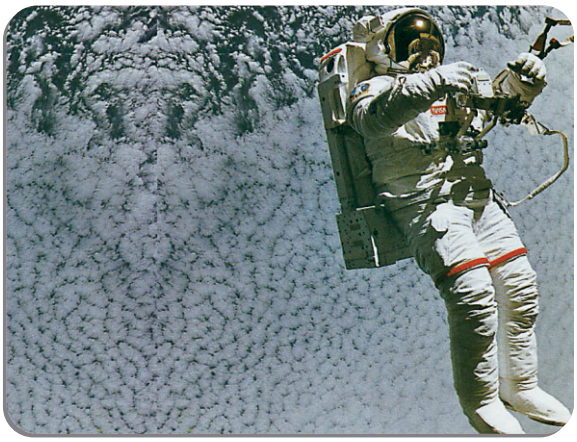
Chapter 12

EXPLORING SPACE



STUDENTS' LEARNING OUTCOMES

After studying this chapter, students will be able to:

- ☑ Describe development of tools and technologies used in space exploration.
- ☑ Analyze the benefits generated by the technology of the space exploration.
- ☑ Explain how do astronauts survive and research in space?
- ☑ Suggest ways to solve the problems that have resulted from space exploration.
- ☑ Identify the technological tools used in space exploration.
- ☑ Identify new technologies used on the Earth that have developed as a result of the development of space technology.
- ☑ Design a spacecraft and explain the key features of design to show its suitability as a spacecraft.

Knowing about space is one of the top priorities of scientific development. Scientists have been using telescopes to look into the space to study the space objects since long. Now-a-days many more techniques and facilities are available for further research about space. Telescope, spectroscope, spacecraft, etc., are some of the latest technologies in this regard. In this chapter, we will study the technological tools used in space exploration and their benefits in everyday life.

12.1 Telescope, Spectroscope and Spacecraft

Telescope

The instrument which is used for observing distant objects is called telescope. Galileo was the first who invented and used telescope in 1610. The invention of telescope opened the gate way to scientific study of space and heavenly bodies in different ways. The modern telescopes are much bigger and equipped with latest accessories.

Types of Telescope

Optical telescopes are of two basic types, i.e., refracting telescope and reflecting telescope.

Refracting Telescope

A simple refracting telescope consists of a long tube fitted with two lenses one at each end of the tube. The lens which refracts the light coming from distant objects at a point (focus) is called **objective lens**. The lens through which the image formed by the objective lens is seen is called **eyepiece** (Figure 12.1).

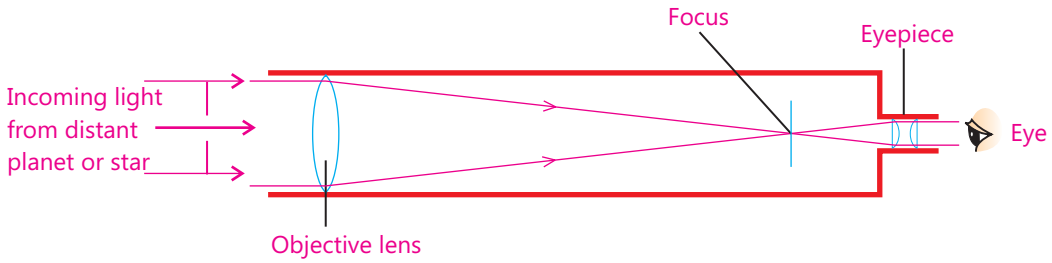


Figure 12.1: Working of Refracting Telescope

Reflecting Telescope

The main parts of a reflecting telescope are a large concave mirror, an eyepiece and a tube that holds them. The **objective mirror** which is a concave mirror reflects and converges the light on an eyepiece directly or through another reflecting mirror. The eyepiece magnifies the image formed by the objective mirror. Reflecting telescope can be made much larger than a refracting telescope, so that a better and bright image can be seen (Figure 12.2).

