

## FIND THE PERIOD OF IO

### INTRODUCTION

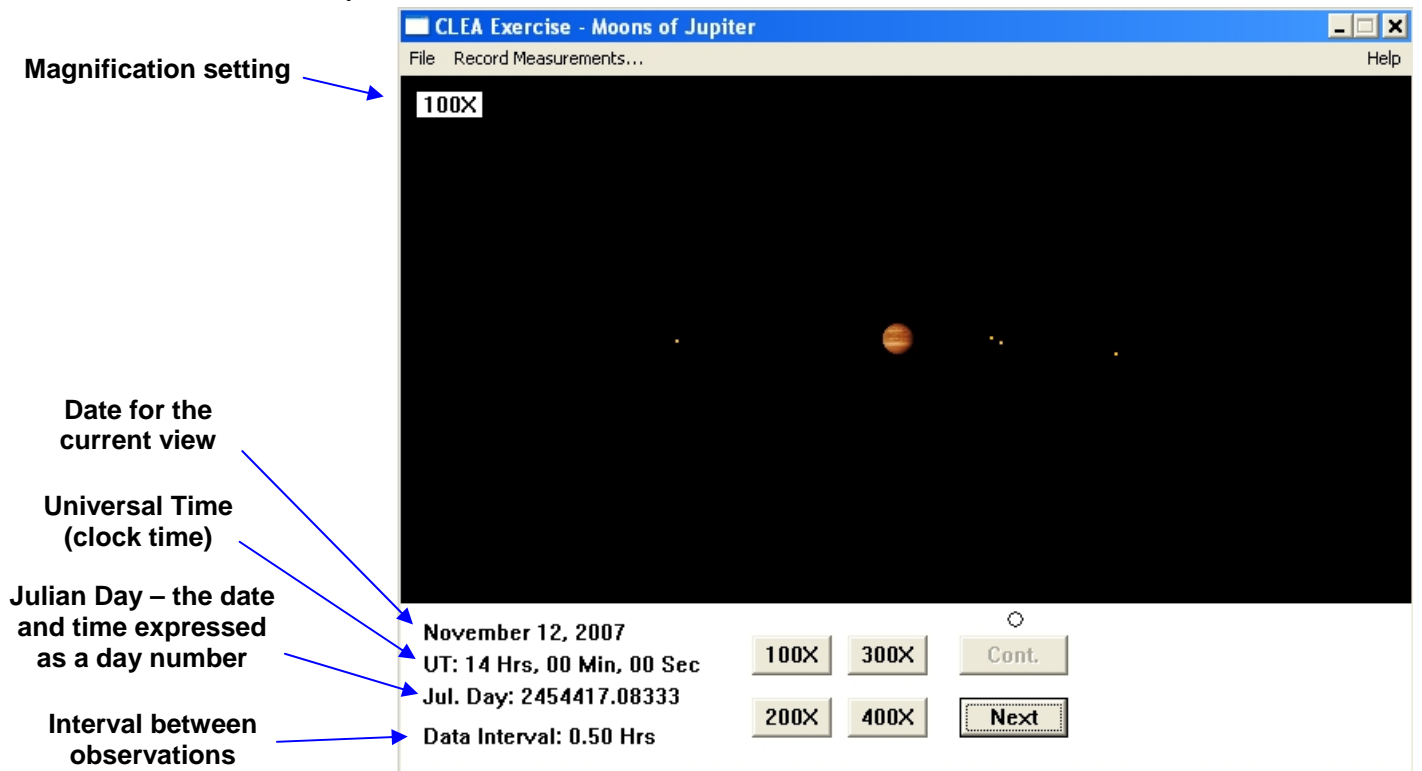
Of the four Galilean satellites, Io is the one that orbits closest to Jupiter. Since it is closest it will have the shortest period of revolution – the time it takes to orbit Jupiter once.

A diligent observer watching Io with a telescope over several days can determine how long the period is. The CLEA program *Moons of Jupiter* allows you to simulate observing Jupiter with a telescope.

The technique for determining Io’s period is to note the time when Io is directly (or as close as possible) in front of Jupiter (this is called a *transit*). Then let time pass and note the time when Io is again directly in front of Jupiter. The time interval from the first transit to the second is Io’s period of revolution.

### BUT TRY THIS FIRST

- Open the *Moons of Jupiter* CLEA program.
- Under **FILE** go to **PREFERENCES** and then go to **TIMING**
- Set the **OBSERVATION INTERVAL** to **0.5 hours** – we will look at Jupiter every half hour.
- The magnification for the view should be **100x** – check that it is.
- Now click the **NEXT** button over and over and watch the satellites of Jupiter.
- Click repeatedly and let two or more days go by (watch the date indicator on the lower part of the frame). Several of the moons go far to the left and right of Jupiter. But one moon stays close...that is Io.



After you track the satellites for a bit, change the magnification to **400x** and click through another day or two.

At this setting, only Io stays inside the viewing window. Other moons pass through and disappear off to the right and left. Io is the moon that stays inside the window.

**TELLING THE TIME**

The bottom of the window displays several bits of information about time.

