DISTANCE AND SIZE OF A PLANET

Purpose of Exercise:

To learn the simple technique of finding the approximate distance and size of a planet.

Equipment needed:

telescope, stop watch, ruler, protractor.

Introduction:

The main observational difference between a star and a planet is that a planet appears as a disk in the telescope's view, while the star remains but a point of light. This is simply because the planets are so much closer to us than the stars. In this exercise we'll make use of this fact.

Procedure:

(1) At the telescope

(a) Find a planet and center it in the field of view of the telescope. Use a high-power eyepiece.

(b) Move the telescope in right ascension to the East so that the planet is just on the edge of the field of view.

(c) Turn off the clock drive. The Earth's rotation will now move the planet out of the field of view. As soon as the leading edge of the planet touches the edge of the field of view, start the stopwatch. Now, as the whole planet disappears from the field of view, stop the stopwatch. Note how many seconds are required for the whole planet to disappear from the field of view. (Fig.1)

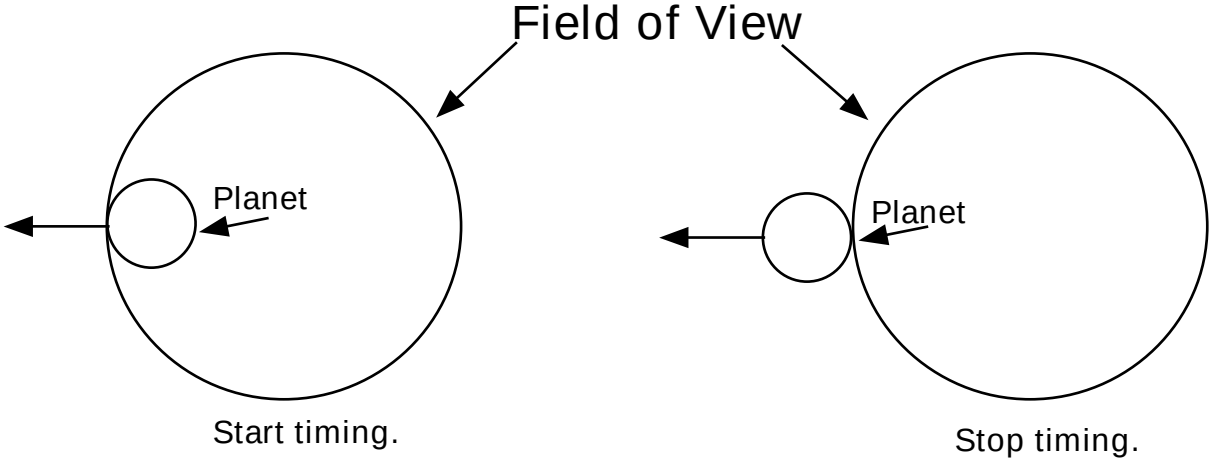

Fig. 1

Since the Earth turns through 15° each hour, simply multiply the number of hours between sunset and the time of your observation by 15. This is the angle of the Sun below the horizon.

To find the angle between the planet and the western horizon, take the result of step (1) (g) above and also multiply by 15. (Note that you must convert minutes to decimal fractions of an hour. For example, 2 hours and 15 minutes (2:15) must be converted to 2 and ¼ hours (2.25).

The angle *a* is therefore:

Angle *a* = (time since sunset in hours) x 15
+(the difference in R.A. between planet and western horizon) x 15

(b) Make a scale drawing with a protractor of the angle *a*. Let 1 AU equal an appropriate number of centimeters (for example, 5.) and draw the Sun and the Earth. Connect them with a line which now represents 1AU. Extend the line from the Earth at angle *a* away from the Sun to the edge of the page as in Fig.2.

(c) The length of the third line in the triangle (Sun to Planet line in Fig.2) represents the distance of the planet from the Sun. The distances of the planets from the Sun are given below:

Planet	Distance from the Sun (AU)
Mercury	0.39
Venus	0.72
Earth	1.00
Mars	1.52
Jupiter	5.20
Saturn	9.54

Determine the planet's distance from the Sun in centimeters using your scale. (For example, 1 AU = 5 centimeters.) This is the length of the third side.

(d) With a centimeter ruler, draw a line of exactly the length just determined in (c) so that it stretches from the Sun and just touches the line drawn in Step (b). You now have a triangle.

(e) Measure the distance between the Earth and the planet on your scale drawing in centimeters. Convert this distance to AU's. You have now found the distance of the planet from the Earth in AU's.

(d) If you wish to find the diameter of the ring system of Saturn, make your timing using the whole ring system and not just the planet itself.

(e) Make at least three timings and take an average.

(f) Center the planet in the field of view and set the right ascension dial to read 0 (zero) hours.

