

Thirty years of observation of natural satellites mutual events: the professional-amateur network

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Abstract

This paper shows how a network of observers dedicated to the observation of phenomena in the solar system and working during decades may be very useful to gather valuable scientific data. In this network, the participation of amateur astronomers appeared to be essential.

1. Introduction

The natural planetary satellites of the giant planets Jupiter, Saturn and Uranus need very accurate astrometric observations in order to constrain dynamical parameters and to detect and understand tidal effects and dissipation of energy inside the satellites. Several types of observations are available but very few have a sufficient accuracy to put into evidence such small effects.

2. Natural satellites' observations

Astrometric observations made by space probes are very accurate but too rare to detect cumulative effects due to dissipation of energy and observable after several decades: other observations of the same accuracy are necessary to be used together. Ground bases direct imaging are not enough accurate and would need several centuries of observations if they were the only type of observation available. The ground based observations of phenomena such as mutual occultations and eclipses allow to reach the kilometer-accuracy as space probes since these observations are based upon the size of the satellites which are well-known thanks to the space probes. Fortunately, these events are observed since the 1970's thanks to the computers which allowed the calculation and the prediction of these events.

3. The phenomena

Regularly, as shown by figure 1, the satellites are occulted and eclipsed either by their primary planet or by themselves [1]. Unfortunately, the events with the planet do not provide accurate astrometric observations since the sizes, shapes and atmospheres of the giant planets are not well known. The mutual events are much more accurate since the satellites have no atmosphere: their precise photometric observations allow to determine very accurate relative positions of the satellites.

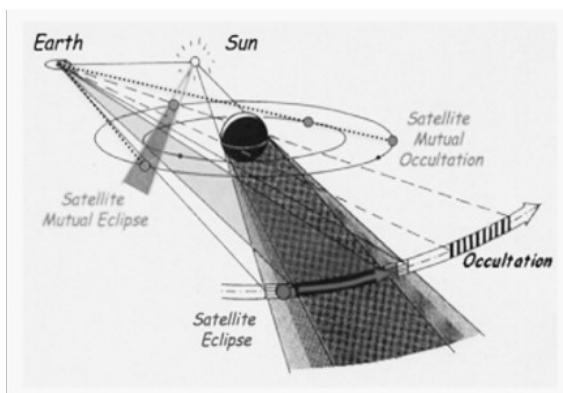


Figure 1: The configuration of the satellite-system during phenomena.

4. The network

These mutual events are very rare, occurring only during the equinox on the planet (the orbits of the satellites are in the equatorial plane of the planet as shown by figure 1) every 6 years for Jupiter, 15 years for Saturn and 42 years for Uranus. Therefore, campaigns of observations have to be organized because phenomena occurred at specific dates observable only from specific sites where the satellite system is above the horizon. A network of observers

is absolutely necessary. Since natural satellites, especially the Galilean ones, are observable with small telescopes (20-30cm aperture), the contribution of amateur astronomers is essential allowing to have several tens of observing sites worldwide.

5. The results

The past campaigns (table 1) have provided catalogues of valuable data [3] which have been used by theoreticians to improved the dynamics of the natural satellites systems. A database provides all the available data on www.imcce.fr/nsdc [2] For example the thermal equilibrium of Io has been demonstrated using all astrometric data of the Galilean satellites including mutual events data appearing as the most accurate [4].

Table 1: The results of the observational campaigns

Year	Number of observations	Number of observing sites
Jupiter		
1973	91	26
1979	18	7
1985	166	28
1991	374	56
1997	275	42
2003	361	42
2009	423	62
Total	1708	
Saturn		
1980	14	6
1995	66	16
2009	30	17
Total	110	
Uranus		
2007	52	19

6. Conclusions

We organized such observations since the 1970's and we know now that the contribution of amateur astronomers is not only valuable but essential: scientific goals will not be reached without amateur observations. See www.imcce.fr/phemu09 .

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References

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