact Lost)
- **Ranger 1** - 23 August 1961 - Attempted Lunar Test Flight
- **Ranger 2** - 18 November 1961 - Attempted Lunar Test Flight

1962

- **Ranger 3** - 26 January 1962 - Attempted Lunar Impact
- **Ranger 4** - 23 April 1962 - Lunar Impact
- **Mariner 1** - 22 July 1962 - Attempted Venus Flyby **(Launch Failure)**
- **Sputnik 19** - 25 August 1962 - Attempted Venus Flyby
- **Mariner 2** - 27 August 1962 - Venus Flyby
- **Sputnik 20** - 1 September 1962 - Attempted Venus Flyby
- **Sputnik 21** - 12 September 1962 - Attempted Venus Flyby
- **Ranger 5** - 18 October 1962 - Attempted Lunar Impact
- **Sputnik 22** - 24 October 1962 - Attempted Mars Flyby
- **Mars 1** - 1 November 1962 - Mars Flyby (Contact Lost)
- **Sputnik 24** - 4 November 1962 - Attempted Mars Lander

1963

- **Sputnik 25** - 4 January 1963 - Attempted Lunar Lander
- **Luna 1963B** - 2 February 1963 - Attempted Lunar Lander **(Launch Failure)**
- **Luna 4** - 2 April 1963 - Attempted Lunar Lander
- **Cosmos 21** - 11 November 1963 - Attempted Venera Test Flight?

1964

- **Ranger 6** - 30 January 1964 - Lunar Impact (Cameras Failed)
- **Venera 1964A** - 19 February 1964 - Attempted Venus Flyby **(Launch Failure)**
- **Venera 1964B** - 1 March 1964 - Attempted Venus Flyby **(Launch Failure)**
- **Luna 1964A** - 21 March 1964 - Attempted Lunar Lander **(Launch Failure)**
- **Cosmos 27** - 27 March 1964 - Attempted Venus Flyby
- **Zond 1** - 2 April 1964 - Venus Flyby (Contact Lost)
- **Luna 1964B** - 20 April 1964 - Attempted Lunar Lander **(Launch Failure)**
- **Zond 1964A** - 4 June 1964 - Attempted Lunar Lander **(Launch Failure)**
- **Ranger 7** - 28 July 1964 - Lunar Impact
- **Mariner 3** - 5 November 1964 - Attempted Mars Flyby
- **Mariner 4** - 28 November 1964 - Mars Flyby
- **Zond 2** - 30 November 1964 - Mars Flyby (Contact Lost)

1965

- **Ranger 8** - 17 February 1965 - Lunar Impact
- **Cosmos 60** - 12 March 1965 - Attempted Lunar Lander
- **Ranger 9** - 21 March 1965 - Lunar Impact
- **Luna 1965A** - 10 April 1965 - Attempted Lunar Lander? **(Launch Failure)**
- **Luna 5** - 9 May 1965 - Lunar Impact (Attempted Soft Landing)
- **Luna 6** - 8 June 1965 - Attempted Lunar Lander
- **Zond 3** - 18 July 1965 - Lunar Flyby

- **Luna 7** - **4 October 1965** - **Lunar Impact (Attempted Soft Landing)**
- **Venera 2** - **12 November 1965** - **Venus Flyby (Contact Lost)**
- **Venera 3** - **16 November 1965** - **Venus Lander (Contact Lost)**
- **Cosmos 96** - **23 November 1965** - **Attempted Venus Lander?**
- **Venera 1965A** - **23 November 1965** - **Attempted Venus Flyby (Launch Failure)**
- **Luna 8** - **3 December 1965** - **Lunar Impact (Attempted Soft Landing?)**

