

# The Phemu 2015 campaign of observations of the mutual events of the Galilean satellites of Jupiter

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## Abstract

From September 2014 to June 2015 mutual events of the Galilean satellites will occur around the Jovian equinox occurring on February 6, 2015. The observations of these events provide very accurate information on the relative astrometry of the satellites. Past campaign of observations have shown the high interest of such observations now performed mainly by amateur astronomers: the Galilean satellites are bright and the magnitude drop during these events is easily observable. The 2014-2015 campaign will be especially favorable because of the maximum of events which will occur during the opposition between the Sun and Jupiter. More, the positive declination of Jupiter will make the observations easier in the Northern hemisphere where many observers are available.

## 1. The mutual events

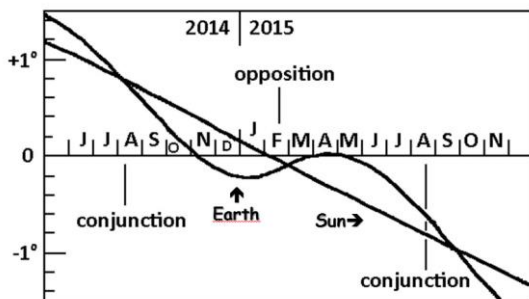


Figure 1: the jovicentric declination of Earth and Sun: mutual events occur when less than one degree.

The Galilean satellites are in the same orbital plane which is the equatorial plane of Jupiter. Therefore, at the Jovian equinox, mutual eclipses and occultations occur and are visible from Earth. The Jovian equinox is occurring on February 6, 2015 but the mutual events occur when the jovicentric declination of the

Earth and the Sun is less than one degree (cf. figure 1). Most of the events will occur from November 2014 to May 2015. Fortunately, the Jovian system will be easily observable (opposition on January 31, 2015). The declination of Jupiter will be positive making the Jovian system more observable in the Northern hemisphere.

As soon as observations were made, it appears that it was possible to extract astrometric positions of the satellites from the mutual event observations as it was made with the eclipses by Jupiter. The absence of atmosphere on the satellites makes the photometric observation of the mutual events more precise than the one of the eclipses by Jupiter.

## 2. Past campaigns

The first campaigns of observations occur when it was possible to make confident predictions of the events. These events are very sensitive to the accuracy of the ephemerides because of the small size of the satellites. An error of 1000 km (which was the accuracy of the ephemerides in the 1970's) may make an event inexistent.

Table 1: number of observers and of observations of the mutual events for the past occurrences

Years	Size of the telescopes		Nb. obs.
	< 60cm (amateurs)	> 60cm (professionals)	
1973	4	20	91
1979	3	7	18
1985	12	12	166
1991	37	19	374
1997	35	10	275
2003	34	15	361
2009	52	10	523

Table 1 shows the evolution of the observers from the former campaigns to the more recent ones. If the professional astronomers were more numerous at the beginning because of the poor sensitivity of the detectors needing a large telescope, the amateurs are now the majority, using the sensitive CCD detectors.

### 3. Observation and reduction of the mutual phenomena

The observation of a mutual event is a photometric measurement of the light flux decreasing and increasing when a satellite is occulted or eclipsed by another satellite. Each point of the light curve must imperatively be linked to the Universal Time UTC at the nearest 0.1 second of time. Then, it will be possible to inverse the light curve to obtain the relative positions of the two involved satellites. Below are presented two different observations made at ESO in 1985 [1].

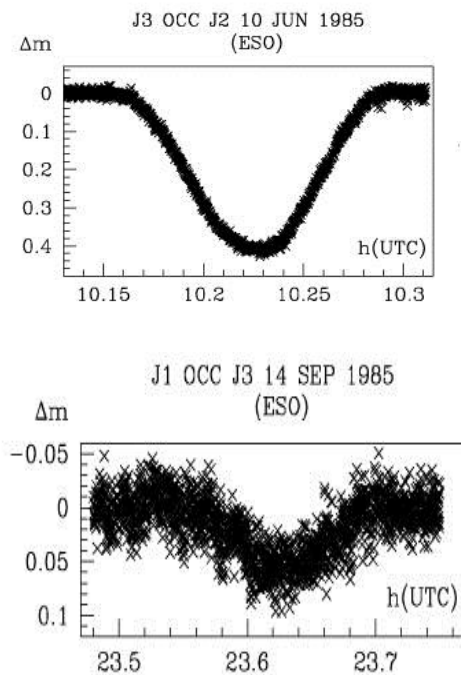


Figure 1: Examples of observations of mutual events.

The first one shows a magnitude drop of 0.4 that is easily observable with a good signal/noise ratio. The second one is a grazing event with a magnitude drop of 0.05. The noise is larger but, since we are making only relative photometry, such a magnitude drop is observable with a small telescope.

### 4. The Phemu 2015 campaign

The 2014-2015 occurrence will be the most favorable since years. Observations will start in October 2014 and will end on July 2015. The maximum of observable events will take place from December to April. Each month, about 30 to 40 events will be observable from a given site depending on its latitude and longitude. We encourage the observers to make as many observations as possible even if other observers are present in the same area in order to limit the influence of bad meteorological conditions.

Note that the predictions of the events are not perfect and an event may occur a few minutes before the theoretical timing, so start the observation about ten minutes in advance. More, the individual photometric measurement of each involved satellite before or after the event is necessary for the reduction. For astronomers using a telescope with an aperture larger than 30cm, eclipses of Amalthea may be observed. They are rare and their observation need to use an infra red filter at 890 nm which will darken the bright disk of Jupiter and which may also be useful for the Galilean satellites events when near of the planet.

All the needed information, all local ephemerides and configurations of the Galilean satellites are available on <http://www.imcce.fr/phemu>.

### 5. Conclusion

We look forward for a fruitful observational campaign which will be the more favorable since years. The gathered data will provide information as useful as data from space probes for astrometric and dynamical purposes.

### Acknowledgements

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### References

- [1] Arlot, J.E. and 43 co-authors: A catalogue of the observations of the mutual phenomena of the Galilean satellites of Jupiter made in 1985 during the PHEMU85 campaign, *Astronomy and Astrophysics Supplement Series*, Vol. 92, pp. 151-205, 1992.