cesar

Cooperation through Education in Science and Astronomy Research

ECLIPSES EDUCATIONAL KIT

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Contents

Introduction:

CESAR (Cooperation through Education in Science and Astronomy Research) welcomes you to an exciting journey in which you will discover and experience solar eclipses… and much more! We aim to accompany you during the years **2026, 2027 and 2028** with clear, accessible resources full of experiences to fully enjoy the extraordinary **trio of European solar eclipses**.

This **educational kit** is designed to spark creativity and help anyone, without the need for prior knowledge, to understand these natural phenomena and take part in related activities.

Throughout this guide we will walk together along a path that begins with the essentials:
What is an eclipse?
How many types are there?
Why do they happen?

How can we observe the Sun safely?

You will also meet female scientists who have made key contributions to the study of the Sun and eclipses.

Later, we will explore practical activities such as:
How to simulate an eclipse at home or in the classroom;
How to choose the best places from which to view an eclipse;

What we can learn about the Sun using real data from the CESAR solar telescopes and ESA missions that observe it.

The experiments are designed to spark curiosity, creativity, and the joy of discovery. In the index you will find, for each activity, the recommended ages, the type of experience, the necessary materials, as well as the ideal time and place to carry it out. Some activities use digital tools, others encourage expression through art, and still others are geared towards the scientific method through observation and data analysis.

They are all inclusive thanks to their variety, the fact that they can be carried out in groups or alone, and their being explained with clear steps, accompanied by images and videos whenever possible. We invite you to explore this kit in a spirit of adventure. Let yourself be guided by curiosity: experiment, observe, and share what you discover.

Eclipses provide a unique opportunity for us to marvel together at the wonders of nature.

Are you ready to begin this journey? Let's go!

Conceptual framework

2.1 Get to know the Sun

The Sun is an enormous sphere of very hot gas that shines with its own light. It functions like a gigantic "power plant", with reactions taking place inside that transform some elements into others. Within the objects of the Universe, the Sun belongs to the category of stars. It is currently in a stable stage called the Main Sequence. In this phase, four hydrogen atoms in its nucleus fuse to form one helium atom, releasing a large amount of energy. That energy is what reaches us in the form of light and heat.

The Sun gives its name to the place where we live: the Solar System. All the planets, including Earth, depend on it, which is why we constantly observe and study it. If we look at the Sun like true explorers, we will see that it is made up of different layers:

Internal layers

- **Core:** It is the centre of the Sun, where the temperature and pressure are so high that nuclear fusion of hydrogen into helium occurs, releasing a huge amount of energy.
- **Radiative zone:** The energy generated in the core is transported outwards in the form of photons, which are constantly absorbed and re-emitted by the plasma in this area.
- **Convection zone**: Energy is transported by convection currents, hot plasma rising, cooling, and then sinking, creating a circular motion similar to a tide.

Outer layers

(known as the solar atmosphere).

- **Photosphere:** The photosphere is the visible surface of the Sun, with a temperature of about 6,000 degrees Celsius. It is the layer where light and heat are emitted into space, and sunspots can be observed here.
- **Chromosphere:** The chromosphere is located above the photosphere, has a reddish hue, and can be observed during a solar eclipse as a ring. The temperature increases in this layer, and features such as prominences and spicules can be seen.
- **Corona:** The corona is the outermost and thinnest layer of the Sun's atmosphere, extending millions of miles into space. It has no defined boundary and can be seen as a halo during a solar eclipse or using a coronagraph. Corona temperatures can reach up to two million degrees Celsius.

The Sun is the Earth's main source of energy. In this kit we will learn that the arrangement of its **inner and outer layers** allows us to explain phenomena such as the **emission of light and heat**, **solar activity** and **day and night**. Furthermore, the construction of **physical models** facilitates the understanding of structures that cannot be directly observed.

Ref: Image of parts of the Sun (Page 46)

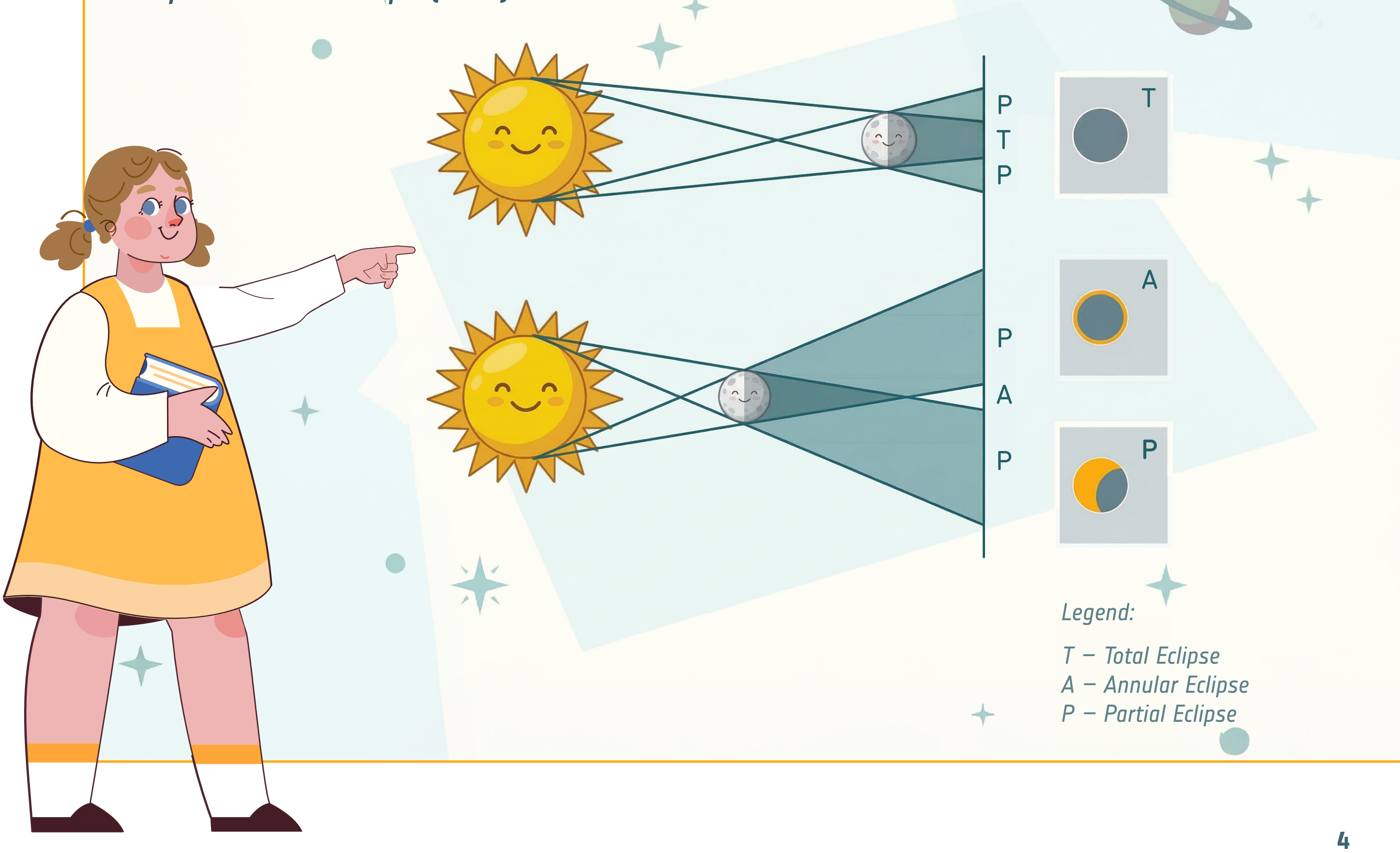
2.2 Types of solar eclipse

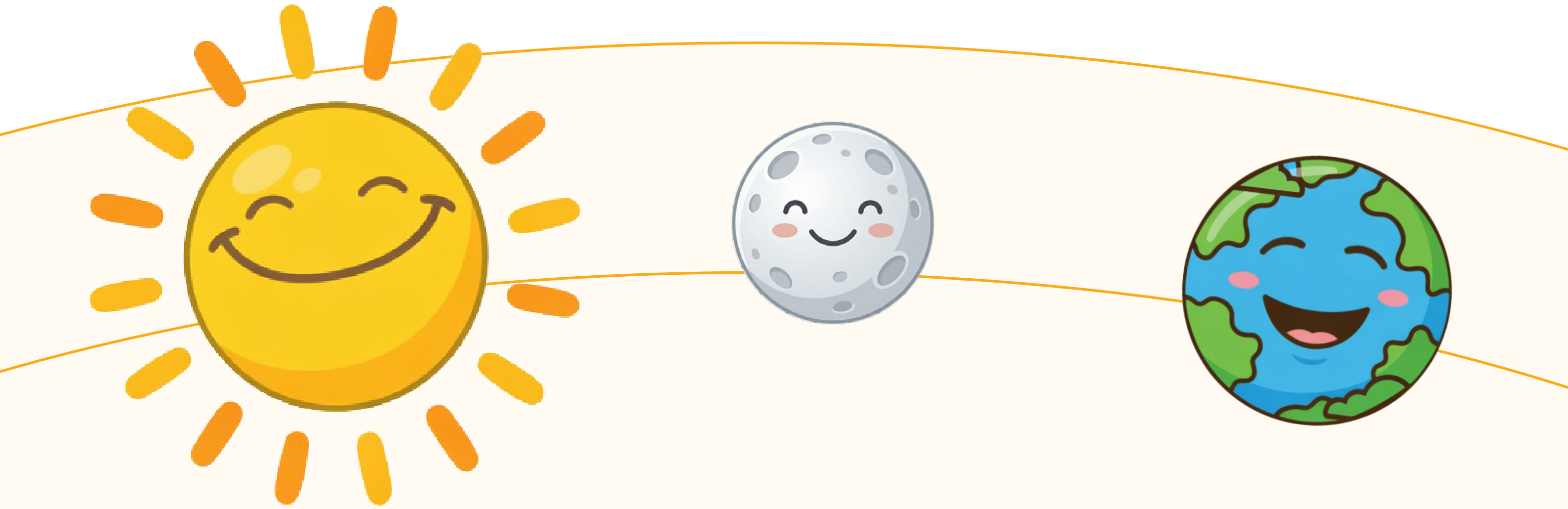
Solar eclipses occur when the Moon passes between the Sun and the Earth, casting its shadow on the Earth's surface. This happens during the New Moon phase, as long as the Moon is very close to the plane of the ecliptic (the orbital plane of the Earth around the Sun). The Moon's orbit around the Earth is tilted slightly (5 degrees) relative to the ecliptic plane; if this were not so, there would be a solar eclipse and a lunar eclipse every month.

There are three main types of solar eclipses, which differ in the exact alignment between the Sun, the Moon and the Earth, and the part of the lunar shadow (umbra, penumbra or antumbra) that falls on the Earth's surface:

- **Total solar eclipse (T):** This occurs when the Moon completely covers the solar disc from the perspective of an observer in a specific strip of the Earth (the band of totality). For a few minutes, day turns into night and the solar corona is visible.
- **Annular solar eclipse (A):** This occurs when the Moon is near its apogee (farthest point from Earth) and it appears smaller than the Sun. As a result, the Moon does not completely cover the Sun, leaving a bright "ring of fire" visible around its edge.
- **Partial solar eclipse (P):** The Moon only blocks part of the Sun. This can occur independently or as an initial or final phase, visible from a much wider region around the path of totality or annularity.

Diagrams of a total solar eclipse (above) T. and of an annular solar eclipse (below) A.

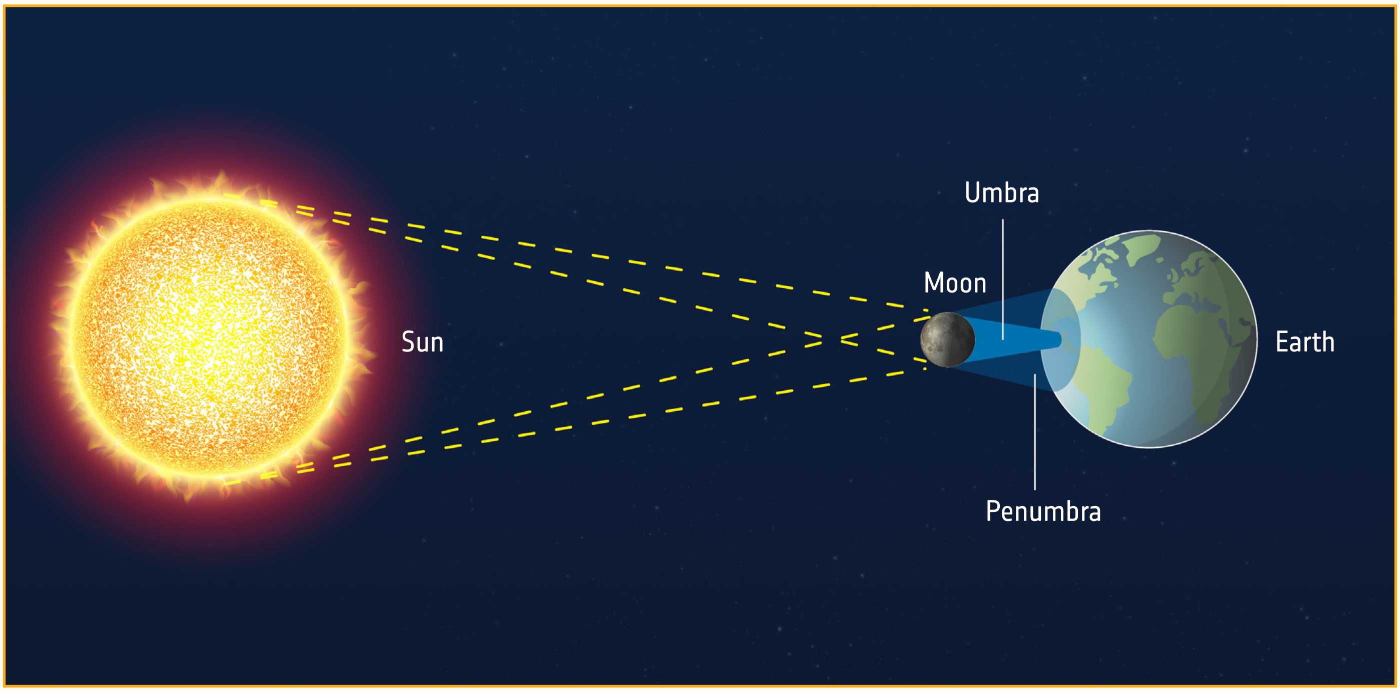




The difference between total and annular eclipses is explained by the **variation of the distance between the Earth and the Moon**, a consequence of the eccentricity of the lunar orbit. The variation in the apparent diameter of the Sun and the Moon determines the type of central eclipse.

1. **Earth-Sun orbit:** The apparent size of the Sun varies 3% from farthest (aphelion) to closest (perihelion).
2. **Earth-Moon orbit:** The lunar orbit is elliptical, which causes a significant variation (up to 12%) in the apparent lunar diameter between perigee (closest to Earth) and apogee (farthest away).
    - **Total eclipse:** This occurs when the apparent lunar diameter is greater than the solar diameter (generally, Moon at perigee, Earth at aphelion). The lunar umbra intersects the Earth.
    - **Annular Eclipse:** This occurs when the apparent lunar diameter is smaller than the solar diameter, and the extension of the umbra generates an antumbra. The Moon appears surrounded by a bright ring of sunlight.

We are going to develop different activities in which we will learn about the different types of solar eclipses.



2.3 How to observe the Sun safely

Safe observation of the Sun requires caution and the use of appropriate methods to protect the eyes from harmful radiation. In general, it is recommended to avoid looking directly at the Sun, even during partial eclipses, and to use projection methods or certified solar filters. The Sun should never be looked at directly without adequate protection. Observing the Sun is a highly motivating scientific experience, but direct observation without protection poses a serious risk to eye health.

There are, in general, several methods of solar observation:

2.3.1 **Direct observation.**
Looking directly at the sun through an approved filter.

Credits: Getty Images

A. Approved glasses for solar eclipses. They must comply with the international standard **ISO 12312-2:2015.**
Attention:
Conventional sunglasses, X-rays, or photographic negatives are not safe in any case.

Credits: Sam0252

B. Astronomical telescopes and binoculars with solar filter. If specialised optical equipment is available, it is essential to install a suitable solar filter **on the lens or where the light enters. It must never be placed on the eyepiece**, as this concentrates the heat and can break the filter.

2.3.2 **Indirect observation.**
Looking at the projected image of the Sun.

Credits: Luis Fernández García

Credits: Robin Scagell / Science Photo Library

A. Through a **telescope**, on a **screen**.

Credits: CESAR

B. Using a pinhole camera with a small hole to project the image of the Sun onto the opposite surface.

Ref: Page 32.

Credits: Joy Ng

C. Observing the **shadows projected**, through gaps in tree leaves and household items such as milk frothers, tea strainers, etc.

Additional recommendations:

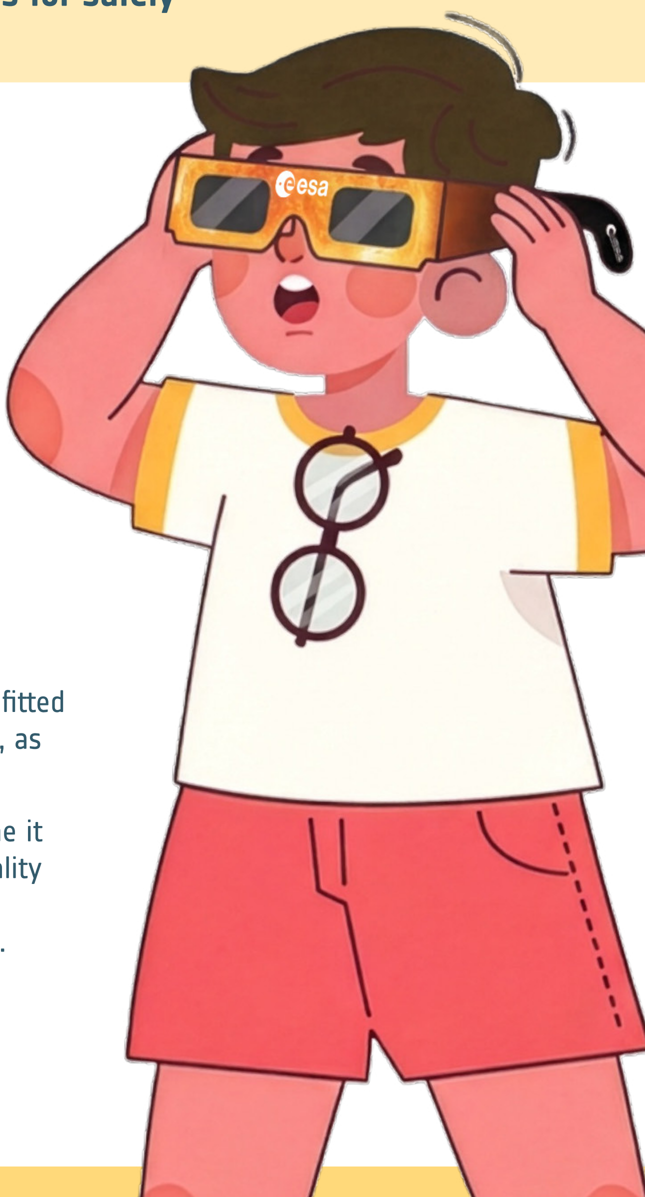
Never look at the Sun through smoked glass, X-ray film, floppy disks, CDs, foil wrappers, or filters in the telescope eyepiece. Avoid looking at the Sun with the naked eye, even during a partial eclipse.

Do not use sunglasses, binoculars, or cameras without appropriate solar filters. If using a telescope, make sure the finder scope is covered to prevent direct light from entering the eye.

For solar eclipses, it is important to remember that the Moon does not always completely cover the Sun, and radiation can be dangerous even during the partial phase.