1966

- **Luna 9** - **31 January 1966** - **Lunar Lander**
- **Cosmos 111** - **1 March 1966** - **Attempted Lunar Orbiter?**
- **Luna 10** - **31 March 1966** - **Lunar Orbiter**
- **Luna 1966A** - **30 April 1966** - **Attempted Lunar Orbiter? (Launch Failure)**
- **Surveyor 1** - **30 May 1966** - **Lunar Lander**
- **Explorer 33** - **1 July 1966** - **Attempted Lunar Orbiter**
- **Lunar Orbiter 1** - **10 August 1966** - **Lunar Orbiter**
- **Luna 11** - **24 August 1966** - **Lunar Orbiter**
- **Surveyor 2** - **20 September 1966** - **Attempted Lunar Lander**
- **Luna 12** - **22 October 1966** - **Lunar Orbiter**
- **Lunar Orbiter 2** - **6 November 1966** - **Lunar Orbiter**
- **Luna 13** - **21 December 1966** - **Lunar Lander**

1967

- **Lunar Orbiter 3** - **4 February 1967** - **Lunar Orbiter**
- **Surveyor 3** - **17 April 1967** - **Lunar Lander**
- **Lunar Orbiter 4** - **8 May 1967** - **Lunar Orbiter**
- **Venera 4** - **12 June 1967** - **Venus Probe**
- **Mariner 5** - **14 June 1967** - **Venus Flyby**

- **Cosmos 167** - **17 June 1967 - Attempted Venus Probe**
- **Surveyor 4** - **14 July 1967 - Attempted Lunar Lander**
- **Explorer 35 (IMP-E)** - **19 July 1967 - Lunar Orbiter**
- **Lunar Orbiter 5** - **1 August 1967 - Lunar Orbiter**
- **Surveyor 5** - **8 September 1967 - Lunar Lander**
- **Zond 1967A** - **28 September 1967 - Attempted Lunar Test Flight (Launch Failure)**
- **Surveyor 6** - **7 November 1967 - Lunar Lander**
- **Zond 1967B** - **22 November 1967 - Attempted Lunar Test Flight (Launch Failure)**

1968

- **Surveyor 7** - **7 January 1968 - Lunar Lander**
- **Luna 1968A** - **7 February 1968 - Attempted Lunar Orbiter (Launch Failure)**
- **Zond 4** - **2 March 1968 - Test Flight**
- **Luna 14** - **7 April 1968 - Lunar Orbiter**
- **Zond 1968A** - **23 April 1968 - Attempted Lunar Test Flight? (Launch Failure)**
- **Zond 5** - **15 September 1968 - Lunar Flyby and Return to Earth**
- **Zond 6** - **10 November 1968 - Lunar Flyby and Return to Earth**
- **Apollo 8** - **21 December 1968 - Crewed Lunar Orbiter**

1969

- **Venera 5** - **5 January 1969 - Venus Probe**
- **Venera 6** - **10 January 1969 - Venus Probe**
- **Zond 1969A** - **20 January 1969 - Attempted Lunar Flyby and Return (Launch Failure)**
- **Luna 1969A** - **19 February 1969 - Attempted Lunar Rover? (Launch Failure)**
- **Zond L1S-1** - **21 February 1969 - Attempted Lunar Orbiter (Launch Failure)**

- 🇺🇸 **[Mariner 6](#)** - **25 February 1969 - Mars Flyby**
- 🇺🇸 **[Mariner 7](#)** - **27 March 1969 - Mars Flyby**
- 🇷🇺 **[Mars 1969A](#)** - **27 March 1969 - Attempted Mars Orbiter** **(Launch Failure)**
- 🇷🇺 **[Mars 1969B](#)** - **2 April 1969 - Attempted Mars Orbiter** **(Launch Failure)**
- 🇷🇺 **[Luna 1969B](#)** - **15 April 1969 - Attempted Lunar Sample Return?** **(Launch Failure)**
- 🇺🇸 **[Apollo 10](#)** - **18 May 1969 - Crewed Lunar Orbiter**
- 🇷🇺 **[Luna 1969C](#)** - **14 June 1969 - Attempted Lunar Sample Return?** **(Launch Failure)**
- 🇷🇺 **[Zond L1S-2](#)** - **3 July 1969 - Attempted Lunar Orbiter** **(Launch Failure)**
- 🇷🇺 **[Luna 15](#)** - **13 July 1969 - Lunar Orbiter (Attempted Lunar Lander?)**
- 🇺🇸 **[Apollo 11](#)** - **16 July 1969 - Crewed Lunar Landing**
- 🇷🇺 **[Zond 7](#)** - **7 August 1969 - Lunar Flyby and Return to Earth**
- 🇷🇺 **[Cosmos 300](#)** - **23 September 1969 - Attempted Lunar Sample Return?**
- 🇷🇺 **[Cosmos 305](#)** - **22 October 1969 - Attempted Lunar Sample Return?**
- 🇺🇸 **[Apollo 12](#)** - **14 November 1969 - Crewed Lunar Landing**

