

Teacher Guide for the BLOSSOMS Lesson, The Parallax Activity: Measuring the Distances to the Nearby Stars

One of the hottest topics in astronomy in recent years has been the discovery of planets orbiting other stars. Over 800 exoplanets have been found, ranging from hot Jupiters to planets the size of Earth orbiting in the goldilocks zone around their parent stars. All this excitement has led to intense interest in the nearby stars, including what they are like and where they are located. Finding the three-dimensional position of stars and other objects in space is an important concept in astronomy.

This lesson teaches students how the distances to nearby stars are measured using the parallax effect. As Earth orbits the sun, the positions of the nearest stars seem to wobble back and forth compared with the background stars; this isn't because the stars are moving but because the Earth is. This is called the parallax effect: how the apparent position of an object seems to change because of differences in the observer's position.

Even the nearest stars have parallax angles that are less than one arcsecond of a degree (or less than $1/3600$ of a degree) and are very difficult to measure without specialized equipment. This lesson simulates the process by laying out simulated "planets" around our "sun" in a parking lot, large lawn, or practice field. Four "stars" are laid out perpendicular to the line of the planets. The teacher will measure all the distances between the sun and planets and the sun and the stars beforehand. During the activity, the students will use a homemade quadrant (a meter stick, protractor and plumb bob) to measure the parallax angles from each of the planets to each of the stars, and the distances from the planets to the sun. They will then use the tangent function to calculate the distances from the sun to the stars. These distances will then be compared with the actual distances to see how close the students came.

In addition to the main activity, students will practice doing the calculations by measuring the angle from their location to the top of a local landmark, such as a mountain or building, then use the Ruler tool in Google Earth to find the horizontal distance. Each team will need a quadrant (a meter stick with a protractor and plumb bob attached) to find the angle, then use a calculator or trig table to find the height of the landmark.

This lesson also suggests ways in which parallax and trigonometry functions are used in real-world applications, such as surveying, solar navigation, and even 3D movies. It also discusses how the actual parallax angles to stars are measured, and other techniques for finding the distances to stars.

This lesson takes about 90 minutes to complete and can be separated into different days; the introductory activities can be done on the first day and the actual parallax

activity and calculations done on the second day. It also requires some set up time on the part of the teacher to lay out the planets and stars and to measure their distances from the central sun. This lesson can be used in an earth science or astronomy class or a trigonometry class and is appropriate for students from 7-12 grades. Some of the science education standards it fulfills include Measurement, Coordinate Systems, Modeling, Estimation, and Applications of Math to Science.