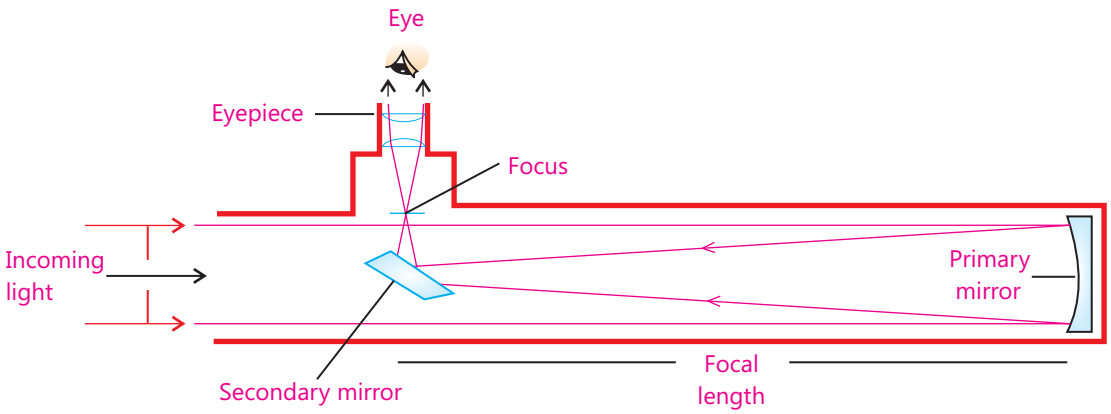


Figure 12.2: Working of reflecting telescope

Ground based telescopes have the disadvantage that dim light coming from stars passes through atmosphere, and the images so formed are not clear. In order to

overcome this problem, telescopes have been sent into space.

Hubble space telescope is the first space-based reflecting telescope launched in 1990 (Figure 12.3). It orbits around the Earth at a height of 600 km and works round the clock. It has taken clear pictures of galaxies, billions of kilometres away.

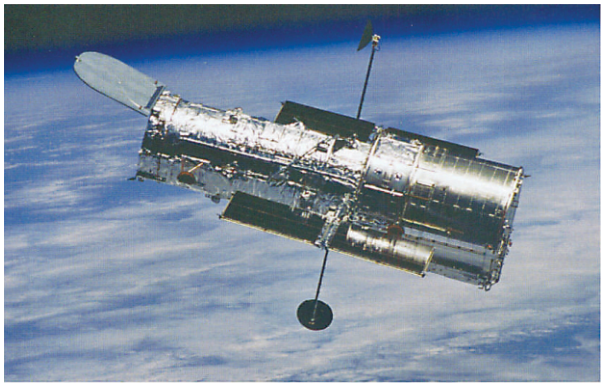
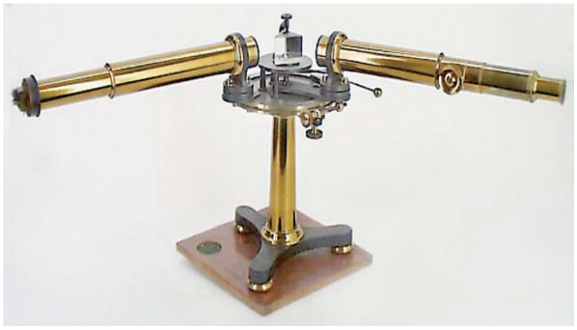


Figure 12.3: Hubble telescope

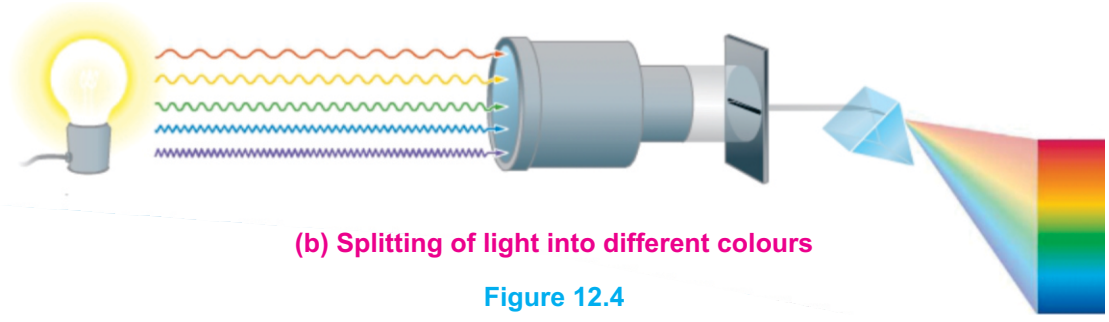
Spectroscopes

A spectroscope is an instrument which is used to examine different wavelengths (colours) of a light. It consists of a series of prisms that split white light into different colours. The set of different colours obtained in this way is called **spectrum**.

