FIND YOUR EXOPLANET

NASE-UNESCO, INERNATIONAL DAY OF LIGHT 2026

FROM MARCH 20 TO SEPTEMBER 22

Find your exoplanet

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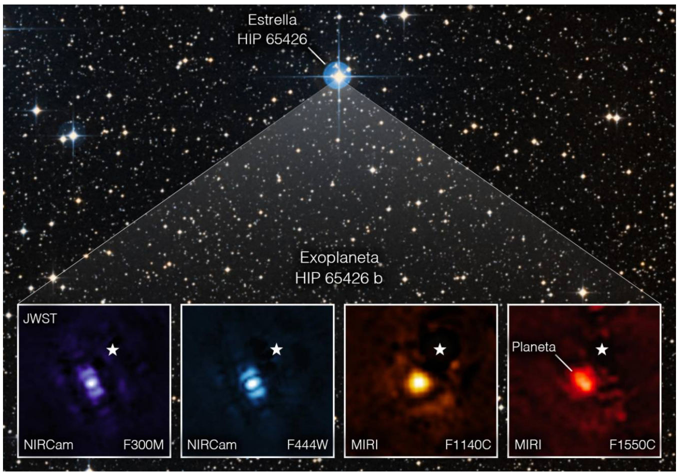

Fig. 1: First direct image of an exoplanet, HIP 65425 b, obtained with the James Webb Space Telescope at different wavelengths. (Credit: NASE, ESA, CSA).

NASE's proposal for the International Day of Light (IDL) in 2026 involves choosing an exoplanet, investigating its nature, and arguing whether it could be a second Earth, using the indicators from the Kepler Mission. The project can be carried out between **March 20 and September 22**, 2026. To participate, we invite you to perform the three experiments outlined in the accompanying text and choose one of the possible candidates from among the known exoplanets. This project is listed on the UNESCO IDL website among the events proposed worldwide.

The report, including the data sheet for the chosen exoplanet and two or three photos of the students completing the activities, should be saved as a PDF file and named with the first three letters of the country, the month, the day, and any three numbers from 000 to 999. For example, SPA0515123.pdf. The report must be uploaded using the form: https://forms.gle/NgsHkWfjdSWMgq7U6

PRELIMINARY IDEAS

What is an exoplanet?

An exoplanet is a planet that orbits a star other than the Sun. According to NASA, more than 6,000 exoplanets have been confirmed. They are not usually seen directly, but rather detected by observing the perturbations the planet produces in the star it orbits: small movements, a decrease in light as it passes in front, etc. For this reason, most of the exoplanets discovered are very large and very close to their star; they are usually gaseous (they do not have a solid surface), very large, and hot. It is not easy for life, as we know it, to develop on them.

However, there are some that are more similar to Earth and have better conditions for harboring life. They are rocky, neither too large (so that gravity does not crush life) nor too small (so that the atmosphere does not escape), and with a temperate temperature so that liquid water, necessary for life, can exist. These are the ones that interest us in this project. We will see where and how to find them.

Most stable region of a galaxy

Not all places in a galaxy are equally suitable for life. In the central region of galaxies, there are large, energetic events with enormous explosions and high energy levels, deadly to life. In the region near the edge of galaxies, atoms heavier than hydrogen and helium, which are necessary for life, are lacking. Consequently, the area where life has the greatest chance of arising is a circular zone that, in the case of our galaxy, is located between a radius of 23,000 light-years and 30,000 light-years from the galactic center. The Sun is 27,000 light-years from the center of our Galaxy, in this zone (Figure 2). In Activity 1, galaxies will be reproduced using simple materials..