(g) Turn the telescope tube until it is pointing directly at the western horizon (which means it will be horizontal.) Read the right ascension dial and subtract this reading from 24 hours (24:00).

(h) Record the time of the last observation and the approximate time of sunset on the date of this observation.

(2) Computations

(a) Assume that the Sun, Earth and planet are situated as shown below in Fig. 2.

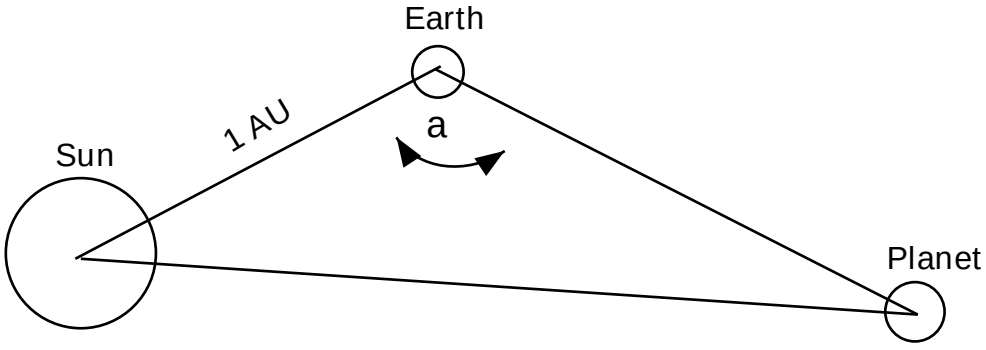

Fig. 2

The angle a is the angle between the Sun and the planet in our view. It is the sum of two angles: the angle between the planet and the horizon, and the angle of the Sun below the horizon. Fig 3.

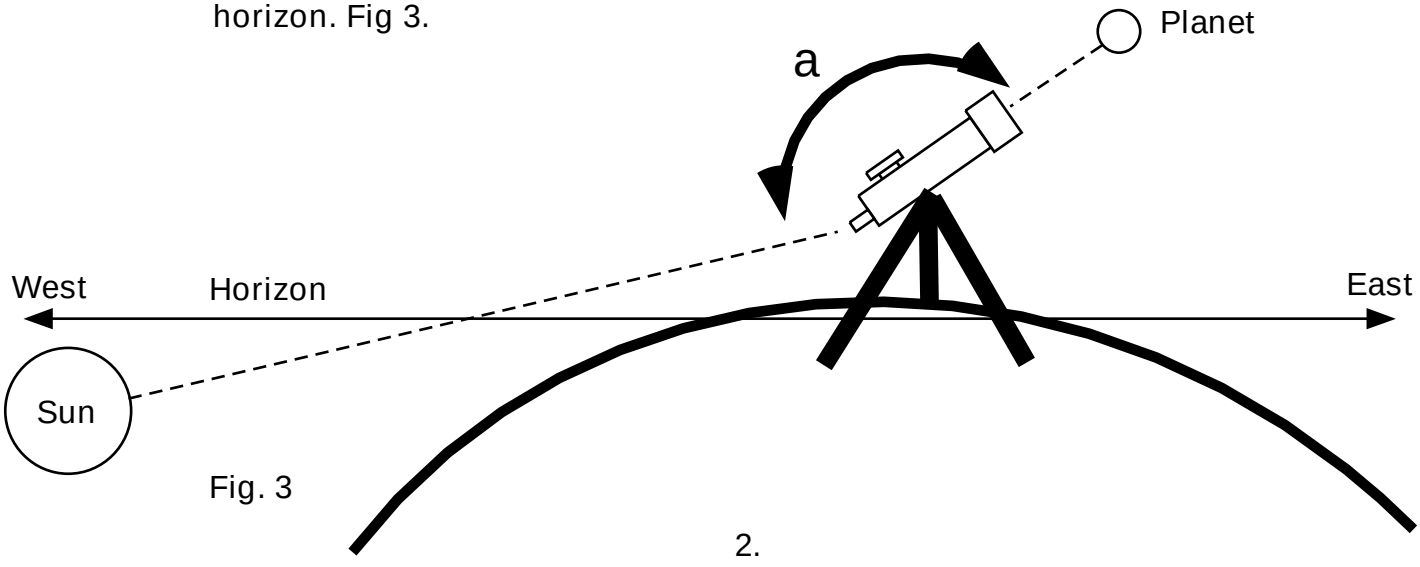

Fig. 3

(f) Estimate the apparent size of the planet. Since the Earth turns through approximately 15 seconds of arc each second, the apparent size of the planet is simply given by:

Apparent size = 15 x t (secs)

where t is the number of seconds you measured in Step (1) (c).

(g) Determine the actual size of the planet. The actual diameter (in kilometers) of the planet is given by:

Diameter (km) = 727 x (distance to the planet in AU's) x (apparent size)

This completes the exercise.