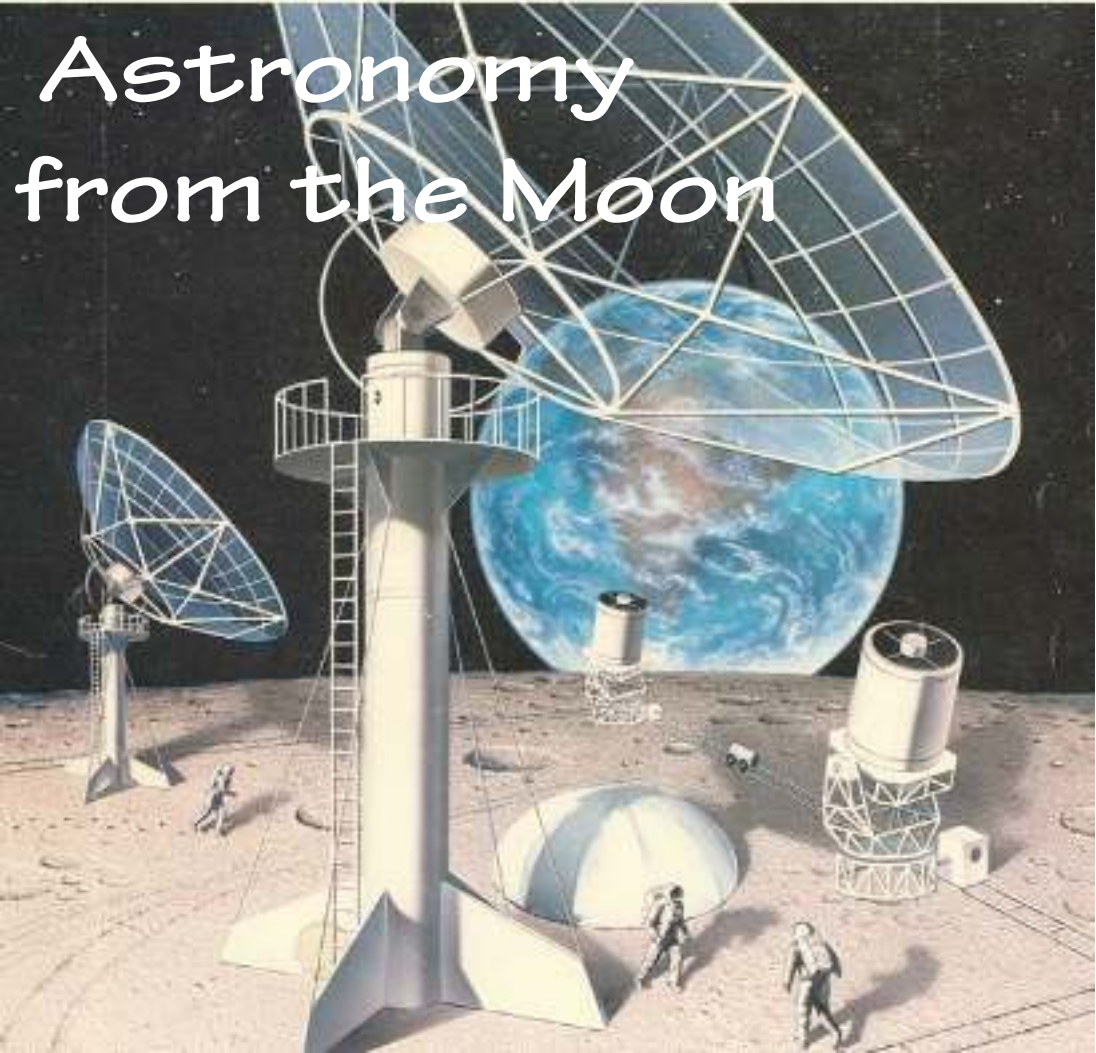


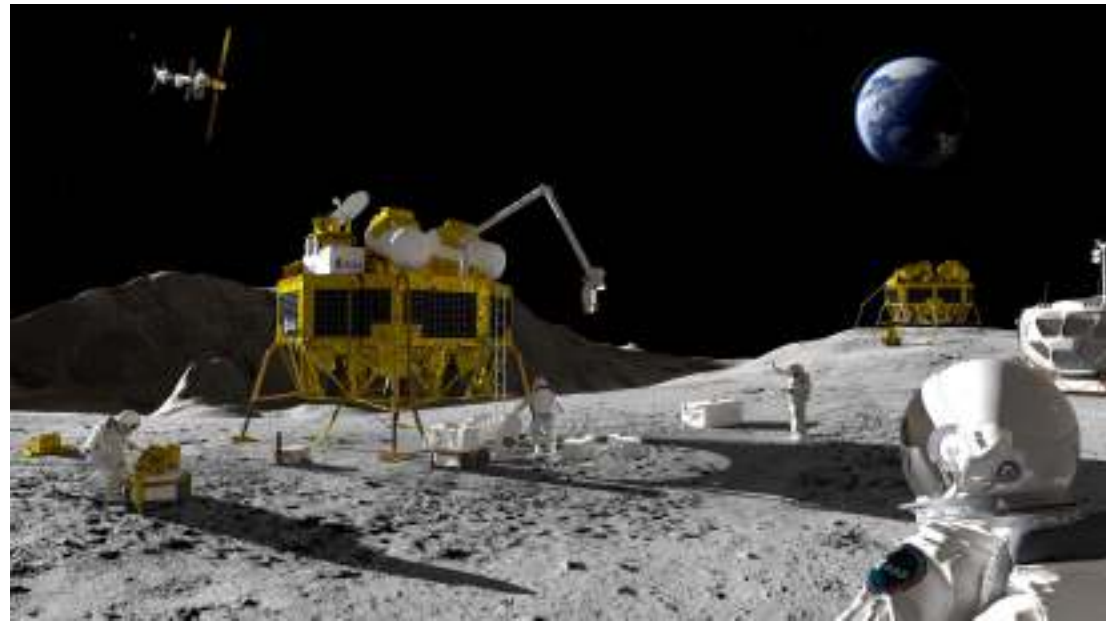
The Universe in my pocket

# Astronomy from the Moon



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Paris Observatory



*The Moon offers many practical and astronomical advantages for new observations of the stars.*

*This mini-book explains*

*1 The advantages of the Moon for Astronomy*

*2 Scientific goals and spin-offs*

*3 Implementation*

# Why the Moon?

On the Moon there is no atmosphere, so no atmospheric turbulence, and we have access to the entire light spectrum, from gamma rays to radio waves.

The gravity which is  $1/6$ th of Earth's gravity means that one can build there telescopes that are larger than on Earth. In addition the instruments can be constantly upgraded and repaired.

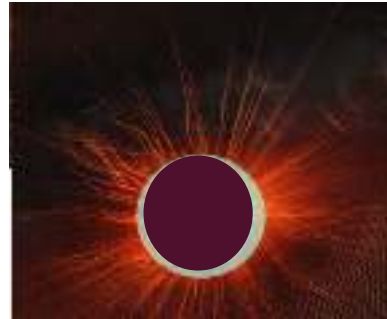
To set up and operate telescopes on the Moon, one needs to know the terrain, send robots and then humans, and build houses. One will also need vehicles to transport people from one place to another as well as energy sources.

Investigations on all these aspects are progressing very quickly.



- Observation of the Earth's global light. This will make it possible to observe the Earth as if it were an exoplanet that we can only see as a point.

