

7.7: Wrapping It Up 7 - The Galilean Moons of Jupiter

You are tasked with determining the mass of Jupiter by making careful observations of three of the planet's four major moons: Callisto, Europa, and Ganymede. Io's data have already been taken and analyzed as an example.

The mass of an object can be determined through Newton's laws. Earlier in this chapter, we found that:

$$4\pi^2 r^3 = GMT^2$$

where M is the mass of an object being orbited, r is the distance to an orbiting object, and T is the period of the orbiting object. We can re-write this to create an expression for the mass of the object (in this case Jupiter):

$$M = \frac{4\pi^2 r^3}{GT^2}$$

In this activity, you will measure the period and distance of three of Jupiter's moons and use that information to determine the mass of Jupiter.

7.7.1: Part I: Data Acquisition

Play Activity

Click on the moons in the telescope's field of view, which will allow your computer to measure the moon's distance from Jupiter.

- Do this for each of the three moons and then click "next" to retrieve the next day's image.
- Repeat the process for at least 17 consecutive days worth of data (preferably 33 days).

Don't worry if you cannot click on a particular moon during one or more days. You will still gather enough data.

The data used in this activity were obtained from observatory.tamu.edu:8080/Widgets/galilean.html.

7.7.2: Part II: Data Analysis

Now that you have collected 17-33 days worth of data on where the moons of Jupiter are in relation to their parent planet, you can perform data analysis on your results.

- Click on the "Data Analysis" button on the lower right side of the telescope's field of view. This brings up a graph of the data for Io and for the three moons you observed: Europa, Ganymede, and Callisto.
- Click on the "Europa" tab at the top and then click on the "Overlay Sine Wave." The blue line represents the overlay.
- Adjust the Amplitude, Period, and Phase sliders until the overlay matches your data. Repeat this process for your Ganymede and Callisto data.



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7.7.3: Part III: Results

Once you have analyzed your data, click on the “Results” button next to the “Data Analysis” button on the lower right. This will bring up the Results window, which you can drag around the field so you can better see your data analysis results.

The Results tool will automatically calculate the mass of Jupiter based on the expression derived from Newton’s laws. To do this:

- Fill out the fields in the Results window with your data, where “amp” indicates the measured amplitude and “per” the measured period .
- Once you have filled out a moon ’s data into the equation, click on the equals sign to get the result.
- Once you have all four moons filled out (Io is already done as an example), click on the equal sign for the “Averaged Jupiter Mass” at the bottom of the Results window.



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7.7.4: Part IV: Reporting



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7.7.5: Part V. Discussion

We can also use our data to examine the orbital energetics of Jupiter's moons.



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*The radius of Jupiter is 7.15×10^7 m

** The number of seconds in a day is 8.64×10^4 s/day



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