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P-615

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## **CONTENTS**

<b>Introduction</b>	-----	<b>01</b>
<b>Space programmes of Russia and America.</b>	-----	<b>02</b>
<b>Space stations</b>	-----	<b>08</b>
• <b>MIR</b>	-----	<b>11</b>
<b>Ulyses space craft</b>	-----	<b>14</b>
<b>Chandra observatory</b>	-----	<b>17</b>
<b>Lunar exploration</b>	-----	<b>19</b>
• <b>Beyond Hubble</b>	-----	<b>23</b>
<b>Bibliography</b>	-----	<b>27</b>

## INTRODUCTION

Space exploration is man's quest for knowing the unknown in space. In that efforts manned spacecraft are used. Unmanned spaceprobes have even crossed the borders of the Solar System to collect information about not only the Earth's neighbours, but also about planets in other stars, galaxies, etc. Cosmonauts and Astronauts have visited the Moon There are plans to send man to Mars, as well.

Space travel has opened up a new dimension in man's study of the Universe. Astronomers can now photograph in close-up the distant galazies and stellar explosion which earlier they could only see dimly through the dense blanket of the Earth's atmosphere. Even though observatories are located on mountain tops 2,000 meters or more in height, astronomers on Earth are still hampered by blurring and filtering effect of the atmosphere. Only by going into space can they achieve the clearest view of the sky, and also detect radiations such as X-rays and ultra violet light, that are blocked by the top layers of the atmosphere. Launching of Chandra X-ray observatory into space is a great effort in this direction.

## **SPACE PROGRAMMES OF RUSSIA & AMERICA**

Space exploration is about four decades old now. The space age began on October 4, 1957, when Russia launched Sputnik 1 into orbit. This was followed a month later by Sputnik 2 which was carried the dog Laika. Measurement of the animal's heartbeat, body temperature and other reactions, radioed to Earth, suggested that human beings might also survive prolonged periods in space.

The National Aeronautics and Space Administration (NASA) of USA was formed in 1958. The first US satellite, Explorer 1, was sent on January 31, 1958. Its instruments made the first major discovery of the space age - the Van Allen radiation belts around the Earth, where electrons and protons from the sun are trapped by the Earth's magnetic field. Soon after, probes were sent to explore the moon and planets and on the way they detected the Solar Wind of sub-atomic particles streaming from the Sun.

Mankind got the first glimpse of the Moon's far side when the picture arrived from the Russian Luna 3 in October 1959. The first manned space flight was made on April 12, 1961, when Yuri A. Gagarin, a Soviet cosmonaut, orbited the Earth in the spaceship Vostok (later called Vostok 1). In the same year Alan B. Shepard, Jr. became the first American to orbit the Earth. Later Russian cosmonauts, including the first space woman, Valentina Tereshkova, (June 16, 1963) were able to stay in orbit for up to five days.

The work of the early space probes has been extended and improved by later planetary landings on the Moon, Venus and Mars-the last in a search for the possibility of life. The Pathfinder mission in 1997 to Mars, is the best example, in the sense that Sojourner was successfully controlled from the Earth from where the commands took at least 10 minutes to reach there.

The US mariner 2 in 1962 flew past Venus confirming both its slight temperature and the reverse direction of its rotation which has been suspected by astronomers.

The team of astronauts in the Gemini programme practised rendezvous manoeuvres, docking procedures and space walks in preparation for the Apollo missions to the Moon.

The first, American, manned voyage to the Moon began on Dec. 21, 1968, when the Apollo 8 spacecraft was launched. It orbited the Moon 10 times and returned safely to the Earth. The vital components of Apollo 11 was the fourlegged Lunar Module. On July 20, 1969. U.S. astronauts Neil. A . Armstrong and EdwinE. Aldrin, Jr. landed their Lunar Module on the Moon. Armstrong became the first person to set foot on the Moon.

A total of 12 Americans walked on the Moon during the Apollo programme, bringing back 380 kg of rock and soil. These samples from the moon, along with scientific measurements made on the surface and

a detailed picture of our nearest neighbour in space. The Apollo lunar programme ended in 1972.