Spectroscope also measures the wavelengths of different colours of the spectrum (Figure 12.4). The wavelengths of light coming from the stars help the scientists to know about the elements and compounds present in the stars. Spectroscopes are mostly attached with the telescopes.



(a) Spectroscope



(b) Splitting of light into different colours

Figure 12.4

Spacecraft

Spacecraft is a vehicle designed to travel in space (Figure 12.5). It is used for different purposes like communication, Earth's observation, meteorology, navigation, planetary exploration and transportation of humans and cargo in space.

There are two major classes of spacecraft; robotic space craft and manned spacecraft. Robotic spacecraft are sent into space for collection of data about space, planets and

other heavenly bodies such as asteroids. A robotic spacecraft is controlled from the centre on Earth. Voyager I and voyager II were two robotic spacecrafts which were used for collecting data about planets Mars and Jupiter.

Figure 12.5: Spacecraft

Manned spacecrafts carry humans and equipments to space. These spacecrafts are larger and have specially built compartments which have the facilities necessary for human survival such as oxygen, pressurized cabins, food, water and specially built bathrooms. They also have special structure to protect from dangerous radiations which are very intense in space.

Space Stations

For very long stay in space or for performing experiments in space, large spacecraft called **space stations** are used (Figure 12.6). A space station is built in space by carrying its many small parts to space and then assembling them there. It has more facilities for prolonged living in space. It may have television for entertainment, bags for sleeping, exercise machine and kitchen for fresh food. One important part of a space station is the scientific laboratory where astronauts perform such experiments that cannot be done on Earth because of its gravity. Now-a-days a large space station orbits the Earth. Russians, Americans and other scientists jointly work in this space station. This is called international space station.

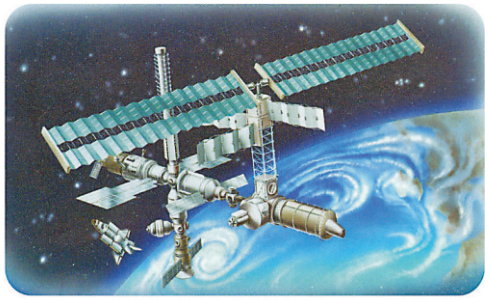


Figure 12.6: Space station

Space shuttle

It is an especially developed manned space craft which can be used many times. It is sent into space with the help of a rocket (Figure 12.7). It carries scientists and equipments. It docks with the space station to transfer its load. After performing its task, it returns and lands back on Earth like an aeroplane.

Figure 12.7: Space shuttle

12.2 Space Exploration

Scientific study of the space using especially developed technology is called space exploration. Common objectives for exploring space include advancing scientific knowledge, ensuring the future survival of humanity and developing defense capabilities.

12.2.1 Benefits of Space Exploration

Special technologies developed for space are now being used on Earth to improve the quality of life. A few examples are as follows:

Health and Medicine

- In the field of health and medicines, space exploration has enabled man to develop medical devices such as WARP 10 and hand-held high intensity LED unit etc. These machines are used for getting relief in muscle, joint pains and arthritis (Figure 12.8).
- The infrared thermometer has been developed to measure the temperature of body without contact (Figure 12.9).
- Kidney dialysis machines and mini cameras for taking the photographs of internal organs of human body have been developed using the research output of space exploration.

Figure 12.8
High intensity LED unit

Figure 12.9
Infrared ear thermometer

- The materials used to keep our homes warm are based on the technology used for insulating the space stations.

Global Navigation

- Geostationary Orbits and Global Positioning System (GPS) use the network of satellites orbiting the Earth to facilitate communication and essential navigation (Figure 12.10). This system helps our television receivers and mobile phones to catch signals from the satellites moving around the globe.
- The travellers can use this system not only for knowing where they are travelling but

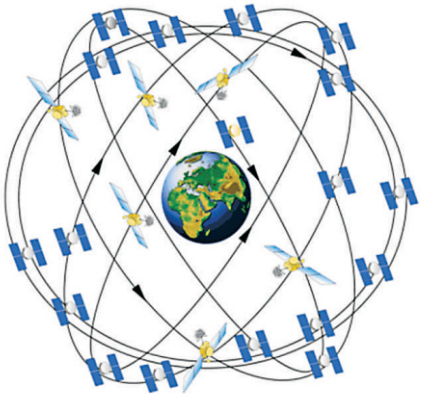


Figure 12.10
GPS satellites around the Earth

also for selecting best route to their destination. Aeroplane pilots, sailors of the boats or desert hikers also use the GPS in mobile phones to find their positions and get information about the surroundings.