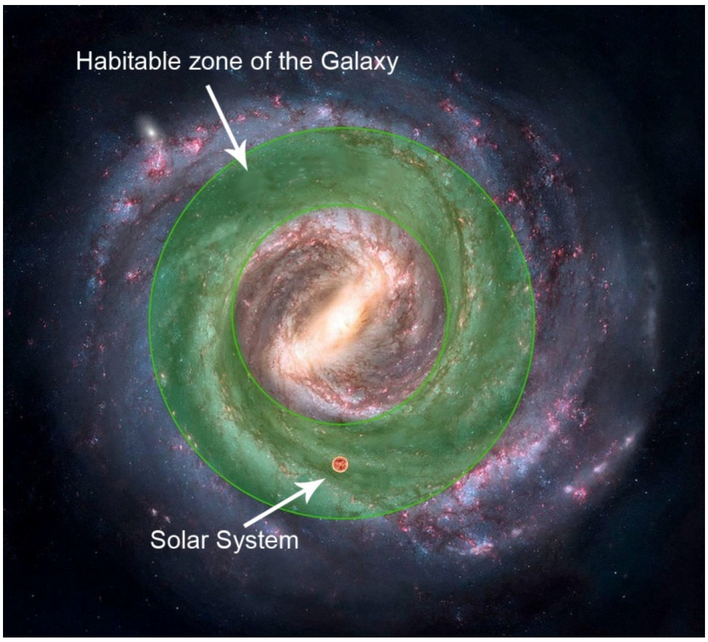

Fig. 2: Habitable Zone of the Galaxy (Credit: NASA)

Distance to the star. Habitable zone

The habitable zone of a star is the distance at which, if water exists on a planet, it can be found in a liquid state. If the star is very hot, a potential planet with liquid water must be much farther away than if the star is cooler. The habitable zone depends on the type of star (Table 1). For example, in the case of the Sun (a star of spectral type G5V), Earth is at a distance of 1 AU, within its habitable zone. Activity 2 will visualize the Sun's habitable zone.
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Table 1: Habitable Zone according to the spectral type of the star

Spectral type	Temperature K	Habitable Zone (AU)
O6V	41 000	450-900
B5V	15 400	20-40
A5V	8 200	2,6-5,2
F5V	6 400	1,3-2,5
G5V	5 800	0,7-1,4
K5V	4 400	0,3-0,5
M5V	3 200	0,07-0,15

Many stars have more than one exoplanet, forming exoplanet systems, just like our solar system. The Titius-Bode Law is an empirical mathematical relationship that was used to describe the distances of planets from the Sun, although it failed in some cases. Currently, it is also used to describe the orbits of exoplanets in multi-body systems, revealing patterns in the distribution of their orbital distances, although its physical explanation remains unclear. In Activity 2, a model of the solar system is created using this law.

Masses and diameters

In 2009, NASA launched the Kepler space observatory with the mission of searching for exoplanets, especially those similar to Earth. Because it had to measure minute changes, the selected stars were within 3,000 light-years of the Sun, within the habitable zone of our galaxy. The observatory was active from 2009 to 2018 and located approximately 2,600 exoplanets, more than 50 of which are Earth-like. Based on this data, it was estimated that between 20% and 50% of the stars visible in the night sky likely host Earth-like planets.

Mission managers determined that exoplanets that could potentially harbor life (similar to Earth) must meet the following characteristics.:

a). a) Size: They cannot be too large, as excessive gravity would crush living beings. It was decided that **the radius should be less than twice the radius of the Earth and its mass less than ten times the mass of the Earth**. Furthermore, it cannot be too small either, as its gravity must be able to maintain an atmosphere with a certain pressure. For example, Mars is too small, and its gravity was unable to retain most of its atmosphere, so there cannot be liquid water on its surface; at the pressure and temperature of the Martian surface, water boils and evaporates, as demonstrated in Activity 3..

b). b) The host star cannot be a massive star, because these have a short lifespan, and time is needed for life to evolve. Therefore, it was decided that **the mass of the host star should be less than 1.6 times the mass of the Sun**.

In Activity 4, an exoplanet will be chosen that has all the necessary characteristics to be capable of supporting life..

ACTIVITIES

Activity 1: Simulation of spiral galaxies

A spiral galaxy model can be generated (Figure 3) with a glass full of water and a product that has very small grains, for example, very fine sand, sodium bicarbonate or table salt (NaCl), although the latter has the disadvantage that it dissolves too easily in water (Figures 4 and 5).

Fig. 3. Galaxy NGC 5457 (ESA/Hubble)

Fig. 4. Galaxy with baking soda.

Fig. 5. Galaxy with sand.

Begin by stirring the water in the glass with a spoon at a fairly rapid pace. Stop stirring, add a spoonful of the available material, and wait for the grains to settle at the bottom of the glass. This will create a small mound of material in the center (the galaxy's nucleus) and spiral arms, very similar to those found in galaxies. Figure 6 shows a real galaxy viewed edge-on (NGC 4565) and the models obtained using baking soda and sand.

