Lesson 5

In Transit

Detecting exoplanets by measuring a dip in light

Curriculum links

England Light
Scotland Light
Wales How things work – light | Enquiry skills
Northern Ireland Light and shadows

Artist's impression of a transiting Jupiter-mass exoplanet around a star. Credit: ESO

Background

When a planet orbits its star, it may pass between Earth and the star, preventing some of the light from that star from reaching us. This is called a transit. Measuring the intensity of light over a period of time can help scientists to detect distant planets and their stars. In this activity, the children learn about light and shadows, the transit of exoplanets around a star, stars as light emitters and the absorption of light.

Objectives

To learn:

- when an opaque or translucent object blocks a light source, a shadow is produced
- the closer the object to a light source, the larger the shadow produced
- stars emit light
- planets orbit stars blocking some of the star light
- planets can absorb and reflect light

Resources per group of four

Wooden lollipop sticks or skewers
Card
Scissors
Adhesive tape
Polystyrene spheres 3 sizes (or substitute with card circles)
Light source eg torch or LED lamp
Whiteboard
Datalogger and laptop (optional)
Activity sheets 5a and 5b

Advance preparation

Have available balls of several sizes eg football, sponge ball, tennis ball

Prepare role badges for ‘transit photometrist’ if required

Activity

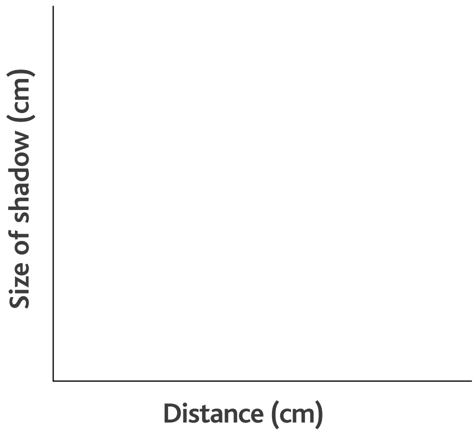
Introduction

Ask the children what happens when an opaque object passes in front of a light source. Demonstrate moving an object across the beam from the class projector and capturing the shadow on the whiteboard. Alternatively, use a torch or lamp and capture the shadow on a white card or children’s whiteboard placed behind.

Pose the questions: What happens to the size of the shadow when an object is moved closer to or further away from the light? How could you find out?

In groups, the children cut out a small figure or shape from card and attach it to a card base so that it stands upright. The children plan their investigation, make predictions and carry out the activity, taking careful measurements and recording their results. They may wish to use the recording example on Activity sheet 5a. The groups share their findings and explain their conclusions. What did they discover? What happened to the size of the shadow when the figure moved closer/further from the light source? How did they ensure a fair test each time? Can they use the data to plot a graph showing size of shadow versus distance from light?

Graph to show size of shadow versus distance from the light



Show this animation, Transiting Exoplanet Graph, showing the simulated light curve as a planet orbits a star: http://youtu.be/OX_QWa_v5rw

Model the transit of a planet across its star using the whiteboard and the class projector as the star. The class should notice the shadow on the screen as two children throw a ball from one side of the whiteboard to the other. Try varying the size of ball used.

Lesson 5

In Transit

Detecting exoplanets by measuring a dip in light

In groups, the children model the transit of a planet around its star using polystyrene spheres (or circles of card) for exoplanets and wooden skewers or lollipop sticks to hold the planets. A light source, such as a torch or an LED lamp, represents the star. Connecting a data logger to a laptop and measuring light intensity should show a drop in light measured when the planet passes across the light source.

The children are shown Activity sheet 5b displaying a set of graphs showing level of light over time as an exoplanet orbits a star. Graph a also shows how the graph would look if a larger planet orbited. On diagrams b, c and d, can they draw a line to show the graph obtained if a smaller, faster or slower planet orbits the star?

Plenary

Challenge each group to model one of the light curves shown on Activity sheet 5b. Can they explain how the light curve is changed by speed of transit or size of planet orbiting the star? Discuss the main learning points from the practical activities. Remind the children that by carefully observing a star's brightness over a period of time, scientists can detect a tiny drop in the amount of light we see from the star. They can measure this brightness and create a graph called a light curve. Planets are usually tiny compared with their star and so the drop in light is extremely small. Earth-sized planets are particularly difficult to spot. Exoplanets that are big are easier to spot, especially when we can detect many orbits. NASA's Kepler Mission has been observing the same patch of sky for years, roughly 100,000 stars, hoping to detect transits: https://kepler.nasa.gov/index.cfm