Occultation of the Sun. Earth's diameter is 3.7 times larger than the Moon's diameter, so solar eclipses seen from the Moon last 3.7 times longer



Earth



Example of a mutual eclipse, invisible from Earth, of binary asteroids

# Studying the Solar System

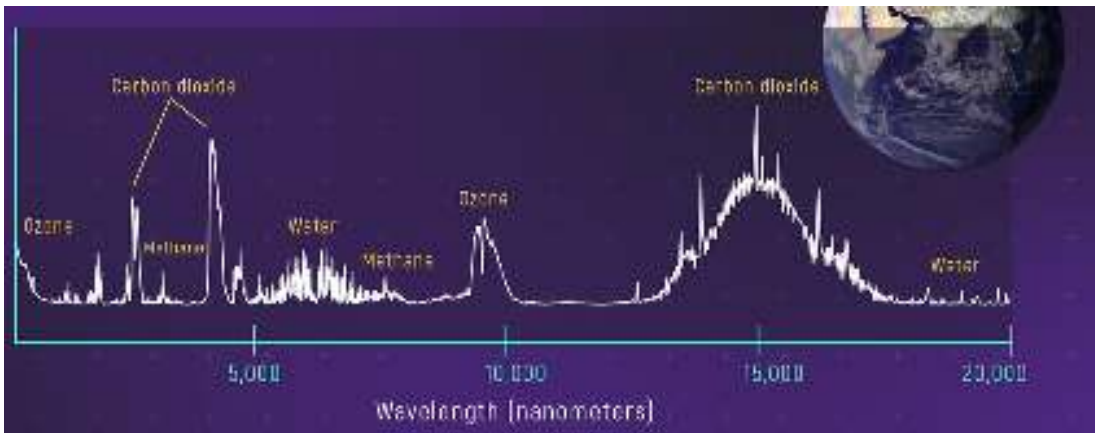
Instruments on the Moon will be able to study the Moon itself.

Spectrographs will determine the chemical composition and the crystallographic and mechanical properties of the lunar soil known as "regolith". An important point for humans is the detection of water.

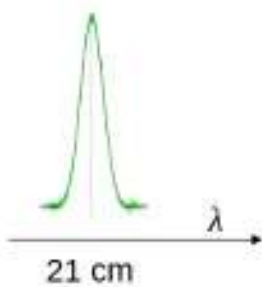
Seismometers will measure the Moon's seismic activity.

From the Moon, we can see the Solar System from a different angle than from Earth. This will enable us to observe the entire Earth itself and eclipses of the Sun by the Earth.

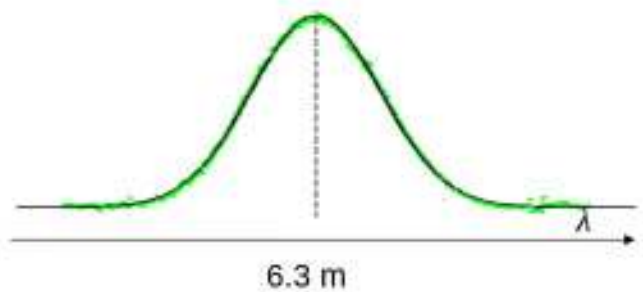
Under favourable geometric conditions mutual eclipses of binary asteroids and occultations of stars by asteroids, invisible from Earth, will be detected from the Moon.



We can see the entire spectrum (see TUIMP 30) of an exoplanet, from the ultra-violet to the far infra-red.



Hydrogen line observed at 21 cm in a galaxy close-by



In a galaxy at 2 Gigaparsec (6 000 000 000 light years) the same line would be stretched and observed at 6.3 m (a wavelength very difficult to observe from Earth)

# From exoplanets to cosmology

By combining the advantages of angular resolution and/or sensitivity and/or the full spectral range offered by the Moon, one can

**For exoplanets** (see TUIMP 8)

Carry out spectroscopy of an exoplanet's atmosphere across the full range of wavelengths.

Some exoplanets may have oceans, and if so, we might be able to see the reflected light of the parent star.

**For the first galaxies**

Observe the hydrogen line emitted at 21 cm, which for a primordial galaxy with a spectral shift of 30, is observed at 6.3 m, a wavelength a wavelength that is difficult to observe from Earth.

