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Jovian Shadow Events

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JOVIAN SHADOW EVENTS

BY LANDON GLYNN

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Introduction

Many people enjoy experiencing the wonderful spectacle of solar eclipses on Earth, but neighboring planets also grant eclipse viewing experiences many people overlook. Jupiter has a lunar arrangement that allows us to view eclipses cast onto its surface, and in some cases, we can observe double or triple shadow events. However, timing and location is critical to a successful shadow event viewing. In order to observe a double shadow event, Jupiter needs to be perfectly visible from the region of Earth the event is being viewed from and two of Jupiter's moons need to be casting shadows in Jupiter's surface. Viewing a single shadow event only requires a single moon to be casting a shadow and are much more common. The calendar below overlays the degree of visibility with shadow events to display the ideal times to view single and double shadow events in the Pacific Northwest.



Galilean Moons

The Galilean moons are the four moons discovered by Galileo Galilei, and they consist of Io, Europa, Ganymede, and Callisto. Galileo was able to view these moons after he made improvements to his telescope that allowed magnification at 30X. The first documentation Galileo made of his discovery was in January of 1610. The four Galilean moons are an important discovery because they were the first celestial bodies that could be observed orbiting a body other than Earth. The discovery was a devastating blow to the then-accepted geocentric model of the universe, which had the idea that Earth was the center of the universe. Galileo's discovery also brought the telescope into the eye of the public because it was now evident that there was more to the universe than what humans could see with the naked eye, a fact that few considered before the development of telescopes and the discovery of the Galilean moons.

Since 1610, humans have learned much more about the Galilean moons. For example, Io is one of the most geologically active celestial bodies in the solar system with over 100 volcanos, and Europa is one of the smoothest celestial bodies in the solar system. Io, Europa, and Ganymede also display a rare orbital pattern called a laplace resonance, which ties in with the shadow events produced by the moons. A laplace resonance is a phenomenon in which the orbit of Europa (the second most distant satellite from Jupiter) has twice the orbital period as Io (the closest satellite), and Ganymede (the third most distant satellite) has twice the orbital period as Europa, which has four times the orbital period as Io. This orbital pattern results in very consistent times and locations in which the moons align to create shadow events.

Viewing a Shadow Event

Like Galileo, the first necessary item to view a Jovian shadow event is a telescope. Although it needs to be much more powerful than Galileo's; a telescope with an aperture of at least 90 MM is recommended. A number of natural events also need to line up in order to view an eclipse.