If you are going to observe the Sun during an eclipse, use sunscreen, a hat, and light-coloured clothing to protect your skin.

In summary, here is a ten-point guide to basic rules for safely observing the Sun during an eclipse:



1. **Never look directly at the sun!** Not even when it is partially eclipsed, as the light can cause instant and irreparable retinal damage, without pain, and can burn your eye.
2. **Use certified eclipse glasses (ISO 12312-2):** Look for solar filters that comply with this international standard; they are the only ones safe for direct observation.
3. **Inspect your eclipse glasses before using them:** Do not use scratched, perforated, cracked, or dirty glasses; destroy them and replace them.
4. **Don't use ordinary sunglasses:** Several together, welder's glass, photographic negatives, CDs, aluminium foil, or water used as a reflector—none of these block harmful radiation.
5. **Be careful with optical devices:** Do not look through cameras, telescopes, or binoculars without a special solar filter, properly fitted and placed on the aperture or objective lens (not the eyepiece), as they concentrate the light and can burn your eye and the filter.
6. **Just one safe moment to take off your glasses:** The only time it is safe to look at the Sun with the naked eye is during the totality phase of a total (non-annular) solar eclipse, which is when the Moon completely covers the Sun and direct light is not harmful. Since it only takes a few seconds, it's best not to remove your glasses, or not to look directly for more than a few seconds.

7. **Using indirect methods:** Project the image of the Sun through a hole or a pinhole camera (e.g., with a box) onto a white surface to view it safely.
8. **Protect your skin:** Use sunscreen, a hat, and clothing, as solar radiation remains intense during the eclipse.
9. **Observe for short periods:** Take breaks between observations to rest your eyes.
10. **Consult experts:** If you want to use optical equipment, look for special approved filters and advice from astronomers.

In this kit we will learn how to observe a solar eclipse safely and acquire safety habits by comparing direct observation methods using certified eclipse glasses and indirect observation by building a pinhole camera.

2.4 How we study the Sun

Studying the Sun is fundamental to understanding life on Earth, learning about other stars, and predicting space climate phenomena. The Sun is the source of energy, light and heat that makes life on Earth possible, and regulates our climate and the seasons. Its behaviour can affect satellites, communication systems, and electrical grids. That is why the European Space Agency (ESA) studies it using space telescopes and dedicated missions.

Since it is the closest star, we can study it better. The European Space Agency (ESA) has been studying it for decades, both from an astrophysical point of view (its evolution as a star), and to understand space climate (solar eruptions, coronal mass ejections, etc.).

This is important because the particles ejected by the Sun can reach Earth.
Although the magnetosphere (protective shield) protects us, they can affect satellites, communications, and electrical systems.

Next, we will develop different activities in which we will see different ways of studying the Sun, with telescopes on Earth, with the study of light and with missions sent to its vicinity for a more direct study.

2.5 References

HYPATIA (370-415)

She is considered **the first female astronomer in history**. She lived in ancient Egypt and loved learning and teaching mathematics and philosophy at the Library of Alexandria, alongside her father. She is known for her study of conics, the invention of the hydrometer, and improvement of the astrolabe.

She said: *"Defend your right to think, because even thinking incorrectly is better than not thinking at all."*

credits: mujeresconciencia.com

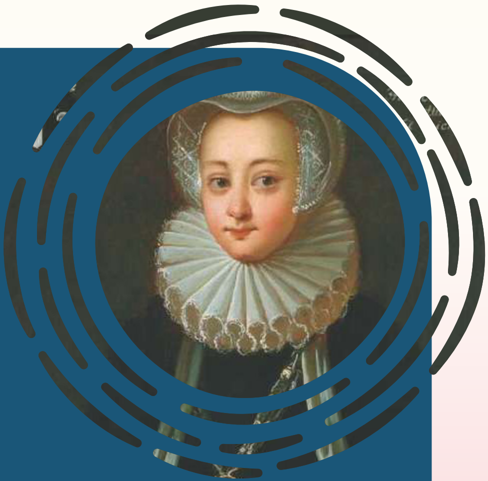
FÁTIMA DE MADRID (~ year 900)

There are writings that mention a wise woman who lived between Madrid and Cordoba at the end of the 10th century during the time of **Al-Andalus**.

She trained alongside her father in astronomy and wrote *"Corrections of Fátima."* She worked on the **Arabic tables** which were calendars, positions of the Sun, the Moon, the planets and data on eclipses.

Credits: AMIT Madrid

SOPHIA BRAHE (1556 - 1643)



She was the younger sister of Tycho Brahe, and lived in Denmark more than 450 years ago. She studied chemistry, medicine and horticulture and learned astronomy on her own. She helped her brother in collecting data that would later prove fundamental to the development of the modern theory of orbits, the basis of Kepler's work.

Her brother Tycho referred to Sophia as *"the invincible anonymous one" of "determined mind".*

credits: mujeresconciencia.com

WANG ZHENYI (1768-1797)

She was born in China and trained in literature and poetry. Thanks to the education she received from her father and grandfather, she was able to learn astronomy, mathematics, geography, meteorology and medicine. She did medical internships and wrote many works on astronomy, particularly on the phases of the Moon and lunar eclipses.

She said: *"Both men and women are people, they have the same reasons to study (...) and contribute to society."*

Awards: *A crater on Venus was named after her (IAU, 1994).*

credits: mujeresconciencia.com

MARY SOMERVILLE (1780-1872)

She was born in Scotland and, from the age of 13, studied mathematics with books that her brother brought to her. It wasn't until she was 45 that she was able to conduct scientific experiments on magnetism. In addition, she translated works such as Newton's Philosophiæ Naturalis Principia Mathematica, among others, which earned her recognition from the Royal Astronomical Society, along with Caroline Herschel.

She said: *"Nothing has allowed me to be more certain of the existence of a God than mathematics and science."*

credits: mujeresconciencia.com

ADA LOVELACE (1815-1857)

She was born in England and received training in music, languages, history and mathematics, even during childhood when she was ill. She was guided by the scientist Mary Somerville, whom her mother deeply admired. She met Charles Babbage, father of the Analytical Engine, and translated the workings of this machine, adding her own contributions, which tripled the manuscript. Ada realised that this machine could go beyond numerical calculation and generate music or represent abstract ideas. Because of this vision she is considered **the first programmer in history.**

She said: *"The intellectual, the moral, and the religious seem to be interrelated in a harmonious whole."*

credits: mujeresconciencia.com

CECILIA PAYNE (1900-1979)

Born into an English-American family, she studied botany, physics, and chemistry at Cambridge. There she discovered **her passion for astronomy** after hearing a talk by Eddington about his expedition to Africa to see the **total solar eclipse.**
Faced with a lack of scholarships in her country, she moved to the United States, where she wrote a thesis on stellar atmospheres, considered **the most brilliant in astronomy.** Despite being an exceptionally active scientist, she never received the same salary as her male colleagues.

She was the first to establish that the elements in the stars are the same as on Earth, with Hydrogen (a million times more than on Earth) and Helium being dominant.

credits: mujeresconciencia.com

ANTONIA FERRÍN (1914-2009)

She was born in Galicia (Spain) into a humble family that made a great effort to give her a higher education. Antonia was brilliant and very hard-working, and she began her Chemistry degree at the age of 16. She studied Chemistry, Pharmacy and Exact Sciences at the University of Santiago de Compostela (USC) and taught at a high school to earn a living. She collaborated for more than 20 years with the director of the USC Astronomical Observatory, who directed her thesis on occultations of stars by the Moon. In 1963 she became **the first woman to receive a doctorate in Astronomy in Spain.**

She spoke of the *cold on the nights of observation, as she could not wear trousers at that time because she was a woman.*

credits: mujeresconciencia.com

MARIA ASSUMPCIÓ CATALÀ (1925-2009)

She was born in Barcelona (Spain). Her great-uncle, a professor of geography, instilled in her an interest in astronomy through games. Assumpció studied Mathematics, in order to dedicate herself to Astronomy. She worked as a maths teacher at a high school. She was the first woman to receive a doctorate **in Mathematics** from the University of Barcelona (1971). For 30 years she observed the **spots and flares of the Sun** with the telescope of the UB Observatory where she eventually became a lecturer in the history of Arab science.

She was appointed honorary professor of the UB in 2011 and awarded the Creu de Sant Jordi in 2009.

Upon receiving this award, she said: *Tell your young students never to be discouraged, to cultivate their vocation, which will bring them much satisfaction.*

credits: mujeresconciencia.com

CAROLE MUNDELL

She was born in the United Kingdom and her interest in science began at age 5, when she wanted to decipher the mathematical symbols on a dress her mother gave her. She studied Physics and Astronomy in Glasgow (1992) and completed her thesis at the Jodrell Bank Observatory (Manchester, 1997). She led radio astronomy research on active galaxies at the University of Maryland and at John Moores University (Liverpool).

She has received numerous awards for her scientific and technological work: RCUK (2005), Professor at LJMU (2007), award for her studies on gamma-ray bursts (2007), Wolfson Research Merit (2011–2016), and Woman of the Year (2016). She was head of the Physics Department at the University of Bath (2016–2018), advisor to the STFC and Scientific Advisor to the Foreign Office (2018).

She is currently **Director of Science at ESA and head of the Space Astronomy Centre (ESAC)** in Madrid. Her great commitment to the dissemination of science to society leads her to champion this **educational initiative for the trio of European eclipses.**

Regarding eclipses, she asserts: *"A total solar eclipse allows you to physically feel a connection with the cosmos."*

Credits: ESA

SARA GARCÍA ALONSO

Born in León (Spain), she was always an explorer. She studied for her degree and master's in Biotechnology at the University of León and completed a thesis in molecular biology for the cure of cancer at the University of Salamanca (2018), for which she received the Extraordinary Prize. Since 2019, she has been part of the CNIO, in the team of Dr. Mariano Barbacid, where she leads projects and doctoral theses on the development of drugs against pancreatic and lung cancer.

In addition, since 2022 she has been **an ESA reserve astronaut** and a role model for girls. She has received awards such as the Ada Byron Award for Women in Technology (2023), the Silver Medal of the Community of Madrid (2023), and the Passion for Science Award (2025). She is the author of Orbits. Notes from a life in continuous exploration (2025).

She states: *"There are no professions for girls and professions for boys. Come on, because science needs us."*

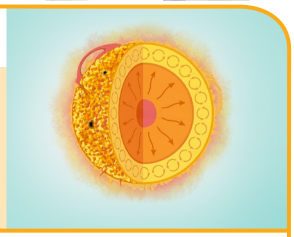
Credits: ESA

Recommended activities for ages 6-12

3.1 Get to know the Sun

Experiment

1 CONSTRUCTION OF 2D & 3D MODELS OF THE SUN



Construction of 2D and 3D models of the Sun	6-12 years
"Hands-on" cooperative project	90 min
Materials for the experiment: - Coloured modelling clay. (3D) - Several transparent acetate sheets. (2D) - Coloured permanent markers (yellow, orange, red, blue, white). (2D) - Black card-stock (for the base). (2D) - Scissors, glue, ruler. (2D)	Indoor activity Applicable to those with disabilities, hearing impairment and ASD.

Activities in detail

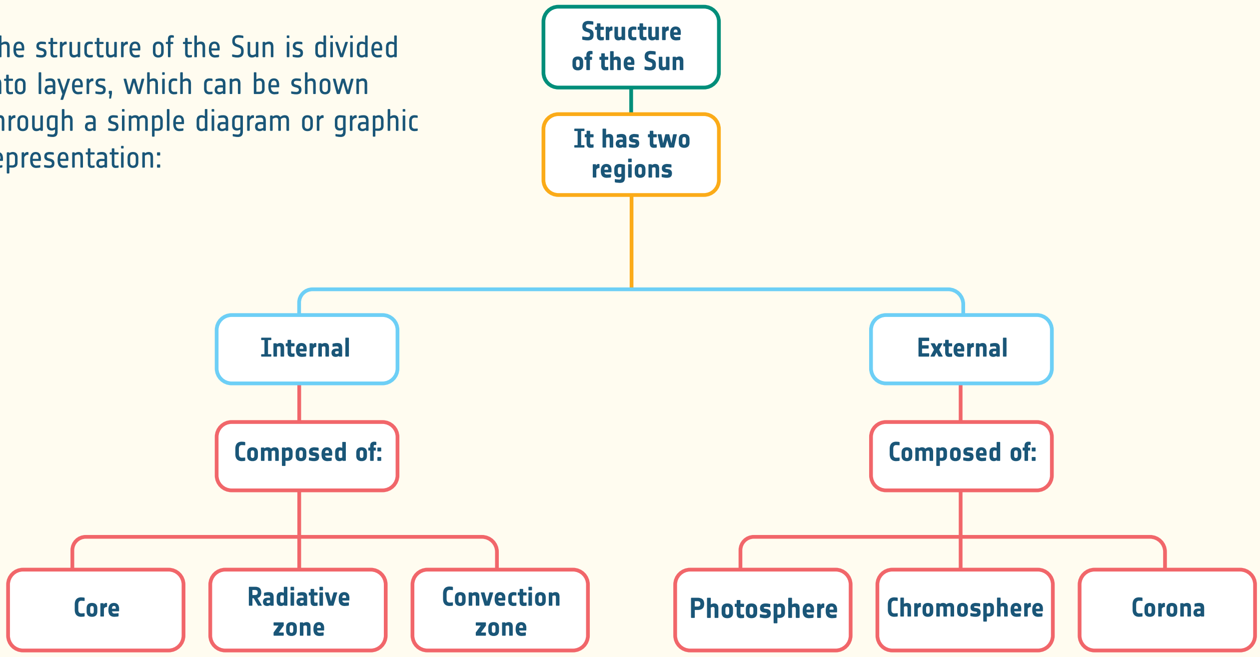
EXPERIMENT 1: Construction of 2D and 3D models of the Sun

DESCRIPTION:

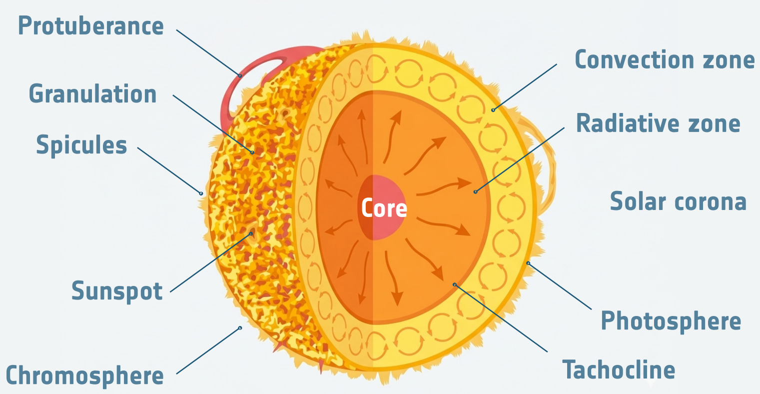
Represent the Sun in a 2D and 3D model to understand that it has internal and external layers.

NOTE 1:

The structure of the Sun is divided into layers, which can be shown through a simple diagram or graphic representation:



Example of a simple diagram of the structure of the Sun

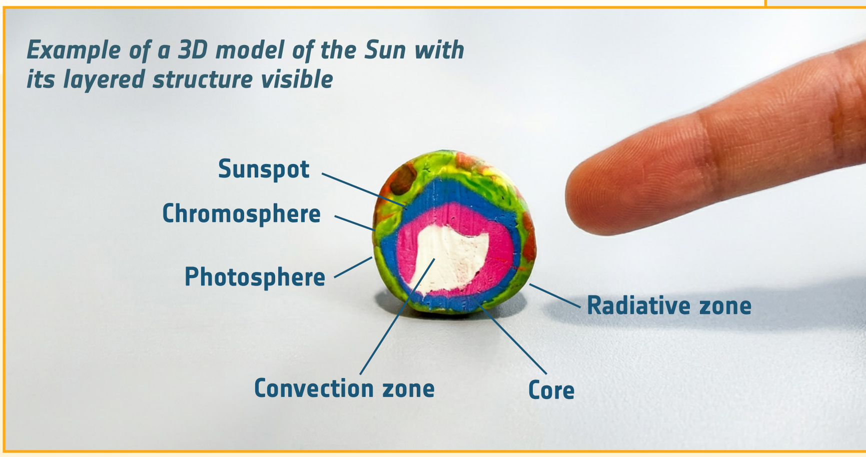


The following link allows you to explore the structure of the Sun:
https://sketchfab.com/3d-models/the-structure-of-the-sun-4de530d825d94d84b1f4c0c66ed2a012

3D model of the Sun made with coloured modelling clay

STEPS:

We use coloured modelling clay to represent the layers of the Sun in order to understand its internal and external structure. The layers of the model, from the inside out, are: the core, the radiative layer, the convection layer, the photosphere, and the chromosphere. The outermost layer, the corona, can be added later using cotton, to represent the "frayed" structure of the corona, visible only during total eclipses.



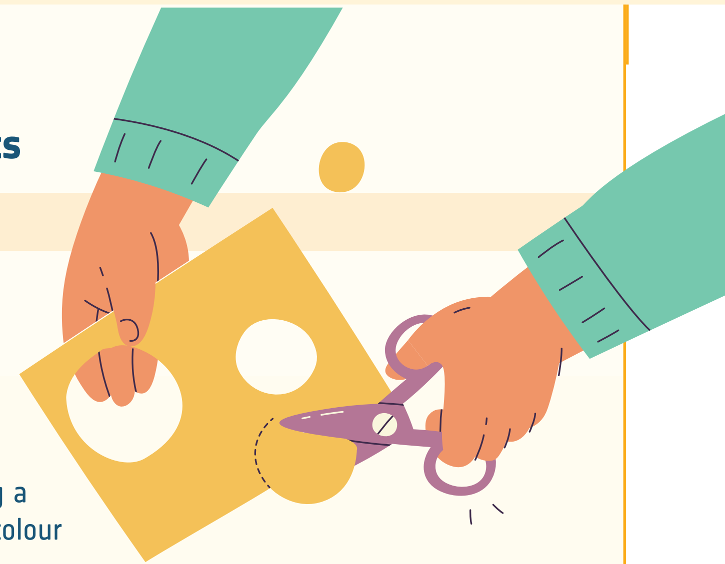
Example of a 3D model of the Sun with its layered structure visible

Credits: Carolina Escobar Quirós (Helios group) and León Jaime Restrepo Quirós

2D model of the Sun with acetate sheets

NOTE 2:

To make a model of the Sun's layers with acetate sheets, you need transparent sheets to represent the layers (Photosphere, Chromosphere, Corona, Radiative Zone, Convection Zone, Core) and coloured markers to draw the features and temperatures, stacking the acetate sheets from the outside in to show the internal structure, creating a visual effect of depth and differentiating each layer by its colour and key data.



STEPS:

1. **Define the layers:** The inner and outer layers of the Sun are represented. The main ones are (inwards):

   a. External (Atmosphere): Corona, Chromosphere, Photosphere.

   b. Internal: Convection Zone, Radiative Zone, Core.

2. **Prepare the base:** Use a piece of black card-stock to simulate space and to be able to stack the acetate sheets.

3. **Create each layer on an acetate sheet:**

   a. Acetate Sheet 1 (Outer): Corona. Draw with blue, white, and yellow markers. You can make irregular shapes that extend, simulating magnetic fields and high temperature (millions of degrees).

   b. Acetate Sheet 2: Chromosphere. Using red and orange, draw lines or shapes that simulate flames and solar protrusions (tens of thousands of degrees).

   c. Acetate Sheet 3: Photosphere. Use bright yellow and white for the visible solar disc, drawing some sunspots (thousands of degrees).

   d. Acetate Sheet 4: Convection Zone. Using orange and red tones, draw patterns of "cells" or swirls that go up and down, representing convection (like when water boils in the pan when you make pasta).

   e. Acetate Sheet 5: Radiative Zone. A more uniform tone, perhaps pale orange or very light yellow, to indicate energy transfer.

   f. Acetate Sheet 6: Core. A central circle in very intense yellow or white, representing the energy source.