During the 1970's astronauts and cosmonauts developed skills for living in space aboard the skylab and salyut space stations. (In 1987 and 1988, two soviet consmonauts spent 366 consecutive days in orbit). In the skylab space station, and its smallest Russian counterpart called salyut, space crew involve in scientific research. For example, they might analyse the effects of microgravity on various materials, investigate the Earth's surface, or study the stars and planets. Scientists may assemble equipments and do the expansion of the station's facilities including erecting beams, connecting electrical and gas lines, and welding permanent joints between sections of the station. The crew also fix or replace broken equipment.

Before the promising applications of space can be fully exploited, the cost of space launches must be brought down. This demand was an incentive for NASA to develop a new transportation scheme called the space Shuttle. The space shuttle system consists of three parts : (1) an orbiter (2) an external tank, and (3) two solid rocket boosters. The crafts, the Orbiter, which is launched by means of rockets but can glide to Earth like an aircraft, landing on a runway. The major technological challenges were developing the shuttle's reusable main engines for many missions. A flexible but reliable system of computer control, and a new type of heat shield that could withstand many re-entries into the Earth's atmosphere.

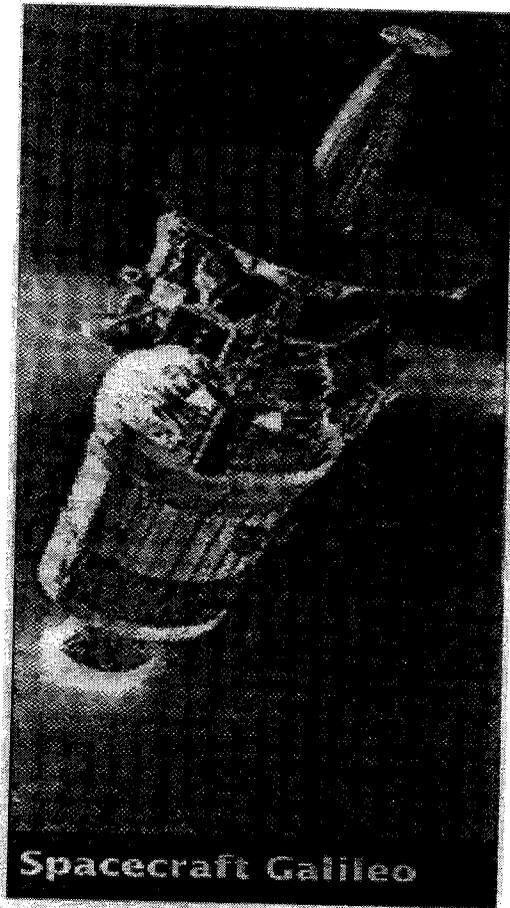
Shuttle Challenger took Sally Ride, the first U.S. woman to space on June 18, 1983. The first night flight, launched on August 30, 1983, carried also America's first Negro, Guion S. Bluford. The shuttle made successful retrieval and repair of satellite Solar Max in April, 1984.

The American space programme received setback when the 10th of the space shuttle challenger scheduled as the 25th space shuttle mission on January 28, 1986, exploded in midair, 73 seconds after lift off. Six astronauts and a woman school teacher named Christa McAuliffe, 37, died. The challenger tragedy was a setback not only for the U.S. but also for many other countries including India which had programmed multipurpose satellites to be launched by the shuttle. The US redoubled its efforts and successfully launched shuttle Discovery on September 29, 1988 with a five-member crew aboard. In March 1989, space shuttle 'Atlantis' launched a spacecraft on a 1300 - million km space shuttle. Deceivers again launched the scientific spacecraft Ulysses into deep space to probe the polar regions of the Sun.

In the subsequent launches, astronauts released a number of unmanned space probes, such as Galileo, Magellan, and Ulysses. Large scientific research satellites such as the Hubble Space Telescope, the Compton Gamma Ray Observatory, and the Upper Atmosphere 1993, a shuttle crew flew to the orbiting Hubble Space Telescope and repaired its optical system. Meanwhile, NASA made improvements in the shuttle fleet.

New computers and life -support hardware were installed. A drag parachute and new brakes made landings easier to control. The computerised autopilot and life support systems were also improved.