Fig. 6. Galaxy NGC 4565, with the central bulge (Credit ESO/NASA),

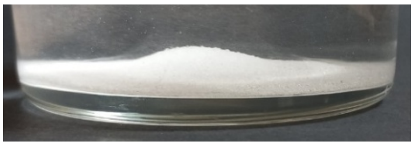

Fig. 7. Model with baking soda, seen from the side

Fig.8. Sand galaxy model, seen from the side

Activity 2: Distances in the Solar System, Titius-Bode Law.

In the 19th century, the distances of the planets from the Sun were known with good approximation, and it was known that each distance was almost double the previous one. Titius and Bode established an experimental rule that fit well with the distances of the planets known at that time. It predicted a missing planet between Mars and Jupiter and suggested there might be another beyond Saturn. In 1781, Herschel discovered Uranus, located at the distance predicted by the Titius-Bode law. In light of this, in 1796, it was decided to form a group of astronomers to search for the planet predicted by the Titius-Bode law between Mars and Jupiter. This group of observers was called the "Sky Detectives." They discovered many small asteroids, but failed to find the sought-after planet. It was Giuseppe Piazzi, who did not belong to that group, who discovered Ceres in 1801, which conformed to the Titius-Bode law.

Neptune was discovered in 1846, much closer than the distance predicted by the Titius-Bode Law. It is not known today whether this law has any theoretical basis or is simply an experimental rule, but it proved useful at the time for searching for planets and is still sometimes used to locate exoplanets.

The distances in the Solar System are shown in Table 2. It can be seen that, approximately, the distance of one planet from the Sun is twice that of the previous planet. For example, the distance from Saturn to the Sun is twice that of Jupiter to the Sun..

Table 2: Distances of the planets from the Sun

Planet or region	Distance (km)
Mercury	57 900 000
Venus	108 300 000
Earth	149 700 000
Mars	228 100 000
Asteroid Belt (average)	410 000 000
Jupiter	778 700 000
Saturne	1 430 100 000
Uranus	2 876 500 000
Neptune	4 506 600 000
Kuiper belt (average)	5 700 000 000

With this idea in mind, we're going to build a simple model showing the distances in the Solar System. We'll use a strip of cardboard or paper (Figure 9).

- At the far left, we'll write an S (Sun) and at the far right, KB (Kuiper Belt). We'll fold the strip in half and write a U (Uranus) at that point.

- Now we'll fold it in half between U and KB and write an N (Neptune). If we fold it in half between the Sun and Uranus, we'll write an S (Saturn) in the center.

- We'll fold the strip between the Sun and Saturn, and write a J (Jupiter) in the center.

- When we fold the strip in half between the Sun and Jupiter, we'll write AB (the Asteroid Belt) in the center.

- If we fold the strip between the Sun and AB, we'll write an M (Mars) in the center.

- Fold the tape in half between the Sun and Mars, and draw a V (Venus).

Now, between the Sun and Venus, draw another M (Mercury), and also between Venus and Mars, draw a E in the center representing Earth.

The Sun's habitable zone extends from Venus to Mars, including Earth (shown in yellow in Figure 9).

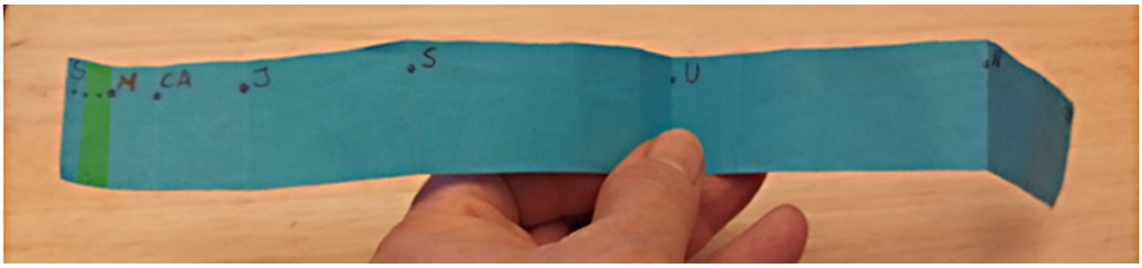

Fig. 9. Model of the Solar System, following the Titius-Bode Model, made with cardboard. Most of it is outside the Sun's habitable zone (in yellow).