4. **Assemble the model:**

   a. Place the acetate sheet of the Core on the black card.

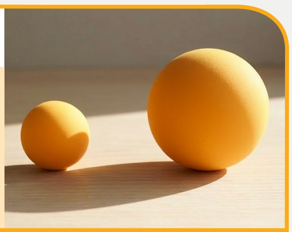
   b. Stack the remaining acetate sheets on top of each other, from the Radiative Zone to the Corona, making sure they are centred.

5. **Label the layers and identify some of their characteristics:** Small signs or labels can be added to each layer to indicate its name and temperature, using pieces of paper or directly onto the acetate sheets with coloured markers.

3.2 What are eclipses?

Experiment

1 LIGHTS AND SHADOWS. A 3D ECLIPSE



Create a 3D Sun-Earth-Moon system using everyday objects and simulate eclipses

6-12 years

"Hands-on", cooperative project

2⁺ hrs

Materials for the experiment:

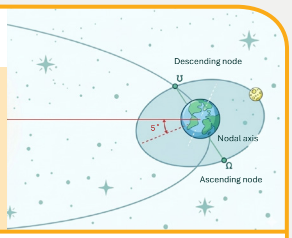
- Air-dry clay
- Sheet of paper
- Pencil
- Pair of compasses
- Protractor
- Ruler
- Styrofoam balls
- Compass
- Optional: tennis ball, orange, chickpea or refillable balls

Indoor and outdoor activity

Applicable to those with visual impairment, hearing impairment and ASD

Experiment

2A ORBITS-I - TACTILE RECONSTRUCTION



Create the orbits of the Sun-Earth-Moon system using cardboard.

6-8 years

"Hands-on" cooperative project

2⁺ hrs

Materials for the experiment:

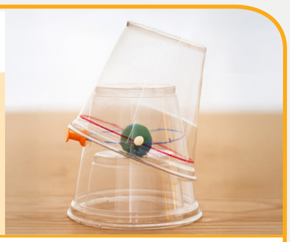
- Card-stock: black (1 unit of A3, 1 unit of A4), yellow (1 unit of A3), light blue card-stock (1 unit of A4), green (1 unit of A4), light grey (1 unit of A3)
- White pencil (or yellow crayon)
- Eraser
- Protractor

Indoor activity

Applicable to those with visual impairment, hearing impairment and ASD

Experiment

2B ORBITS-I - ADVANCED TACTILE RECONSTRUCTION



Recreate eclipses with everyday materials

8-10 years

“Hands-on”, cooperative project

1 hr

Materials for the experiment:
- Simple (blue and green plasticine or air-dry clay)
- Sellotape
- Coloured permanent markers
- Finger paints (blue and grey)
- 2-3 transparent glasses
- Cutter
- Bright torch to represent the Sun

Indoor activity

Applicable to those with visual impairment, hearing impairment and ASD

Experiment

3 ORBITS-II - SPACE CHOREOGRAPHY

Create a dance choreography to recreate the rotational and translational movements of the Sun-Earth-Moon system and dance.

6-9 years

Integration of movements with the body, rhythms and cooperative

2⁺ hrs

Materials for the experiment:
- Comfortable shoes and clothing
- Optional: music, costumes, set design or instrument to mark the rhythm (for example)

Indoor and outdoor activity

Applicable to those with visual impairment, hearing impairment and ASD

EXPERIMENT 1: LIGHTS AND SHADOWS. A 3D ECLIPSE

DESCRIPTION:

Create a Sun-Earth-Moon system with everyday elements and simulate eclipses.

NOTE:

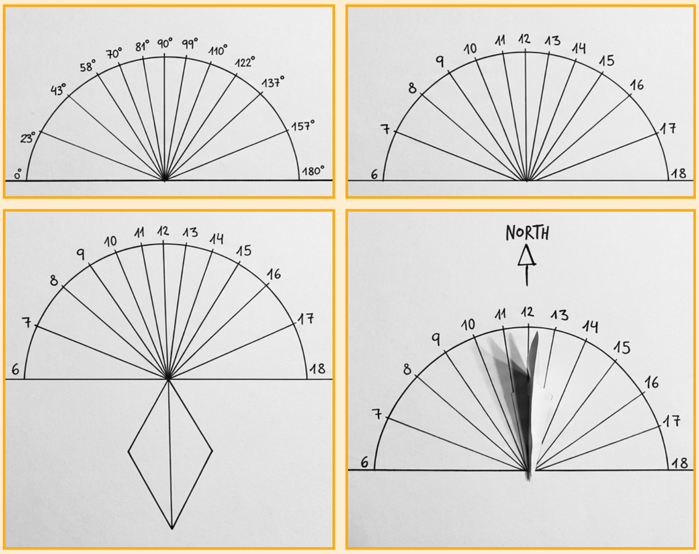
The diameter of the Earth will be four times that of the Moon and the Earth-Moon distance will be 30 times the diameter of the Earth.

Credits: CESAR

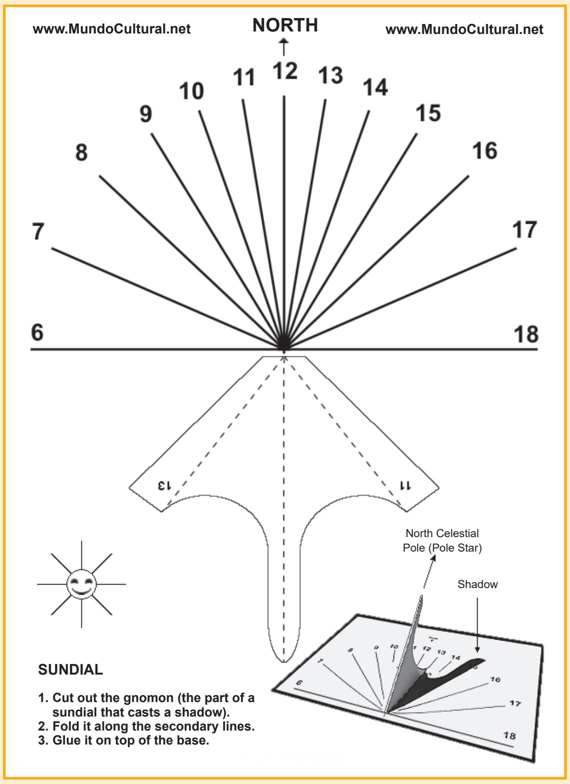
STEPS:

1. Place the object that represents Earth on the ground and hold the object that represents the Moon in your hand using natural sunlight. You will be able to see how the Moon eclipses the light of the Sun.
2. Place the object that represents the Moon on the ground and pick up the object that represents the Earth with your hand using natural sunlight. You will be able to see how the Earth eclipses the light of the Sun.

OPTIONAL: CREATE A SUNDIAL AND RECORD THE LENGTH OF THE SHADOWS



Credits: Mundo Cultural



EXPERIMENT 2A: ORBITS-I - TACTILE RECONSTRUCTION

DESCRIPTION:

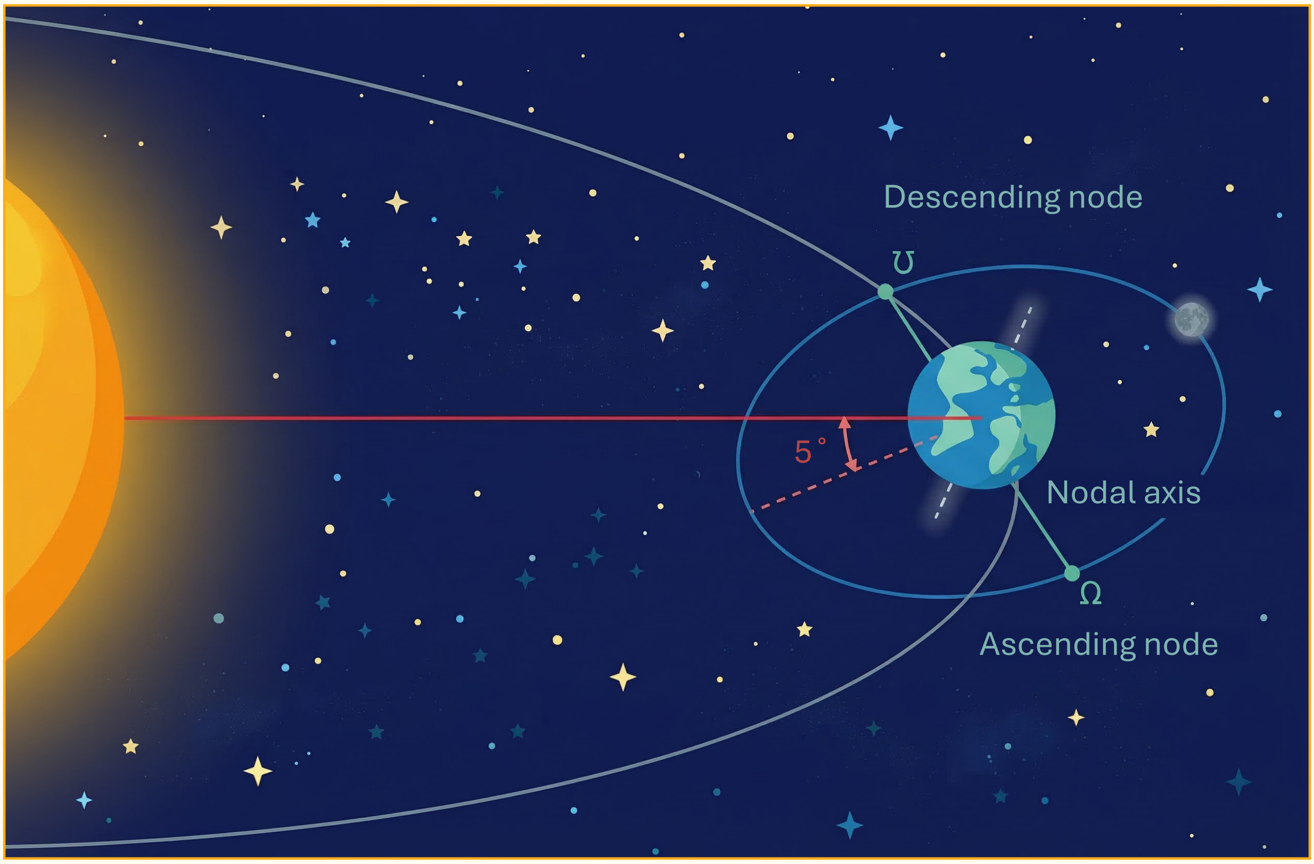
Create the Sun-Earth and Earth-Moon orbits on different cardboard sheets and integrate the system.

NOTES:

- The orbits are not circular, but slightly elliptical, with the Sun and Earth at one focus.
- The planes of both orbits form a 5-degree angle between them.
- The diameter of the Sun is 110 times greater than that of the Earth, and that of the Earth is four times greater than that of the Moon.

STEPS:

1. Use an A3 piece of cardboard to represent the Sun-Earth system.
2. Use an A4 sheet of card to represent the Earth-Moon system.
3. Watch the Paxi video: Day, Night and the Seasons: https://www.youtube.com/watch?v=TagG32gwiBo
4. Integrate both pieces of cardboard into the position of the Earth, forming an angle of 5 degrees.
5. Use the yellow, green, blue, and grey pieces of cardboard to design the Sun, Earth, and Moon.



Credits: Scribd

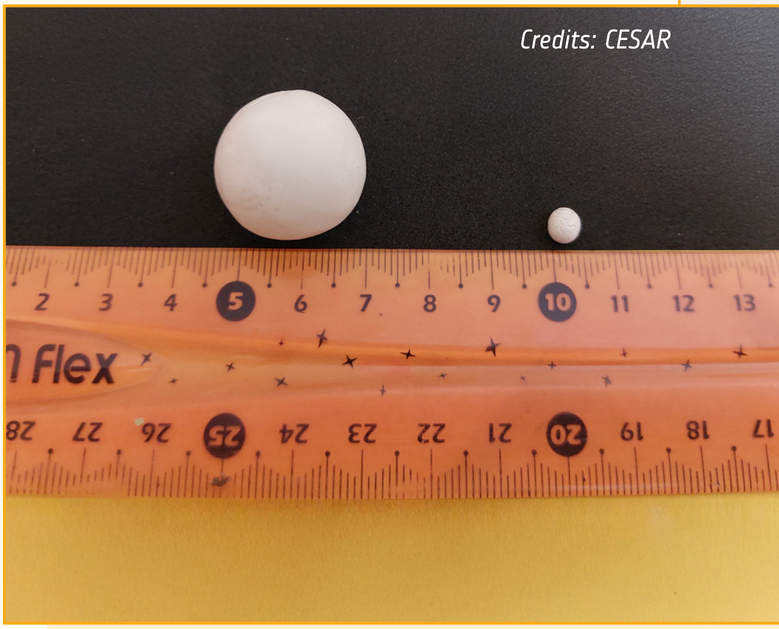
EXPERIMENT 2B: ORBITS-I - ADVANCED TACTILE RECONSTRUCTION

DESCRIPTION:

Create the Sun-Earth and Earth-Moon orbits in different transparent glasses, integrate the system and reproduce solar and lunar eclipses.

NOTES:

- The glasses should be as transparent as possible to clearly see the effect of the shadows.
- The diameter of the Earth will be four times that of the Moon.



Credits: CESAR

STEPS:

1. Take a clear glass and place it upside down on a table.
2. Place your Earth object on top of the base of the glass.
3. Take your Moon object and tape it with clear tape onto a second clear plastic cup 2.
4. Put a drawing pin on the side closest to the base of the first glass.
5. Place the second glass on top of the first glass, using the drawing pin to create an incline between the two glasses.
6. Using a powerful torch, to represent the light of the sun, illuminate the system creating a shadow
   a. on Earth by the Moon: Solar eclipse
   b. on the Moon by the Earth: Lunar Eclipse

Credits: CESAR

Activities in detail

EXPERIMENT 3: ORBITS-II - SPACE CHOREOGRAPHY

DESCRIPTION:

Create a dance choreography to recreate the rotational and translational movements of the Sun-Earth-Moon system and dance.

NOTES:

- See these links for help with preparation:
  - Video: Paxi – Day, Night and the Seasons: https://www.youtube.com/watch?v=TagG32gwiBo
  - Simulator: https://www.tutiempo.net/astronomia/sistema-solar.html
- Use hand-claps to measure time, **1 clap being the duration of 1 day.**
- Possibility of creating masks for the main characters: Moon, Sun and Earth.

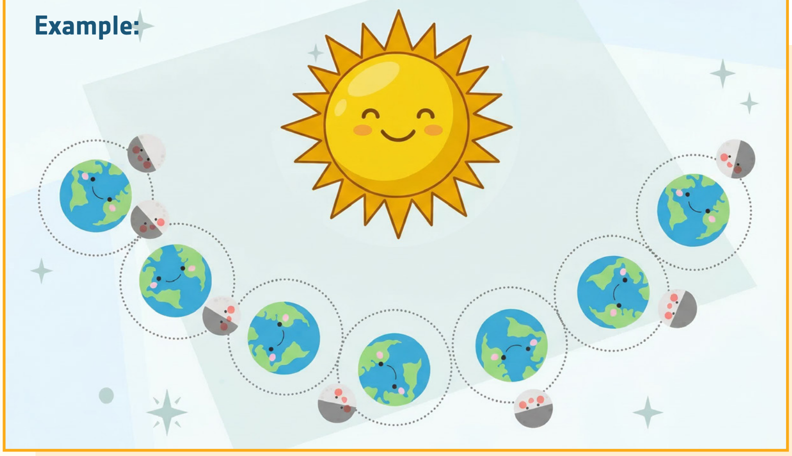
Example:

Credits: CESAR

STEPS:

1. The person playing the SUN completes a full rotation in 25 claps (we consider the rotation speed at the Sun's equator).
2. The person playing EARTH turns around once in one clap.
3. The person playing the MOON revolves around the Earth in 27 claps, always with the Earth and the Moon facing each other, face to face.
4. The person playing PHASES OF THE MOON will always be positioned between the SUN and the EARTH. This person will be moving, passing through all the phases of the Moon in 27 days.

Example:



Credits: CESAR

ADVANCED MODE:

- The Earth-Moon orbit forms an angle of 5 degrees with the Earth-Sun orbit.
- The Earth's rotation axis forms an angle of more than 20 degrees with the Earth-Sun plane.
- The diameter of the Sun is almost 110 times larger than that of the Earth.
- The diameter of the Earth is four times larger than that of the Moon.
- The average Earth-Sun distance is almost 400 times that of the Earth-Moon.
- The Earth-Sun and Moon-Earth movements are not circular, but form an ellipse with the Sun and Earth at the foci of their orbits.
- We can add the other planets of the Solar System taking into account the data in the table.

Planet	Translation	Rotation (sidereal day)	Solar day
Mercury	88 ed	58.6 ed	176 ed
Venus	225 ed	243 ed	116.75 ed
Earth	1 year	23h 56m 04s	24 hours
Mars	1.88 ey	24h 37m 22s	24h 39m 35s
Jupiter	11.86 ey	9.925 hours	9.925 hours
Saturn	29.46 ey	10.5 hours	10.5 hours
Uranus	84.01 ey	17.24 hours	17.24 hours
Neptune	164.8 ey	16.11 hours	16.11 hours

ed : Earth days
ey : Earth years

We can place the stars in the background to understand the different constellations we see throughout the year:

Credits: CESAR

3.3 Types of solar eclipses

Experiment

1 HOW MANY TYPES OF SOLAR ECLIPSES ARE THERE?

Using balls of different sizes, we will simulate different types of eclipses.

6-12 years

"Hands-on", cooperative project

50 min

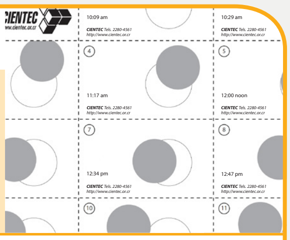
Materials for the experiment:
- Large ball (Sun), medium ball (Earth), small ball (Moon) or cardboard discs
- Powerful torch
- Measuring tape

Indoor and outdoor activity

Applicable to those with hearing impairment and ASD

Experiment

2 SCIENTIFIC FLIPBOOK OF THE ECLIPSE



Construction of an animated flipbook to visualise the sequence of phases that take place during an eclipse

6-12 years

"Hands-on", cooperative project

60 min

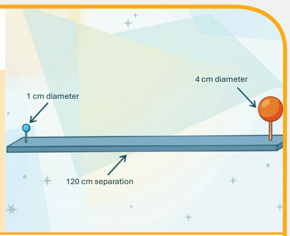
Materials for the experiment:
- Computer with internet access
- IGN Eclipse Maps (2026-2027-2028)
- Paper and pencil

Indoor activity

Applicable to those with hearing impairment and ASD

Experiment

3 CONSTRUCTION OF AN ECLIPSE SIMULATOR



A scale model with small balls is used to represent the Earth and the Moon and the distance between them to simulate solar eclipses.

6-12 years

“Hands-on”, cooperative project

50 min

Materials for the experiment:

- Wooden strip: approximately 120 cm long
- Two nails (one for each ball)
- Balls: one 4 cm in diameter (Earth) and another 1 cm (Moon)
- Equipment: for attaching the balls to the nails, such as glue or wire

Indoor and outdoor activity

Applicable to those with hearing impairment and ASD

EXPERIMENT 1: HOW MANY TYPES OF SOLAR ECLIPSES ARE THERE?

DESCRIPTION:

In this experiment, a scale model is used with balls (inflatable or not) or with discs of different materials to represent the Sun, Earth, and Moon and the distance between them.

NOTES:

Next, the passing of the Moon between Earth and Sun is simulated to show partial, total or annular solar eclipses. To represent the Sun, you can use a large ball, a disc, or also a light source that allows you to illuminate the Earth and place the model corresponding to the Moon between it and the light.