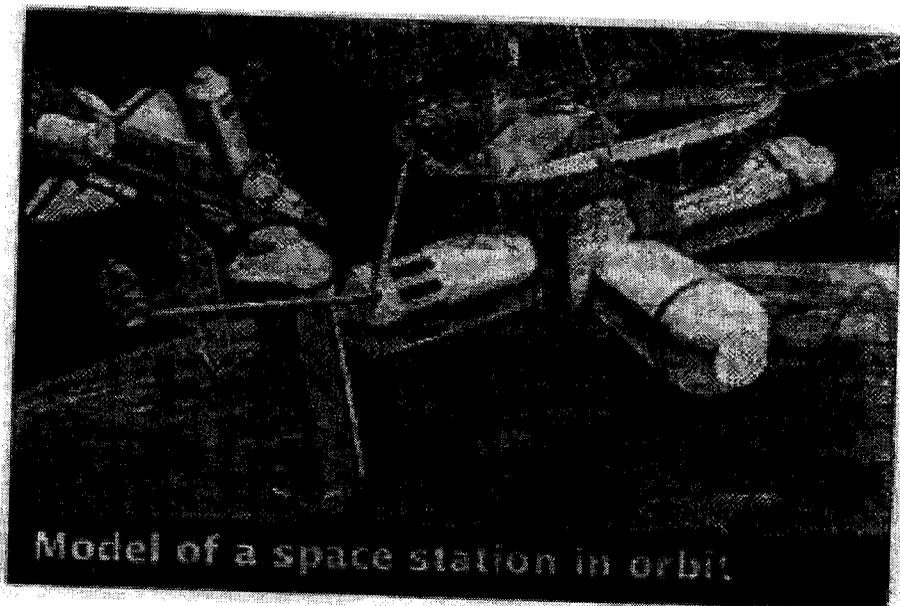
The soviet union achieved a spectacular space feat on a February 20, 1986, when it launched the new orbital space station called Mir (Peace) described as a this generation space laboratory. It joined the Salyut-7 space station that has been in orbit around the Earth since April 1982. The 130-tonne 'Mir' is a multinodular station which can accommodate six spacecraft at the same time. It has been fitted with one module called 'Quant'. Two more joining, these modules will function as factories.



The Russians have been cosmonauts aboard soyuz-T spacecraft to the space stations for proplonged stay scientific experrments on a regular basis. For the first time, the Soyuz T-15 launch on March 13, 1986 was televesed lived throguhout the world. The solovyoz, crew. Leonid Kizim and Vladmir Solovyuting from one space station to another. Salyut 7 is stationed in the near-Earth orbit and it has been manned by batches of crews including Rakesh Sharma, an Indian Cosmonaut.

## SPACE STATIONS

A space station is a place where people can live and work in space for long periods while orbiting the Earth, and at a height of about 300 to 480 kilometers. A space station may serve as an observatory, laboratory, factory, workshop, warehouse, and fuel depot. Spacecraft transport men and huge and massive. Spacecraft transport men and materials (like food, water, medicine, equipment, and mail), between the Earth and the space station. A space station now a days has more than one docking port to which a visiting spacecraft can dock. Most docking ports consists of a rimmed doorway called a hatch that can connect with a hatch on the visiting spacecraft to form an airtight seal. When the two hatches open, they form a pressurised tunnel between the station and the visiting spacecraft.



Model of a space station in orbit.

Salyut and Skylab Missions to the Moon dominated the U.S. and Soviet space programs, in the 1960's. Meanwhile, both countries also developed simple space stations. These early stations were cylindrical shaped, with a docking port at one end and solar power panels sticking out from the sides; designed to hold enough air, food, and water to last for about 6 to 12 months. The U.S. Apollo and the Soviet Soyuz were the manned spacecraft originally built for lunar flight - but later modified to transport people to the space stations.

Salyut the Soviet union launched the first space station, Salyut1, on April 19, 1971. It consisted of a single module with one docking port. On June 7, 1971, three cosmonauts Geogi T. Dobrovoklsky, Victor L. Patsayev, and Vladislav N. Volkov-linked their Soyuz 11 spacecraft with Salyut 1. They spent 23 days aboard the space station, making medical observations and performing experiments. In a tragic accident, the air leaked out of the Solyuz 11 spacecraft during the return journey, killing all three cosmonauts.