Show the following: an interesting animated video explaining the work of the Kepler Mission and how the telescope discovers planets:
https://kepler.nasa.gov/multimedia/Interactives/HowKeplerDiscoversPlanetsElementary/flash.cfm

Lightgrapher: https://kepler.nasa.gov/education/ModelsandSimulations/lightgrapher/

Extension

A lightbox can be made from a shoebox. At one end, make a hole through which to shine a light source, such as an LED torch. At the other end, make a hole directly opposite the light source. Cut a half circle in the lid near to the end where the light source is located. Insert a stick through the slit and attach a ball of plasticine to one end of the stick to represent the planet; ensure that the planet is in the beam of light. Move the stick with planet attached from one end of the semi-circular slit to the other, to represent part of the orbit. To avoid looking directly at the light, use a mobile phone or iPad positioned at the viewing hole, to take a video of the passage of the planet as it is moved around the slit.

Appendix

Lesson 5
Activity Sheet 5a

Our question is
We predict
We will change
We will measure
We will keep these things the same

Our results	
Distance from light (cm)	Size of shadow (cm)

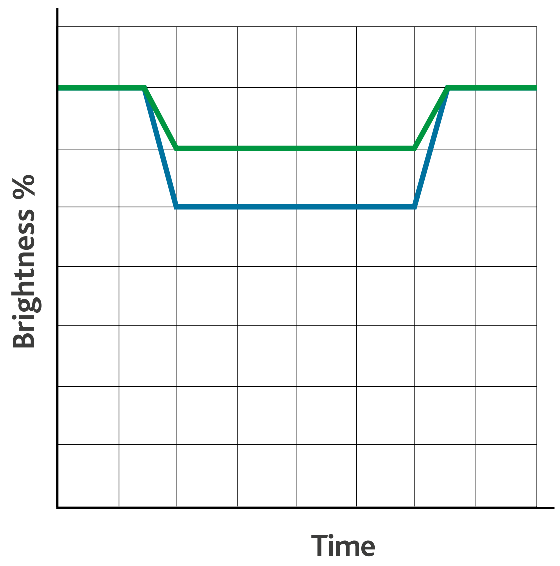
Our results show

Appendix

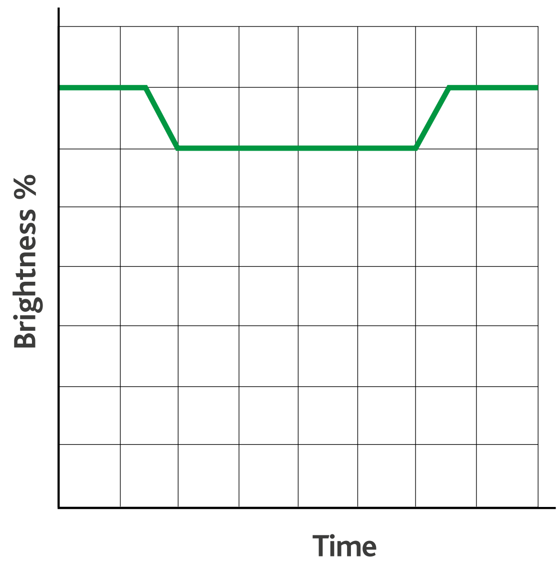
Lesson 5
Activity Sheet 5b

Here are four copies of the same light curve plotted during the transit of a planet across its star.
Graph a) also shows the curve (shown in blue) obtained when a larger planet orbited the star.
Draw another curve on the graphs to show: b)a smaller planet, c)a faster transit and d) a slower planet

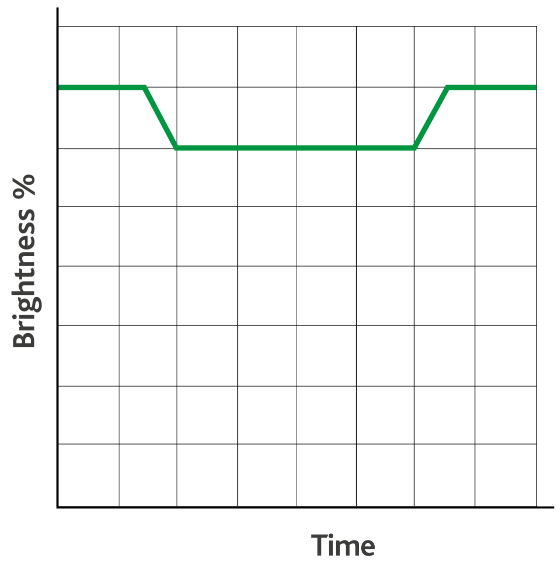
Graph A



Graph B



Graph C



Graph D