



Science in School

The European journal for science teachers

ISSUE 77 – April 2026

Topics Astronomy/space | General science |
Mathematics | Physics | Resources | STEAM

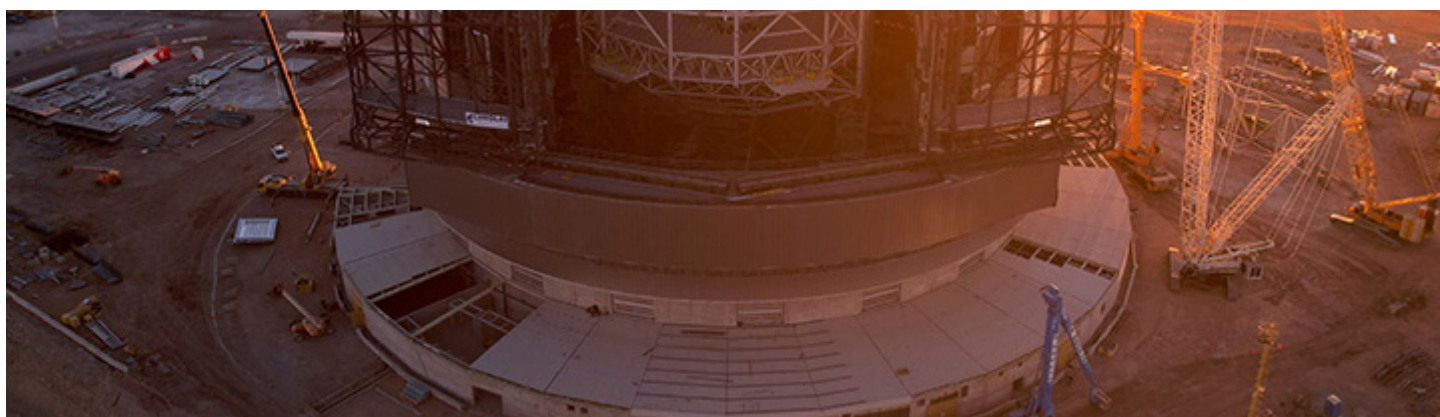


Image courtesy of NASA, ESA, and M. Kornmesser (ESO)

Are we alone? Exoplanets may hold the answers

ESA Education

Exoplanets are planets orbiting stars beyond our Sun. Discovering them may answer one of the most asked questions: Are we alone in the universe?

Introduction

Exoplanets are planetary bodies that orbit a star other than our Sun. By late 2025, scientists had discovered more than [6000 exoplanets](#) with diverse sizes, compositions, and potential for habitability.^[1] Habitability is the keyword when it comes to why scientists are searching for exoplanets. If an exoplanet lies within the habitable zone of its star, it may be suitable for hosting life. The [habitable zone](#), also known as the 'Goldilocks zone', is the region around a star in which liquid water could exist and potentially sustain life.^[2] A great example of a planet that lies in the habitable zone of its star is our very own Earth! Some exoplanets were found to lie in a habitable zone, you can find more information in the resources.

Scientists are very keen on finding Earth-like exoplanets, but finding an exoplanet is not easy. The light reflected from an exoplanet is much dimmer compared to its bigger and brighter host star – it is like searching for a burning match near a lighthouse. Now imagine that the lighthouse and match are 40000000000000 km away. This is the distance between Earth and the closest known exoplanet Proxima Centauri B and its host star (figure 1). Finding a burning match from such a vast distance may seem impossible, but fortunately, satellites equipped with highly sensitive instruments can detect details far beyond the limits of our human eyes.