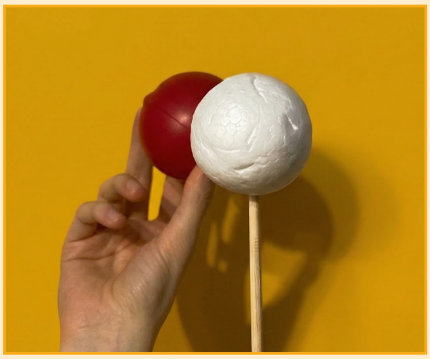
STEPS:

1. Put the white ball on the end of a stick. This will represent the Moon.
2. Place the red ball (the Sun) behind so that the white ball (the Moon) covers it.
3. Move the red ball to the right or left to show the evolution of an eclipse.
4. If the red ball is not visible when the white ball is in front, it is the total eclipse phase.
5. If part of the red ball is visible when the white ball is in front, it is a partial or annular eclipse.

Credits: Bridget Coady

Example of a total eclipse using balls to scale

Example of an annular eclipse using balls to scale



Example of a partial eclipse using balls to scale

EXPERIMENT 2: SCIENTIFIC FLIPBOOK OF THE ECLIPSE

DESCRIPTION:

Construction of an animated flipbook to visualise the sequence of phases that take place during an eclipse.

STEPS:

The sequence of a total eclipse consists of five main phases:

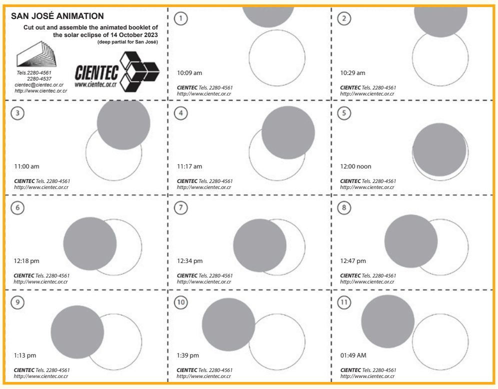
1. **First Contact (Start of partial phase)**, this phase is the beginning of the partial phase
2. **Second Contact (Start of totality)**, this phase is the beginning of totality, with the appearance of the diamond ring and the "Baily's Beads".
3. **Totality**, is the central moment, when the eclipse occurs and the solar corona and prominences are visible.
4. **Third Contact (End of totality)**, this phase is the end of totality, with the appearance of the second diamond ring.
5. **Fourth Contact (End of partial phase)**, this phase is the completion of the eclipse. The Moon leaves the Sun's disc.

The sequence of an annular eclipse also consists of five main phases:

1. **First Contact (Start of partial phase):** The Moon touches the edge of the Sun for the first time, beginning to cover it.
2. **Second Contact (Start of annularity):** Just before annularity, "Baily's Beads" (sunlight shining in the lunar valleys) are seen, and then the "ring of fire" forms.
3. **Maximum Eclipse:** The Moon is centred, forming the perfect "ring of fire", with the centre of the Sun dark and a luminous rim around it.
4. **Third Contact (End of annularity):** The Moon begins to move, and "Baily's Beads" reappear before the ring breaks and the Moon begins to move away from the solar disc.
5. **Fourth Contact (End of partiality):** The Moon separates completely from the Sun, ending the eclipse, and sunlight returns to normal, although protective glasses should still be worn.

Activities in detail

NOTE 1:



Flipbook example for an annular eclipse

Credits: cientec.or.cr

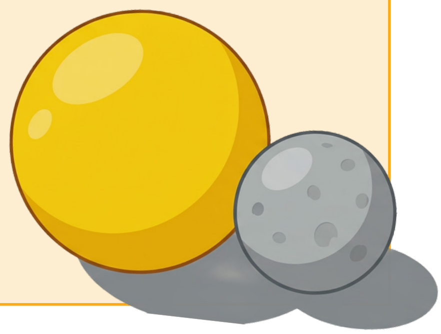
The Flipbook can include main and intermediate phases to create a smoother and more complete animation. The minimum number of drawings would be 12.

The National Geographic Institute has created an application that allows you to obtain 13 simulated images of the phases of the next solar eclipses that will take place in Spain in the coming years. It is very intuitive; simply select the province on the map to obtain the eclipse sequence as it will be seen from its corresponding capital, with the times expressed in official time. From these images, the necessary drawings can be made to create the Flipbook.

For the total solar eclipse of 12 August 2026:
https://eclipses.ign.es/eclipse-total-sol-de-12-de-agosto-2026.html

For the total solar eclipse of 2 August 2027:
https://eclipses.ign.es/eclipse-total-sol-de-2-de-agosto-2027.html

For the annular solar eclipse of 26 January 2028:
https://eclipses.ign.es/eclipse-anular-sol-de-26-de-enero-2028.html



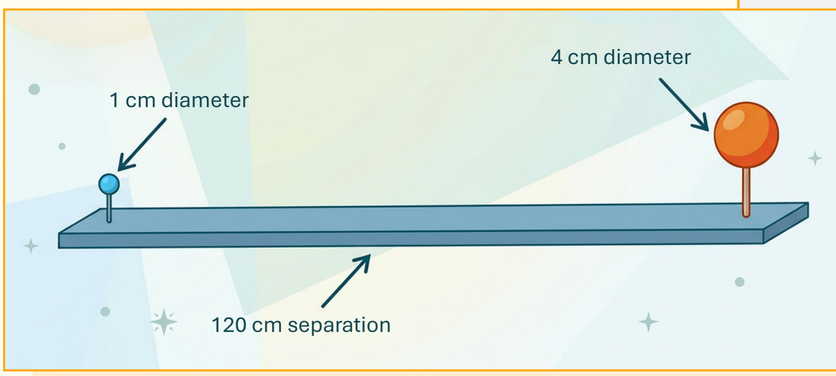
EXPERIMENT 3: CONSTRUCTION OF AN ECLIPSE SIMULATOR

DESCRIPTION:

A scale model is used with small balls to represent the Earth and the Moon and the distance between them to simulate solar eclipses.

NOTE 1:

To build your eclipse simulator, use two nails or wires spaced 120 cm apart on a wooden strip and attach a 4 cm ball (Earth) and a 1 cm ball (Moon) to each nail. To simulate a solar eclipse, align the wooden strip with the Sun and place the shadow of the Moon ball over that of the Earth. For a lunar eclipse, invert the strip so that the shadow of the Earth ball falls on the Moon ball.



Credits: CESAR

https://www.conicet.gov.ar/wp-content/uploads/SolyEclipses_cast.pdf

Activities in detail

STEPS:

1. Secure the balls:

Place the two nails in the wooden strip, 120 cm apart. Fix the 4 cm ball to one nail and the 1 cm ball to the other, respecting this distance to maintain the proportion.

2. Simulate a solar eclipse:

1. Turn the strip towards the Sun.
2. The Sun, the Moon, and the Earth must be aligned.
3. Place the shadow of the Moon ball (the 1 cm one) over the Earth ball (the 4 cm one). The shadow of the Moon is a small dark spot that is projected onto the Earth.

3. Simulate a lunar eclipse:

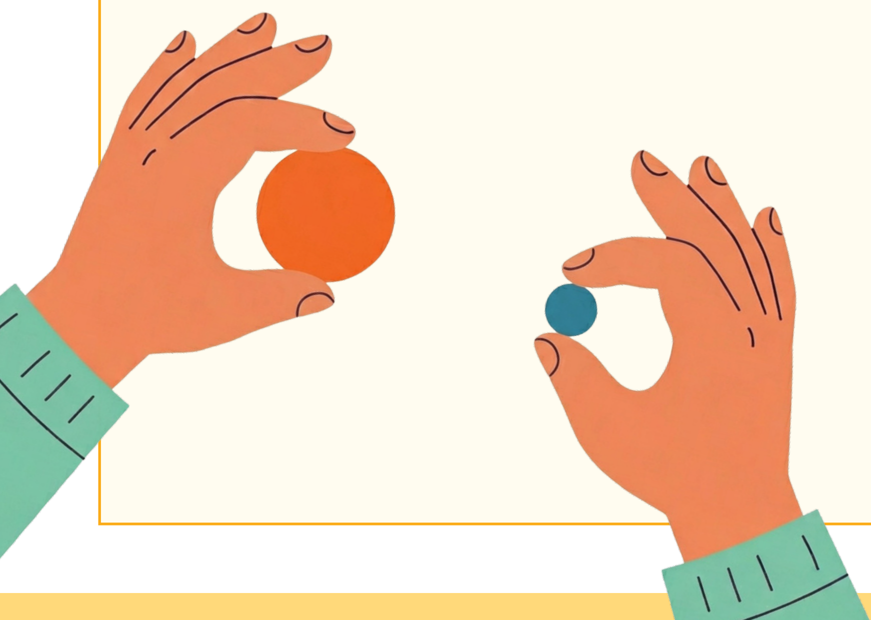
1. Turn the strip round.
2. Face the Earth towards the Sun.
3. The shadow of the Earth's ball (the 4 cm one) must fall on the Moon's ball (the 1 cm one).

NOTE 2:

Alignment: Aligning the strip with the Sun is difficult, which helps to understand why eclipses don't happen every month. This demonstrates the importance of precise alignment for an eclipse to occur.

Scale: The proportions of this model are accurate for the relative size of the distance between the Earth and the Moon. The distance between the two balls (120 cm) corresponds to the actual distance between the Earth and the Moon to scale.

Example of using the eclipse simulator – Solar eclipse



3.4 How to safely observe a solar eclipse

Experiment

1 CORRECT USE OF CERTIFIED ECLIPSE GLASSES

Learn how to use eclipse glasses correctly	6-12 years
"Hands-on", cooperative project	30 min
Materials for the experiment: Certified eclipse glasses	Outdoor activity
	Applicable to those with hearing impairment and ASD

Experiment

2 BUILDING A PINHOLE CAMERA

Building a pinhole camera with a box	6-12 years
"Hands-on", cooperative project	50 min
Materials for the experiment: - Cardboard box - White sheets of paper - Aluminium foil - Adhesive tape - Scissors - Cutter - A pin or needle	Indoor and outdoor activity
	Applicable to those with hearing impairment and ASD

EXPERIMENT 1: CORRECT USE OF CERTIFIED ECLIPSE GLASSES

DESCRIPTION:

In this experiment we will learn the correct use of **certified eclipse glasses.**

STEPS:

1. **Check your glasses:** Make sure your eclipse glasses have ISO 12312-2 safety certification and are in good condition, with no scratches or damage to the filter.
2. **Put your glasses on first:** Before looking at the Sun, put on eclipse glasses to protect your eyes from the bright light.
3. **Look at the Sun:** Now you can look directly at the Sun through the glasses. Observe in intervals of no more than 15-30 seconds, with one-minute breaks for your eyes.
4. **Remove your glasses correctly:** When you have finished observing, take off your glasses *after* looking away from the Sun.

NOTES:

What NOT to do:

- **Don't look at the sun without protection:** Never use regular sunglasses, x-rays, photo negatives, CDs, aluminium foil or home-made devices. They can give a false sense of security and cause irreversible damage.
- **Don't look through devices:** Do not look at the Sun through cameras, telescopes, or binoculars without special solar filters, as they concentrate the rays and can damage the filter and your eyes.

During totality (only in total eclipses)

- **Only during totality!**
  Only when the Moon completely covers the solar disc and it darkens, can you take off your glasses to see the solar corona. It's a very brief moment.
- **Put your glasses back on immediately:**
  As soon as the first glimmer of the Sun appears after totality, put your glasses back on.

EXPERIMENT 2: BUILDING A PINHOLE CAMERA

DESCRIPTION:

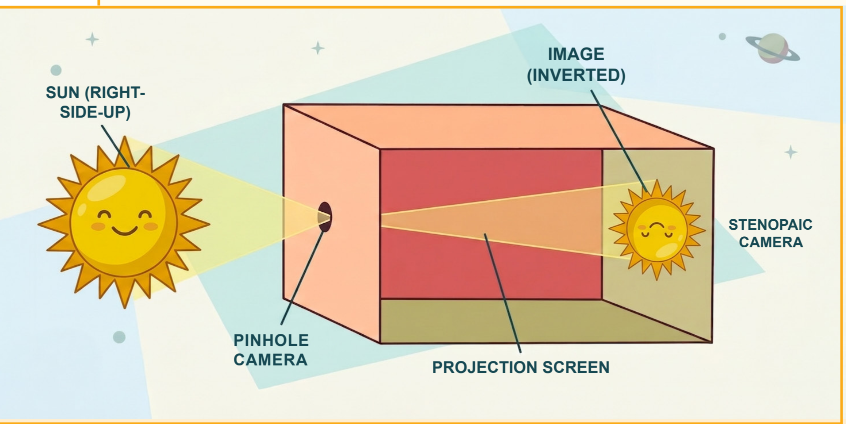
In this experiment we will learn how to build a pinhole camera using a cardboard box.

NOTES:

The pinhole camera is an instrument usually made with a box, thanks to which we can observe the effect produced when we "capture" an image that is projected inside it. The light, which enters through the small hole made in one side of the box, projects an inverted image of what is in front of the hole onto the opposite side. This invention helps us understand how a camera works.

The artist's pinhole camera was the basis for conducting experiments in the early days of photography. This is the origin of the modern camera, since the place where the inverted image is reflected is where we would place the film or negative, which is a light-sensitive material from which we will obtain the final photo. The box with the pinhole camera is sometimes referred to as a *stenopaic* camera. This pinhole camera produces an image by limiting possible light paths from luminous points on the chosen object to only one.

In our case, we can use this principle of the pinhole camera to make an indirect observation of the Sun, projecting its image inside a box and allowing for safe observation.



Representation of a pinhole camera for observing the Sun.

Activities in detail

STEPS:

1. Make a small square cut in one of the sides of the box to create the side window through which you will look.
2. Make another square cut for the place where the sunlight will enter.
3. If your box is not white, cut out a rectangle of white paper slightly smaller than the size of the side opposite the one you chose to let sunlight in, and then glue it to the inside of the box. This sheet will be the screen where you can observe the image of the Sun.
4. You must seal any gaps or openings through which sunlight could enter to make the box completely dark.
5. Finally, cover the square where sunlight will enter with a piece of aluminium foil and make a hole in it with a needle or pin.
6. If everything has gone well, look through the viewfinder window to see the image of the Sun projected in your pinhole camera.

Steps to make a pinhole camera

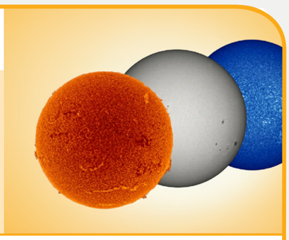
General diagram of a pinhole camera with a side viewfinder

Practical example of using a pinhole camera to observe the Sun

3.5 How we study the Sun

Experiment

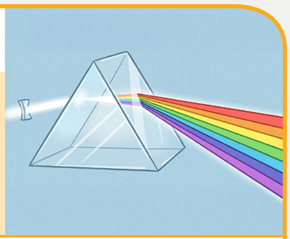
1 OBSERVING THE SUN WITH CESAR'S SOLAR TELESCOPE (HELIOS)



Building a pinhole camera with a box	6-12 years
"Hands-on", cooperative project	30 min
Materials for the experiment: Device with internet access	Indoor activity Applicable to those with hearing impairment and ASD

Experiment

2 BUILDING A HOME-MADE SPECTROGRAPH

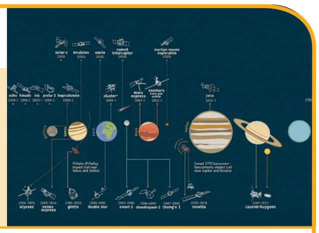


Using materials we have at home, we will build a spectrograph to learn more about what light is.	8-12 years
"Hands-on", cooperative project	45 min
Materials for the experiment: - Cardboard tube (can be from kitchen paper) - Piece of cardboard - CD or DVD - Cutter or scissors - Sellotape, adhesive tape - Light source (torch or indirect sunlight)	Indoor activity Applicable to those with hearing impairment and ASD

How we study the Sun

Experiment

3 ESA MISSIONS THAT STUDY THE SUN



You will discover ESA missions that have studied and are studying the Sun and its impact on our daily lives.

6-12 years

Digital, hands-on and cooperative project

45 min

Materials for the experiment: computer with internet access, paper and ballpoint pens

Indoor activity

Applicable to those with hearing impairment and ASD

Activities in detail

EXPERIMENT 1: OBSERVING THE SUN WITH CESAR'S SOLAR TELESCOPE (HELIOS)

DESCRIPTION:

In this experiment, you will learn to see the differences between solar images taken with different filters. Basic phenomena such as spots, prominences and different active regions on the Sun will be recognised.

STEPS:

1. We access the CESAR website:

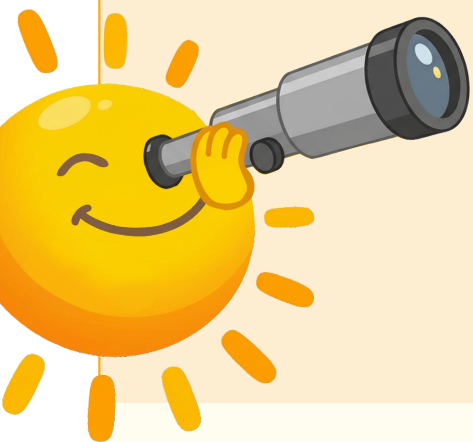
   https://cesar.esa.int/index.php?Section=Live_Sun and we find the latest images obtained with our telescope. At the bottom of the image you can see the day and time when they were taken.

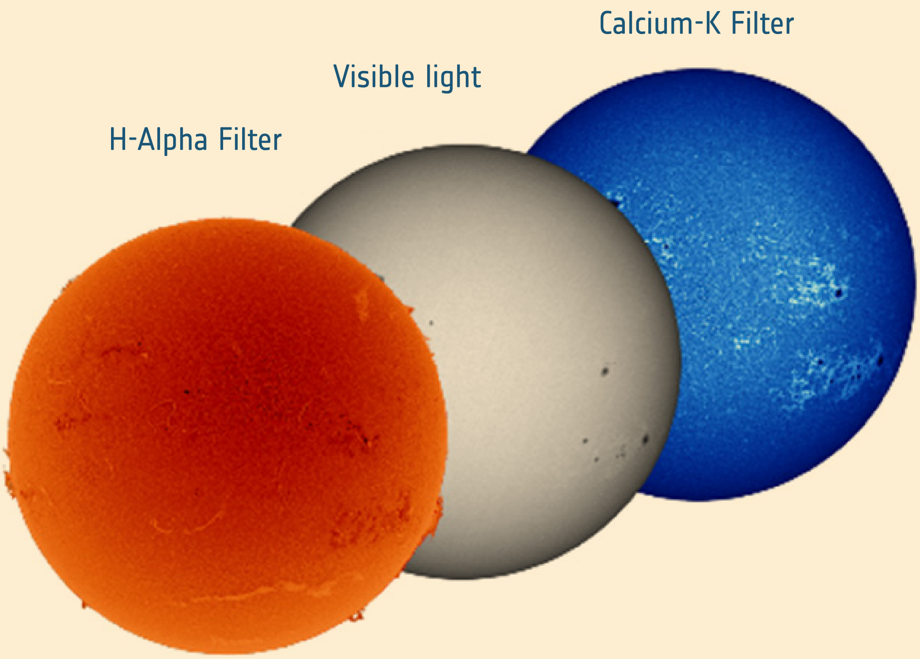
2. Two images appear; in both there is a line in the centre; this line separates the image into the visible part (right side) and the image with one of the filters (H-Alpha, Calcium-K). From the central part, you can move the line until you can see the image completely in the visible range or with the filter used.

