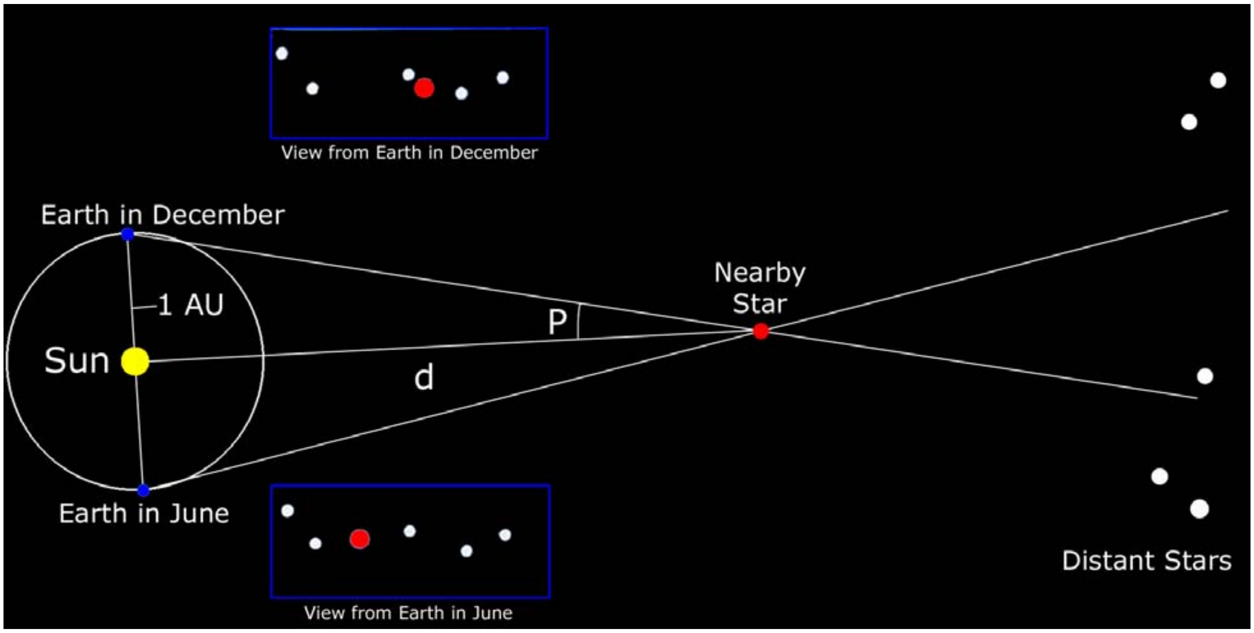
Parallax—How Far Is It?



Goals:

- To demonstrate the concept of parallax and how it is related to distance
- To show a method that astronomers use to measure astronomical distances

Overview:

In this activity from the Project ASTRO Resource Notebook: *The Universe at Your Fingertips, Activity J-2, Parallax—How Far Is It?*, students will use a simple device to measure angles of parallax for objects within the classroom. They will use their measurements to calculate the distances to those objects.

The activity, as written for Project ASTRO, asks students to calculate the distance to an object by using a table of factors of baseline distances for a measured parallax angle. For a more inquiry-oriented and quantitative approach see the **Going Further** sections.

Astronomers use this very method to measure the distance to nearby stars. They use the diameter of Earth's orbit as their baseline.

Going Further (Supplement to Project Astro Activity):

Another alternative approach for this activity would be to have students measure the parallax angle and directly measure the distance for each object and record the data in a table (see next page). Then, they should graph the data, plotting parallax angle as a function of distance.

The students should analyze the graph and determine an approximate functional dependence for parallax with distance. Then, if the students are studying—or have studied—trigonometry, have them draw diagrams of the parallax measurements; and, ask them to use what they know from trigonometry to derive what the actual functional dependence is:

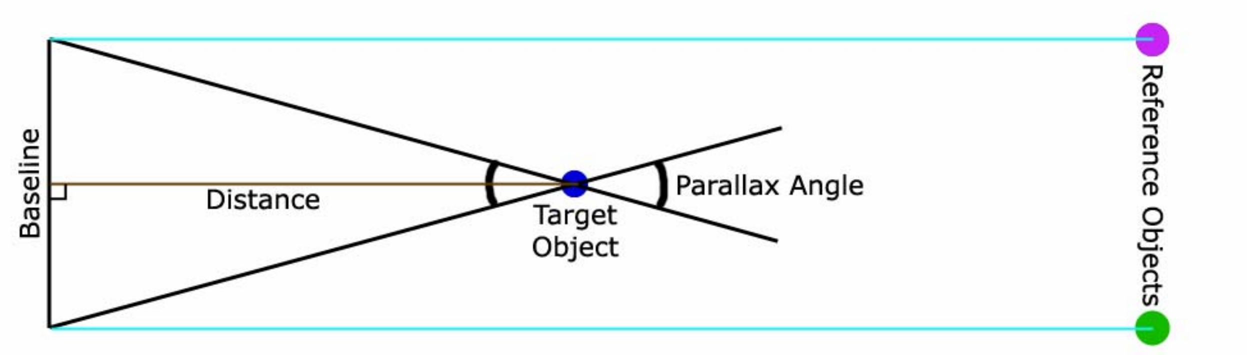
b = baseline, p = parallax angle, d = distance

$$\tan(p/2) = (b/2)/d$$

$$\mathbf{p = 2\tan^{-1}(b/2d)}$$

Have them plot this function on the same graph as their data and compare their measurements with the theoretical prediction from geometry.

Note: For this to work properly, the reference point used in the parallax measurements must be far away and exhibit little parallax itself. Otherwise, the data will be systematically skewed to lower parallax values. One way to do this is to place reference targets on the far wall of the classroom and space them apart the same length as the baseline the students are using. When the students are on one side of the baseline, they should line up with the reference target on the same side of the target object (see figure below). It is important that students line up the eye arrow with either the reference object or target object arrow plus the objects themselves when making their measurements. To do this, students must keep the angle measurer fixed in place but move their eye to line up the arrows with the targets. If they do not move their eye, they will get parallax values systematically skewed to higher values.



Distance to Object	Parallax Angle

Example Data:

Distance to Object (ft.)	Parallax Angle (degrees)
2	58
4	30
6	19
8	15
10	12
12	9
14	8
16	7.5
18	6
20	5