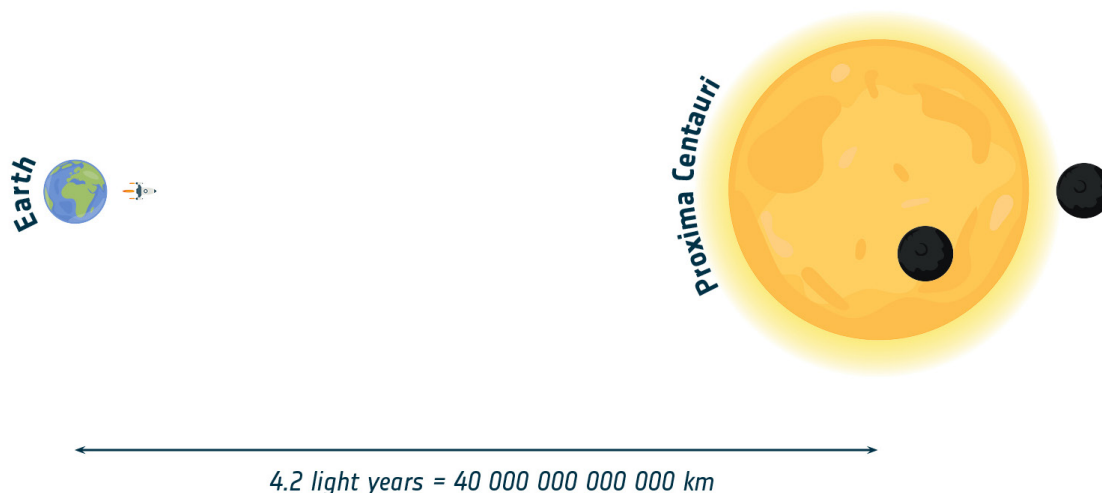


Figure 1: The distance between Earth and the closest known exoplanet and its host star
©ESA

The European Space Agency (ESA) has a fleet of these satellites that scour the universe in search for exoplanets, such as the [Cheops](#) satellite launched in 2019. The fleet is ever-growing, with upcoming launches of [Plato](#) and [Ariel](#) expected in 2026 and 2029 respectively.^[5] There is no single perfect way to detect an exoplanet. ESA's exoplanet satellites use a variety of methods to detect and characterise them.^[6]

In this hands-on activity, students will use the 'transit method' to detect exoplanets orbiting around their own modelled star. When an exoplanet passes in front of (i.e. transits) its host star, it causes a dip in starlight observed by the satellite (figure 2). By measuring the depth of the dip and the interval between dips, one can discover more about the exoplanet's characteristics, such as its size and distance to the host star.

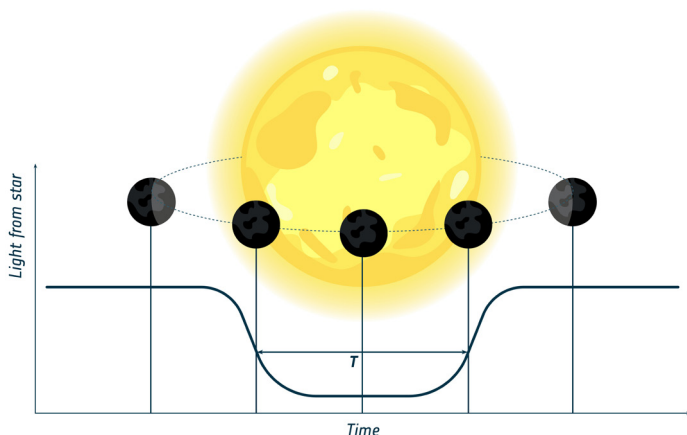


Figure 2: Representation of an exoplanet transiting in front of its star causing a dip in the light curve
©ESA

This activity is aimed at students aged 14–19 years old, but can be adapted to fit younger audiences as well. In this activity, students learn to...

- ...compare the main differences between stars and planets, including their size, composition, and energy source (Physics).
- ...apply mathematical methods to model how exoplanets are detected, including reading and interpreting light curves (Mathematics).
- ...design and carry out experiments using data-logging tools to collect measurements and analyse results (Scientific experimentation).

Activity 1: Exploring what exoplanets are

In Activity 1, students are introduced to the characteristics of exoplanets, how they differ from stars, and why they are difficult to detect. This activity may be conducted as a classroom discussion, a group discussion, or individually.

Info box

The entire teaching resource, created by ESA, can also be found in this downloadable [teacher guide](#). For added clarity, the worksheets have also been linked separately here on the *Science in School* page.

Materials

- [Teacher guide](#)
- [Fact sheet](#)
- [Activity 1 worksheet](#)

Procedure

1. Introduce the students to exoplanets through the introductory information in this article and/or the additional information in the teacher guide.
2. Provide the students with the activity 1 worksheet (page 11 in the teacher guide).