Activities in detail

3. What can we see with each filter?

- **Visible light:** This filter simply removes most of the sunlight, so we can look at it safely. It allows us to see the “surface” of the Sun, where dark spots appear that are areas slightly cooler than the rest.
- **Red filter (called H-Alpha):** This filter only lets red light through and allows us to see a layer of the Sun where very striking things happen, such as “solar flares” at the edges.
- **Blue filter (called Calcium-K):** This filter lets blue light through and helps us see very bright areas, where the Sun is very active.





4. After observing the different images, each person draws three circles representing the Sun and in each of them reproduces what he or she has seen in each type of image.

Many images of the Sun could be taken during 2017. View the visible file and observe how sunspots change over time:

CESAR News - The Sun in 2017

Activities in detail

EXPERIMENT 2: BUILDING A HOME-MADE SPECTROGRAPH

DESCRIPTION:

In this experiment we will build a basic spectrograph, which will enable us to better understand what light is and to see that white light is made up of different colours, which we will identify, learning the colours of the visible spectrum.

STEPS:

1. We prepare the disc (DVD or CD); to do this, we must make it “transparent”, if necessary removing the sticker that indicates the contents, size, etc., so that light can pass through. This can be done with tape, pressing on the non-transparent surface and pulling to peel off the sticker.
2. Next, we prepare the tube. A diagonal semicircular slot needs to be made where the disc will later be placed, and at the same height on the opposite side, a rectangular opening.

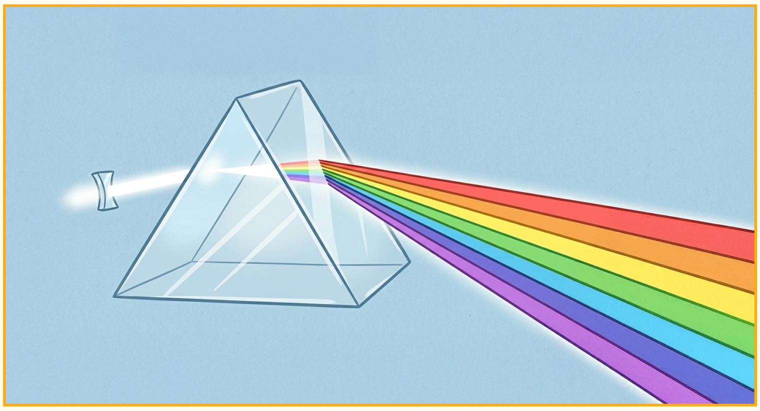
Credits: starhop.com

Activities in detail

3. We cover the end of the tube near the slots with a piece of cardboard, and the other end as well, but we make an opening through which we will look.

4. The disc is inserted into the semicircular slot, facing downwards and we look through the slot, while another person focuses the torch through the rectangular opening - or if it is sunny we can use the sunlight itself indirectly. On the disc we will see the different colours that make up white light.

Credits: starhop.com



EXPERIMENT 3: ESA MISSIONS THAT STUDY THE SUN

DESCRIPTION:

In this experiment we will learn about the ESA (European Space Agency) and some of its missions to investigate the Sun. This will help us learn more about the Sun and its impact on space weather, technology and understanding the origin of stellar activity.

Activities in detail

STEPS:

1. Learn more about ESA and its missions that study the Sun:

   The study of the Sun has been one of the lines of work at ESA since its creation.

   First it collaborated on international missions and then developed its own missions to study solar activity, the solar wind and its interaction with the environment.

   Since then, the study of the Sun has become one of ESA's strategic lines of action, especially due to its impact on space weather, technology and the understanding of the origin of stellar activity.

   You can learn more about these missions on this page:

   CESAR ESA missions related to the Sun

2. Draw a time-line showing at least 5 ESA missions that have studied the Sun
3. Choose one of these missions and make a mural showing:

   - Mission name
   - When it was launched
   - What aspect(s) of the Sun it studies
   - A drawing of the satellite

3.6 Local activities for solar eclipses in 2026, 2027 and 2028

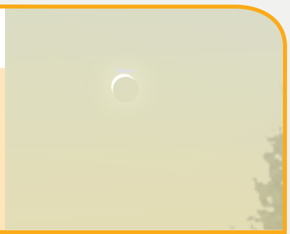
Experiment

1 THE ECLIPSES WE ARE GOING TO SEE. 2D RECONSTRUCTION AND ANIMATION.

Reconstruct the phases of an eclipse in 2D, based on IGN maps	5-10 years
"Hands-on" project	1-2 hours
Materials for the experiment: - Black card-stock (1 unit, A3) - Black EVA foam (1 unit, A3) - Orange plush (1 unit, A3) - White or yellow wax - Circular mould or glass - Glue - Scissors	Indoor activity Applicable to those with visual impairment, hearing impairment and ASD

Experiment

2 ECLIPSE HUNTERS (STELLARIUM)



Recreate the eclipse in a location	8-12 years
Digital project	1 hr
Materials for the experiment: Computer with internet access	Indoor activity Applicable to those with visual impairment, hearing impairment and ASD

Activities in detail

EXPERIMENT 1: THE ECLIPSES WE ARE GOING TO SEE. A 2D RECONSTRUCTION AND ANIMATION

DESCRIPTION:

Reconstruct the temporal phases of an eclipse in 2D using tactile materials, based on maps from the National Geographic Institute (IGN). Create an animation with them.

NOTES:

1. Access the time maps for each province which can be obtained from the **IGN website for the eclipse** https://eclipses.ign.es/
2. Select the year of the eclipse: **2026, 2027 or 2028**:
3. Access 'CONOCE TODA LA INFORMACIÓN' (get full information) and then the tab **"Desde las capitales de provincia"** (from provincial capitals)**.**
4. Select **"Comunidad Autónoma"** (Region) and **"Provincia"** (Province).

Procedure in images

Credits: IGN

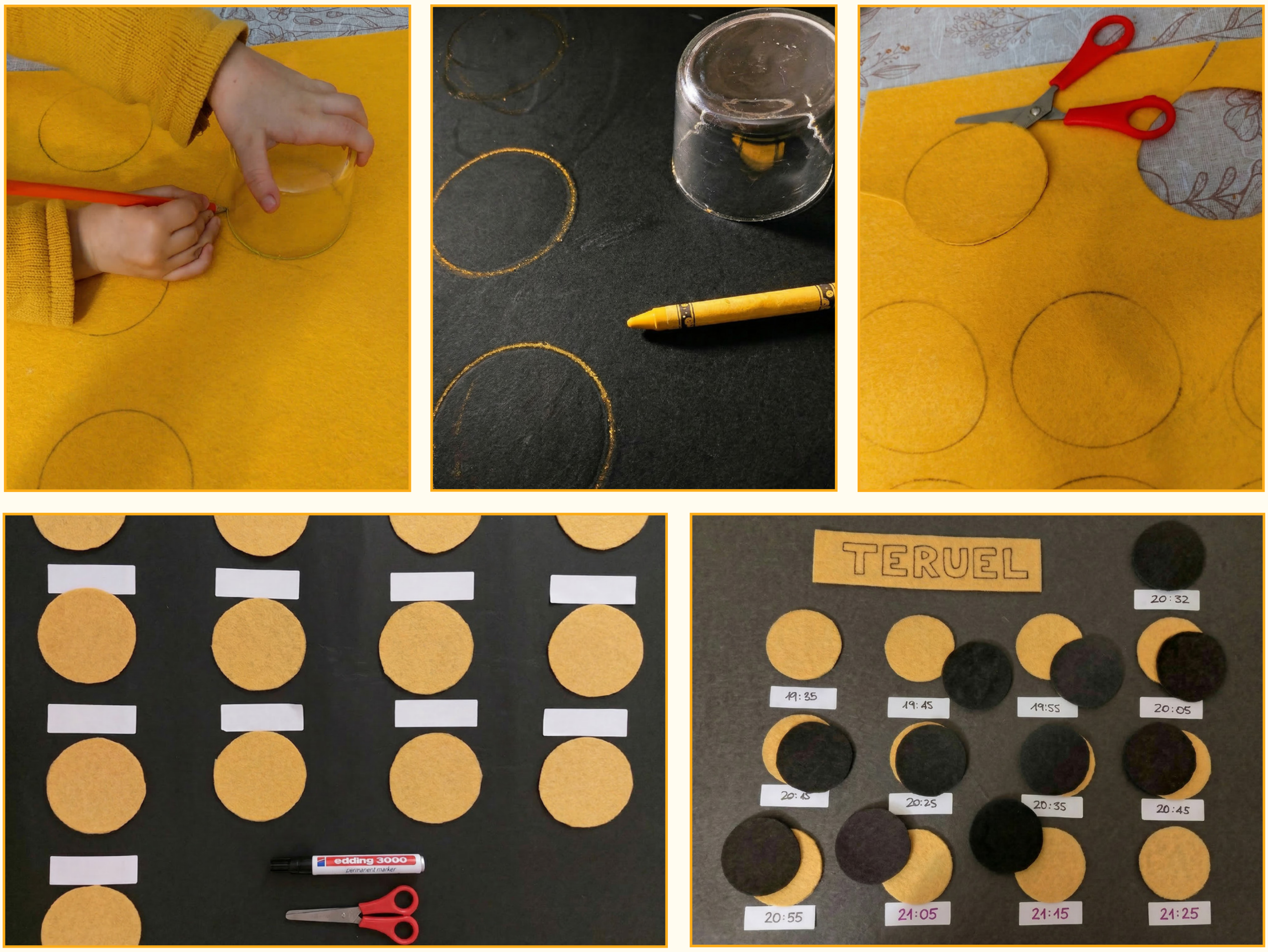
- Others: Video about the history of 2D paper animation: https://youtu.be/eXv23qVSA7k

Activities in detail

BUILD YOUR ECLIPSE TIME MAP

STEPS:

1. **Map:** Get your eclipse time map from a provincial capital.
2. **Suns:** Draw and cut out 13 identical orange felt circles that will serve as the Sun's discs at 13 different moments.
3. **Moons:** Cut out 11 identical EVA foam rubber circles that will represent the Moon's discs.
   - a. **For the eclipses of 2026 and 2027:** The Moon's discs are all the same as each other and the same as the Sun's discs.
   - b. **For the 2028 eclipse:** The Moon's discs are all the same size as each other but smaller than the Sun's discs
4. Write the times for each of the 13 phases to be represented as shown on the map (hours and minutes in black, each separated by 10 minutes). NOTE: Those phases of the eclipse where the Sun would be below the horizon from your provincial capital will be written in red.
5. Place the 13 moments or times of the eclipse phases on the A3 black card as shown on the IGN map.
6. Glue the sun discs onto the white stickers with the times using felt, as shown in the procedure in the images.
7. Glue the EVA foam Moon discs onto 11 of the sun discs. Look at the procedure in pictures and leave the first and last Sun discs free.
8. The moment has arrived to feel the composition of the eclipse: close your eyes and gently run your hand over your composition. You can also ask someone on your team to help you go through the different moments of the eclipse in an orderly fashion.



Credits: CESAR *Procedure in images*

Activities in detail

CREATE AN ANIMATION OF THE ECLIPSE

STEPS:

1. Cut another piece of black card-stock into 13 sheets to create your animation book.
2. Use the materials created in steps 2-4 on the previous sheet or recreate them.
3. If you decide to reuse the materials from the previous procedure, peel off the Sun disc with the Moon disc on top and place it in the centre of each sheet of black cardboard.
4. Make sure that the central temporal moment of the eclipse (also called maximum) is located in the middle of the black cardboard book.
5. Create the animation by flipping through the book.

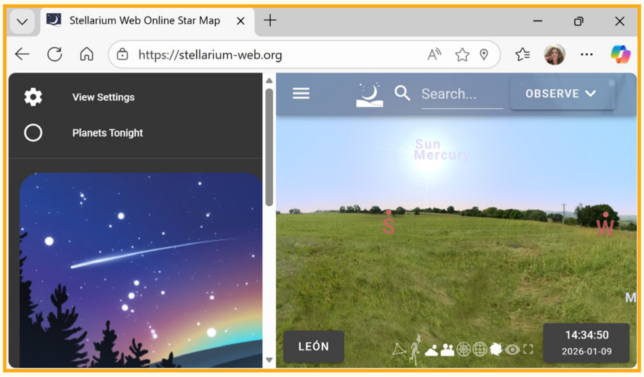
EXPERIMENT 2: ECLIPSE HUNTERS (STELLARIUM WEBSITE)

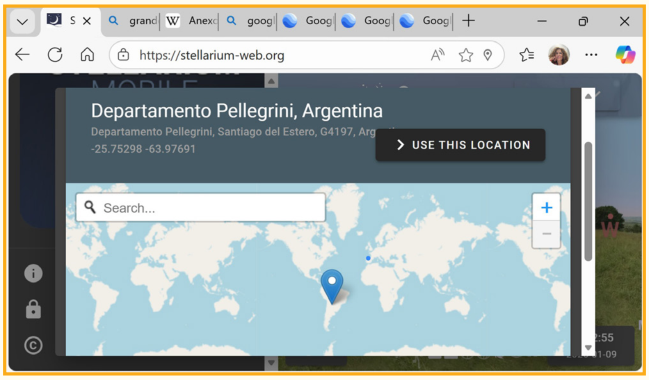
DESCRIPTION:

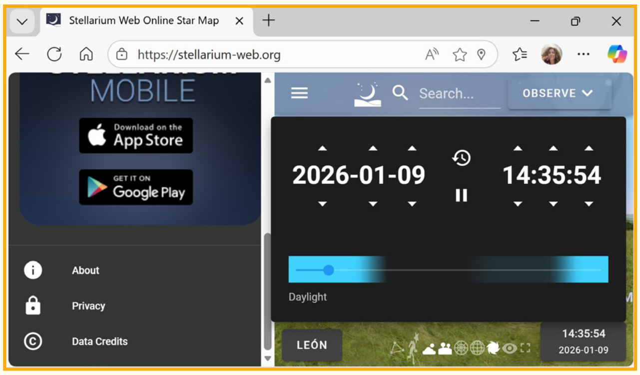
In this experiment, students will digitally reproduce the solar eclipse for a specific date and location.

NOTES:

1. Access the Stellarium website
   https://stellarium-web.org/
2. Select a **place** for observation (by map or by name)
3. Select **the date of the eclipse**, given in year-month-day hour: minutes: seconds







Credits: Stellarium

Procedure in images

Activities in detail

For the total solar eclipse of **2026.08.12:**
https://visualizadores.ign.es/eclipses/2026

For the total solar eclipse of **2027.08.02:**
https://visualizadores.ign.es/eclipses/2027

For the annular solar eclipse of **2028.01.26:**
https://visualizadores.ign.es/eclipses/2028

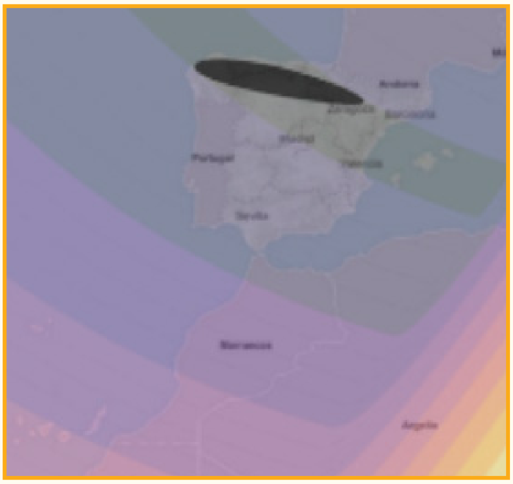
SIMULATE YOUR ECLIPSE

STEPS:

1. Choose a year (2026, 2027 or 2028) to study the solar eclipse and access the viewer for that year in the NOTES section.

2. Open the Stellarium website (see link in NOTES) and select, from the information in the IGN viewer:

- **a.** An observation site on the path of totality (e.g., León for 2026)
- **b.** The date of the solar eclipse at that location (for example, 2026-08-12 19:30 approximately)



Credits: IGN

Credits: Stellarium

- **Procedure in videos:**

  IGN's eclipse simulator video for 2026:
  https://cesar.esa.int/download.php?Id=3822&N=24627925

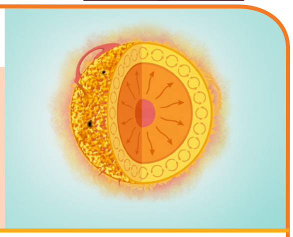
  Stellarium web video from León for the afternoon of 12 August 2026:
  https://cesar.esa.int/download.php?Id=3850&N=11017239

Recommended activities for ages 13-18

4.1 Get to know the Sun

Experiment

1 CONSTRUCTION OF 2D AND 3D MODELS OF THE SUN



Construction of 2D and 3D models of the Sun	13-18 years
"Hands-on", cooperative project	90 min
Materials for the experiment: - Coloured plasticine (3D) - Several transparent acetate sheets (2D) - Coloured permanent markers (yellow, orange, red, blue, white) (2D) - Black card-stock (for the base) (2D) - Scissors, glue and ruler (2D)	Indoor activity Applicable to those with disabilities, hearing impairment and ASD.

Activities in detail

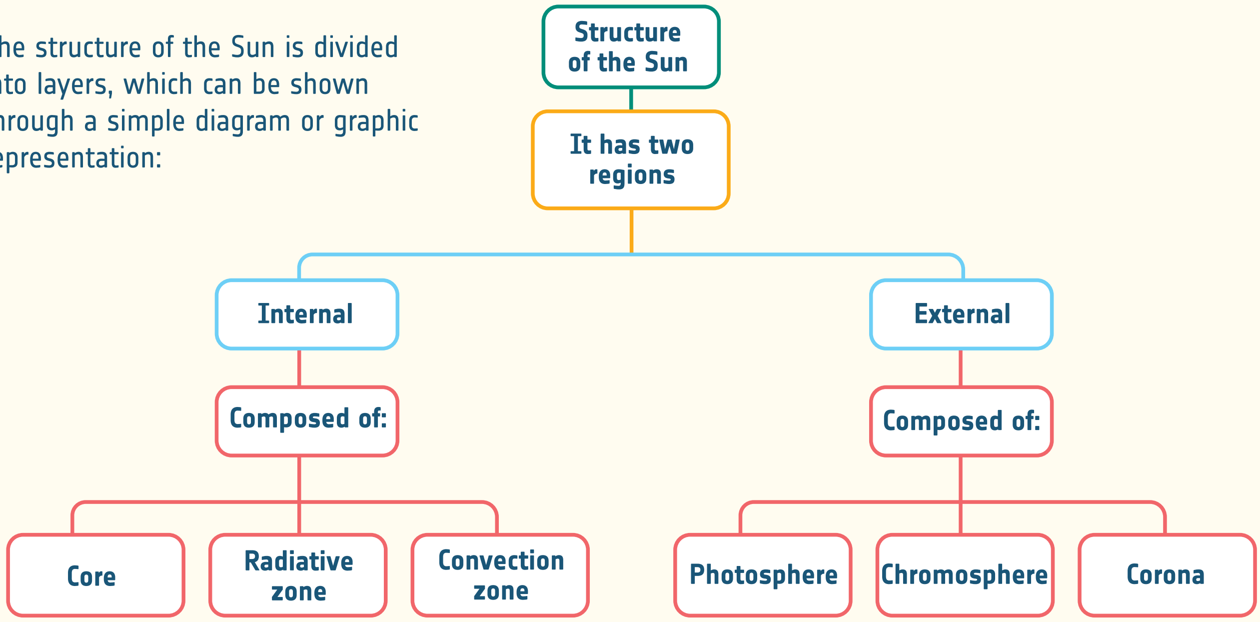
EXPERIMENT 1: Construction of 2D and 3D models of the Sun

DESCRIPTION:

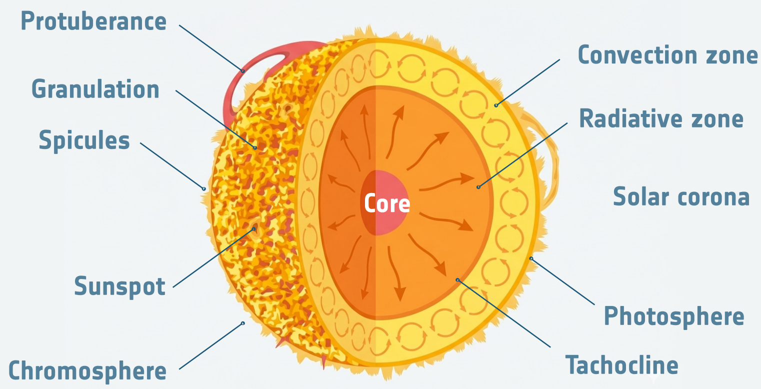
Represent the Sun in a 2D and 3D model to understand that it has internal and external layers.