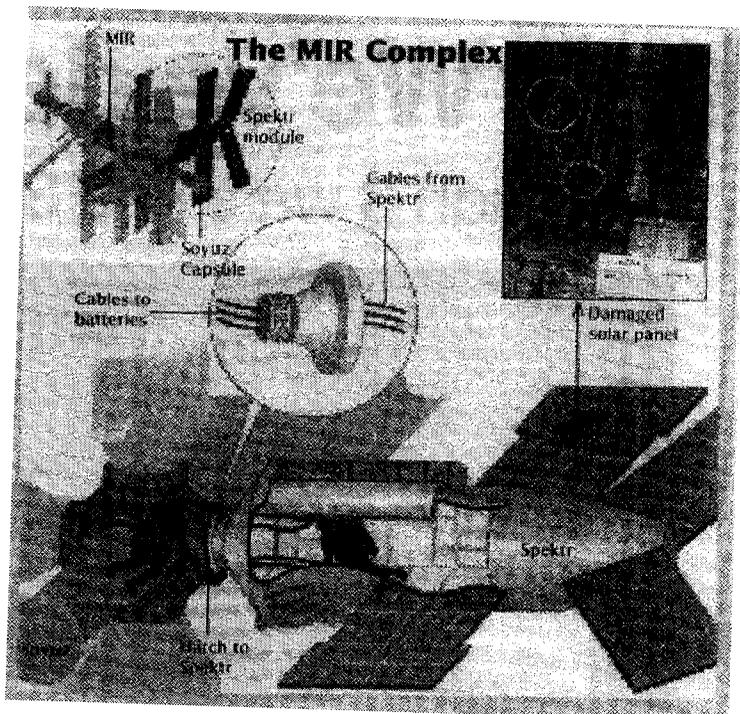
Salyut 3, in 1974, was on a 15-day mission to photograph the Earth. Sayut 4 was launched twice in 1975. In 1976, Salyut 5 repeated photgraph mission. In 1977, the soviet Union launched salyut 6. It had two docking ports, one at either end of the main module. A modified, unmanned Soyuz spacecraft called progress began delivering new supplies and equipment to Salyut 6 in January 1978. Thus it became the first space station to eb resupplied and refuelled.

Skylab the first U.S. space station was skylab, launched into orbit by a Saturn 5 booster on may 14, 1973 skylab was built from the empty third stage of a saturn 5 rocket, within an attached air lock module, docking port, and solar telescope.

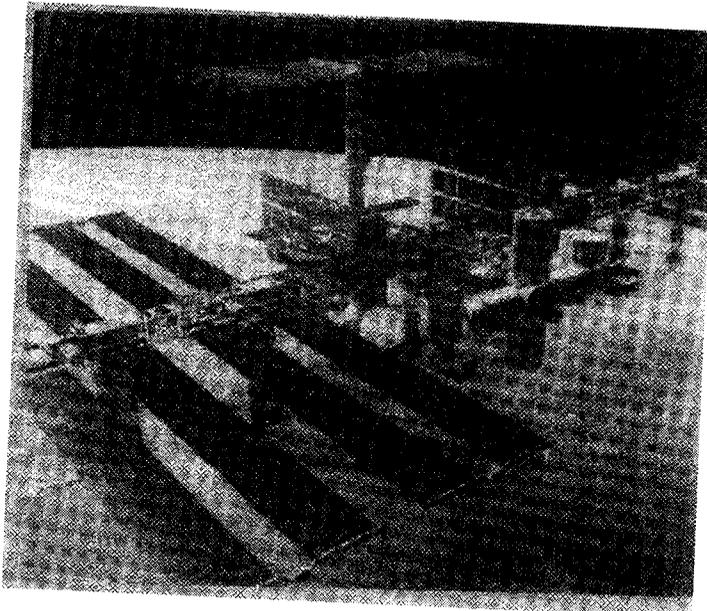
On July 15, 1975 the united states and the Soviet Union launched the Apollo Soyuz Test project the first international manned space mission.