1970

- 🇷🇺 **[Luna 1970A](#)** - **6 February 1970 - Attempted Lunar Sample Return?** **(Launch Failure)**
- 🇷🇺 **[Luna 1970B](#)** - **19 February 1970 - Attempted Lunar Orbiter?** **(Launch Failure)**
- 🇺🇸 **[Apollo 13](#)** - **11 April 1970 - Crewed Lunar Mission (Landing Aborted)**
- 🇷🇺 **[Venera 7](#)** - **17 August 1970 - Venus Lander**
- 🇷🇺 **[Cosmos 359](#)** - **22 August 1970 - Attempted Venus Probe**
- 🇷🇺 **[Luna 16](#)** - **12 September 1970 - Lunar Sample Return**
- 🇷🇺 **[Zond 8](#)** - **20 October 1970 - Lunar Flyby and Return to Earth**
- 🇷🇺 **[Luna 17/Lunokhod 1](#)** - **10 November 1970 - Lunar Rover**

1971

- [Apollo 14](#) - 31 January 1971 - Crewed Lunar Landing
- [Mariner 8](#) - 9 May 1971 - Attempted Mars Flyby **(Launch Failure)**
- [Cosmos 419](#) - 10 May 1971 - Attempted Mars Orbiter/Lander
- [Mars 2](#) - 19 May 1971 - Mars Orbiter/ Attempted Lander
- [Mars 3](#) - 28 May 1971 - Mars Orbiter/ Lander
- [Mariner 9](#) - 30 May 1971 - Mars Orbiter
- [Apollo 15](#) - 26 July 1971 - Crewed Lunar Landing
- [Luna 18](#) - 2 September 1971 - Attempted Lunar Sample Return
- [Luna 19](#) - 28 September 1971 - Lunar Orbiter

1972

- [Luna 20](#) - 14 February 1972 - Lunar Sample Return
- [Pioneer 10](#) - 3 March 1972 - Jupiter Flyby
- [Venera 8](#) - 27 March 1972 - Venus Probe
- [Cosmos 482](#) - 31 March 1972 - Attempted Venus Probe
- [Apollo 16](#) - 16 April 1972 - Crewed Lunar Landing
- [Soyuz L3](#) - 23 November 1972 - Attempted Lunar Orbiter **(Launch Failure)**
- [Apollo 17](#) - 7 December 1972 - Crewed Lunar Landing

1973

- [Luna 21/Lunokhod 2](#) - 8 January 1973 - Lunar Rover
- [Pioneer 11](#) - 5 April 1973 - Jupiter/Saturn Flyby
- [Skylab](#) - 14 May 1973 - Crewed Earth Orbiter
- [Explorer 49 (RAE-B)](#) - 10 June 1973 - Lunar Orbiter/Radio Astronomy
- [Mars 4](#) - 21 July 1973 - Mars Flyby (Attempted Mars Orbiter)
- [Mars 5](#) - 25 July 1973 - Mars Orbiter