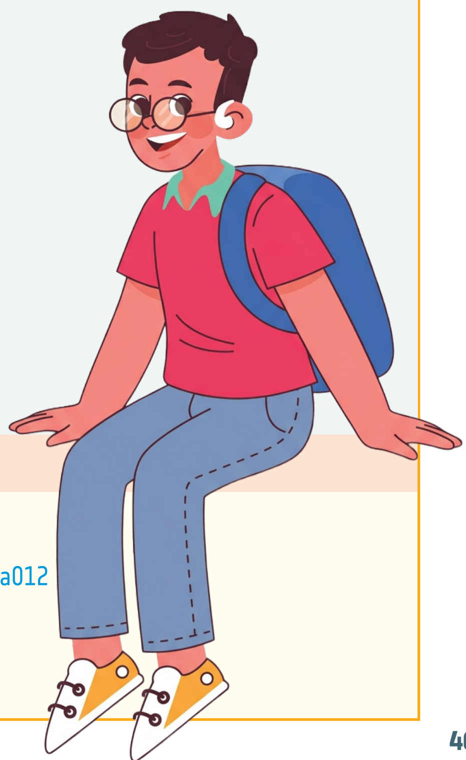
NOTE 1:

The structure of the Sun is divided into layers, which can be shown through a simple diagram or graphic representation:



Example of a simple diagram of the structure of the Sun





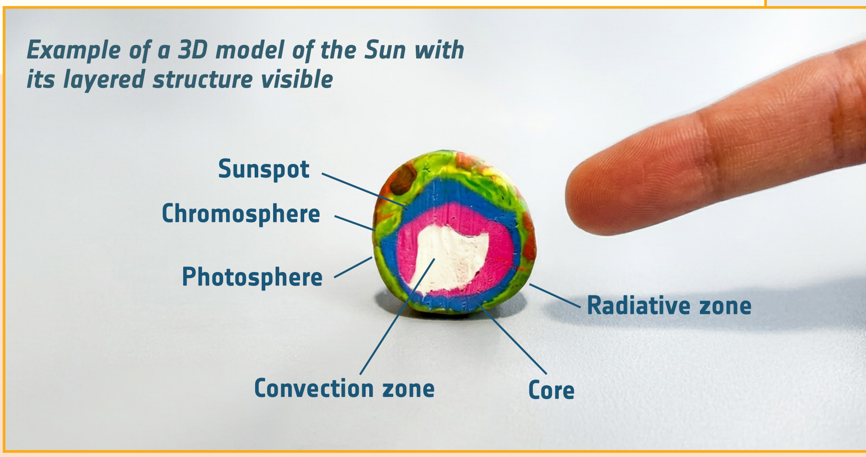
The following link allows you to explore the structure of the Sun:
https://sketchfab.com/3d-models/the-structure-of-the-sun-4de530d825d94d84b1f4c0c66ed2a012

Diagram of the Sun's layers with some of their characteristics:
https://www.esa.int/ESA_Multimedia/Images/2015/12/The_anatomy_of_our_Sun

3D model of the Sun made with coloured modelling clay

PASOS:

We use coloured modelling clay to represent the layers of the Sun in order to understand its internal and external structure. The layers of the model, from the inside out, are: the core, the radiative layer, the convection layer, the photosphere, and the chromosphere. The outermost layer, the corona, can be added later using cotton, to represent the "frayed" structure of the corona, visible only during total eclipses.



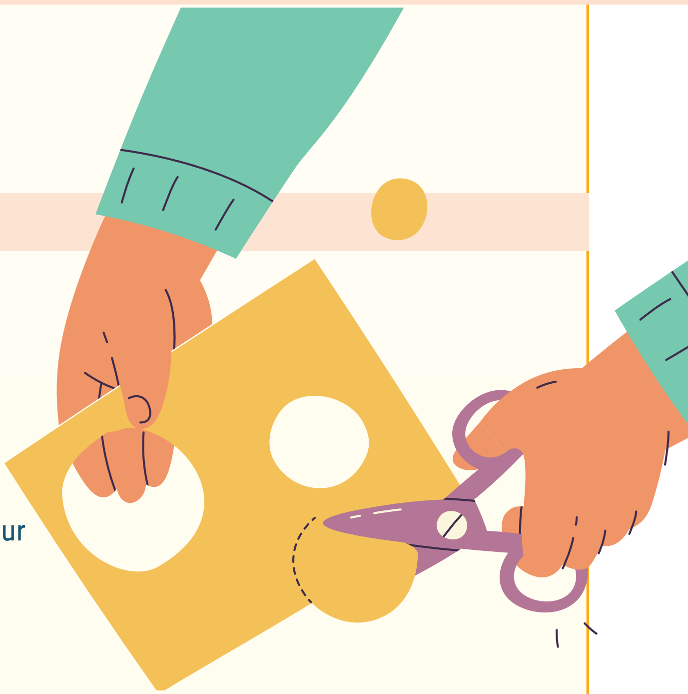
Example of a 3D model of the Sun with its layered structure visible

Credits: Carolina Escobar Quirós (Helios group) and León Jaime Restrepo Quirós

2D model of the Sun with acetate sheets

NOTE 2:

To make a model of the Sun's layers with acetate sheets, you need transparent sheets to represent the layers (Photosphere, Chromosphere, Corona, Radiative Zone, Convection Zone, Core) and coloured markers to draw the features and temperatures, stacking the acetate sheets from the outside in to show the internal structure, creating a visual effect of depth and differentiating each layer by its colour and key data.



STEPS:

1. **Define the layers:** The inner and outer layers of the Sun are represented. The main ones are (inwards):

   a. External (Atmosphere): Corona, Chromosphere, Photosphere.

   b. Internal: Convection Zone, Radiative Zone, Core.

2. **Prepare the base:** Use a piece of black card-stock to simulate space and to be able to stack the acetate sheets.

3. **Create each layer on an acetate sheet:**

   a. Acetate Sheet 1 (Outer): Corona. Draw with blue, white, and yellow markers. You can make irregular shapes that extend, simulating magnetic fields and high temperature (millions of degrees).

   b. Acetate Sheet 2: Chromosphere. Using red and orange, draw lines or shapes that simulate flames and solar protrusions (tens of thousands of degrees).

   c. Acetate Sheet 3: Photosphere. Use bright yellow and white for the visible solar disc, drawing some sunspots (thousands of degrees).

   d. Acetate Sheet 4: Convection Zone. Using orange and red tones, draw patterns of "cells" or swirls that go up and down, representing convection (like when water boils in the pan when you make pasta).

   e. Acetate Sheet 5: Radiative Zone. A more uniform tone, perhaps pale orange or very light yellow, to indicate energy transfer.

   f. Acetate Sheet 6: Core. A central circle in very intense yellow or white, representing the energy source.

4. **Assemble the model:**

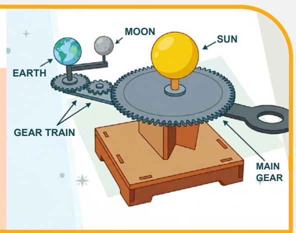
   a. Place the acetate sheet of the Core on the black card.

   b. Stack the remaining acetate sheets on top of each other, from the Radiative Zone to the Corona, making sure they are centred.

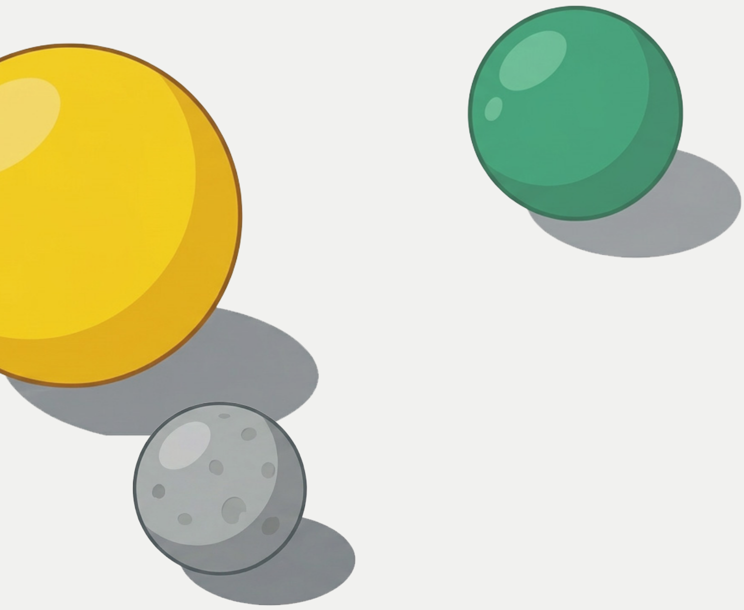
5. **Label the layers and identify some of their characteristics:** Small signs or labels can be added to each layer to indicate its name and temperature, using pieces of paper or directly onto the acetate sheets with coloured markers.

Experiment

1 ORBITS-II - BUILD YOUR OWN MODEL



Build a tellurion and explain Sun-Earth-Moon movements.	13-18 years
"Hands-on" project	1 hr
Materials for the experiment: Tellurion pieces with defined numbering and instructions	Indoor activity
	Applicable to those with visual impairment, hearing impairment and ASD



Activities in detail

EXPERIMENT 1: ORBITS II – BUILD YOUR OWN MODEL

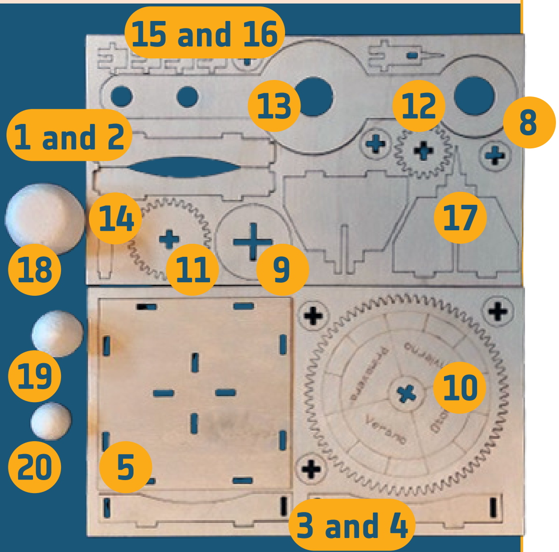
DESCRIPTION:

Build a tellurion to understand the Sun-Earth-Moon system following the instructions. The QR code presents an explanatory video about eclipses.

STEPS:

cesar
Cooperation through Education in Science and Astronomy Research

Watch this video and learn what an eclipse is

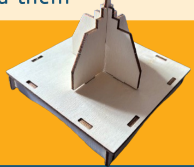


Credits: Tellurion generated by SpaceRobotics.eu

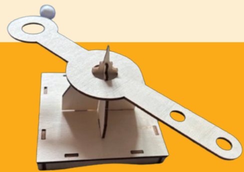
Join pieces **1, 2, 3** and **4**

Add piece **5**

Join pieces **6** and **7** and Add them



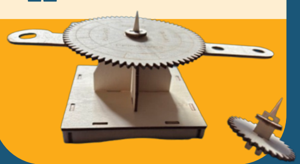
Add piece **8**



Add piece **9**

Add piece **10**

Add pieces **11** and **12**



Add piece **13**

Add piece **14**

Add pieces **15, 16** and **17**

Add pieces **18, 19** and **20**

4.3 Types of solar eclipses

Experiment

1 HOW MANY TYPES OF SOLAR ECLIPSES ARE THERE?

Using balls of different sizes, we will simulate different types of eclipses.

12-16 years

"Hands-on", cooperative project

50 min

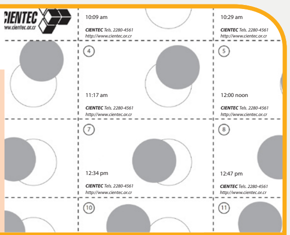
Materials for the experiment:
- Large ball (Sun), medium ball (Earth), small ball (Moon) or cardboard discs
- Powerful torch
- Measuring tape

Indoor and outdoor activity

Applicable to those with hearing impairment and ASD

Experiment

2 SCIENTIFIC FLIPBOOK OF THE ECLIPSE



Construction of an animated flipbook to visualise the sequence of phases that take place during an eclipse

12-16 years

"Hands-on", cooperative project

60 min

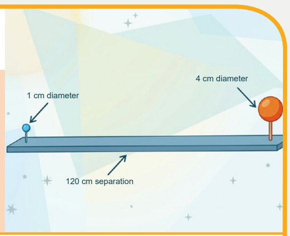
Materials for the experiment:
- Computer with internet access
- IGN Eclipse Maps (2026-2027-2028)
- Paper and pencil

Indoor activity

Applicable to those with hearing impairment and ASD

Experiment

3 CONSTRUCTION OF AN ECLIPSE SIMULATOR



A scale model with small balls is used to represent the Earth and the Moon and the distance between them to simulate solar eclipses.

13-18 years

“Hands-on”, cooperative project

50 min

Materials for the experiment:

- Wooden strip: approximately 120 cm long
- Two nails (one for each ball)
- Balls: one 4 cm in diameter (Earth) and another 1 cm (Moon)
- Equipment: for attaching the balls to the nails, such as glue or wire

Indoor and outdoor activity

Applicable to those with hearing impairment and ASD

Activities in detail

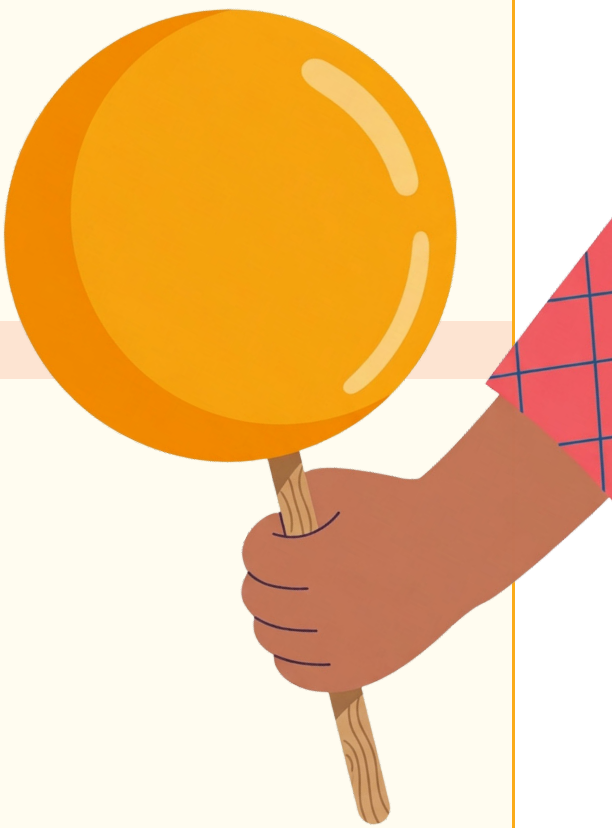
EXPERIMENT 1: HOW MANY TYPES OF SOLAR ECLIPSES ARE THERE?

DESCRIPTION:

In this experiment, a scale model is used with balls (inflatable or not) or with discs of different materials to represent the Sun, Earth, and Moon and the distance between them.

NOTES:

Next, the passing of the Moon between Earth and Sun is simulated to show partial, total or annular solar eclipses. To represent the Sun, you can use a large ball, a disc, or also a light source that allows you to illuminate the Earth and place the model corresponding to the Moon between it and the light.



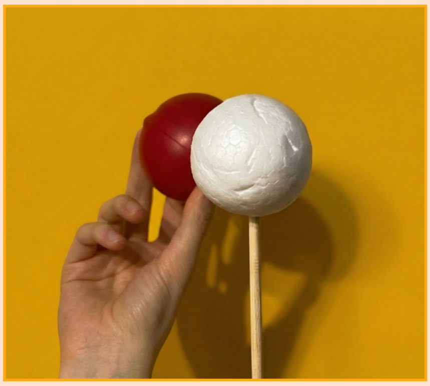
STEPS:

- Relative scale representation.
- Experimental identification of umbra, penumbra and antumbra.
- Discussion of the limitations of the model.

Credits: Bridget Coady

Example of a total eclipse using balls to scale

Example of an annular eclipse using balls to scale



Example of a partial eclipse using balls to scale

Activities in detail

EXPERIMENT 2: SCIENTIFIC FLIPBOOK OF THE ECLIPSE

DESCRIPTION:

Construction of an animated flipbook to visualise the sequence of phases that take place during an eclipse.

STEPS:

The sequence of a total eclipse consists of five main phases:

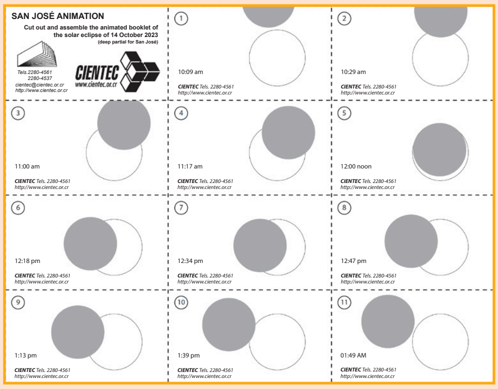
1. **First Contact (Start of partial phase)**, this phase is the beginning of the partial phase
2. **Second Contact (Start of Totality)**, this phase is the beginning of totality, with the appearance of the ring of diamonds and "Baily's Beads."
3. **Totality**, is the central moment, when the eclipse occurs and the solar corona and prominences are visible.
4. **Third Contact (End of Totality)**, this phase is the end of totality, with the appearance of the second diamond ring.
5. **Fourth Contact (End of partial phase)**, this phase is the completion of the eclipse. The Moon leaves the Sun's disc.

The sequence of an annular eclipse also consists of five main phases:

1. **First Contact (Start of partial phase):** The Moon touches the edge of the Sun for the first time, beginning to cover it.
2. **Second Contact (Start of annularity):** Just before the annularity, "Baily's Beads" (sunlight shining in the lunar valleys) are seen, and then the "ring of fire" is formed.
3. **Maximum Eclipse:** The Moon is centred, forming the perfect "ring of fire", with the centre of the Sun dark and a luminous rim around it.
4. **Third Contact (End of annularity):** The Moon begins to move, and "Baily's Beads" reappear before the ring breaks and the Moon begins to move away from the solar disc.
5. **Fourth Contact (End of partiality):** The Moon separates completely from the Sun, ending the eclipse, and sunlight returns to normal, although protective glasses should still be worn.

Activities in detail

NOTES:



Flipbook example for an annular eclipse

Credits: cientec.or.cr

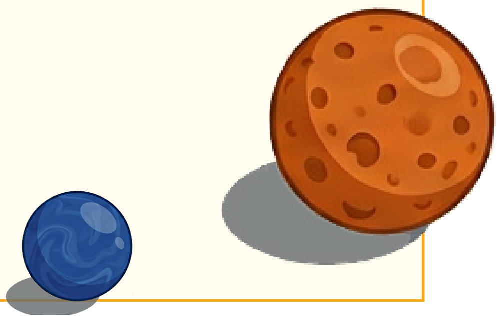
The Flipbook can include main and intermediate phases to create a smoother and more complete animation. The minimum number of drawings would be 12.

The National Geographic Institute has created an application that allows you to obtain 13 simulated images of the phases of the next solar eclipses that will take place in Spain in the coming years. It is very intuitive; simply select the province on the map to obtain the eclipse sequence as it will be seen from its corresponding capital, with the times expressed in official time. From these images, the necessary drawings can be made to create the Flipbook.