Weather Forecast and Prediction of Natural Calamities

- The accurate and reliable weather reports on hourly basis are possible because of the weather satellites in the space(Figure 12.11). These satellites have also made it easy to predict natural calamities such as floods, storms, tornadoes and hurricanes.

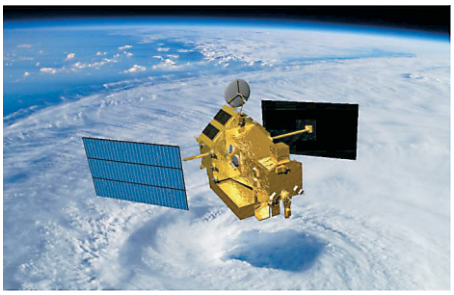


Figure 12.11: Weather satellite

Advanced Electronics and Computers

- Electronic and computer systems were developed mainly to facilitate space exploration. Satellites are fitted with electronic and computer systems which can perform many functions automatically. Now-a-days many items are made in factories automatically or by computer controlled robots.

Locating Minerals, Fossil Fuels and Water Reserves

- Deeply buried precious ores of minerals, fossil fuels (coal, petroleum and natural gas) and underground water reserves can be located with the help of satellites (Figure 12.12). This study is known as remote sensing.

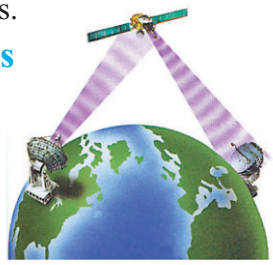


Figure 12.12:
Locating ores and resources

12.2.2 How do Astronauts Survive and Research in Space?

For living in space, astronauts need basic necessities (air, food, water, shelter and warmth) for survival, and a suitable compartment for personal comfort on the spacecraft. For this purpose, large space stations have been built in the space. Each space station consists of two main sections. (i) Pressurized section in which scientists work without space suits. (ii) Open-to-Space section on which equipment is mounted for observing the Earth and sky. Unprotected human body cannot survive more than a few minutes in space. As liquid boils at lower temperature at lower pressure, the water in human body can begin to boil at low pressure resulting immediate death. The astronauts wear a specially designed suit called **space suit** to protect from such hazards when they go out into space (Figure 12.13).

For breathing in space, they carry air tanks with them that contain pressurized oxygen and nitrogen. Their suits circulate the air to their helmets and throughout the suit so that they can breathe.

Special foods are prepared and packed for easier transportation and a variety of tastes for the astronauts.

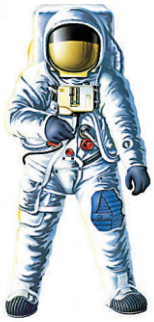


Figure 12.13
Astronaut wearing space suit

12.2.3 Problems Created by Space Exploration and their Solutions

Space sickness, effects of weightlessness, conditions resulting from exposure to radiation and many unwanted side effects are the problems created during the stay in space. Pollution caused by burning of rocket fuel and disposal of rocket parts, etc. is one of the major problems created by space exploration.

1. Hazards for the space crew on missions are the main problems. Many deaths have resulted during the manned spaceflights. Space scientists and engineers need continuous work to improve safety in space missions.
2. Skylab fell from its orbit to Earth in 1979. This type of incidences could be dangerous for population.
3. Space programmes are very costly. These are causing economic burden on common man. Involvement of private sector in missions could be a possible solution.

12.2.4 Technological Tools Used in Space Exploration

A few of the tools which are used in space exploration programmes are mentioned as follows:

1. Space Rockets

Space rockets are the means of transporting spacecrafts, space shuttles and space stations into the space (Figure 12.14).

