ASTR101L

Planetary Observations Lab Supplement

Objective: To find the distance to Saturn and the diameter of its rings

(For part D and the first part of E, you don't have to align your telescope. Saturn is visible to the naked eye so you can manually move your telescope to view it)

Part D:

- Make a sketch of your field of view (when looking at Saturn) in one of the circles on your data sheet. We don't have extremely high magnification, so do your best. Mark any possible moons you see. (HINT: If Saturn looks like a donut, you're out of focus).

Part E:

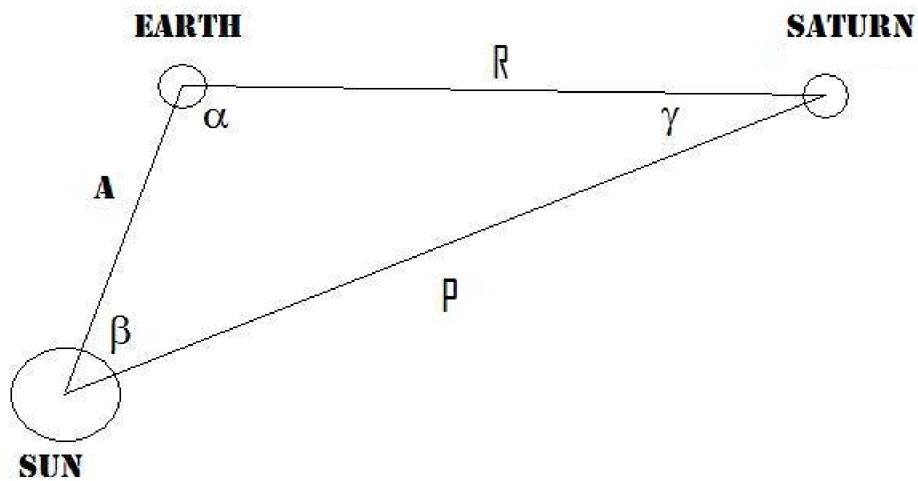
1. **Measuring the Apparent Size of Saturn**
   - With an unaligned telescope, center Saturn in the field of view.
   - View it long enough to see what direction the planet drifts.
   - Move the planet to the edge of the field of view so that it will drift out of the field of view perpendicular to the edge (see figure 1 in manual).
   - Time how long it takes for the planet to fully leave the field of view (consider the rings as marking the diameter of the planet). Do this at least 3 times. This lets you find the angle, θ.
2. **Finding the distance to Jupiter**
   - Align the telescope if you have not done so already
   - Our immediate goal is to find the angle between the Sun and Saturn, α (see figure 2). α is composed of two separate angles, the angle between Saturn and the horizon, φ_1, and the angle between the horizon and the Sun, φ_2 (see figure 3).
     1. Find Saturn and write down its current right ascension (r_1).
     2. Slew your telescope so that it is facing the horizon (so the tube is level with the ground) and then point the telescope west (the Computer Control panel on the telescope faces west, so feel free to use it as a guide).
     3. Record this new right ascension (r_2).
     4. To find φ_1, take the difference of the two right ascensions, converted to angles
        $$\varphi_1 = 15|r_1 - r_2| \text{ degrees}$$
     5. The other angle, φ_2, can be found by subtracting your current time and the sunset time, IN HOURS, and multiplying by 15.
        $$\varphi_2 = 15(t_{current} - t_{sunset}) \text{ degrees}$$

6. **6.** Add φ $_1$ and φ $_2$ to get α ($\alpha = \varphi_1 + \varphi_2$ degrees)

- You now have a choice in how to determine the distance, R, from the Earth to Jupiter. Either
    a. Follow steps 2-4 in part E of the lab manual to construct a scale drawing of the Earth, Sun, Saturn system, and find the distance from your diagram.

    or

    b. Use simple geometry:



- We know α, P, and A. We want to find R.
- The *law of cosines* allows us to solve for R

$$R^2 = A^2 + P^2 - 2AP\cos\beta$$

However, we don't know β. Luckily, we can find it though from the *law of sines*. First, we find γ:

$$\frac{P}{\sin\alpha} = \frac{A}{\sin\gamma} \Rightarrow \gamma = \arcsin\left(\frac{A\sin\alpha}{P}\right)$$

We know that all the angles in a triangle add up to 180 degrees. This lets us find β:

$$\beta = 180 - \alpha - \gamma$$

Plugging β into the law of cosines formula gives us R, the distance to Jupiter.

3. **Finding the diameter of Saturn (or Saturn's rings)**
    - Follow the instructions under "TO FIND THE SIZE OF THE PLANET" on page 24.

For the lab report

- There's basically no background theory for this lab. Focus your introduction on the purpose and procedures.
- Clearly show all calculations, and be sure to give a percent error for the diameter of Saturn (don't worry about trying to give a percent error for the distance between Earth and Saturn).
- DON'T cite the alignment of the telescope as a source of error.

MAKE SURE I SIGN YOUR DATA SHEET BEFORE YOU LEAVE!!!