

Lab 4

Parallax Measurements and Determining Distances

4.1 Relevant Lecture Chapters

This laboratory exercises draws upon the material in Chapter 10: Geocentric and Heliocentric Models. There are loosely related concepts for visualization of objects and orientations in Chapter 7: Mechanics of the Solar System and Chapter 8: Geometry of the Solar System.

4.2 Learning Objectives

After completing this laboratory exercise, the student should be able to do the following:

- Use a ruler to measure linear distances, and a protractor to measure angular separations.
- Describe the effect of varying the observational baseline or the distance to an object on its apparent change in angular position against a panorama of distant objects.
- Understand the concept of a parallax measurement, and explain how the parallax technique can be used to determine the distances to solar system and galactic objects.
- Visualize the connection between an astronomical unit, an arcsecond, and a parsec, and use the first two to define the third.
- Connect the differences between repeated measurements of a single quantity to a measure of error or accuracy.

4.3 Keywords

Arcminute – An arcminute is a unit of angular size, equal to $1/60$ of a degree (recall that there are 90 degrees in a right angle). There are 60 arcseconds in an arcminute (see below).

Arcsecond – An arcsecond is a unit of angular size, equal to $1/60$ of an arcminute or $1/3600$ of a degree. Astronomers often measure the angular separation between neighboring objects on the sky in units of arcseconds.

Astronomical unit – The average distance between the Earth and the Sun, equal to 1.5×10^8 kilometers.

Degree – A unit used to measure angles. There are 90 degrees in a right angle, and 360 degrees in a full circle.

Light year – A unit of distance (not time), equal to the distance which light travels in a year. One light year is equal to 0.307 parsecs.

Parallax – A technique for estimating the distances to objects, by measuring their apparent angular shifts on the sky relative to distant objects when they are observed from two separated locations.

Parsec – A unit of distance defined as the distance at which an object exhibits a parallax shift of one arcsecond. As the Earth rotates around the Sun and shifts by a length of one astronomical unit, a star which lies one parsec away from Earth will appear to shift by one arcsecond across the sky. One parsec is equal to 3.26 light years or 206,265 astronomical units.

Radian – A unit used to measure angles. There are $\pi/2$ degrees in a right angle, and 2π radians in a full circle.

Small angle approximation – For small angles (less than 10 degrees, or $\pi/18$ radians), the tangent of the angle is roughly equal to the angle itself, measured in radians.

4.4 References and Notes

1) This laboratory exercise is based on an in-class parallax exercise taken from the 2007 New Mexico State University Astronomy Department ASTR110G laboratory manual.