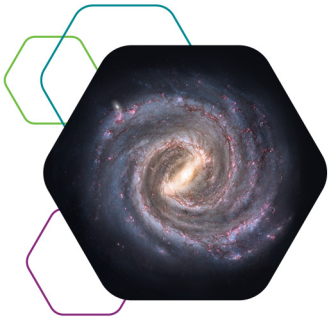

FACILITATOR GUIDE

Exoplanet Transits

Learning objectives

- Scientists are searching the universe for planets orbiting distant stars.
- When a planet, or other object, moves between its star and Earth, some light from that star gets blocked from view.
- The transit method is one of the ways NASA scientists search for distant planets.

Materials

- Desk lamp
- Light box with 16-square grid
- 1 large, medium, and small cube
- Canvas bag to hold the cubes
- Acrylic stand
- *Mystery Objects Data Collection* worksheet
- Pencils
- Electrical outlet (not provided)
- Activity and facilitator guides
- Information sheets
- *Tips for Leading Hands-on Activities*

The Explore Science toolkit comes complete with all necessary materials for this activity. Materials are also readily available to create or restock activity kits. The light boxes with a printed grid are custom ordered for the physical toolkits. You can purchase table-top photography light boxes from online retailers and add black lines with a permanent marker to create a 16 square grid. Graphic files can be downloaded from www.nisenet.org.

Safety

Remind participants to not look directly at the light bulb or shine it in anyone's eyes. The diffuser makes the light less bright, but it's still a strong light.

Advance preparation

Before doing this activity, you will need to find a location close to an electrical outlet so you can plug in the desk lamp, assemble the light box, and set up the other materials. The lamp should be positioned so that it is shining directly into the lightbox and onto the inside of the white grid, with the acrylic stand placed between these two items, about two times closer to the grid than to the lamp. Place one of the cubes on the stand. Position the box so that participants won't be able to easily see around to the cube.

Place the other cubes into the bag so they are hidden away. It is your role, as the facilitator, to swap the mystery objects (cubes) for the participant. Start with one of the cubes on the acrylic stand. While facilitating the activity, keep the stand at approximately the same distance from the "star" (desk lamp) every time. Size and distance are compressed in this model, so placing a smaller cube closer to the light source will make it appear bigger than a large cube placed farther away. When swapping out the cubes, remind visitors to close their eyes and not peek!

Notes to the presenter

Exoplanets can be detected using a variety of methods. The one most closely modeled in this activity is called the *transit method*. With the transit method, astronomers first scour the universe to find stars that "blink," indicating that there might be a planet passing between the star and Earth. Then scientists study the light curve coming from the star and look for dips. The size of a planet is directly proportional to the dip in the light curve. Scientists also measure the speed of the transit across a star to approximate how far out it orbits. Planets closer to a star have faster orbits.

Other methods for finding exoplanets include measuring radial velocity, direct imaging, gravitational microlensing, and astrometry. NASA.gov has more detailed information on each of these methods.

Young children enjoy playing the role of scientist by applying their counting skills, and become especially engaged when they can compare their data to the data gathered by the facilitator or an older sibling, whether or not they record that data on a worksheet. Some young children may not fully understand the concept of planets transiting stars, but it is worthwhile to make connections to other, Earth-based phenomena involving shadows, such as how shadows cast by the Sun change size and position throughout the day.

Conversational prompts

This activity allows you to have fun collecting and interpreting data! The desk lamp is a model for a distant star and the cubes model different-sized planets that might orbit that star. The grid screen is a model for how we collect and analyze observations from Earth or from a space telescope. Try using these terms to refer to the objects as you engage participants. You can also remind them that, in a way, they are taking on the roles of both the telescope and sensor looking at the star, and the scientist interpreting the data to form a hypothesis.

In this activity, participants have an opportunity to make observations about which cube blocks the most or least light by counting how may squares on the grid are mostly dark or mostly light. Younger visitors may have difficulty determining if a square is "mostly" dark or light. Try suggesting that "More than half counts as mostly."

Optional extensions

This activity can be fun for a group of participants to do together. Encourage participants to compare their observations and guesses.

Difficult concepts

In this model, the cubes (planets) block a lot of the light from the lamp (star). In reality, an exoplanet blocks only a tiny amount of light, so researchers must use very sensitive instruments to detect that small change.

When discussing systems of planets around stars, people often misinterpret illustrations they see. Sometimes systems are shown with the planets nicely spaced and evenly "lined up" so that the order or maybe even the sizes of planets can be compared. More realistic illustrations show how planets are distributed in a plane area around a star and don't line up. Also, when talking about the transit method, it is important to discuss that planets often orbit a star in such a way that the planet doesn't cross the star from our point of view, which makes the planet undetectable using this method. You can model this by showing how the cube (planet) could orbit the lamp (star) perpendicularly to the floor and not cross between the lamp and the grid (observers on Earth).

Staff training resources

Refer to the *Tips for Leading Hands-on Activities* sheet in your activity materials.

- An activity training video is available at vimeo.com/245834714
- A content training video is available at vimeo.com/245835228
- The NISE Network has a curated list of programs, media, and professional development resources in the NASA Wavelength Digital Library that directly relate to the toolkit. These resources can be viewed and downloaded from nasawavelength.org/users/nisenet.

Credits and rights

Image of the ISS transiting the Sun during the 2017 eclipse courtesy NASA/Joel Kowsky.

Light curve graph courtesy NASA/ JPL-Caltech/M.Gillon (Univ. of Liege, Belgium).

Artist's impression of Kepler-22; TRAPPIST-1 Light curve graphic; artist's impression of one of the TRAPPIST-1 planets; and impression of the TRAPPIST-1 system courtesy NASA/JPL-Caltech.

Artist's rendering of Webb Telescope courtesy NASA.

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