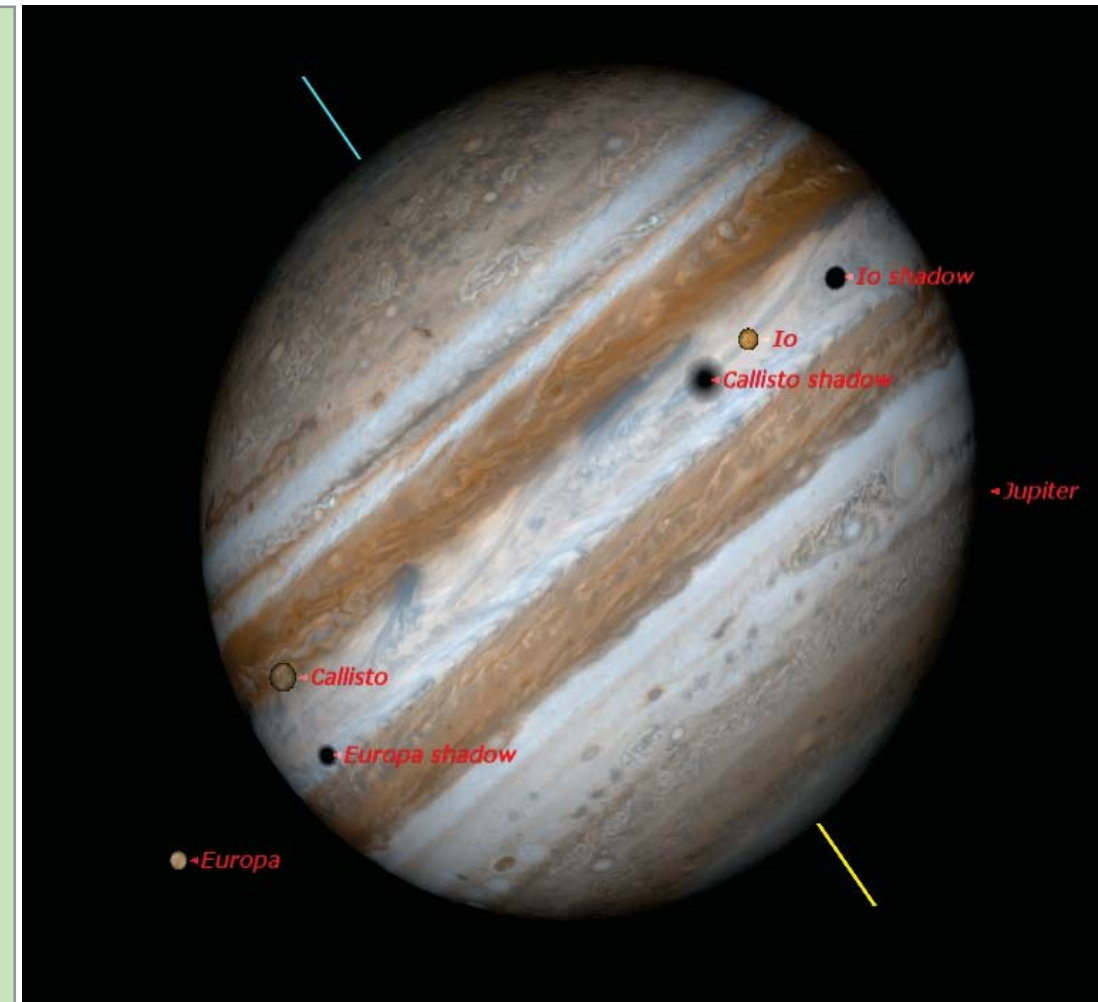
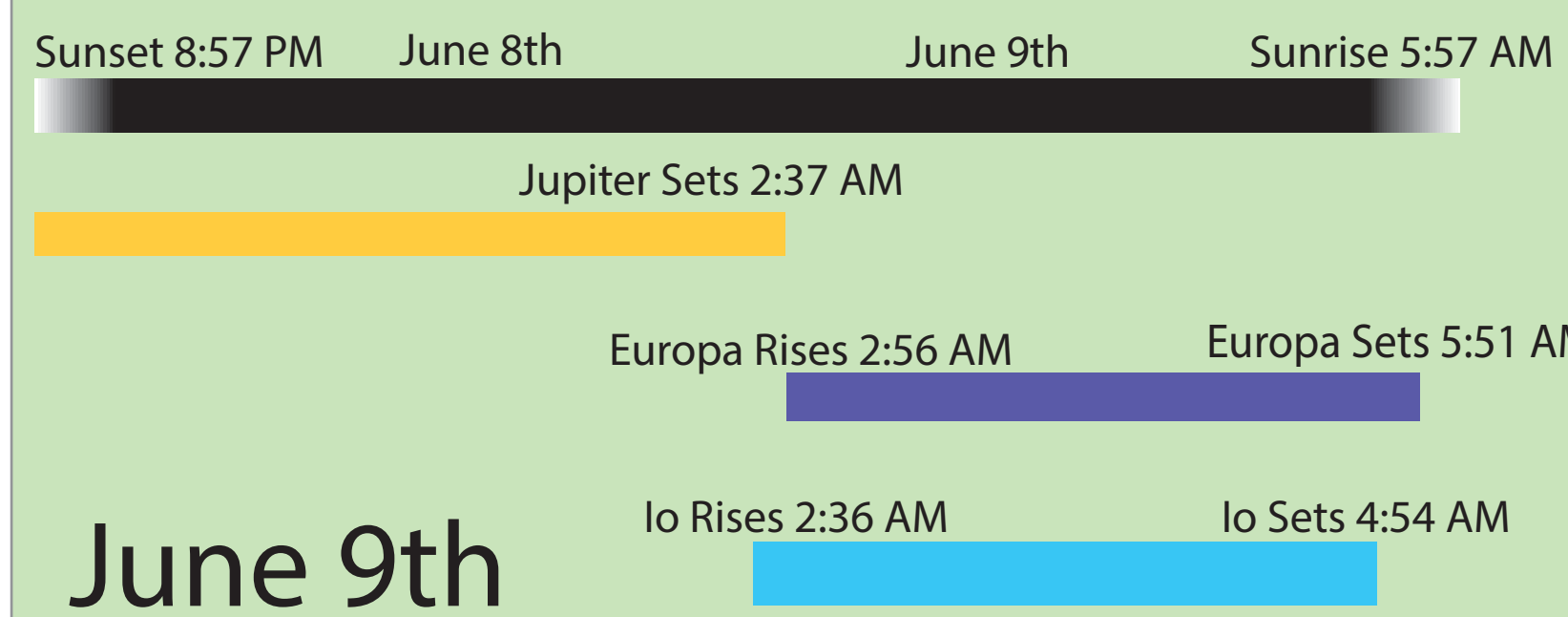
The first natural event that needs to occur is the solar eclipse (shadow event) itself. However, shadow events are much more common on Jupiter than on earth. The main reason for this is the number, size, and orbital plane of the four Galilean moons. Unlike the earth's moon, most of the Galilean moons (Callisto being the exception) orbit on flat planes so every time the moon orbits it passes between the sun and Jupiter to produce a shadow on the surface of Jupiter. The Earth's moon on the other hand orbits at an angle relative to the plane of the planets so most of the time the moon is casting a shadow into empty space. Io, Europa, and Ganymede have orbital times of 1.7, 3.5, and 7.15 days, respectively, and orbit on a plane level with the planetary plane so they cast shadows on Jupiter in intervals equal to their orbit time. Castillo has an orbit time of 17 days but does not cast a shadow every 17 days due to its tilted orbit.