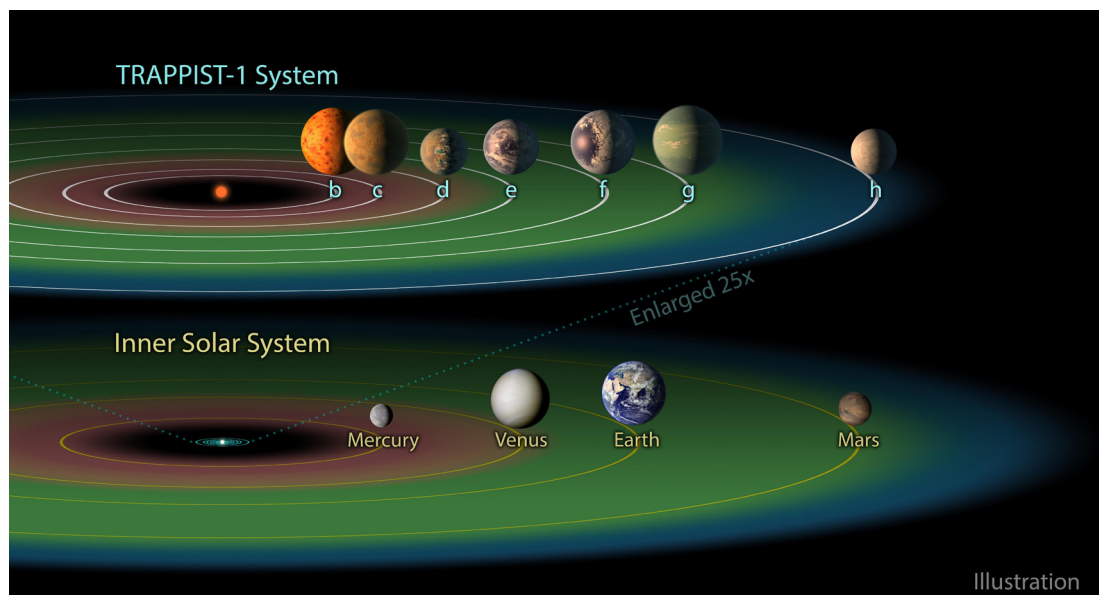


Figure 3: Illustration of the habitable zone (in green) of the TRAPPIST-1 exoplanet system (top) and our solar system (bottom)

Image courtesy of NASA/JPL-Caltech

3. Let the students explore the concept of exoplanets through the following two questions (on the worksheet):
- What are the differences between stars and planets?

Example answer: Stars are large gaseous bodies consisting mainly of hydrogen and helium that shine because they produce energy through nuclear fusion. They form when massive clouds of gas collapse under gravity. Planets, however, do not produce light themselves; they form from the dust and gas around a nearby star and simply reflect its light.^[7]

- Whilst life outside Earth has not been discovered yet, scientists are searching for it in our solar system and beyond. What conditions do you think life would need to develop?

Example answer: When searching for life beyond Earth, scientists must make assumptions about what life is. One sign of life that scientists look for is simple organisms, as these are more common and resilient than advanced species. They also look for water-based life, since liquid water is essential for life as we know it. This limits the search to planets in the habitable zone around stars, where conditions allow water to stay liquid because the temperatures are just right (figure 3). Not too hot, not too cold!

Activity 2: Build your exoplanet in a box

In Activity 2, students build their own physical model of exoplanets transiting in front of their host star in a box. Using the transit method, students will measure the dip in light observed when an exoplanet passes in front of a light source,

and learn how to interpret the resulting graphs. It is recommended that students work in groups of 3–4.



Safety notes

The construction of the box involves the use of sharp tools

Materials

- Cardboard shoebox
- Flashlight
- Light meter (e.g. smart phone with app or datalogger)
- Craft knife or scissors
- Protractor or math compass
- Clothes peg
- Wooden cocktail sticks
- Sticky tape
- Play clay (modelling clay)
- [Instruction for building an exoplanet in a box](#)
- [Activity 2 worksheet](#)

Procedure

1. Start by explaining to the students that they will plan and design a physical model of an exoplanet transiting its host star. You can show this [video demonstration](#) or refer to the photo [instructions for building an exoplanet in a box](#).
2. Instruct the students to plan how they want to build their exoplanet model and which variables need to be measured.

Answer: Illuminance out of transit, maximum illuminance changes during transit.

- After presenting their plan, the materials can be distributed, and the students can start building.



Figure 4: Build your own exoplanets in a box with the step-by-step instructions.

©ESA

Activity 3: Starlight analysis

In Activity 3, students perform a starlight analysis of exoplanet transits by moving clay exoplanet models of different sizes in front of the light source and measuring the change in illuminance. An example of a transit light curve measured by a real satellite (Cheops) of the exoplanet WASP-189b is shown in figure 5.