For the total solar eclipse of 12 August 2026:
https://eclipses.ign.es/eclipse-total-sol-de-12-de-agosto-2026.html

For the total solar eclipse of 2 August 2027:
https://eclipses.ign.es/eclipse-total-sol-de-2-de-agosto-2027.html

For the annular solar eclipse of 26 January 2028:
https://eclipses.ign.es/eclipse-anular-sol-de-26-de-enero-2028.html



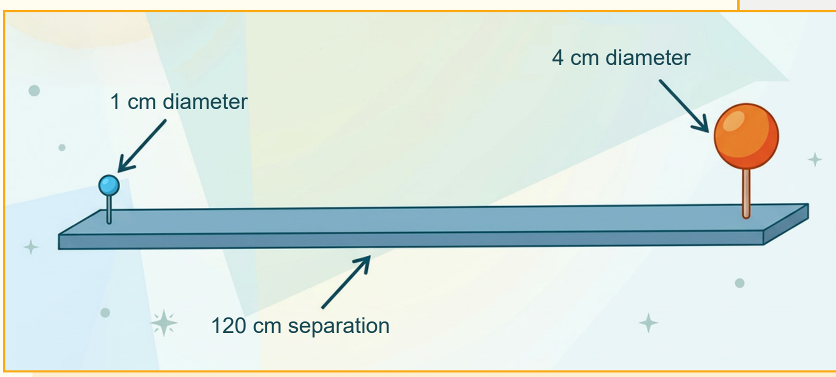
EXPERIMENT 3: CONSTRUCTION OF AN ECLIPSE SIMULATOR

DESCRIPTION:

A scale model is used with small balls to represent the Earth and the Moon and the distance between them to simulate solar eclipses.

NOTE 1:

To build your eclipse simulator, use two nails or wires spaced 120 cm apart on a wooden strip and attach a 4 cm ball (Earth) and a 1 cm ball (Moon) to each nail. To simulate a solar eclipse, align the wooden strip with the Sun and place the shadow of the Moon ball over that of the Earth. For a lunar eclipse, invert the strip so that the shadow of the Earth ball falls on the Moon ball.



Credits: CESAR

https://www.conicet.gov.ar/wp-content/uploads/SolyEclipses_cast.pdf

Activities in detail

STEPS:

1. Secure the balls:

Place the two nails in the wooden strip, 120 cm apart. Fix the 4 cm ball to one nail and the 1 cm ball to the other, respecting this distance to maintain the proportion.

2. Simulate a solar eclipse:

1. Turn the strip towards the Sun.
2. The Sun, the Moon, and the Earth must be aligned.
3. Place the shadow of the Moon ball (the 1 cm one) over the Earth ball (the 4 cm one). The shadow of the Moon is a small dark spot that is projected onto the Earth.

3. Simulate a lunar eclipse:

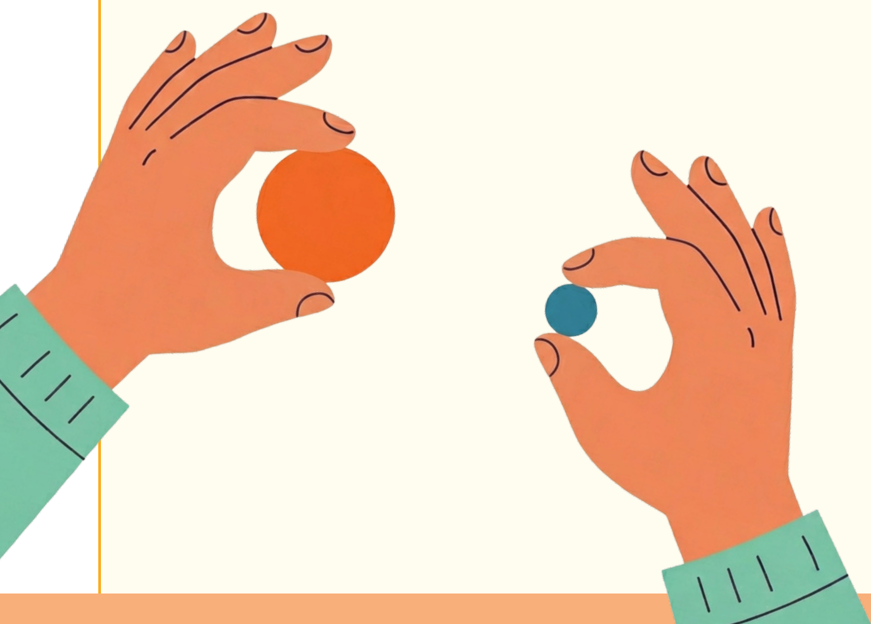
1. Turn the strip round.
2. Face the Earth towards the Sun.
3. The shadow of the Earth's ball (the 4 cm one) must fall on the Moon's ball (the 1 cm one).

NOTE 2:

Alignment: Aligning the strip with the Sun is difficult, which helps to understand why eclipses don't happen every month. This demonstrates the importance of precise alignment for an eclipse to occur.

Scale: The proportions of this model are accurate for the relative distance between the Earth and the Moon. The distance between the two balls (120 cm) corresponds to the actual distance between the Earth and the Moon to scale.

Example of using the eclipse simulator – Solar eclipse



4.4 How to safely observe a solar eclipse

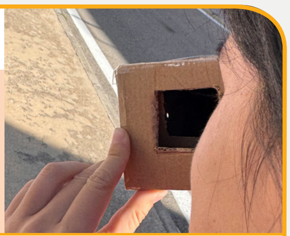
Experiment

1 CORRECT USE OF CERTIFIED ECLIPSE GLASSES

Learn how to use eclipse glasses correctly	13-18 years
"Hands-on", coopera-tive project	30 min
Materials for the experiment: Certified eclipse glasses	Outdoor activity
	Applicable to those with hearing impairment and ASD

Experiment

2 BUILDING A PINHOLE CAMERA



Building a pinhole camera with a box	13-18 years
"Hands-on", coopera-tive project	50 min
Materials for the experiment: - Cardboard box - White sheets of paper - Aluminium foil - Adhesive tape - Scissors - Cutter - A pin or needle	Indoor and outdoor activity
	Applicable to those with hearing impairment and ASD

EXPERIMENT 1: CORRECT USE OF CERTIFIED ECLIPSE GLASSES

DESCRIPTION:

In this experiment we will learn the correct use of **certified eclipse glasses.**

STEPS:

1. **Check your glasses:** Make sure your eclipse glasses have ISO 12312-2 safety certification and are in good condition, with no scratches or damage to the filter.
2. **Put your glasses on first:** Before looking at the Sun, put on eclipse glasses to protect your eyes from the bright light.
3. **Look at the Sun:** Now you can look directly at the Sun through the glasses. Observe in intervals of no more than 15-30 seconds, with one-minute breaks for your eyes.
4. **Remove your glasses correctly:** When you have finished observing, take off your glasses *after* looking away from the Sun.

NOTES:

What NOT to do:

- **Don't look at the sun without protection:** Never use regular sunglasses, x-rays, photo negatives, CDs, aluminium foil or home-made devices. They can give a false sense of security and cause irreversible damage.
- **Don't look through devices:** Do not look at the Sun through cameras, telescopes, or binoculars without special solar filters, as they concentrate the rays and can damage the filter and your eyes.

During totality (only in total eclipses)

- **Only during totality!** Only when the Moon completely covers the solar disc and it darkens, can you take off your glasses to see the solar corona. It's a very brief moment.
- **Put your glasses back on immediately:** As soon as the first glimmer of the Sun appears after totality, put your glasses back on.

EXPERIMENT 2: BUILDING A PINHOLE CAMERA

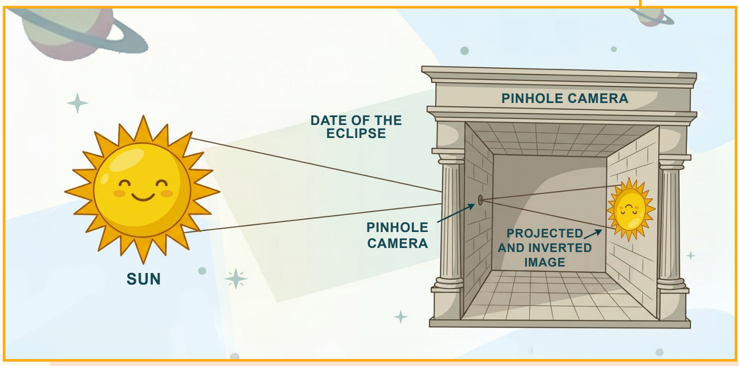
DESCRIPTION:

In this experiment we will learn how to build a pinhole camera using a cardboard box.

NOTES:

What is a Pinhole camera?

The pinhole camera is an instrument usually made with a box, thanks to which we can observe the effect produced when we "capture" an image that is projected inside it. The light, which enters through the small hole made in one side of the box, projects an inverted image of what is in front of the hole onto the opposite side. This invention helps us understand how a camera works.

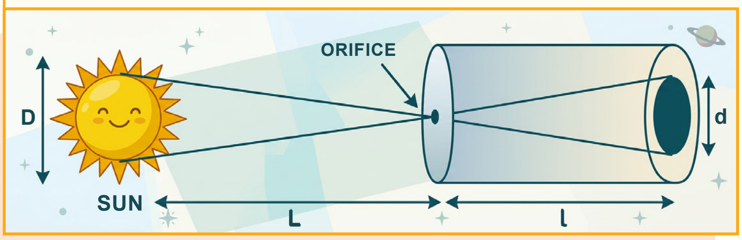


Representation of a pinhole camera for observing the Sun.

The artist's pinhole camera was the basis for conducting experiments in the early days of photography. This is the origin of the modern camera, since the place where the inverted image is reflected is where we would place the film or negative, which is a light-sensitive material from which we will obtain the final photo. The box with the pinhole camera is sometimes referred to as a *stenopaic* camera. This pinhole camera produces an image by limiting possible light paths from luminous points on the chosen object to only one.

In our case, we can use this principle of the pinhole camera to make an indirect observation of the Sun, projecting its image inside a box and allowing for safe observation.

From the diagram above we can infer the value of the solar diameter, D, using similar triangles and knowing the length of the box, l, the diameter of the image of the Sun on the screen, d; and the distance from the Earth to the Sun, L.



$$\frac{\text{Diameter of the Sun (D)}}{\text{Distance from the Earth to the Sun (L)}} = \frac{\text{Image diameter (d)}}{\text{Distance from the image to the hole (l)}} \qquad \frac{D}{L} = \frac{d}{l} \rightarrow D = L \times \frac{d}{l}$$

Activities in detail

STEPS:

1. Make a small square cut in one of the sides of the box to create the side window through which you will look.
2. Make another square cut for the place where the sunlight will enter.
3. If your box is not white, cut out a rectangle of white paper slightly smaller than the size of the side opposite the one you chose to let sunlight in, and then glue it to the inside of the box. This sheet will be the screen where you can observe the image of the Sun.
4. You must seal any gaps or openings through which sunlight could enter to make the box completely dark.
5. Finally, cover the square where sunlight will enter with a piece of aluminium foil and make a hole in it with a needle or pin.
6. If everything has gone well, look through the viewfinder window to see the image of the Sun projected in your pinhole camera

Credits: CESAR

Steps to make a pinhole camera

General diagram of a pinhole camera with a side viewfinder

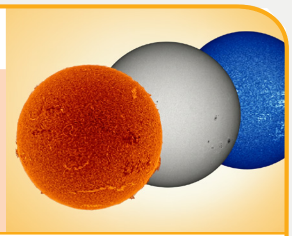
Credits: CESAR

Practical example of using a pinhole camera to observe the Sun

4.5 How we study the Sun

Experiment

1 OBSERVING THE SUN WITH CESAR'S SOLAR TELESCOPE (HELIOS)



Activities about the Sun based on images of the Sun taken with our telescope, accessible on the CESAR website

13-18 years

"Hands-on", coopera-tive project

30 min

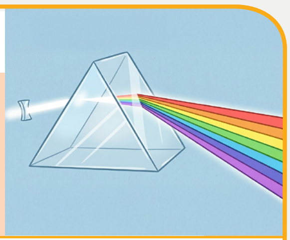
Materials for the experiment:
Device with internet access

Indoor activity

Applicable to those with hearing impairment and ASD

Experiment

2 BUILDING A HOME-MADE SPECTROGRAPH



Using materials we have at home, we will build a spectrograph to learn more about what light is.

13-18 years

"Hands-on", coopera-tive project

45 min

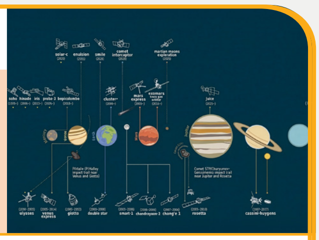
Materials for the experiment:
- Cardboard box or crisp tube
- CD or DVD
- Cutter
- Ruler
- Scissors
- Black paper or dark card-stock
- Black adhesive tape

Indoor activity

Applicable to those with hearing impairment and ASD

Experiment

3 ESA MISSIONS THAT STUDY THE SUN



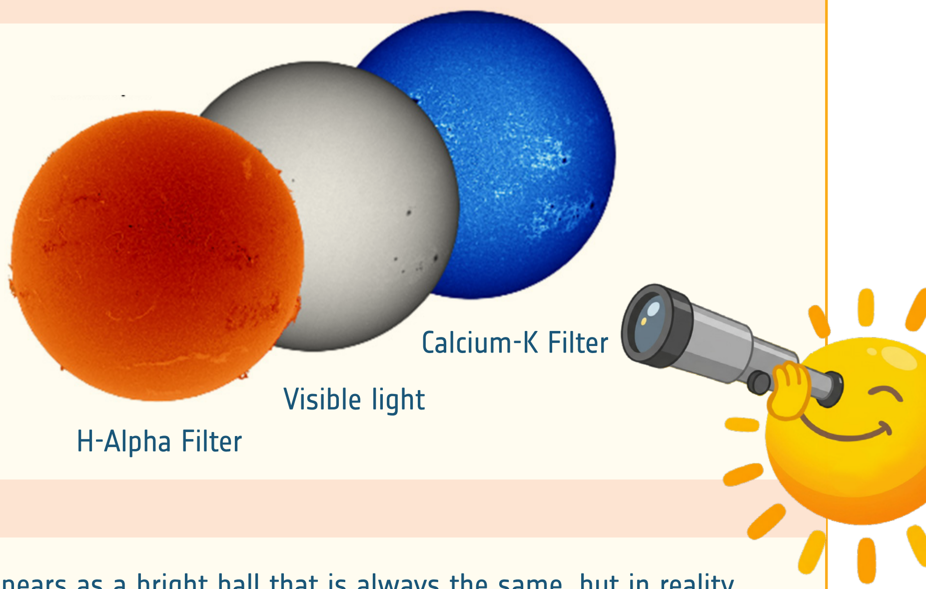
You will discover ESA missions that have studied and are studying the Sun and its impact on our daily lives.	13-18 years
Digital, hands-on and cooperative project	60 min
Materials for the experiment: - Computer with internet access - Printer - Paper - Scissors - Glue	Indoor activity Applicable to those with hearing impairment and ASD

Activities in detail

EXPERIMENT 1: OBSERVING THE SUN WITH CESAR'S SOLAR TELESCOPE (HELIOS)

DESCRIPTION:

In this experiment, you will gain a better understanding of the Sun's internal and atmospheric structure, and you will learn to see the differences between solar images taken with different filters. Basic phenomena such as sunspots, prominences and different active regions on the Sun will be recognised.



NOTES:

When we look at the Sun from Earth, it appears as a bright ball that is always the same, but in reality it is constantly changing. Direct solar observation is extremely dangerous; therefore, the study of the Sun is carried out using solar telescopes equipped with specific filters, which isolate certain wavelengths of the electromagnetic spectrum, allowing the observation of different layers (Photosphere, Chromosphere, Corona, etc.) and solar phenomena.

Comparing images obtained with different filters is a key tool in solar astrophysics for understanding the dynamics and evolution of the Sun.

STEPS:

1. We access the CESAR website:
   https://cesar.esa.int/index.php?Section=Live_Sun

   and we find the latest images obtained with our telescope.
   At the bottom of the image we see the day and time when it was taken.
2. Two images appear; in both there is a line in the centre; this line separates the image into the visible part (right side) and the image with one of the filters (H-Alpha, Calcium-K). From the central part, you can move the line until you can see the image completely in the visible range or with the filter used.
3. What can we see with each filter?
   - **Visible light:** It allows us to observe sunspots, regions of lower temperature associated with intense magnetic fields.
   - **H-Alpha filter (656.28 nm):** the chromosphere, where prominences, filaments, spicules and flares are observed, indicators of solar magnetic activity.
   - **Calcium-K filter (393.4 nm):** It allows visualisation of active regions and areas of intense magnetic activity in the upper layers of the solar atmosphere.
4. It identifies sunspots, prominences and filaments in the different images, active regions in the different filters.
5. Fill in the table according to whether or not the following phenomena are observed in each of the filters.

Activities in detail

Solar observation table

Solar phenomenon / property	H-Alpha (red)	Visible light	Calcium-K (blue)	Observations
Sunspots				
Umbra and penumbra				
Filaments				
Protrusions (solar rim)				
Bright active regions				
Flares				
Photospheric granulation				
Obvious magnetic activity				
Rapid changes over time				

6. During the year 2017, many images of the Sun could be taken:
   - CESAR News - The Sun in 2017

   View the visible light images and observe how sunspots change over time. View the images taken with the H-Alpha filter and observe how magnetic activity (prominences, filaments, etc.) changes.

EXPERIMENT 2: BUILDING A HOME-MADE SPECTROGRAPH

DESCRIPTION:

In this experiment, by building a spectrograph with materials we have at home, we will better understand the nature of light and see how it breaks down into different wavelengths. The origin of the visible spectrum will be examined, relating it to the phenomena of diffraction and/or refraction, and different spectra of natural and artificial light sources will be analysed.

Activities in detail

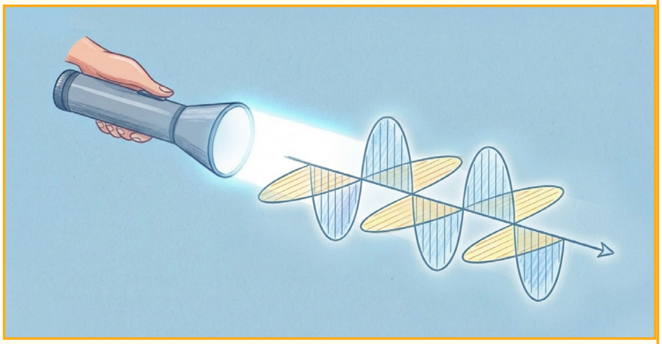
NOTES:

What is a spectrograph?

A spectrograph is an instrument that separates light into its different colours or wavelengths and records them. This enables us to find out:

- What elements are present in the source that emitted the light, in this case the Sun
- The temperature of the Sun's layers
- Whether the gases are moving towards us or away from us (Doppler effect).

What is a diffraction grating?

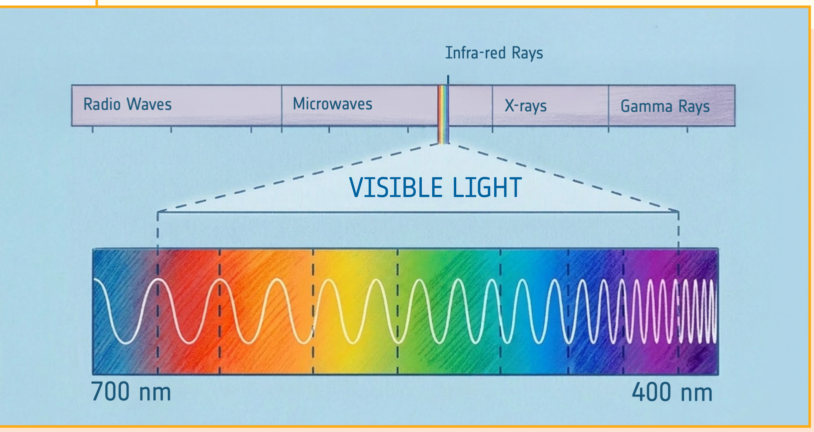


A diffraction grating is a sheet with many lines or slits very close together (thousands per millimetre). When light passes through it, the waves separate and are deflected according to their wavelength, and in this way we can study them separately. Diffraction gratings are the basis of how spectrographs work.

