

## **Phenomena of Jupiter's moons in 2014/15**

During the 2014/15 apparition, the Jupiter system will be edge-on to the Earth and Sun, which allows observers to see fascinating phenomena of the galilean moons. First, this alignment allows the moons and the shadows to transit across the Equatorial Zone so that observers have the greatest chance of seeing one or more of them on the disk. Second, it allows the moons to eclipse and occult one another in so-called 'mutual phenomena'. These events can be followed even with modest telescopes, especially mutual eclipses where one can see the rapid dimming of the eclipsed moon even if it cannot be resolved. Larger telescopes do allow the moons to be resolved, and should allow some impressive images and even videos to be obtained.

This is an especially favourable series of mutual events; in fact the jovian equinox (when the Sun crosses Jupiter's equatorial plane) is on 2015 Feb.5, just one day before opposition on Feb.6, so there are many events while the planet is well placed. The first observable events are in 2014 September, and they go on until 2015 July. For observers in the UK, the best will be in February and March.

Full sets of predictions by Jean Meeus have been posted by the BAA Computing Section at:

[http://britastro.org/computing/applets\\_jupiter.html](http://britastro.org/computing/applets_jupiter.html)

[http://britastro.org/computing/handbooks\\_jocc2014.html](http://britastro.org/computing/handbooks_jocc2014.html)

[http://britastro.org/computing/handbooks\\_jecl2014.html](http://britastro.org/computing/handbooks_jecl2014.html)

There are also predictions from the French IMCCE at:

[http://www.imcce.fr/langues/en/observateur/campagnes\\_obs/phemu15/](http://www.imcce.fr/langues/en/observateur/campagnes_obs/phemu15/)

For eclipses, the French predictions give longer durations because they include penumbral phases. For occultations, the two sets of predictions often differ by up to 20 seconds and sometimes by more, as they were derived from different versions of the orbital elements; it is an exercise for the observer to discover which are more accurate.

Also, the WinJUPOS program gives accurate graphical simulations of the events (**Figure**).

Some of the more impressive combinations of events, especially those visible from Britain, are listed in the **Table**.

During the last edge-on apparition, in 2009, some observers managed to obtain the first resolved time-lapse videos of mutual phenomena, and these were collected on a web site by Marc Delcroix of the Société Astronomique de France:

<http://www.astrosurf.com/planetessaf/occultations/>

This is a challenging task which requires a large telescope and good seeing. As the events happen quickly, the modern techniques of extensive image summation and derotation cannot be applied. (And please do not send synthetic images which aim to recreate the view – only real images!)

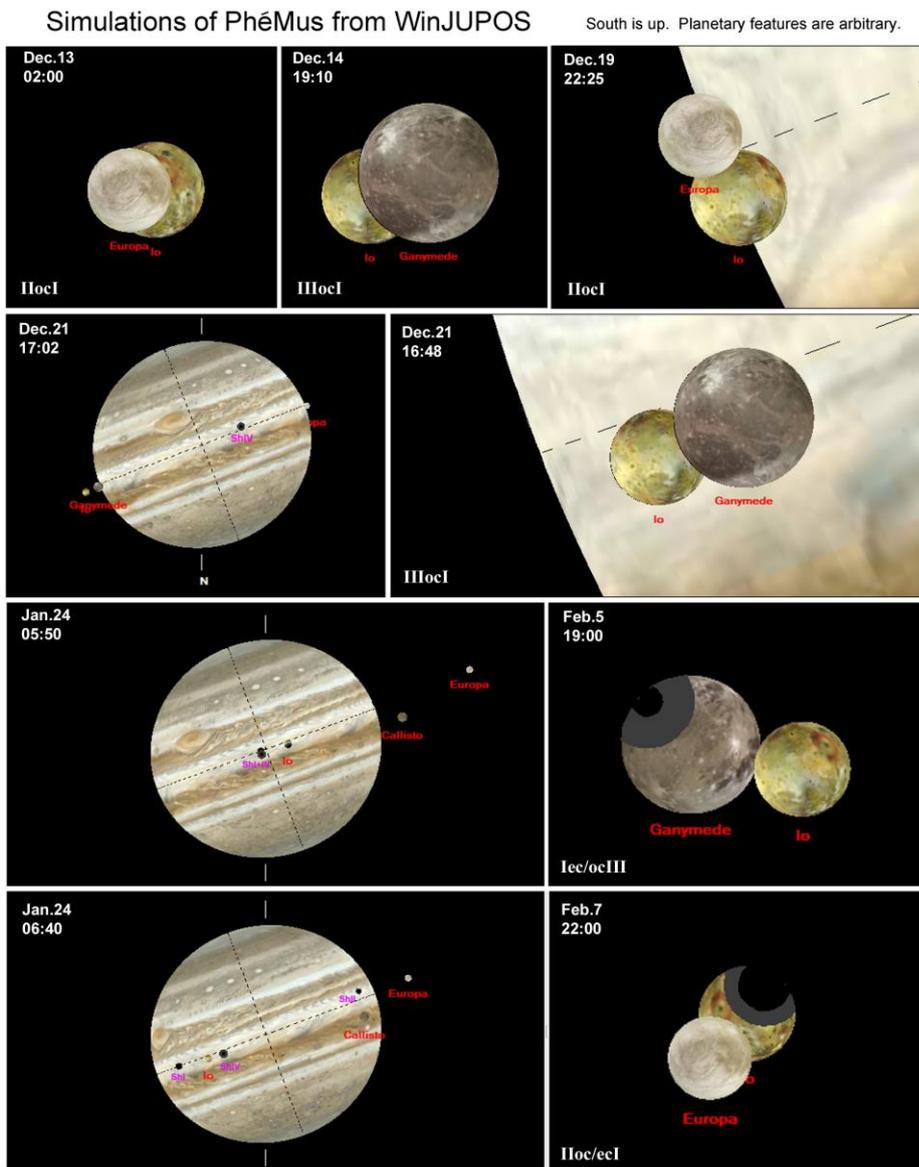
Accurate photometric records of the events, particularly eclipses, with precise timings, can be useful in refining the orbits of the moons. For this purpose, the moons do not have to be resolved so a large telescope is not essential, but a good signal-to-noise ratio is required, and it is desirable to have another satellite in the field of view for comparison. French astronomers have taken the lead in coordinating observations of the "phénomènes mutuelles" (PhéMus): full details of the observing programme, called PHEMU2015, in English and French, are provided at:

[http://www.imcce.fr/langues/en/observateur/campagnes\\_obs/phemu15/](http://www.imcce.fr/langues/en/observateur/campagnes_obs/phemu15/)

Observers who can do precise high-speed photometry are invited to contribute to that programme. Those who obtain resolved videos are asked to send them to Marc Delcroix ([delcroix.marc@free.fr](mailto:delcroix.marc@free.fr)) to be posted on his web site. The BAA Jupiter Section will be pleased to receive copies of these results or web links to them, as well as snapshot images or visual observations by BAA members. We will update section members by e-mail, and we will post selections of observations on the Jupiter Section web site.

*John Rogers*  
*BAA Jupiter Section Director*

**Figure: Simulations of some of the mutual phenomena in 2014-15, from the WinJUPOS program** (created by Grischka Hahn; <http://jupos.org>). South is up. Planetary features are arbitrary (the GRS will not be visible when shown).



**Table: Some notable multiple and mutual phenomena in 2014-15**

*In this table, the moons are abbreviated by their numbers:*

*I, Io; II, Europa; III, Ganymede; IV, Callisto; ShI, shadow of Io (and so on).*

*For mutual events, IocII means Io occults Europa; IIIecIV means Ganymede eclipses Callisto.*

*All times are in UT.*

*This list includes some multiple transits across the planet, as well as mutual events. Note that, because of the coupling of their orbits, Io, Europa and Ganymede can never all be in transit together; however two of them can be, and then the other one may be eclipsed or occulted by the planet at the same time. Three satellites can transit together if one of them is Callisto.*

Dec.12/13: IlocI for over 3 hours (23:13-02:19)! Visible from Europe.

Dec.14: A long series of events visible from the Far East. Double transit of III + I (III, ShI, I, are all on the disk from 11:44 to 13:24); then II emerges from behind the planet (14:39) and I emerges from transit (15:04); then IIIocI twice (18:25-19:33, 20:49-21:51).

Dec.19: Double transit of II + I, ending 22:25, while IlocI from 22:18-22:37. Visible from eastern Europe.

Dec.21: A long series of events visible from the Far East. IVecI (11:54-12:06) while ShIII is on the planet. Then III, ShI, I, and ShIV, all cross the disk (at least 2 of them from 13:37-16:59, all 4 from 15:17-15:54). IIIocI in transit at 16:27-50, then the double transit of I + III ends at 16:52-59.

January: A series of double transits of I + II and their shadows, visible from Britain on Jan.2/3, 9/10, and 17; culminating in a fine set of phenomena on Jan.24:

Jan.24: Triple transit (visible from N. America; low from Britain): of ShIV, IV, ShI, I, ShII, II, at least two are on the disk from 04:35-10:02, and 4 or 5 from 06:19-08:00. At 05:46-53, IVecI while in transit: a partial eclipse, with ShIV being largely penumbral due to its distance, but expected to dim I by a very noticeable 45%.

Feb.7, 21:54-22:03: IlocI & IlecI, overlapping as this is the day after opposition.

February: Close to opposition, there are other occasions when a pair of satellites undergoes mutual eclipse and occultation within a short time, notably some almost-total events between I + III, which are visible from Britain:

Feb.2, IIIec/ocI, 18:19-18:37; Feb.5, Iec/ocIII, 18:57-19:05; Feb.9, IIIoc/ecI, 20:55-21:11;

Feb.12, Ioc/ecIII, 21:22-21:49; Feb.16, IIIoc/ecI, 23:18-23:58.

Feb.12, 18:24-28: IocII, just after I emerges from transit (17:56) and before II is occulted by the planet (19:04).