Activity 3: Liquid Water on Mars

On Mars, gravity is weak, and the atmosphere is thin. Currently, atmospheric pressure is much lower than on Earth, only 0.7% of Earth's. Clouds have been detected, and there is ice at the planet's poles, but no liquid water. With the low atmospheric pressure and at room temperature, liquid water is unstable and turns into a gaseous state (boils). However, dry riverbeds and lakebeds are observed, demonstrating that in the past there was large quantities of liquid water on the planet, perhaps when the atmosphere was much denser. Where did that water go? Perhaps it's underground. Discovering whether underground water exists on Mars is part of current research related to that planet.

We will simulate this situation with a simple experiment using a syringe and some hot water, about 80°C. We put the water into the syringe and cover the opening with our finger (Figure 10). Pulling the plunger back (Figure 11) lowers the pressure inside the syringe, causing the water to boil—that is, to turn into steam—and gradually disappear. To accurately simulate Martian pressure, we would need to pull the plunger back about 9 meters.

Fig. 10: Hot water at 80°C inside a syringe

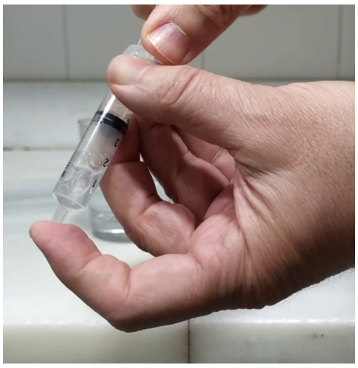

Fig. 11: At low pressure, water begins to boil at less than 100°C

Activity 4: Choosing a habitable planet

We now know enough about exoplanets, and we can reach the project's ultimate goal: choosing our habitable exoplanet that could be a second Earth, an alternative for humanity.

Remember that it must meet these conditions.

1. Host star mass less than or equal to 1.6 times the mass of the Sun.
2. Exoplanet mass less than 10 times the mass of the Earth.
3. Exoplanet radius less than 2 times the radius of the Earth.
4. The distance of the exoplanet from the central star must fall between the two values in the last column of Table 1, on the line corresponding to the closest spectral type of the host star.

We can look for it in two ways:

A) In the list below (Table 3), with 30 candidates.
B) Older students can search for the exoplanet using the following NASA links.:

https://science.nasa.gov/exoplanets/exoplanet-catalog/

https://eyes.nasa.gov/apps/exo/#/filter/type/terrestrial

The second link allows you to view exoplanetary systems, see their sizes and whether they are in the habitable zone of the central star, compare it with our Solar System, etc. (Figure 12).