The second natural occurrence necessary for a proper shadow event viewing is a good view of Jupiter. Jupiter rises and sets in a fashion similar to that of Earth, but the times it is above the horizon oscillates between day time and nighttime. Obviously, a shadow event on Jupiter would be very difficult to see if Jupiter were above the horizon during day time and below the horizon at night. Therefore, in order to view a shadow event Jupiter must be above the horizon, and it must be night time. The last natural factor that must fall into place is a lack of clouds. Examples of a visible double shadow event and a missed shadow event are shown in the enlarged boxes for June 3rd and June 9th. The June 3rd box shows how the rise and set of Jupiter lines up with the shadow transit of both Io and Europa. On June 9th, Jupiter is already set when the shadows begin their transit so the event will not be visible in the Portland area.

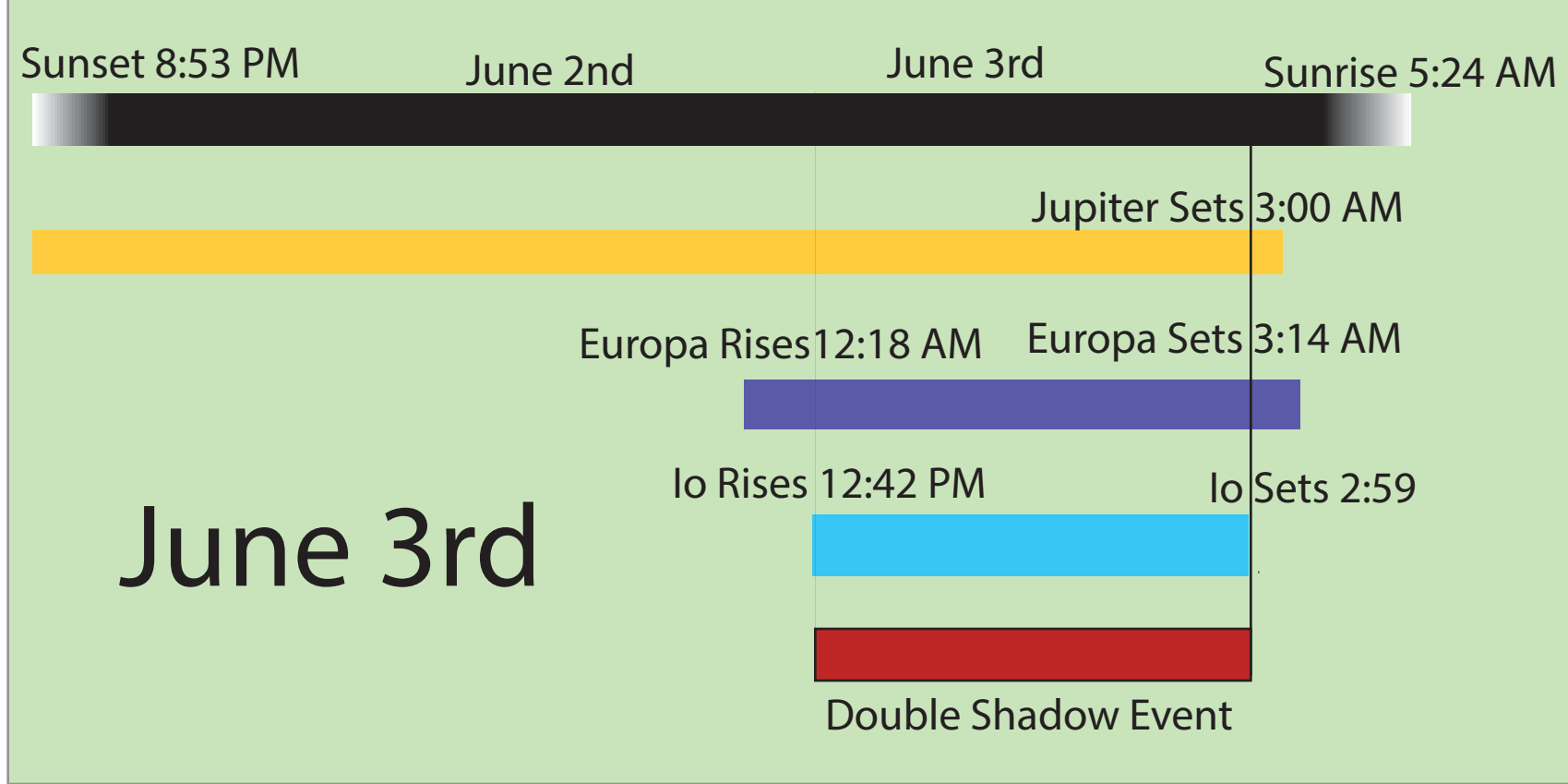
Double and triple shadow events occur when shadows of two of three moons are cast on the surface of Jupiter at one time. The enlarged June 3rd box describes a perfect double shadow event that will be visible in Portland. Triple shadow events are the rarest of the shadow events and occur on time intervals of month or years and all necessary factors for viewing may not line up for years or tens of years. The image to the left shows a triple shadow event that occurred in January of 2015.