# MIR

MIR consists of 6 inter-locking modules and resembles a giant cross, about 25 meter long on each side if its two main wings. The Russian space station, MIR got bogged down existence. In February 97, a defective oxygen generator sparked a 14-minute fire that sent hunks of moltend metal flying. Soon the colloing system began to leak. After a while, not only the oxygen generator failed once again but also the carbon-di-oxide removal system broke down. The series of mishaps began after a Russian space cargo ship, progress, rammed into the orbiting Mir station during a trail for docking with it. The progress grazed against a solar panel and ruptured the outer layer of speak-the science module. It resulted on power failure and pressure in six modules.



The problem of MIR station became worse when one of the crewmen yanked a cable while preparing for the repair mission. The cable disabled the computer that controls Mir's orientation, and the space stations started to drift. A backup system also failed. With the solar arrays no longer pointed at the sun, power drained out of the space station's batteries. Light, temperature control, oxygen generation equipment was shut down to save energy. Data transmissions to ground control were cut off. The crew moved to Soyuz rocket and used its systems to communicate with ground control.



The mission control centre and the Mir crew worked quickly to reorient the solar arrays by firing the jets on from the Soyuz rocket. These are the near disasters that plagued MIR in 1997.

The Mir project is scheduled to get over itself in 1999 and the Government had committed to bring it down in a gradual manner and let it burn in the atmosphere. But the Russian scientists are claiming that after 13 years in orbit and 400 kms above the earth, Mir has a thought in - flight overhaul. Mr. Balery Ryumin, a cosmonaut said, "Mir is in excellent shape and can carry on in service until 2005". Another argument put forward is that there is no need to kill Mir in order to put \$ 40 b international space station (ISS) in place. Besides ISS would yield results only few years from now as its construction in space will not be finished for several years.

Russian Council of Chief Designers and senior Russian space Agency officials in July 1998, approved plans to maintain the 140 tonne complex, the largest spacecraft is going to cause some worry for NASA because it fears that its multi-billion-pound (ISS) project, which is already a year behind schedule, would be put on the back burner. ISS is a consortium of 16 nations US, Russia, Canada, Japan, Brazil and 11 European countries. Their share - US (\$17b), Russia (\$10), Japan (\$3.1b), ESA (\$3.77b), Canada (\$850m), Italy (\$550), etc. For cost reduction NASA is planning to reserve 30% space in its laboratory for commercial users like pharmaceutical. Biotechnology companies, etc. on payment.

But as far as Mir goes, it is breadwinner for the cash-starved Russian in space programme.

## ULYSSES RACING TO SUN

A European spacecraft has arrived near the sun on what it is expected to be one of the most exhaustive examinations of the sun ever undertaken.

The \$750 million Ulysses probe has taken three-and-a-half years to travel the 150 million km from earth to the sun's south pole. It will scrutinise the sun from the totally new perspective because it will be the first time the sun has been observed from pole. Previous surveys have been conducted on an ecliptical plane. (Around sun's equator)-the way the planets revolve round the sun, except Pluto.

Ulysses, which is named after a Greek king and hero of literature, was launched into space by the US space shuttle Discovery on October 6, 1990. Its trajectory was programmed to move away from the sun for 16 months in the direction of Jupiter.

Ulysses while racing at the speed of 1,50,000 km per hour has already transmitted useful scientific information. Scientists have learnt that the solar winds that blow from the solar surface move twice as fast over the south pole as they do over the sun's equator. The solar winds cause a steady loss of mass - about 1.2 billion kg per second - in the intensely hot gases that make up the sun.

Nothing is more vital for life on earth than the sun, which is the

million km in diameter and revolves around its own axis every 27 days. A slight change in the sun's temperature could lead to a new ice age on our planet or cause the polar ice caps to melt and the oceans to overflow.

In May 1995, Ulysses reached 700 north of the sun's equator and begin a pass over its North Pole. The pass over the South Pole to end

in November 1994.