- 🚩🇨🇳 [Mars 6](#) - 5 August 1973 - Mars Lander (Contact Lost)
- 🚩🇨🇳 [Mars 7](#) - 9 August 1973 - Mars Flyby (Attempted Mars Lander)
- 🚩🇺🇸 [Mariner 10](#) - 4 November 1973 - Venus/Mercury Flybys

1974

- 🚩🇨🇳 [Luna 22](#) - 2 June 1974 - Lunar Orbiter
- 🚩🇨🇳 [Luna 23](#) - 28 October 1974 - Attempted Lunar Sample Return

1975

- 🚩🇨🇳 [Venera 9](#) - 8 June 1975 - Venus [Orbiter](#) and [Lander](#)
- 🚩🇨🇳 [Venera 10](#) - 14 June 1975 - Venus [Orbiter](#) and [Lander](#)
- 🚩🇺🇸 [Viking 1](#) - 20 August 1975 - Mars Orbiter and Lander
- 🚩🇺🇸 [Viking 2](#) - 9 September 1975 - Mars Orbiter and Lander
- 🚩🇨🇳 [Luna 1975A](#) - 16 October 1975 - Attempted Lunar Sample Return?

1976

- 🚩🇨🇳 [Luna 24](#) - 9 August 1976 - Lunar Sample Return

1977

- 🚩🇺🇸 [Voyager 2](#) - 20 August 1977 - Jupiter/Saturn/Uranus/Neptune Flyby
- 🚩🇺🇸 [Voyager 1](#) - 5 September 1977 - Jupiter/Saturn Flyby

1978

- 🚩🇺🇸 [Pioneer Venus 1](#) - 20 May 1978 - Venus Orbiter
- 🚩🇺🇸 [Pioneer Venus 2](#) - 8 August 1978 - Venus Probes
- 🚩🇺🇸 [ISEE-3/ICE](#) - 12 August 1978 - Comet Giacobini-Zinner and Halley Flybys
- 🚩🇨🇳 [Venera 11](#) - 9 September 1978 - Venus [Orbiter](#) and [Lander](#)
- 🚩🇨🇳 [Venera 12](#) - 14 September 1978 - Venus [Orbiter](#) and [Lander](#)

1979

1980

1981

- **Venera 13** - 30 October 1981 - Venus **Orbiter** and **Lander**
- **Venera 14** - 4 November 1981 - Venus **Orbiter** and **Lander**

1982

1983

- **Venera 15** - 2 June 1983 - Venus Orbiter
- **Venera 16** - 7 June 1983 - Venus Orbiter

1984

- **Vega 1** - 15 December 1984 - Venus Lander and Balloon/Comet Halley Flyby
- **Vega 2** - 21 December 1984 - Venus Lander and Balloon/Comet Halley Flyby

1985

- **Sakigake** - 7 January 1985 - Comet Halley Flyby
- **Giotto** - 2 July 1985 - Comet Halley Flyby
- **Suisei (Planet-A)** - 18 August 1985 - Comet Halley Flyby

1986

1987

1988

- **Phobos 1** - 7 July 1988 - Attempted Mars Orbiter/Phobos Landers
- **Phobos 2** - 12 July 1988 - Mars Orbiter/Attempted Phobos Landers

1989

- **Magellan** - 4 May 1989 - Venus Orbiter
- **Galileo** - 18 October 1989 - Jupiter **Orbiter** and **Probe**

1990

- **Hiten** - 24 January 1990 - Lunar Flyby and Orbiter
- **Hubble Space Telescope** - 25 April 1990 - Earth Orbiting Observatory
- **Ulysses** - 06 October 1990 - Jupiter Flyby and Solar Polar Orbiter

1991

1992

- **[Mars Observer](#)** - 25 September 1992 - Attempted Mars Orbiter (Contact Lost)

1993

1994

- **[Clementine](#)** - 25 January 1994 - Lunar Orbiter/Attempted Asteroid Flyby

1995

1996

- **[NEAR](#)** - 17 February 1996 - Asteroid Eros Orbiter
- **[Mars Global Surveyor](#)** - 07 November 1996 - Mars Orbiter
- **[Mars 96](#)** - 16 November 1996 - Attempted Mars Orbiter/Landers
- **[Mars Pathfinder](#)** - 04 December 1996 - Mars Lander and Rover