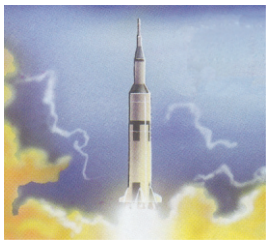


Figure 12.14: Space rocket

2. Rocket Launching pads

The sites from which rockets are launched into space are called Rocket Launching Pads (Figure 12.15). These are especially built platforms for firing rockets into the space. They can withstand extremely high temperature and large forces produced by rocket exhausts.

3. Telecommunication system

Rockets and spacecrafts are provided with telecommunication system so that the space crew in the rocket capsule can communicate with each other and with the Earth stations.

Figure 12.15
Rocket launching pad

4. Ground Mission Control Stations

Ground stations receive and process the information from satellites to monitor and guide their motion in space. The main tasks of ground mission control are as follows:

i. Tracking

Continuously reporting the position of the satellite or space probe.

ii. Monitoring

Receiving signals from a spacecraft and decoding them into useful information for the scientists is known as monitoring. Progress of a space mission is closely observed and necessary instructions are issued from time to time.

12.2.5 New Technologies Developed on the Earth as a Result of Space Exploration

We have learnt in section 12.2.1 about the technologies and benefits of space exploration. In order to reiterate some of the new technologies developed on the Earth as a result of space exploration are listed below:

1. Special types of metal alloys and ceramic materials developed for rocket engines and space shuttles can withstand very high temperature and pressure. These are now being used in Jet engines. Similarly, special foam seats developed for spacecrafts are now being used in aeroplane and car seats.
2. Solar cells were originally developed to provide electricity to spacecrafts. Millions of them are being installed on the Earth now-a-days to produce almost free electricity from sunlight.
3. In case of illness, astronauts have difficulty in swallowing medicine pills in space. Special medicines have been developed for use in space. These medicines, directly pass through the skin and enter the body of the patient. These medicines are now being manufactured for the patient on the Earth who finds it difficult to swallow the pills.
4. Special sensors and computers were developed for monitoring the physical

conditions of astronauts such as pulse rate, blood pressure, blood sugar, etc. Now-a-days the same technology is used to monitor patients present at in-accessible areas, with the help of satellite communications. A doctor in an advanced city hospital can check a patient who is far away in a remote village and suggest medicine for him. By this method doctor can even perform surgical operations on remote patients.

KEY POINTS

- Telescope is an instrument that helps to see heavenly objects clearly.
- Hubble telescope can produce clear images of astronomical objects which are very far from the Earth.
- There are two types of spacecrafts, robotic spacecraft and manned spacecraft.
- A spectroscope is an instrument which is used to examine different wavelengths (colours) present in a light radiation coming from stars.
- Geostationary satellites and Global Positioning System (GPS) help a television receiver, or a mobile phone to catch signals from the satellites moving around the globe.
- Knowledge gained from space exploration has enabled man to develop technologies to serve the humankind in the different fields like health and medicine, navigation, weather forecasting, locating minerals, fossil fuels and water reserves.
- Space rockets, rocket launching pads, telecommunication system, telescopes, spectroscopes, etc. are different technological tools used in space exploration.
- The application of space exploration technologies has improved business, industry and quality of life on Earth.

QUESTIONS

12.1. Encircle the correct option.

(i) An instrument that helps for seeing heavenly objects:

a. microscope b. telescope c. spectroscope d. kaleidoscope

(ii) Telescopes on the Earth suffer from the fact that the light coming from the stars has to pass through:

a. space b. water c. air d. sea

(iii) A vehicle, designed to carry satellite in outer space is:

a. rocket b. air bus c. air jet d. spacecraft

(iv) Spectroscope is an instrument used to examine the wavelengths of:

a. light waves b. water waves

c. air waves d. sound waves

(v) Physical exploration of space is conducted both by human spaceflights and:

a. telescope b. robotic spacecraft

b. rocket d. spectroscope

12.2 Give short answers.

(i) How does reflecting telescope differ from refracting telescope?

(ii) What are rockets?

(iii) What is the advantage of putting a telescope in space?

(iv) What is remote sensing?

(v) For what GPS stands for?

12.3 Describe the benefits generated by technology of space exploration.

12.4 Explain how do astronauts survive and work in space.

12.5 Describe the technological tools used in space exploration.

12.6 Describe four problems created from space exploration and their solutions.

12.7 Write short notes on the following:

(i) Hubble Space Telescope (ii) Space Probes (iii) Space Stations

Critical Thinking

Extended Activity

Sketch the design of a spacecraft and describe its key features for its suitability as a spacecraft.