Understanding the behaviour of the Sun helps us predict phenomena such as eruptions or solar storms, which can affect satellites, power grids and navigation systems. Since we cannot travel to the Sun, we study it through the light it emits.

Light is a form of electromagnetic energy that propagates in waves.

Only a small part of those waves is visible to the human eye: the visible spectrum, which includes the colours from violet to red.



Each colour has a different wavelength:

- Violet has short waves and more energy.
- Red has long waves and less energy.

In addition to visible light, there are other types of radiation: ultraviolet rays, infra-red rays, microwaves, X-rays, etc. ESA instruments can detect all these wavelengths that the human eye cannot perceive, allowing scientists to study different phenomena, regions, and layers of the Sun.

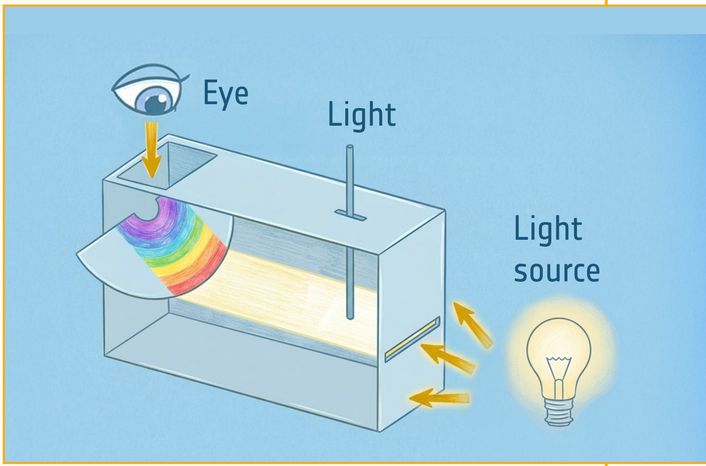
White light, like the light that reaches us from the Sun, is broken down (when passing through a prism or a diffraction grating), and is separated into all its colours: this is the light spectrum.

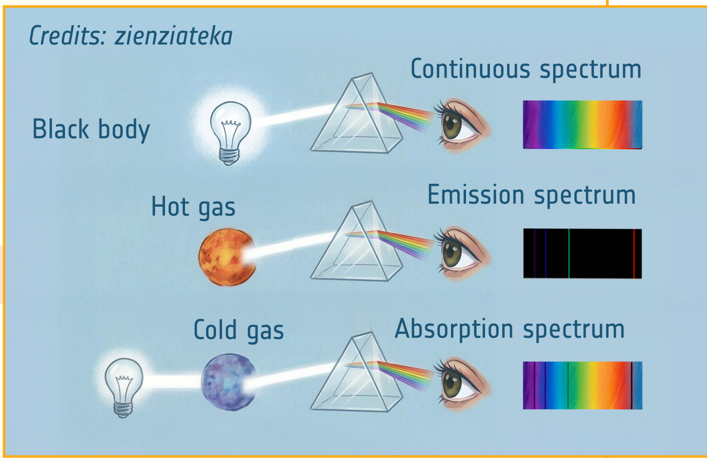
Activities in detail

But we observe that the Sun's spectrum is not a continuous band of colours that change uniformly, but rather has dark and bright lines that give us clues about the chemical elements it is composed of. These are the absorption and emission lines:

- Absorption lines: These are dark lines that appear in the spectrum when certain chemical elements of the Sun absorb some of the light that passes through them.

  Emission lines: These are bright lines that appear when a hot gas emits light, and they do so in a specific way depending on the chemical elements it is composed of.
- These lines function like a "fingerprint": each chemical element has a unique pattern of lines, so by studying the lines of the spectrum that reaches us from the Sun we can study what elements compose it and what processes occur in it.





Credits: zienziateka

STEPS:

1. We prepare the disc (DVD or CD); to do this, we must make it "transparent", if necessary removing the sticker that indicates the contents, size, etc., so that light can pass through. This can be done with tape, pressing on the non-transparent surface and pulling to peel off the sticker.
2. Cut a rectangular fragment from the reflective part of the disc the width of the cardboard tube.
3. Take the lid of the cardboard tube and cut a rectangular hole in it.
4. Completely cover the lid with black tape, making sure no light gets in.
5. Using a cutter, make a very thin, straight slit in the lid: this will be the opening through which the light will enter.
6. Stick the piece of the disc you cut out inside the tube, on the part furthest from the lid, **placing it at an angle**.
7. Make an opening with the cutter so you can see inside where the disc is located.
8. Place the cap on the tube; light will have to enter through the slot in the cap. Try using different lights to see the different spectra.


Credits: CESAR

EXPERIMENT 3: ESA MISSIONS THAT STUDY THE SUN

DESCRIPTION:

In this experiment we will learn about the ESA (European Space Agency) and some of its missions to investigate the Sun. This will help us learn more about the Sun and its impact on space weather, technology and understanding the origin of stellar activity. We will make a model of one of the missions that study the Sun.

STEPS:

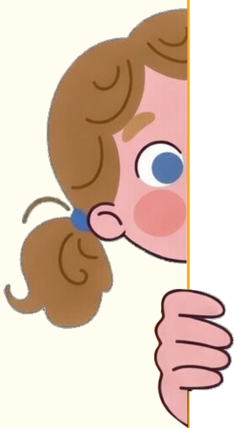
1. Learn more about ESA and its missions that study the Sun:
   The study of the Sun has been one of the lines of work at ESA since its creation.

   It first collaborated on international missions of other agencies and later on its own missions focused on understanding solar activity, the solar wind and the interaction of the Sun with the heliospheric environment.

   Since then, the study of the Sun has become one of ESA's strategic lines of action, especially due to its impact on space weather, technology and the understanding of the origin of stellar activity.

   You can learn more about these missions on these pages:
   CESAR Milestones of Sun missions
   CESAR ESA missions that study the Sun

   Learn more about the Proba-3 mission:
   scifleet.esa.int/model/proba_3/
2. Build the SOHO model:
   https://assets.science.nasa.gov/content/dam/science/psd/solar/2023/09/s/SOHO_Model.pdf?emrc=6942fbabec2ea

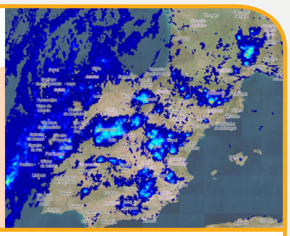


3. Draw a time-line showing at least 10 ESA missions that have studied the Sun.
   Add some distinctive features that sets them apart from the others.

4.6 Local activities for solar eclipses in 2026, 2027 and 2028

Experiment

1 CHOOSE YOUR ECLIPSE VIEWING LOCATION (EOBROWSER WEBSITE)



Study of cloud map (SENTINEL)	13-18 years
Digital project	1 hr
Materials for the experiment: Computer with internet access	Indoor activity
	Applicable to those with visual impairment, hearing impairment and ASD

Activities in detail

EXPERIMENT 1: CHOOSE YOUR ECLIPSE VIEWING LOCATION (EOBROWSER WEBSITE)

DESCRIPTION:

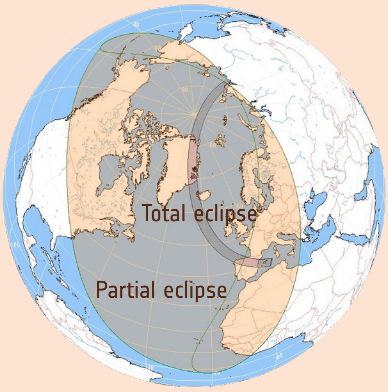
Analyse 2D and 3D weather maps prior to 2026 and select areas of low cloud density on the path of totality as optimal observation locations.

NOTE 1:

2D MAPS OF THE ECLIPSE

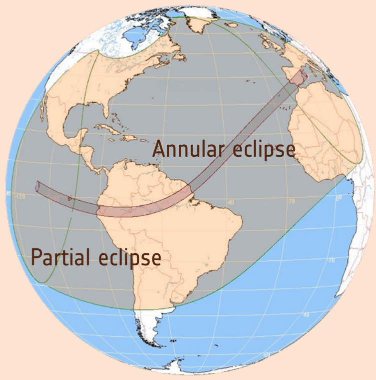
3D MAPS OF THE ECLIPSE

TOTAL SOLAR ECLIPSE 12 AUGUST 2026



TOTAL SOLAR ECLIPSE 2 AUGUST 2027

ANNULAR SOLAR ECLIPSE 26 JANUARY 2028

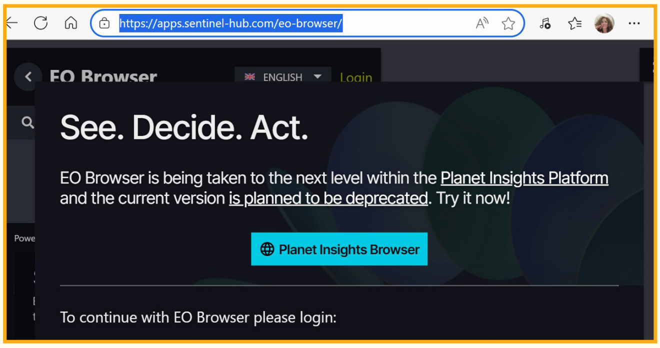


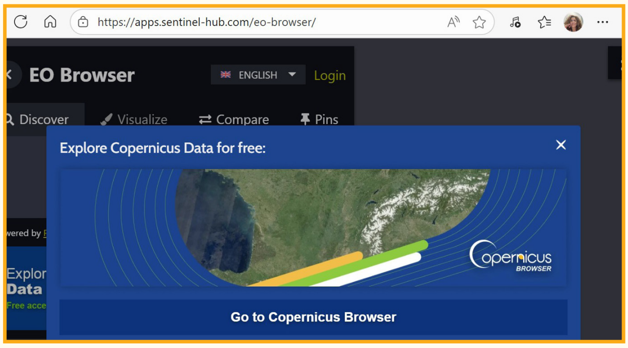
GOBIERNO DE ESPAÑA
MINISTERIO DE TRANSPORTES Y MOVILIDAD SOSTENIBLE
INSTITUTO GEOGRÁFICO NACIONAL

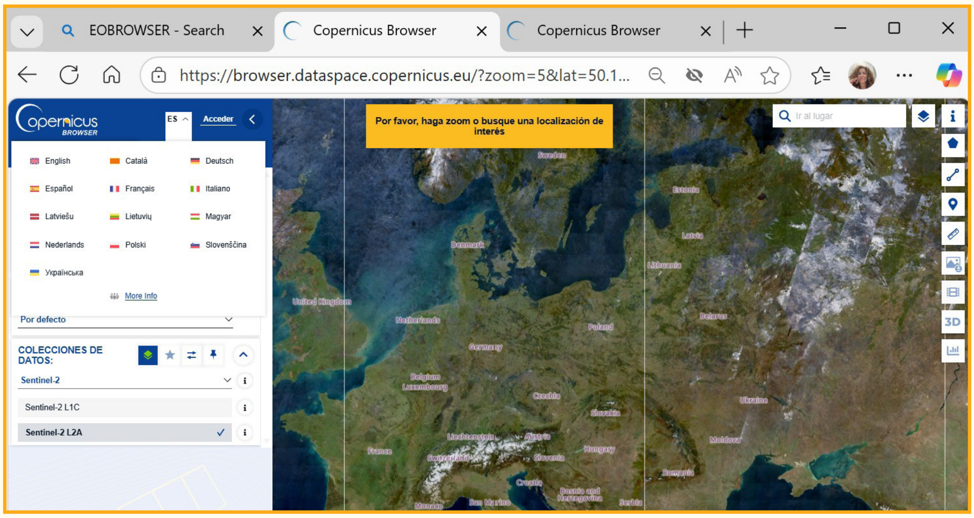
Activities in detail

NOTE 2:

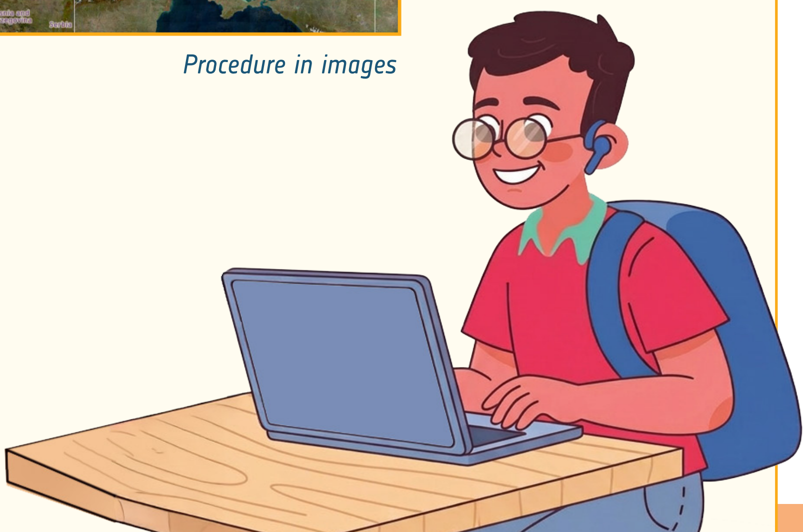
1. Access Sentinel Hub EOBrowser: https://apps.sentinel-hub.com/eo-browser/
   - You do not need an account if you access anonymously to view Sentinel-1 data.
   - It will show you maps from the Copernicus Programme's Sentinel-2 satellite around your location.
2. Select the web application language you are most comfortable with.
3. Modify in the CONFIGURATION PANEL from "default" → "Atmosphere and air pollution", accessing the Sentinel-5P satellite data of the Constellation.
4. Study the areas of greatest cloud thickness. To do this, choose the filters "Cloudiness" → "Optical cloud thickness", these are the areas where it is not advisable to observe the eclipse.



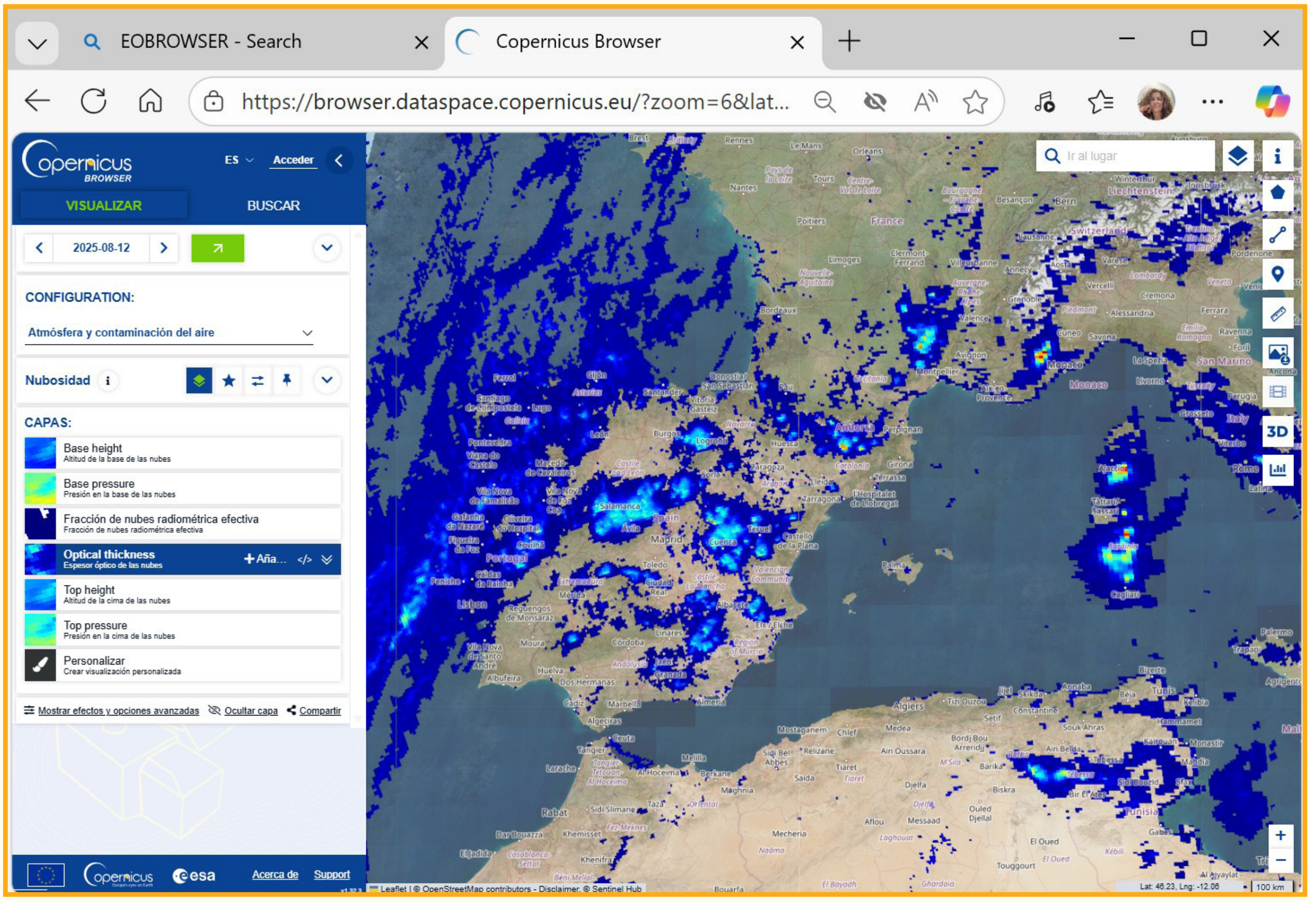




Credits: Copernicus browser *Procedure in images*



Activities in detail



Credits: Copernicus browser *Procedure in images*

2D MAPS

STEPS:

1. Access the EOBrowser Cloudiness data, as indicated in NOTE 2.
2. Select the “Optical Thickness of Clouds” map.
3. Choose the date of the eclipse, but with the previous year (since there are no future data). For example, for the 2026 eclipse, the first date to study would be: 2025-08-12.
4. Observe the result on the map 1-3 days before and after using the arrows.
5. Repeat steps 3 and 4, in previous years, that is: 2024-08-12 ±1-3 days, 2023-08-12 ±1-3 days.
6. For each possible observation site (on the path of totality) repeat steps 3-5.

Activities in detail

ADVANCED
WITH 2D AND 3D MAPS

STEPS:

1. Now look at the eclipse of 26 January 2028, in particular at the 3D map (NOTE 1).
2. Execute steps 1-2 of the above procedure in EOBrowser (Supporting NOTE 2)
3. Switch from 2D to 3D EOBrowser and vice versa, in the area of total darkness of the 2028 eclipse, as shown in the following video: https://cesar.esa.int/upload/202602/3d_europamapa_eclipse2028.mp4
4. Analyse possible observation areas, with less cloud density, within the path of totality. Meteorological images are large, so a map wider than 300 km is not recommended to allow for image loading.
5. Once you have your area to study its cloud cover, switch from 2D to 3D view.

3D AND 2D ANIMATION
OF SOLAR ECLIPSES (IGN)

NOTE 3:

12 August 2026
https://eclipses.ign.es/src/img/eclipse-26/SOL.webm

2 August 2027
https://eclipses.ign.es/src/img/eclipse-27/SOL.webm

26 January 2028
https://eclipses.ign.es/src/img/eclipse-28/SOL.webm