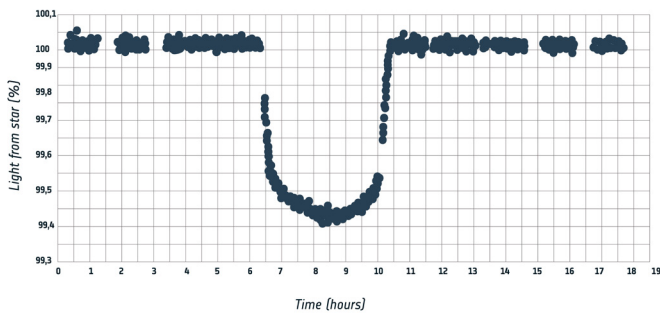


Figure 5: Example of a transit light curve obtained by Cheops of exoplanet WASP-189b

©ESA

Materials

- The constructed box model
- Clay exoplanet models of different sizes
- [Activity 3 worksheet](#)

Procedure

- Let the students simulate transits by instructing them to moving the clay models in front of the light source. They should obtain graphs that are similar to figure 5 and 6.
- Students record their measurements in the table of the [activity 3 worksheet](#). For each exoplanet clay model, they should note down two variables:

- Illuminance out of transit (i.e. the exoplanet model is not transiting the light source).
 - Maximum change in illuminance that measured during the model exoplanet transit (i.e. transit depth).
- After completing the measurements, ask the students to discuss whether they observed any differences in the light curves of different-sized exoplanets.
Answer: Smaller exoplanets block less light than larger exoplanets. Therefore, the dip observed in the light curve is smaller for smaller exoplanets, and larger for larger exoplanets.

Activity 4: Calculate the size of your exoplanet

In Activity 4, students calculate the size of one of their clay exoplanet models as if it was orbiting Proxima Centauri – the star closest to our Sun – as shown in figure 1. During transit, the dip in the observed light curve is a measure of the fraction of the star’s circular disc that is covered by the exoplanet’s circular disc, as described by the following equation:

$$\text{transit depth} = \frac{\pi \cdot R_p^2}{\pi \cdot R_s^2} \cdot \text{starlight out of transit}$$

Where R_p is the radius of the exoplanet and R_s the radius of the star.

Materials

- Table with recorded measurements
- Scientific calculator
- [Activity 4 worksheet](#)

Procedure

- Let the students rearrange the equation ([activity 4 worksheet](#)) to calculate the radius of an exoplanet (i.e. to $R_p = \dots$). If this step is too advanced for the students, you can also perform the rearrangements on the board.

Answer:

$$R_p = \sqrt{\frac{\text{transit depth}}{\text{starlight out of transit}}} \cdot R_s$$

- Proxima Centauri has a radius of 100 900 km. The students can now calculate the size of one or more of their exoplanets as if it was orbiting Proxima Centauri.
Example: As shown in the example graph in figure 7, the starlight out of transit is +/- 25 lux, and the transit depth is +/- 20 lux.

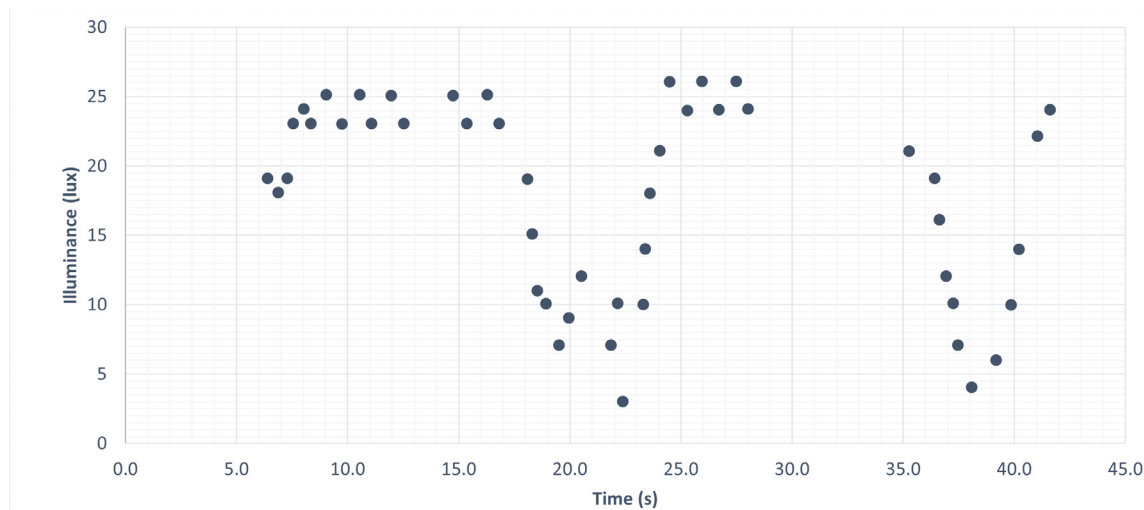


Figure 7: Example of a light curve
©ESA

Entering the values in the rearranged equation gives:

