

Lesson 21: Missions Outside Our Solar System: Kepler

Summary

This learning module is meant for adaptation into any course wishing to introduce students to planets outside Earth's solar system. Students will learn about the 'habitable zone' and apply techniques used to find planets outside our solar system.

Learning Goals

Students will be able to:

- Identify and explain the “habitable zone”
- Explain and apply the planet transit technique of detecting planets outside our solar system in the Kepler Mission.
- Utilize software programs such as Planet Hunters and the Kepler Exoplanet Transit Hunt sponsored/created by NASA missions.

Context for Use

This learning module can be used in any course of instruction where instructors would like to introduce students to planets outside our solar system and the concept of the habitability zone.

Description and Teaching Materials

In-Class Activity

In-Class Activity 1: Seeing like Kepler

Homework/Lab

Homework 1: Light Grapher

Homework 2: Planet Hunters!

Teaching Notes and Tips

1. Purchase or order an orrery device in order to use *In-Class Activity 1* Seeing Like Kepler in your course
2. All Homework sets can be adapted for the classroom if desired.

3. Before students are assigned *Homework 1* “Light Grapher” provide a demonstration of how the software works and explain to students that they will need a webcam in order to do the homework
4. Create a planethunters.org account so you can demonstrate how the website interacts with the user in the *Homework 2* “Planet Hunters”.

Assessment

Methods of assessment are within each individual *In-Class Activity* and *Homework*.

Mars for Earthlings

References and Resources

1. Kepler Exoplanet Transit Hunt computer interaction:
<http://kepler.nasa.gov/multimedia/Interactives/keplerFlashAdvDiscovery/#>
2. Orrery suggestions for building:
<http://kepler.nasa.gov/education/ModelsandSimulations/LegoOrrery/>
3. Planet Hunters: <http://www.planethunters.org>



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In-Class Activity 1

Missions Outside our Solar System_MFE

Seeing like Kepler

Purpose: Understand how Kepler locates planets outside our solar system.

Preparation:

1. Purchase or make an orrery (model planet system)
2. Have Internet access in the classroom

Resources:

1. Orrery suggestions for building:
<http://kepler.nasa.gov/education/ModelsandSimulations/LegoOrrery/>
2. Kepler Mission: <http://kepler.nasa.gov>
3. Kepler Exoplanet Transit Hunt:
<http://kepler.nasa.gov/multimedia/Interactives/keplerFlashAdvDiscovery/>

Engage

Show students a model planet system (orrery) and ask students how they might be able to detect the planet orbiting its sun if it is thousands of light years away.

Explore

Ask students what problems might they encounter in trying to detect a planet orbiting a star.

- The star is far brighter than the planet and a scientist can't see it because planets are not as bright
- The planet is too small for detection

Have students interact with the online Kepler Exoplanet Transit Hunt simulation:

<http://kepler.nasa.gov/multimedia/Interactives/keplerFlashAdvDiscovery/?CFID=9187896&CFTOKEN=28729865>

Students will:

1. Choose and record the star system they are observing.
2. Manually record and make calculations throughout the simulation. Record calculations below:
3. At the end of the simulation, what kind of planet did the students find? The programs offers an "artist's rendition" of the planet surface....what does it look like?



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4. Determine if their star system has a planet in the habitable zone. Explain the reasoning for why the planet is or is not in the habitable zone.

Explain

Transit method of detecting planets

(http://www.nasa.gov/mission_pages/kepler/multimedia/images/kepler-transit-graph.html):

When a planet crosses in front of its star as viewed by an observer, the event is called a transit. Transits by terrestrial planets produce a small change in a star's brightness of about 1/10,000 (100 parts per million, ppm), lasting for 2 to 16 hours. This change must be absolutely periodic if it is caused by a planet. In addition, all transits produced by the same planet must be of the same change in brightness and last the same amount of time, thus providing a highly repeatable signal and robust detection method. Credit: NASA

Elaborate

Have students brainstorm

1. A detection method for determining an exoplanet
2. Criterion for the “habitable” zone (size of star, proximity of orbiting planet, size of planet etc.)

Evaluate

1. From students experience in the Kepler simulation what is the *habitable zone* and how does it relate to Earth? What criterion makes a zone “habitable”?
2. Ask students to explain the “transit method” of detecting planets.

