

SPACE EXPLORATION – A BRIEF HISTORY

While humans have looked to the sky and observed space objects for thousands of years, systematic exploration of the solar system and beyond was not possible until the middle of the 20th century, when technology allowed people to send objects into space. The large rocket technology pioneered by the German A-4/V2 rocket developed during World War II finally gave people the ability to physically explore space.

After a number of scientific experiments were launched into **suborbital space**, the ‘space age’ began on October 4, 1957, when the Soviet Union placed Sputnik 1 into **orbit** around the Earth. Although this **satellite** had only a simple radio transmitter aboard that emitted a beep as it went around the world, it started a ‘space race’ between the Soviet Union and the United States, with each country trying to outdo the other in space exploration ‘firsts.’ The first American satellite, Explorer 1, was sent into space by the National Aeronautics and Space Administration (NASA) on January 31, 1958. It made a major scientific discovery, of the **Van Allen radiation belt** that circles the Earth, shortly after it entered orbit. Canada was the fourth country (after Great Britain) to place an object in orbit: the satellite Alouette I, launched aboard an American Thor-Agena B rocket, went into space on September 29, 1962. This satellite, which is still in orbit, studied the Earth’s **ionosphere**. The first animal into space was a dog named Laika, which rode into space on board Sputnik 2 on November 3, 1957. Laika was sent into space to prove that animals could survive the stresses of launch and the conditions of space. Laika was also the first animal to die in space, because the Soviet Union had not developed the technologies necessary to bring an object safely back to Earth.



Figure 1: V-2 rocket.

While most of the first satellites (and many since) have had the Earth as the target of their scientific instruments, early in the space race both the United States and the Soviet Union set their aim at other bodies in the Solar System. The Soviet Union was the first country to send a space probe to another body in the Solar System when Luna 1 reached **escape velocity** from the Earth’s **gravitational field** and went to the Moon. Although it was supposed to hit the Moon, Luna 1 missed and thus became the first human-made object to enter orbit around the Sun. The United States performed the first flyby of another planet when Mariner 2 reached Venus on December 14, 1962. Mariner 4, meanwhile, was the first space probe to visit the planet Mars on July 14, 1965 after several failed attempts by both the Soviets and the Americans.

Human exploration of space began on April 12, 1961, when Yuri Gagarin from the Soviet Union orbited the Earth. Alan Shepherd was the first American in space, on May 5, 1961, but an American would not go into orbit until John Glenn on February 20, 1962. The space race went into high gear on May 25, 1961, when US President John Kennedy made the bold promise to send an American to the Moon by the end of the decade. After that, both the Americans and the Soviets began serious work on ambitious projects to send people to the Moon. Along the way, both countries had milestones (first female in

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space – Valentina Tereshkova from the Soviet Union on Vostok 6, June 16-19, 1963; first human spacewalk – Alexey Leonov from the Soviet Union on Voskhod 2, March 18, 1965; first human flight beyond Earth orbit – Frank Borman, Jim Lovell and Bill Anders orbited the Moon on Apollo 8, December 21-27, 1968) and setbacks, including the Apollo 1 launch pad fire that killed astronauts Gus Grissom, Ed White and Roger Chaffee on January 21, 1967 and the crash of Soyuz 1 that killed cosmonaut Vladimir Komarov on April 24, 1967.

Before sending humans to the Moon, scientists had to know whether it was even possible to land on the Moon's surface. Before the Apollo landings, there were numerous attempts to land probes on the Moon. The Soviets finally succeeded in making the first landing of a space probe on another body in space on February 3, 1966, when Luna 9 made a soft landing on the Moon, while the United States landed three Surveyor probes on the surface of the Moon in the late 1960s. These landers provided information that no orbiting spacecraft, manned or unmanned, could gather.

The space race culminated on July 20, 1969, when Neil Armstrong stepped on the surface of the Moon during the Apollo 11 mission. A total of twelve astronauts walked on the surface of the Moon during the Apollo missions and performed a number of scientific experiments while there, as well as bringing back 382 kg (842 lb.) of rocks. Although no human has stepped on the Moon since December 1972, it remains the only object beyond the Earth that humans have visited. Plans to send humans to Mars in the 1980s were cancelled because of budget and technical issues.

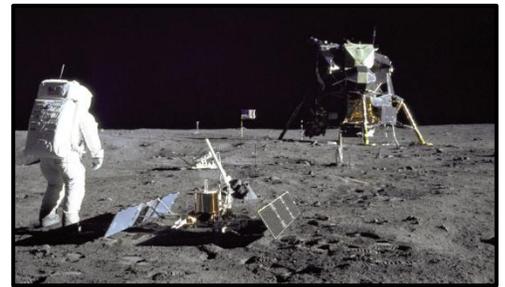


Figure 2: Buzz Aldrin, left, on the surface of the Moon during the Apollo 11 mission, July 20, 1969.

Meanwhile, planetary exploration by unmanned probes continued. A series of landers were sent by the Soviets to Venus beginning in the early 1960s, but the planet's very harsh atmospheric conditions meant that the first data from the surface was not sent until December 15, 1970 by Venera 7.