**For cosmology**

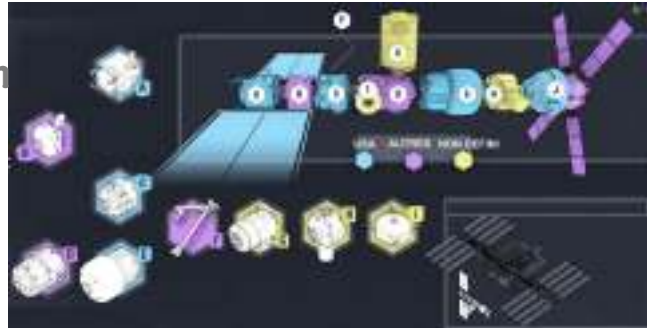
Detect the distortion of the primordial radiation spectrum (see TUIMP 12) by galaxies on the line of sight.





Manufacture of a housing from regolith

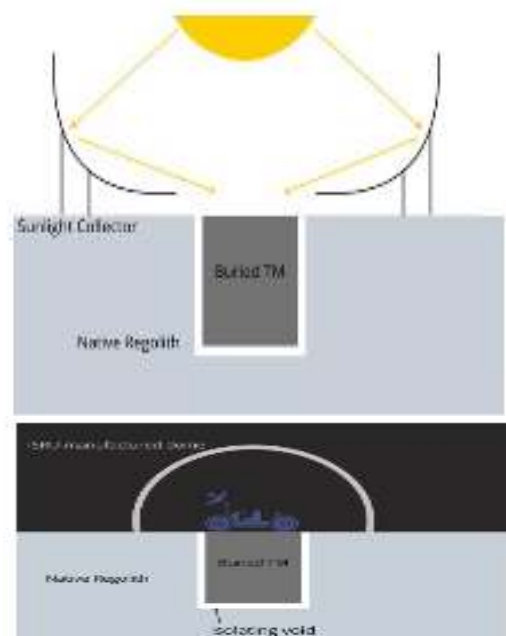
Gateway station around the Moon



The Chinese rover Youtu-2 travelled 1.5 km on the Moon.

Above: storage of the sun's heat during the day.

Below: heat recovery during the night.





# Implementation

## Robots :

They will be used to operate various instruments and build homes.

## Human presence :

Certain delicate tasks cannot be carried out by robots.

## The Gateway circumlunar station:

It will act as a relay between the Earth and the Moon.

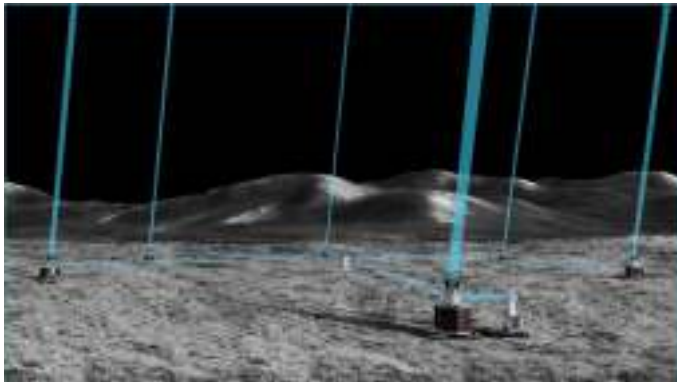
## Means of transport :

In addition to the rockets that will leave from Earth, there will be the Argonaut shuttle between the orbital station and the ground, and vehicles on the ground.

## Energy sources :

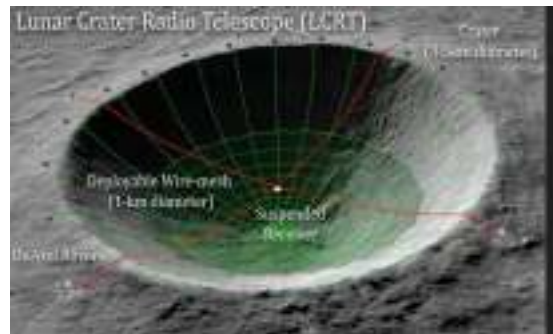
Solar panels, isotope generators, night-time restitution of solar heat stored in the ground, small nuclear power stations.

The Chinese LUT 15 cm ultraviolet telescope was in operation from 2015 to 2018. During 18 months, it monitored the activity of 17 stars.



The AeSI interferometer project from NASA.