The calendar below ties together the visibility factor, the timing of shadow events, and the rise and set of Jupiter in order to show the best times to view an event in the Portland area. The most exciting shadow event for the rest of the year will be the June 3rd double shadow event.

Missed Double Shadow Event



Double Shadow Event



Ideal Shadow Event Viewing Times in Portland, Oregon

Perfect Visibility (Green) Fairly Good Visibility (Yellow)

Average Visibility (Orange) Poor Visibility (Red)

June 2017

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
28	29 Memorial Day	30	31	1 Europa- 12:18 AM - 3:14 PM Io- 12:42 AM - 2:59 AM	2 Ganymede- 9:00 PM - 10:22 PM Io- 8:00 PM - 9:28 PM	3
4	5	6	7	8 Europa- 2:56 AM - 5:51 AM Io- 2:36 AM - 4:54 AM	9 Ganymede- 10:42 PM - 2:21 AM Io- 9:05 PM - 11:22 PM	10
11 Callisto- 9:00 PM - 10:13 PM	12	13	14	15	16 Io- 10:59 PM - 1:17 AM	17
18	19	20	21	22	23	24
25 Io- 12:54 AM - 1:34 AM	26 Europa- 9:00 PM - 12:25 AM	27	28	29	30	1

July 2017

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
25	26	27	28	29	30	1
2	3 Io- 9:17 PM - 11:35 PM	4 Europa- 12:07 AM - 1:00 AM	5	6	7	8
9 Io- 11:12 PM - 12:33 AM	10	11	12	13	14	15
16 Ganymede- 9:00 PM - 10:16 PM	17	18	19 Io- 9:00 PM - 9:53 PM	20 Europa- 9:00 PM - 9:35 PM	21	22
23 Ganymede- 10:36 PM - 11:44 PM	24	25	26 Io- 9:30 PM - 11:33 PM	27 Europa- 9:17 PM - 11:26 PM	28	29
30	31	1	2	3	4	5

August 2017

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
30	31	1	2	3	4	5
6	7	8	9	10	11 Io- 9:00 PM - 10:05 PM	12
13	14	15	16	17	18 Callisto- 9:00 PM - 10:03 PM Io- 10:59 AM - 12:00 AM	19
20	21	22	23	24	25	26
27	28 Ganymede- 9:00 PM - 9:34 PM	29 Europa- 9:02 PM - 9:31 PM	30	31	1	2

September 2017

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
27	28	29	30	31	1 Io- 1:31 AM - 3:49 AM	2
3	4 Europa- 11:38 PM - 2:32 AM	5	6	7 Io- 3:26 AM - 5:44 AM	8	9
10 Io- 9:54 PM - 12:12 AM	11 Ganymede- 2:28 AM - 6:07 AM	12	13 Europa- 2:14 AM - 5:08 AM	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

October 2017

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31	1	2	3	4

November 2017

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
20	21 Halloween	22	23	24	25	26
27	28	29	30	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	1
2	3	4	5	6	7	8

December 2017

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
26	27	28	29	30	1	2
3	4	5	6	7	8	9
10 Io- 4:32 AM - 5:28 AM	11	12	13	14	15 Ganymede- 5:02 AM - 8:00 AM	16
17 Io- 7:22 AM - 8:00 AM	18	19	20	21	22	23
24 Io- 6:57 AM - 8:00 AM	25 Europa- 3:48 AM - 5:22 AM	26	27	28	29	30
31 New Year's Day	1	2	3	4	5	6