Both the Soviets and the Americans, along with the European Space Agency, have sent many missions to Mars since the early 1960s, many of them looking for signs of water or life on the Red Planet. The American Mariner 4 was the first spacecraft to send closeup photos of another planet, when it passed Mars on July 14, 1965. The first successful Mars landings were the American Viking 1 and 2 missions in 1976, which found evidence of water having once flowed across the surface of Mars. Since the 1990s there have been a number of spacecraft constantly studying Mars, either on the surface or in orbit. The most ambitious missions to Mars have been the four rovers that the United States has sent to Mars since 1997. Two of these rovers, Opportunity and Curiosity, are currently (October 2012) operating on the Martian surface. These missions are helping to develop a deeper understanding of Mars' history and conditions and prepare for future unmanned and manned

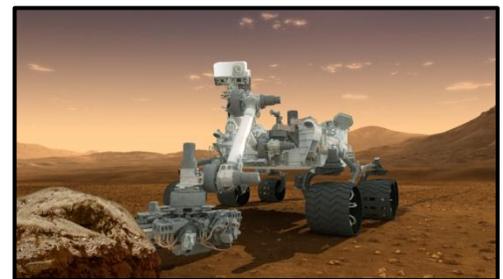


Figure 3: Artist's conception of the Mars Science Laboratory Curiosity on the surface of Mars, August 2012.

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missions. Mars has been very hard on spacecraft, with less than half of the missions sent there being successful.

The United States has been at the forefront of exploring the outer Solar System and beyond with spacecraft. The first spacecraft to visit the gas giants, Jupiter and Saturn, was Pioneer 10 in December 1973. Pioneer 10 sent back the first clear images of Jupiter and conducted research that showed the planet was mostly liquid. Pioneer 10 then headed towards deep space, and the last communications with the probe was in January 2003, when it was 10 billion kilometres from Earth. These were followed up by the spectacular Voyager 1 and 2 missions launched in 1977. These spacecraft flew by both Jupiter and Saturn, sending back amazing images of the planets and their moons and making many important discoveries, including rings around Jupiter and an erupting volcano on Jupiter’s moon Io. Voyager 1 then headed out of the Solar System, while Voyager 2 continued its “Grand Tour” of the outer planets, visiting both Uranus and Neptune. Both spacecraft are still sending data back to Earth, and Voyager 1, 18 billion kilometres away from Earth, is now on the verge of being the first human-made object to leave the Solar System. More recently, the Galileo mission spent seven years orbiting Jupiter from 1995 to 2003 where it performed many investigations of Jupiter and its moons, including dropping a probe into Jupiter’s atmosphere. The Cassini probe was sent to Saturn in 1997, reaching the planet in 2004. Shortly after arriving in the Saturn system, Cassini dropped the Huygens probe onto the surface of Titan, Saturn’s largest moon. Titan is the only other body in the Solar System known to have a dense atmosphere and liquid pools on its surface, and is considered one of the most likely places to find life beyond the Earth. As of late 2012, Cassini is still studying Saturn and its moons.



Figure 4: Photograph of Saturn taken by Voyager 2, 1981.

Human exploration of space has focused on the **low-Earth orbit** (LEO) area of space since the Apollo missions. The United States followed up the Apollo spacecraft with the Space Shuttle, which flew 135 missions from 1981 until 2011. Despite the loss of two of the five Space Shuttles, *Challenger* and *Columbia*, and the 14 astronauts on board them, the Space Shuttle provided many unique capabilities in orbit. During its 30 year career, the Space Shuttle launched satellites, the Galileo space probe to Jupiter, the Hubble Space Telescope, built most of the International Space Station, and provided a huge laboratory for scientists to conduct research in space. A number of new manned spacecraft are being developed for the post-Shuttle era, but no manned American spacecraft is expected to fly until late this decade. In the meantime, the Russian Soyuz capsule, which has been in service for over 45 years, is the primary means for people to get into space. China became the third country able to launch humans into space on October 15, 2003, when Yang Liwei orbited the Earth in Shenzhou 5.



Figure 5: Space Shuttle *Endeavour* docked with the International Space Station, May 23, 2011.

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Since then, Chinese taikonauts have done spacewalks, dockings and lived on the Tiangong 1 space station, and have plans to send humans beyond Earth orbit.

Human presence in space has gone from visiting space for short periods to long-term presence in space on board **space stations**. Space stations are facilities that allow humans to spend long periods of time in space (sometimes over a year) to conduct research; much of this research is intended to help plan long-duration human space missions to Mars and other places beyond Earth orbit, when flight times to and from the destination may be a year or more. There are currently (late 2012) two space stations in orbit: the International Space Station (ISS), which was constructed in space by a consortium including the United States, Russia, Canada, Japan, and the members of the European Space Agency from 1998 until 2011; and Tiangong 1, launched by China in 2011. The ISS, a huge orbiting research laboratory with a crew of six, is expected to stay in service until at least 2020 and possibly until 2028.

What lies in the future of space exploration? We don't know, but there are plans by the Russians and the Chinese to return humans to the Moon, while the Americans hope to lead multinational missions to an asteroid or Mars by the 2030s. On the robotic space exploration front, NASA's New Horizons spacecraft, launched in January 2006, is scheduled to visit Pluto in July 2015, while the European Space Agency and Russian Federal Space Agency are cooperating on the ExoMars mission, consisting of a lander and rover on Mars designed to find signs of life on the Red Planet. Meanwhile, NASA is hoping to send new exploration spacecraft to Mars, including ones that will fly through the Martian atmosphere and one that will return samples from the surface of Mars back to Earth for further study. Hopefully the next fifty years of space exploration will be as exciting as the first 50!