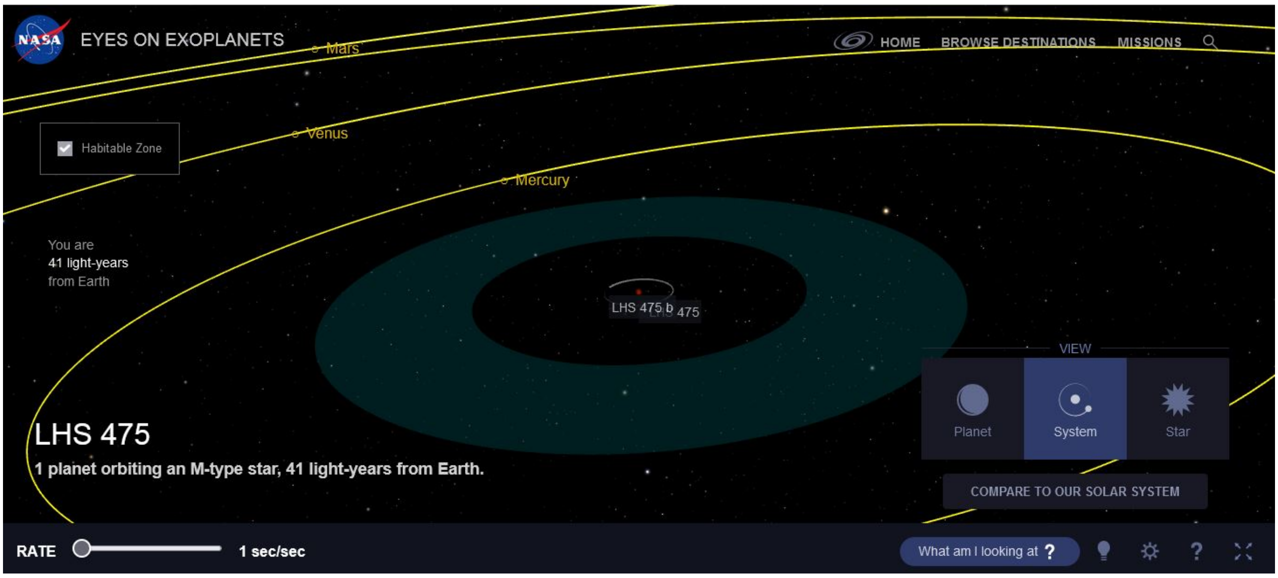

Fig. 12: Example of a NASA website visualization: https://eyes.nasa.gov

Table 3: List of candidates

	Name of the exoplanet	Mass (M_E)	Radius (R_E)	Distance to your star (AU)	Stellar mass (M_S)	Spectral type	Temperature of the star (K)
1	Proxima Centauri b	1,27	1,1	0,0485	0,12	M5.5V	3040

2	TRAPPIST-1 d	0,3	0,78	0,0214	0,089	M8V	2560
3	TRAPPIST-1 e	0,77	0,92	0,0282	0,089	M8V	2560
4	TRAPPIST-1 f	0,93	1,04	0,0371	0,089	M8V	2560
5	TRAPPIST-1 g	1,15	1,13	0,0451	0,089	M8V	2560
6	LHS 1140 b	6,6	1,73	0,093	0,18	M4.5V	3130
7	LHS 1140 c	1,8	1,3	0,026	0,18	M4.5V	3130
8	Teegarden b	1,05	1,02	0,0252	0,09	M7V	2900
9	Teegarden c	1,11	1,03	0,044	0,09	M7V	2900
10	Kepler-442 b	2,36	1,34	0,409	0,61	K5V	4400
11	Kepler-186 f	1,67	1,17	0,356	0,54	M1V	3755
12	Kepler-62 f	2,8	1,41	0,718	0,69	K2V	4925
13	Kepler-62 e	2,6	1,61	0,427	0,69	K2V	4925
14	Kepler-1649 c	1,25	1,06	0,0514	0,2	M5V	3240
15	Kepler-1229 b	2,7	1,40	0,289	0,54	M1V	3720
16	Kepler-452 b	5	1,60	1,05	1,04	G2V	5750
17	Wolf 1061 c	3,41	1,60	0,084	0,29	M3V	3380
18	Wolf 1061 d	7,7	2,0	0,203	0,29	M3V	3380
19	Ross 128 b	1,35	1,1	0,049	0,17	M4V	3190
20	GJ 667 C c	3,8	1,6	0,125	0,31	M1.5V	3350
21	GJ 667 C f	2,7	1,4	0,156	0,31	M1.5V	3350
22	GJ 667 C e	2,7	1,4	0,213	0,31	M1.5V	3350
23	K2-72 e	2,2	1,29	0,106	0,27	M3V	3300
24	K2-72 c	2,4	1,3	0,106	0,27	M3V	3300
25	K2-3 d	1,7	1,48	0,208	0,60	M0V	3890
26	K2-18 b	8,6	2,61	0,143	0,36	M2.5V	3460
27	TOI-700 d	1,72	1,14	0,163	0,42	M2V	3480
28	TOI-700 e	1,1	1,0	0,115	0,42	M2V	3480
29	YZ Ceti d	1,14	0,98	0,016	0,13	M5V	3050
30	YZ Ceti c	1,06	0,96	0,012	0,13	M5V	3050

Table Sources:

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Notes

i https://science.nasa.gov/exoplanets/
ii https://en.wikipedia.org/wiki/Kepler_space_telescope
iii https://science.nasa.gov/mission/kepler/#h-legacy and https://ciencia.nasa.gov/universo/mas-planetas-que-estrellas-el-legado-de-kepler/
iv https://phl.upr.edu/hwc
v https://exoplanetarchive.ipac.caltech.edu/index.html

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