The triangulation and parallax methods
By the Romanian Team

Name   Country

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Purpose

The purpose of this experiment is to measure the distance between two points using the parallax method. We chose to present this because it is of great importance regarding measuring distances in our solar system or to other stars.

From Triangulation to Parallax

Triangulation is used to determine terrestrial distances by forming triangles with a predefined base and measuring the angles formed with the other two sides. One of the most important roles of triangulation is its usage in all our GPS Systems.
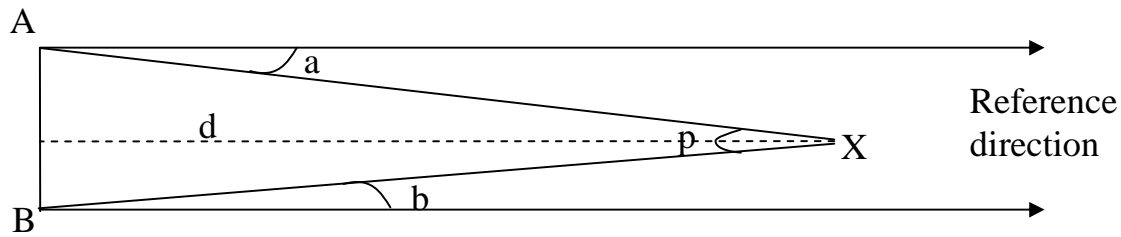Parallax, on the other hand, is used to determine distances that cannot be measured directly. People have figured out that they can find out distances to objects that are several light years away. This method has been used in the past, but thanks to new high-tech angle measurement tools the distances now can be measured much more precisely. More on Parallax and a short experiment is presented later on.

Background

Triangulation is the process of determining the location of a point by measuring angles to it from known points at either end of a fixed baseline, rather than measuring distances to the point directly. The point can then be fixed as the third point of a triangle with one known side and two known angles.
Parallax is an apparent displacement or difference in the apparent position of an object viewed along two different lines of sight, and is measured by the angle or semi-angle of inclination between those two lines. Astronomers use the principle of parallax to measure distances to objects (typically stars) beyond the Solar System.
Distance measurement by parallax is a special case of the principle of triangulation which states that one can calculate all the sides of a triangle if, in addition to all the angles, the length of one side has been measured. In parallax, the triangle is extremely long and narrow, and by measuring its shortest side AB (the motion of the observer) and the small top angle p (the other two being close to 90 degrees), the length d of the long sides (in practice considered to be equal) can be determined.

A, B, a, b, d, p, X, Reference direction

Types of Parallax

Stellar Parallax

On an interstellar scale, parallax created by the different orbital positions of the Earth causes nearby stars to appear to move relative to more distant stars. By observing parallax, measuring angles and using geometry, one can determine the distance to various objects. When the object in question is a star, the effect is known as stellar parallax.

Diurnal parallax

Diurnal parallax is a parallax that varies with rotation of the Earth or with difference of location on the Earth. The Moon and to a smaller extent the terrestrial planets or asteroids seen from different viewing positions on the Earth (at one given moment) can appear differently placed against the background of fixed stars.

Lunar parallax

Lunar parallax (often short for lunar horizontal parallax or lunar equatorial horizontal parallax), is a special case of (diurnal) parallax: the Moon, being the nearest celestial body, has by far the largest maximum parallax of any celestial body, it can exceed 1 degree.

Solar parallax

After Copernicus proposed his heliocentric system, with the Earth in revolution around the Sun, it was possible to build a model of the whole solar system without scale.

Reports & Requirements

Do the experiments described in the next sections for measuring distances using the parallax method. This report should include, in order:

1: The general idea of the experiment.
2: The equipment used for this work.
3: A summary of your experimental results.
4: The conclusions you have reached.

Processes

The purpose of this exercise is to introduce simple techniques for measuring angles, to use these techniques to become familiar with the relationship between distance, angular size and linear size; and to study the principles of the parallax method of determining distances to celestial objects. The processes stressed in this exercise include: Using numbers, identifying variables, controlling variables, using logic.

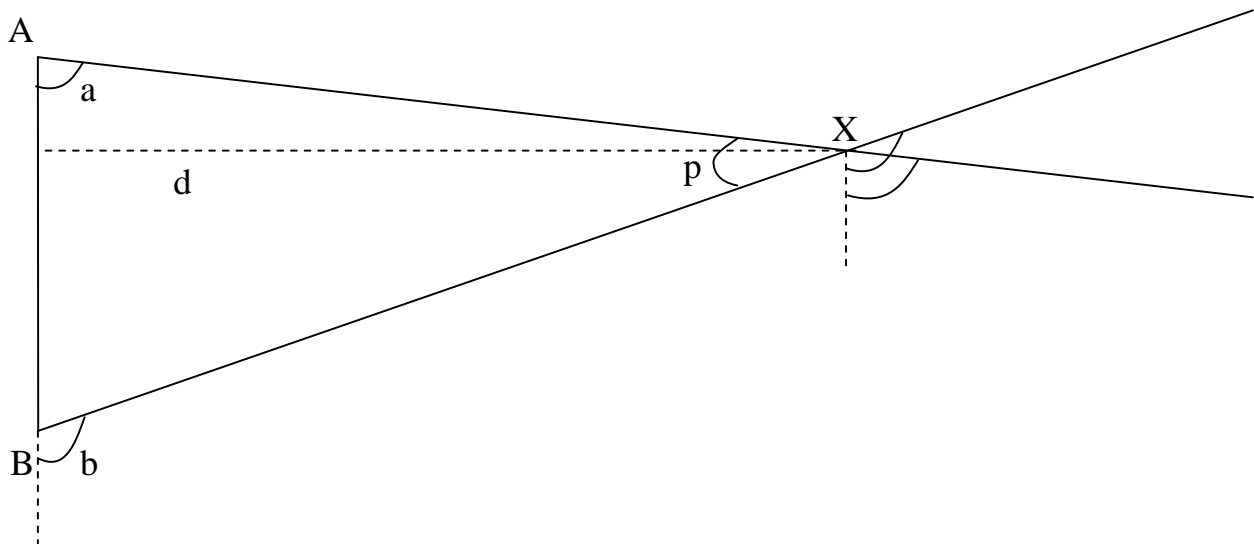Step 1: Choose a point (object) to measure the distance between the base and it (X).
Step 2: Select a base near you and measure its width (AB).
Step 3: Form a triangle (ΔAXB) and measure the angles (a, b).
Step 4: Calculate "p" as being: $p=|a-b|$
Step 5: Apply the formula:

$$d=AB \:/\: p \text{ (radians)}$$

Explications:
We can use "p", in radians, in the above formula instead of sin(p) because the angle is small enough to approximate sin(p).

Parallax error

Precise parallax measurements of distance have an associated error. However this error in the measured parallax angle does not translate directly into an error for the distance, except for relatively small errors. The reason for this is that an error toward a smaller angle results in a greater error in distance than an error toward a larger angle.

Target Angle 1 (a) [   ]

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Target Angle 2 (b) [   ]

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Parallax Angle (p) [   ]

Baseline (AB) [   ]

/

Parallax Angle (p) [   ]

_____

=

Distance to object [   ]

Parallax Angle 1 [   ]

+

Parallax Angle 2 [   ]

+

Parallax Angle 3 [   ]

+

Parallax Angle 4 [   ]

+

Parallax Angle ... [   ]

+

Parallax Angle N [   ]

/Number of Angles

_____

=

Parallax Angle (p) [   ]