The Habitable Zone

Plotting the Orbits of Planets in our own and distant Solar Systems

Classroom Activity

Overview

Age Range:

9-11

Prep. Time:

20 minutes

Lesson Time:

1 hour 45 minutes

Cost per activity:

Medium

Includes the use of:

Calculator, scissors, paper, rulers, coloured pens/pencils, star system info sheets

Outline

In this activity, the children will become galactic astronomers, using mathematical skills and key facts to plot the orbits of Earth and planets in our solar system before plotting the orbits of exoplanets around their stars.

By plotting the orbits of Earth and other planets in our solar system, they can then learn about and calculate the position of the Goldilocks Zone.

They learn that there are other solar systems where planets orbit stars; by plotting the positions of these distant exoplanets, they discover which are potentially habitable.

Pupils will Learn:

- Our solar system consists of eight planets orbiting our star, the Sun
- Earth orbits the Sun in the habitable or Goldilocks Zone
- Other solar systems exist in space
- To interpret information and scales and use decimals to plot orbital distances of planets

Lesson Plan:

Overview of the time required to complete lesson.

The online observatory collaboration consists of the following partners:
Baldone Observatory, Brorfelde Observatory, Cardiff University, Harestua Solar Observatory, Helsinki Observatory

Description	Time	Notes
Activity 1	15 min	Show an animation of a solar system e.g. Paxi and the Solar System: https://bit.ly/3mKHFFU Act out the orbit of Earth, the Moon, and our solar system.
Introduction to Habitable/Goldilocks Zones	15 min	
Break	15 min	
Introduction to activity 2	15 min	Demonstrating the activity by working as a class to plot our solar system and calculate the goldilocks zone
Activity 2	30 min	Students will be provided a chosen star and information about its exoplanets from pdf 'HabitableZones_StarInfoSheets'
Assessment	15 min	

Activity 1:

- Ask the children if they know what a planet is. Can they name any planets in our solar system? How many are there? Do they know which planet we live on and the name of our star?

The teacher will introduce the activity, showing the video available at https://bit.ly/3mKHFFU . If available, 3D models of the planets can be shown.

1. In groups, the children act out the orbits of Earth and the moon around the Sun.
2. They can combine groups and demonstrate the orbits of other planets in our solar system as well.

Introduction to the subject:

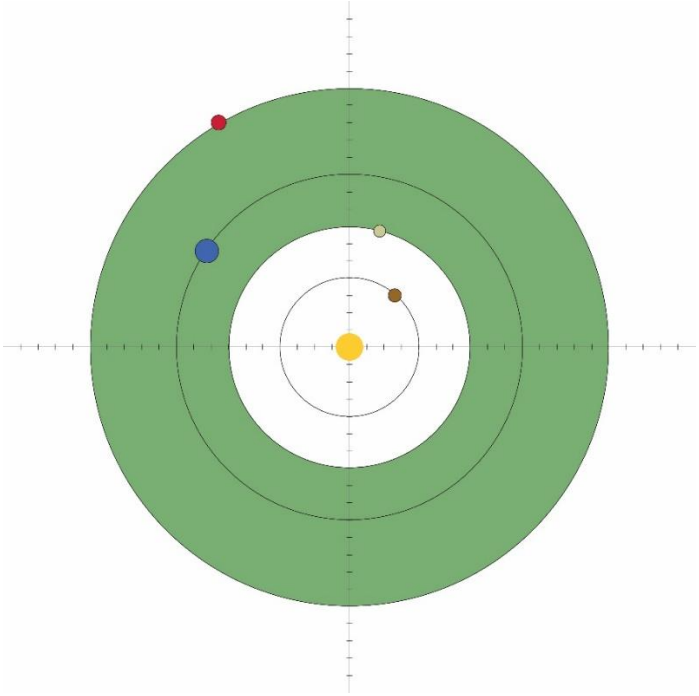
Explain that we need water to exist and life exists on our watery planet, but conditions for life are not present on other planets in our solar system. Planets too close to the Sun are far too hot for water to exist as a liquid; it would be turned to steam and evaporate; too far away from the Sun and water would freeze. Earth's orbit is just right; neither too hot nor too cold. We call this the Goldilocks or habitable zone.

However, there are other planets orbiting different stars which may have favourable conditions for life, without things living on them.

How many of these potentially habitable planets that have life is a big (and exciting!) question. Now we can make observations, which tell us which planets might host life, but that alone won't tell us if alien life exists.

Activity 2:

- Have the students watch as you demonstrate drawing an axis on the whiteboard, explaining each point as 0.1 AU from the centre. Ask them what should be at the centre of our solar system, then mark the sun there. Mark Earth's orbit by drawing a mark at 1AU on each point of the axis, then joining them all in a circle. Repeat for some of the other planets in our solar system, if further demonstration is required. Then have the class help you calculate the inner (1 x 0.7) and outer (1 x 1.5) reaches of the Suns goldilocks zone, adding them to the axis. Ask the students which planets are inside the habitable zone. The figure below shows you the habitable zone for the Sun and the first four planets in our solar system:



- Split students into groups of 4-5 and distribute the stars and relevant exoplanet data (found in the accompanying pdf) to them

The teacher will introduce the activity, by doing a demonstration for our solar system as described above.

1. The students will first need to use rulers to plot out the axis on their 60 x 60 cm squares of paper (the axis values will vary for each star; some guidance has been provided on star information sheets). Have them write the name of their star on the sheet.
2. Cut paper into circles to represent the Star and other exoplanets labelling each one (alternatively make them from plasticine) and place the Star in the centre where the axis meets

3. Have students mark the orbits of each exoplanet in turn, connecting them with a circle and placing the relevant circle on its path
4. Help students to calculate the goldilocks zone, and mark it on the solar system diagram they have created, what planets are inside?

Assessment:

The groups share their results with the class. The results may be displayed on the whiteboard.

1. **Which groups discovered a planet orbiting within the Goldilocks zone of their star system?**
2. **Why would some not be habitable?** Remind the children that we need to live on a rocky planet
3. **Which of their planets would be too hot/cold for life to exist?**

Compare the solar system diagrams made with the example ones at the end of the information sheet pdf.

Further Work:

Have a student represent each star, using the fact sheets can they arrange themselves into the following orders:

1. Distance from Earth
2. Brightness
3. Size/mass

Background Material/Knowledge:

An **astronomical unit (AU)** is the distance of the Earth from the Sun; this distance varies as Earth orbits the Sun, equivalent to 149,597,870,700 metres, or 150 million km.

A **planet** is defined as a body that orbits a star (in our case, the Sun), which is sufficiently massive for its own gravity to make it spherical and has 'cleared its neighbourhood' of smaller objects around its orbit.

A **light year** or ly is the distance light can travel in one year, or 300,000 kilometres/second. Luminosity is a measure of brightness or power of a star, the amount of energy that a star emits from its surface. It is usually expressed in watts and measured in terms of the luminosity of the Sun.

Based on the ESERO UK activity: https://www.stem.org.uk/resources/elibrary/resource/417024/are-we-alone-search-planets-beyond-our-solar-system#&gid=undefined&pid=2