Some of the priorities for Ulysses are to examine the sun's polar magnetic fields, which switch polarity every 11 years in conjunction with the sun's activity cycle and are poorly understood. Scientists have discovered that previous changes in climates were linked to fluctuations in the sun's cycle of activities which peak every 11 years.

Ulysses may increase our understanding of intergalactic Gamma rays, which carry the secrets of the universe as well as gravity waves - at first pinpointed in theory by Albert Einstein. Ulysses will also examine the short-lived but violent solar flares and coronal mass ejections as to the make up of the particles and the conditions existing in the sun's atmosphere.

Ulysses is a joint project of the NASA's Jet Propulsion Laboratory and the European Space Agency, Pasadena, California. NASA's contribution of the current mission cost is about \$500 million and ESA's cost is \$250 million. Since the data relayed back to the earth has proved so valuable, ESA is considering an extension into the next century. One possibility is to programme Ulysses for a second pass over both the north and south poles, a move which would give scientists the opportunity to observe a complete solar cycle of activity.

From the vantage point, Ulysses should be able to study them in a more pristine state than from within the magnetic fields of the ecliptic.



telescope ever to be launched. It will spend much of its 5-year mission to detect faint sources of cosmic X-rays such as quasars, exploded stars and possibly, black holes.

The Chandra X-ray telescope has 8-times greater resolution and will not only be able to detect objects 20 times fainter but also provides 50 times more detailed images. The high-energy X-rays can penetrate a normal mirror. To avoid that, cylindrical mirrors were used. To avoid the cylindrical mirrors, nested cylindrical mirrors have been used which have an appearance of tubes within tubes. Besides, its High Resolution Cameras (HRC) capable of reading a newspaper from a distance of about a kilometer, would make the images reveal even the finest details of celestial events.

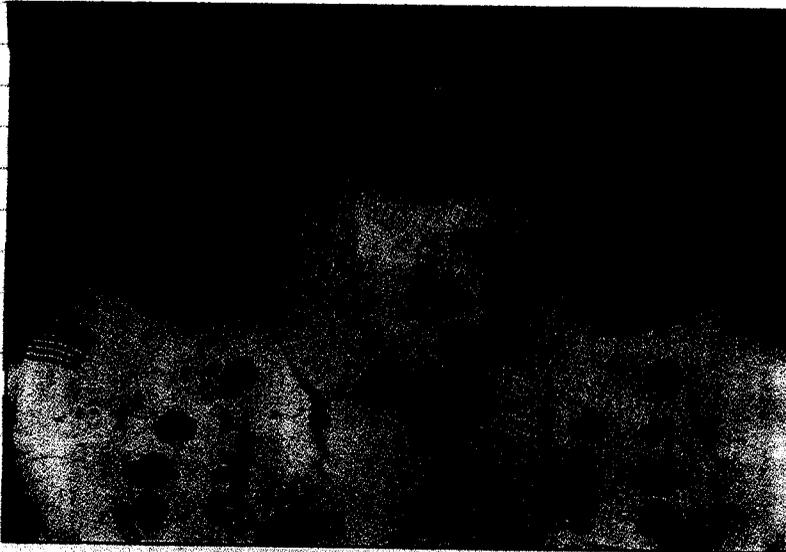
Chandra has an elliptical orbit unlike the Hubble Telescope. At its closest, the telescope will be about 3,800 km away from the Earth and at its farthest, 54,000 km away i.e., almost a third of the way to the moon. This orbit also puts the telescope beyond the radiation belts around the Earth that would otherwise damage the sensitive instrument on board. The telescope would have 55 hours of uninterrupted observation beyond the radiation belts during each orbit.

The telescope was originally called the Advanced X-ray Astrophysics Facility. The NASA renamed it the Chandra X-ray Observatory after conducting a contest which drew 6000 entries from 61 countries. Chandra Shekar made fundamental contributions to the study on particle decay, theory of black hole and other phenomena.

## LUNAR EXPLORATION

The Moon is the Earth's only natural satellite, circling at a distance of 384,00 km. in a slightly elliptical orbit at an extraordinary speed of about 27 days to completely go round the Earth, once.

Although it doesn't revolve around the sun, because of its size and composition, planetary scientists of its size and composition planet scientist call the moon a 'terrestrial planet' akin to Mercury, Venus, Earth and Mars.