$$R_p = \sqrt{\frac{20}{25}} \cdot 109,000 = 90,248 \text{ km}$$

Discussion

In this set of activities, students learned how exoplanets can be detected through the transit model. By designing a physical model, the students gained experience with experimentation and a deeper understanding of the relationship between the transit depth and exoplanet radius. To conclude with the students, it is useful for them to think about the limitations of the model they have constructed. Examples of limitations can be found in the conclusions of the [teacher guide](#).

Interested in teaching more about exoplanets with physics and mathematics? The Hack an Exoplanet website offers a full collection of educational activities and resources on exoplanets developed by the ESA Education Office. Have a look at:

- [Hack an Exoplanet Investigation activity](#): students are tasked to profile mysterious exoplanets using real satellite data from Cheops and complete the casefiles.
- [Exoplanets in transit](#): students learn to analyse and interpret real transit light curves of exoplanet WASP-189b and the TOI-178 exoplanet system.
- [Exoplanets in motion](#): students build their own dynamic exoplanetary system with a turntable, rover or 3D printer.
- [Exoplanets explained by Nobel Prize winner Didier Queloz](#): In this 3-part video series, Didier Queloz explains the who, what, where, when and why of exoplanets.

Acknowledgement

The *Exoplanet in a Box* activity was produced in collaboration with several [European Space Education Resource Offices \(ESERO\)](#). The original concept was developed for ESA by the National Space Academy (UK).

We would like to extend our gratitude to ESA's Directorate of Science and their exoplanet scientists for supporting the ESA Education Office's exoplanet educational activities. Their willingness to share real satellite data with students and contribute with expert knowledge has been invaluable. ◀◀

References

- [1] NASA Exoplanet Archive: <https://exoplanetarchive.ipac.caltech.edu/>
- [2] Habitable zone: <https://esahubble.org/wordbank/habitable-zone/>
- [3] European Space Agency (2023) [Hubble helps discover a new type of planet largely composed of water](#). *Science in School* **61**.
- [4] Tatalović M (2020) [Alien life and where to find it](#). *Science in School* **50**.
- [5] ESA's exoplanet missions: https://www.esa.int/Science_Exploration/Space_Science/Exoplanets/ESA_s_exoplanet_missions
- [6] Vieser W (2020) [Hunting for Exoplanets](#). *Science in School* **49**.
- [7] The atoms that make us: https://www.esa.int/Science_Exploration/Space_Science/Integral/The_atoms_that_make_us

Resources

- Download the [full resource](#) “Exoplanets in a box”.
- Deepen your knowledge about [ESA’s satellite fleet searching for exoplanets](#).
- Check out this overview of [exoplanet detection methods](#).
- Want to teach more about exoplanets? Visit [Hack an Exoplanet](#).
- Find the ESA Education channels on [Youtube](#), [Facebook](#) and [X](#).
- Read about the discovery of a new planet outside our Solar System: Setiawan J (2011) [A planet from another galaxy](#). *Science in School* **19**: 26–29.
- Learn how other planets can help us understand the origin of life on earth: Fridlund M (2009) [The CoRoT satellite: the search for Earth-like planets](#). *Science in School* **13**: 15–18.
- Discover a planet where it rains iron: ESO (2021) [ESO telescope observes exoplanet where it rains iron](#). *Science in School* **51**.
- Find out how astronomers study the past of the Milky Way and peer into its future: Forsberg R (2023) [Galactic Archaeology: how we study our home galaxy](#). *Science in School* **64**.
- Explore the current methods used to discover exoplanets: Vieser W (2020) [Hunting for exoplanets](#). *Science in School* **49**: 8–12.
- Let’s search for alien life: Tatalović M (2020) [Alien life and where to find it](#). *Science in School* **50**.
- Read about the discovery of an entirely new planet type: ESA (2023) [Hubble helps discover a new type of planet largely composed of water](#). *Science in School* **61**.

CC-BY



Text released under the Creative Commons CC-BY license.
Images: please see individual descriptions