The Lunar project Crater Radio Telescope from NASA



# Completed and planned telescopes

## Apollo 16 (1972)

A 7.5 cm telescope

## Lunar Ultraviolet Telescope (2013)

A 15 cm telescope

## ROLSES (2024)

A radio telescope

## LOUPE

A sophisticated camera to observe the Earth as if it were an exoplanet

A 30 cm telescope

LUSTER, dedicated to the spectroscopy of exoplanet transits

## 6 m telescopes

For transit spectroscopy and imaging detection of exoplanets

## Infrared telescopes

For the detection of all stars colder than 1 000 degrees Celsius

## Long-base interferometers

To see the details of stars and galaxies

## Large radio telescopes

For the detection of long wavelengths



Chang'e 6 brought  
back Moon samples  
in 2024

IM-1 studied the lunar  
surface in 2024



PRISM to measure  
moonquakes in  
2025

## Participants in past and future missions

ESA	South Korea	Japan
Germany	United Arab States	Luxembourg
Saudi Arabia	France	Netherlands
Brazil	Hungary	Russia
Canada	India	Turkey
China	Israel	Ukraine
	Italy	USA

# Lunar missions

(Last updated 16 March 2025).

To date, 41 lunar missions have already been carried out or scheduled.

## Among past lunar missions

Chang'e 5: return of samples

Artemis I: flight around the moon

IM-1: soil survey

Chang'e 6: soil measurements

Bue Ghost: soil survey

Resilience and Tenacious: vehicles on the ground

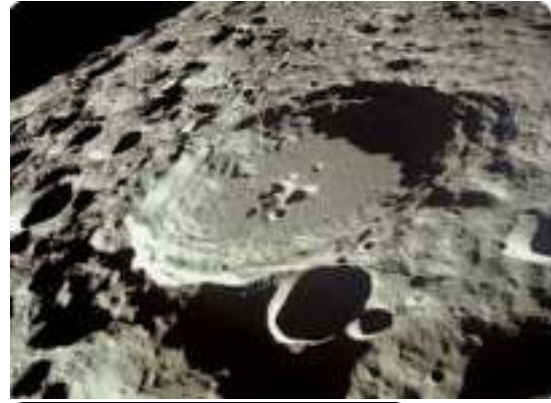
## Scheduled missions include

IM-3: magnetic field measurement

PRISM: seismology of the Moon

PROSPECT (ESA): soil drilling

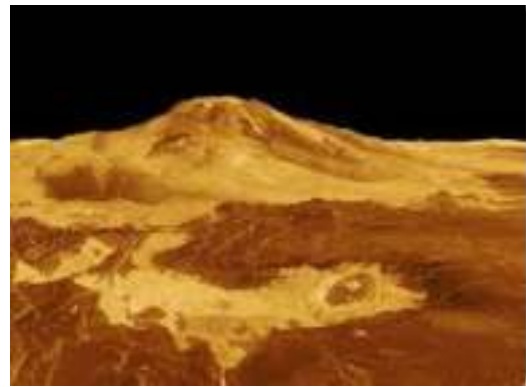
Chang'e 7: lunar vehicle, soil analysis robot



## Quiz

Which of these images represents the Moon?

What is the gravity at the Moon's surface?



Answers  
on previous  
page



The Moon



A desert on Earth



Neptune

## Answers

Gravity on the Moon is  $\frac{1}{6}$ th of that of the Earth



Mist on Mars



A volcano on Venus



# The Universe in my pocket No 40

This mini-book was written in 2025 by Jean Schneider of the Paris Observatory and revised by Stan Kurtz of the IRyA (Mexico).

It gives an instant view of a subject that is progressing very rapidly: see [luth7.obspm.fr/Moon.html](http://luth7.obspm.fr/Moon.html)

The cover image is a representation of future astronomical activity on the Moon, with its optical and radio telescopes and the astronomers and engineers operating the instruments.



To learn more about this series and about the topics presented in this booklet, please visit <http://www.tuimp.org>

Translation: Stan Kurtz  
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