1997

- **[Cassini](#)** - 15 October 1997 - Saturn Orbiter
- **[Huygens](#)** - 15 October 1997 - Titan Probe
- **[AsiaSat 3/HGS-1](#)** - 24 December 1997 - Lunar Flyby

1998

- **[Lunar Prospector](#)** - 7 January 1998 - Lunar Orbiter
- **[Nozomi (Planet-B)](#)** - 3 July 1998 - Mars Orbiter
- **[Deep Space 1 (DS1)](#)** - 24 October 1998 - Asteroid and Comet Flyby
- **[Mars Climate Orbiter](#)** - 11 December 1998 - Attempted Mars Orbiter

1999

- **[Mars Polar Lander](#)** - 3 January 1999 - Attempted Mars Lander
- **[Deep Space 2 (DS2)](#)** - 3 January 1999 - Attempted Mars Penetrators
- **[Stardust](#)** - 7 February 1999 - Comet Coma Sample Return

2000

2001

- **[2001 Mars Odyssey](#)** - 7 April 2001 - Mars Orbiter
- **[Genesis](#)** - 8 August 2001 - Solar Wind Sample Return

2002

- **CONTOUR - 3 July 2002 - Fly-by of three Comet Nuclei**

2003

- **Hayabusa (Muses-C) - 9 May 2003 - Asteroid Orbiter and Sample Return**
- **Mars Express - 2 June 2003 - Mars Orbiter and Lander**
- **Spirit (MER-A) - 10 June 2003 - Mars Rover**
- **Opportunity (MER-B) - 8 July 2003 - Mars Rover**
- **SMART 1 - September 2003 - Lunar Orbiter**

2004

- **Rosetta - 2 March 2004 - Comet Orbiter and Lander**
- **MESSENGER - 3 August 2004 - Mercury Orbiter**

2005

- **Deep Impact - 12 January 2005 - Comet Rendezvous and Impact**
- **Mars Reconnaisance Orbiter - 12 August 2005 - Mars Orbiter**
- **Venus Express - 09 November 2005 - ESA Venus Orbiter**

2006

- **New Horizons - 19 January 2006 - Pluto/Charon and Kuiper Belt Flyby**

2007

- **Phoenix - 04 August 2007 - Small Mars Scout Lander**
- **Kaguya (SELENE) - 14 September 2007 - Lunar Orbiter**
- **Dawn - 27 September 2007 - Asteroid Ceres and Vesta Orbiter**
- **Chang'e 1 - 24 October 2007 - CAST (China) Lunar Orbiter**
- **Lunar-A - Cancelled - Lunar Orbiter and Penetrators**

2008

- **Chandrayaan-1 - 22 October 2008 - ISRO (India) Lunar Orbiter**

2009

- 🇺🇸 **[Kepler](#)** - 7 March 2009 - Extrasolar Terrestrial Planet Detection Mission
- 🇺🇸 **[Lunar Reconnaissance Orbiter](#)** - 18 June 2009 - Lunar Orbiter
- 🇺🇸 **[LCROSS](#)** - 18 June 2009 - Lunar Impactor

2010

- ● **[Akatsuki/Planet-C](#)** - 20 May 2010 - ISAS Venus Orbiter
- 🇨🇳 **[Chang'e 2](#)** - 1 October 2010 - CAST (China) Lunar Orbiter

2011

- 🇺🇸 **[Juno](#)** - 5 August 2011 - Jupiter Orbiter
- 🇺🇸 **[GRAIL](#)** - 10 September 2011 - Lunar Orbiter
- 🇷🇺 **[Phobos-Grunt](#)** - 08 November 2011 - Attempted Martian Moon Phobos Lander
- 🇨🇳 **[Yinghuo-1](#)** - 08 November 2011 - Attempted Mars Orbiter
- 🇺🇸 **[Mars Science Laboratory](#)** - 26 November 2011 - Mars Rover