The primary crew of the Apollo 11 lunar landing mission ... Neil A. Armstrong, Michael Collins and Edwin E. Aldrin.

History : Spacecrafts have been studying the Moon for nearly half a century. The history of directlunar exploration formally began in 1959, when probes from the soviets lunar spacecraft first flew by and then impacted the Moon's surface. Around the same time, NASA's poineer 4 passed within 59,000 km of the moon. Subsequent U.S. orbiter

On July 20, 1969, the dream of putting a human on the moon became reality when Neil Armstrong stepped of the Apollo 11 spacecraft and onto the rock, dusty lunar terrain. Ensuing Apollo missions returned the first scientific samples from an extraterrestrial body to Earth nearly 400 kilograms of moon rock.

While both Soviet and U.S. lunar missions have returned to Earth a wealth of data, including breathtaking pictures and surface rock samples, many scientific questions remain unanswered. Much of the composition and structure of the moon is still a mystery to scientists only a small fraction of its surface has been mapped in detail, and little is known about how it formed, what it is made of, and how it has evolved over time. Much more recently, in 1994, a tiny space-craft called clementine discovered possible indirect evidence for water ice on the moon, in a permanently shadowed very deep crater at the South Pole. Analysis of the Apollo rock samples revealed that the moon consists predominantly of volcanic materials, and that its composition is very similar to that of the surements also suggested that the moon has only tiny metallic core, roughly 15 times smaller than the of the Earth.

## Theory of formation :

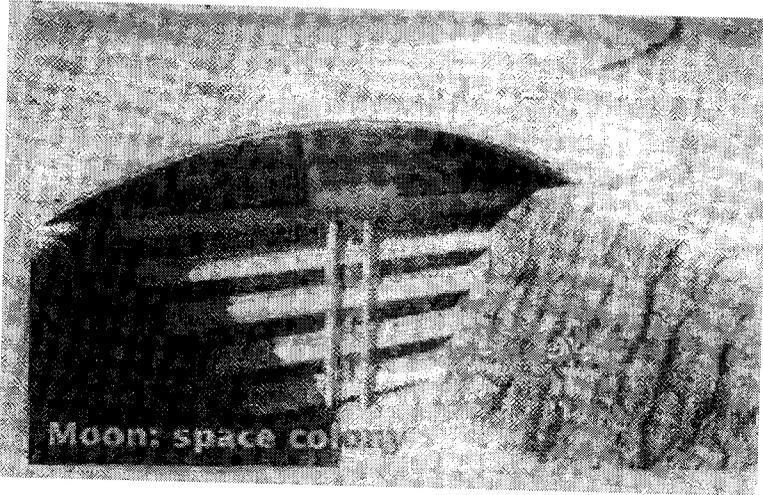
Lunar surface samples, however, contain important clues not only to the origin of the moon itself, but to the beginnings of the entire solar systems.



The impact theory say that the Moon may have formed 4.5 billion years ago, when the Earth collided with a very large object (the size of Mars or larger), ejecting raw materials that eventually became the moon. Currently, the impact theory is perhaps the one most widely accepted by planetary scientists, but other theories are still plausible.

Coaccretion, theory holds that the moon formed in Earth's orbit along with all the other planets in the solar system.

Fission theory states that, when the solar system was very young, the Earth was spinning so fast (nearly) 16,000km/hr, often times its current (speed), that it threw off a large chunk of material in order to