GLOSSARY

Acid: A compound which produces hydrogen ions in its aqueous solution.

Acid rain: The rain which is unusually acidic.

Addition reaction: A chemical change in which simpler substances are combined to form a single compound.

Aerosol: A substance packed under pressure with a device to release it as fine spray.

Alkali: A compound which produces hydroxide ions in its aqueous solution.

Bimetallic strip: Two metallic strips joined together that bends on heating.

Biotechnology: A technology which uses living things for human welfare.

Chemical equation: Representation of a chemical reaction in the form of symbols and formulae.

Chemical reaction: A change in which new substances are formed.

Concave lens: A lens which is thinner in the middle and thicker at the edges.

Convex lens: A lens which is thicker in the middle and thinner at the edges.

Decomposition reaction: A chemical change in which a compound is broken down into simpler substances.

Deforestation: Cutting of forests.

Dialysis: Cleaning of blood by artificial methods.

Diode: Electronic device that changes AC to DC.

Effector: A body part which receives message from brain or spinal cord and produces response.

Endothermic reaction: A chemical change during which heat is absorbed.

Exothermic reaction: A chemical change during which heat is evolved.

Fertilization: Fusion of a sperm with an egg.

Focal length: The distance between the optical centre and principal focus of a lens.

Gene: Basic unit of heredity.

Genetic modification: Removal, addition or repair of genetic material.

Global warming: An increase in average temperature of the Earth.

Glomerulus: Tuft of blood capillaries in the renal corpuscles of the nephron in kidney.

Heredity: Transmission of characters from parents to offspring.

Hydraulic system: Transmission system for using pressurized liquid to drive hydraulic machinery.

Indicator: Organic compound which gets specific colour on dissolving in an acidic or alkaline medium.

Input devices: The devices used to enter data into an electronic system.

Lens: A solid piece of glass or other transparent materials like plastic whose one or both sides are curved.

Long-sightedness: Defect of vision in which one can see distant objects clearly but not the nearby objects.

Meiosis:	Nuclear division during which the number of chromosomes in the daughter nuclei reduces to half as compared to that in the parent cell nucleus.
Mitosis:	Nuclear division during which the number of chromosomes in the daughter nuclei remains the same as that in the parent cell nucleus.
Motor Neurons:	Neurons that carry nerve impulses from CNS to effectors.
Neuron:	Basic structural and functional unit of nervous system.
Neutralization:	Chemical reaction of an acid with an alkali to form salt and water.
Optical centre:	Centre of a lens.
Output devices:	Devices that transform the current or voltage signal into useful physical form.
Ozone depletion:	Decrease in the concentration of ozone in the atmosphere due to certain pollutant gases.
pH:	Negative logarithm of hydrogen ion concentration.
Pneumatics:	Branch of science which deals with the study and application of pressurized gas to produce mechanical work.
Pressure:	Force per unit area.
Receptor:	Body organ, tissue or cell that detects stimuli.
Recycling:	Collection and reuse of waste materials.
Reflex action:	An immediate and involuntary response to the stimulus.
Resistor:	An electrical component which resists or tries to limit the flow of electric current in an electric circuit.
Riveting:	Joining two metal plates with the help of a rivet.
Rocket:	A mean of transporting into the space.
Salt:	A compound formed by the reaction of an acid with an alkali.
Second:	SI unit of time.
Sensory Neurons:	Neurons that carry nerve impulses from receptors to CNS.
SI Units:	An internationally recognized system of units for measuring physical quantities.
Short-sightedness:	Defect of vision in which one can see nearby objects clearly but not the distant objects.
Space exploration:	Exploration of nature outside Earth.
Spacecraft:	A vehicle designed to travel in outer space.
Spectroscope:	An instrument which is used to measures the property of light (wavelength).
Stimulus:	Environmental change that provokes a response in the body.
Telescope:	An instrument used to see far objects.
Thermal Expansion:	Increase in size of an object on heating.
Thermostat:	A device which controls the temperature of an electrical appliance.
Transgenic bacteria:	Bacteria with foreign genes.
Virtual Image:	Image that cannot be obtained on the screen.
Volume:	Space occupied by something.

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