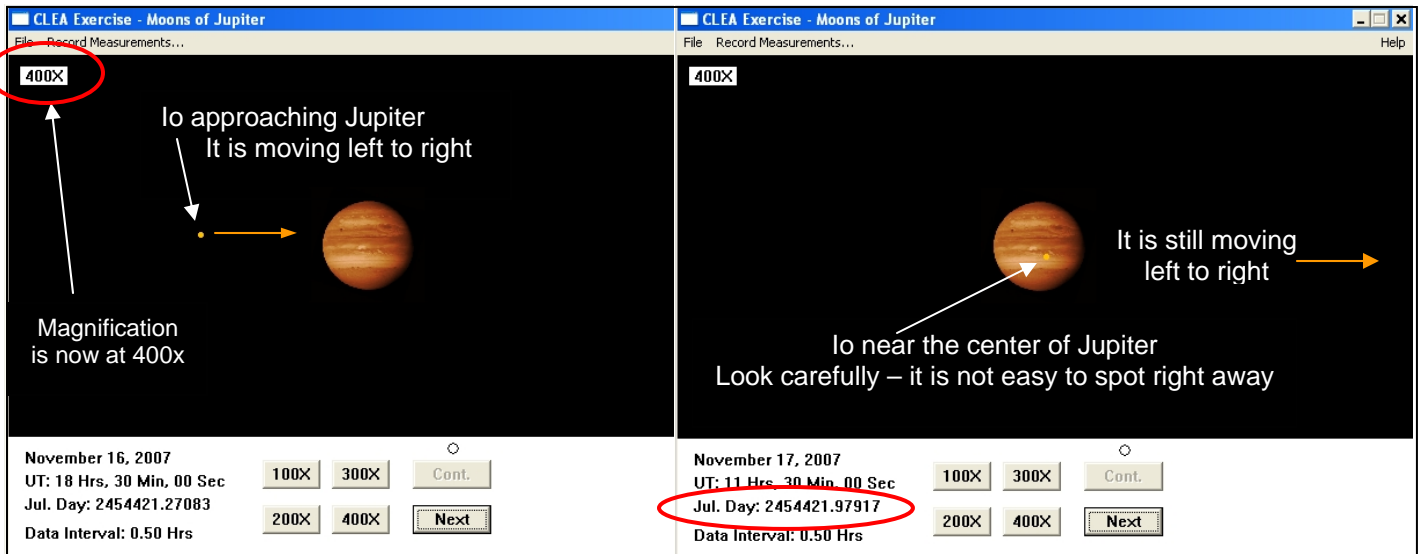
- **The date** – the date for the view of Jupiter
- **UT Time** – Universal Time in hours, minutes and seconds – think of this as a standard clock
- **Jul. Day = Julian day** – this is a running number that shows how many days have passed since an arbitrary starting date way back in the past.

For example, on November 24, 2007 at midnight (0 Hrs 0 Min 0 Sec)  
the Julian Day is: 2454428.50000

One day later on November 25, 2007 at midnight (0 Hrs 0 Min 0 Sec)  
the Julian Day is: 2454429.50000

**MAKING OBSERVATIONS AT 400X**

- Move Io forward in time until it **crosses in front** of Jupiter – it will be going left to right.
- When Io is in front of Jupiter and near the middle of the planet, stop and record the Julian Day in the table on the next page.
- Move Io forward until it goes all the way around Jupiter and passes in front again.
- When Io is near the middle of Jupiter, record the Julian Day again.
- Do this at least three times for **three consecutive passages**.



**RECORD YOUR OBSERVATIONS**

**Important: the Julian Days you observe won't necessarily be the same as mine depending on the date you make the observations**

	Julian Day
<p><b>Record your Julian Day observations in this table</b></p>	1 <sup>st</sup> passage
	2 <sup>nd</sup> passage
	3 <sup>rd</sup> passage
	4 <sup>th</sup> passage

**DETERMINING THE PERIOD**

In order to determine the period of revolution of Io, the number of times Io has gone around Jupiter has to be counted.

Since the 1<sup>st</sup> passage is when you started, Io hasn't gone around at all.

When the 2<sup>nd</sup> passage is observed, Io has orbited once.

By the 3<sup>rd</sup> passage, it has been around twice, and so on.

**The number of orbits then is = the NUMBER OF PASSAGES – 1**

- Subtract the Julian Day for the first passage from the last
- Divide this number by the number of passages minus 1  
 For example: If you had 4 passage times, divide by 3
- This is the period of Io in days

**EXAMPLE CALCULATION**

The Julian Days here are ones I determined using *Moons of Jupiter* and won't necessarily be the same as the ones you determine.

Julian Day

1 <sup>st</sup> passage	<b>2454429.05210</b>
2 <sup>nd</sup> passage	2454430.83323
3 <sup>rd</sup> passage	2454432.60407
4 <sup>th</sup> passage	<b>2454434.38550</b>

Last passage	<b>2454434.38550</b> days
First passage	<b>2454429.05210</b> days
Difference	5.33340 days
<b>Period of Io</b>	= <b>5.33340 days / 3</b>
	= <b>1.77780 days</b>
Period from the textbook	= 1.769 days
Difference in periods	
Text Period – My period	= – 0.0088 days

**This is a difference of 13 minutes from the accepted period**

**SOME THINGS TO CONSIDER**

- At 400x, Io is the only moon that stays within the viewing window. However other moons will pass through – keep your eye on Io!
- Care needs to be taken when watching Io move around Jupiter. A complete orbit occurs when Io moves from in front of Jupiter and comes back to the same location.
- The period determined by this method will depend on where Io is on the face of Jupiter when the Julian Day is recorded. More accurate determinations will be made if the Julian Day is noted when Io is as close to the same position in front of Jupiter for each passage.
- Another way to measure the period is to note the time when Io reaches the farthest distance to the side of Jupiter that it gets. However, larger errors are probable since determining when Io is at the extreme position is very subjective.