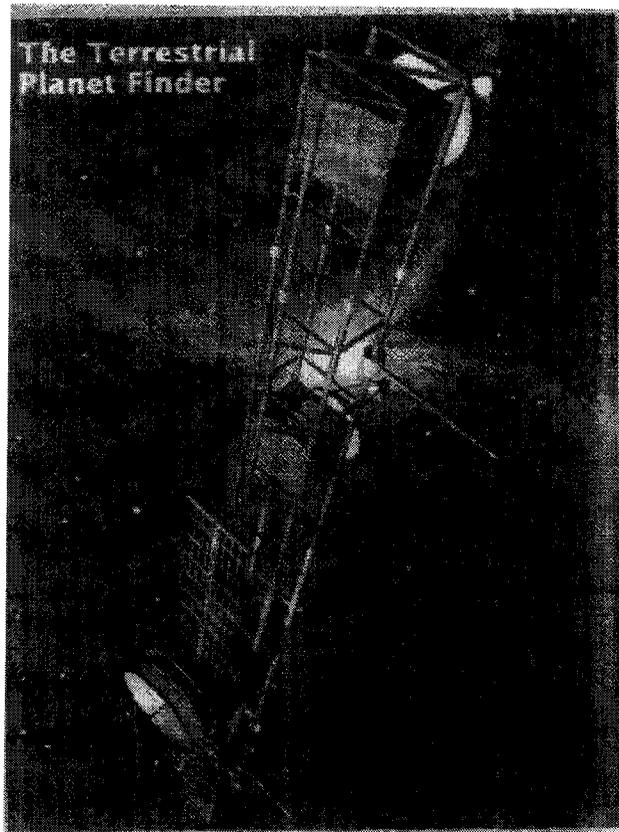
Of all these theories the impact theory fits best with all the data that has thus far been accumulated about the moon. Future lunar exploration, especially that which will determine global bulk composition of the moon, should help scientists settle this issue.

## BEYOND HUBBLE

There \$3-billion Hubble telescope, weighing 11.6 tonnes, launched in 1990, encountered early problems with its 2.4 meter diameter and 826kg main mirror which required a \$8000 m repair in 1993. After 7-years in space the Hubble space telescope's efficiency is coming down. Radiation has degraded some of the telescope's electronics, while very small meteoroids have occasionally slammed into its mirror, damaging the surface. The craft also true changes as its passes in and out of the Earth's shadow. Further servicing is scheduled for 1999 and 2002 to keep it operational until 2005. But Hubble can't go on for ever. Therefore , NASA in collaboration with other companies are developing a low budget-\$400 m replacement, called next Generation space Telescope (NGST). it will be bigger (Weight just 2,500 kg) and better than Hubble but lighter and less costly to build and operate. It will be stationed about 1.5 m kms from the Earth, at a point where the Earth and the sun's gravitational fields cancel out. This location is closer to sun that Hubble and its lonely location would make it easier to be controlled.

In March 2002, the Hubble will get its final maintenance which will help in receiving its service for another 10 years. But sooner or later entropy will claims its toll and the Hubble will go black. That will not marl the end of telescope based space exploration. Not less than four big science telescopes are slated to be launched by NASA in the near

future. The big four space telescope - SIRTF, SIM, NGST, and TPF, NASA as part of its origins program, is planning at least four so-called precursor missions by 2001. Each will gather interesting tidbits of data and images.



**Wire :**

The first off the block probably be the Wide-Field infrared Explorer, a four -month low-Earth orbiter scheduled for launch in September 1998. With its 12-inch mirror, it is small enough to fit in the backseat of a Ford Taurus. Its job will be to find galaxies that are hatchnig new stars as faster - than-normal rates so that astronomers can learn about how galaxies

**Fuse :**

The Far Ultraviolet spectropic Explorer, scheduled for launch this fall into a circular 500-miles orbit, its ultraviolet light detectors will reveal the composition of inter stellar gas, the cores of galaxies and quasars, the outer atmosphere of cool stars and planets, planetary nebulas, and supernovas. Astronomers are hoping it will give them a clue as to how much normal (as opposed to dark) matter there is in the universe. Although its four -segment mirror will be used mainly for spectroscopy, a separate detectors should give visible images.



**Sofia :**

Not so much an orbiting observatory as just a very high one , the stratospheric Observatory for infrared Astronomy is being built into a Boeing 747. When it takes to the skies in 2001, it will train an infrared eye on interstellar clouds, the center of the Milky way, planets in the solar system and distant galaxies-many of the same things that SIRTf will look at a few years hence.

**NMI :**

As the first space-based intertferometer, the new Millennium interferometer is intended mainly to test the laser-guided system for keeping several telescope separated from one another by precise distance - in this half a mile apart, NMI will be launched into orbit around the sun in 2001.

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