2012

2013

- 🇺🇸 **[LADEE](#)** - 06 September 2013 - Lunar Orbiter
- 🇮🇳 **[Mangalyaan](#)** - 05 November 2013 - ISRO (India) Mars Orbiter
- 🇺🇸 **[MAVEN](#)** - 18 November 2013 - Mars Scout Mission Orbiter
- 🇨🇳 **[Chang'e 3](#)** - 01 December 2013 - Lunar Lander and Rover

2014

- 🇨🇳 **[Chang'e 5 Test Vehicle](#)** - 23 October 2014 - Lunar Flyby and Return
- ● **[Hayabusa 2](#)** - 3 December 2014 - JAXA Asteroid Sample Return
- ● **[PROCYON](#)** - 3 December 2014 - JAXA Asteroid Flyby Mission

2015

2016

- ● **[ExoMars 2016](#)** - 14 March 2016 - ESA Mars Orbiter and Lander

- 🇺🇸 **[OSIRIS-REx](#)** - 8 September 2016 - Sample Return Mission to Asteroid Bennu

2017

2018

- 🇺🇸 **[InSight](#)** - 5 May 2018 - Mars Lander

- 🇨🇳 **[Queqiao](#)** - 20 May 2018 - CNSA (China) Lunar Relay Satellite

- 🇺🇸 **[Parker Solar Probe](#)** - 12 August 2018 - NASA Solar Probe - Venus Flybys

- 🌐 **[BepiColombo](#)** - 19 October 2018 - ESA and JAXA Mercury Orbiters

- 🇨🇳 **[Chang'e 4](#)** - 7 December 2018 - CNSA (China) Lunar Farside Lander and Rover

2019

- 🇮🇱 **[Beresheet](#)** - 22 February 2019 - SpaceIL and IAI (Israel) Lunar Lander

- 🇮🇳 **[Chandrayaan 2](#)** - 22 July 2019 - ISRO (India) Moon Orbiter, Lander, and Rover

2020

- 🌐 **[Solar Orbiter](#)** - 9/10 February 2020 - ESA solar orbiting mission

- 🇨🇳 **[Chang'e 5](#)** - 2020 - CNSA (China) Lunar Sample Return Mission

- 🇺🇸 **[Mars 2020](#)** - 17 July 2020 - Mars Rover

- 🌐 **[ExoMars 2020](#)** - 26 July 2020 - ESA Mars Rover and Russian Surface Platform

- 🇦🇪 **[Hope](#)** - July 2020 - United Arab Emirates Mars Orbiter

- 🇨🇳 **[Huoxing 1](#)** - July 2020 - Chinese Mars Orbiter and Rover

2021

- 🇺🇸 **[Double Asteroid Redirection Test (DART)](#)** - July 2021 - Asteroid Impactor

- 🇺🇸 **[Lucy](#)** - 16 October 2021 - Trojan Asteroid Flybys

2022

- 🌐 **[JUpiter ICy moons Explorer (JUICE)](#)** - June 2022 - ESA Ganymede-Callisto-Europa multiple flyby mission

- 🇰🇷 **[Korea Pathfinder Lunar Orbiter](#)** - July 2022 - KARI (South Korea) Lunar Orbiter

- 🇺🇸 **[Psyche](#)** - August 2022 - Main Belt Asteroid Orbiter

2023

- **[Chang'e 6](#) - 2023-2024 - CNSA (China) Lunar Sample Return Mission**
- **[Europa Clipper](#) - 2023-2025 - Jupiter Orbiter - Multiple Europa Flybys**

2024 on

- **[Chang'e 7](#) - TBD - CNSA (China) Lunar Survey Mission**
- **[Chang'e 8](#) - TBD - CNSA (China) Lunar Technology Test**