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The First PHEMU Campaign in 1908

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ABSTRACT: The observation of mutual phenomena of Jovian satellites in the PHEMU campaigns have been known since 1973. Research on such observations in the pre-internet era showed that, after random observations in the 19th century, the first international campaign on such events took place as early as 1908. The predictions published by Oudemans in 1906 were the basis for 11 observers from several countries to observe systematically. In the paper 17 observed events are compared with the modern simulation. The mean value of the O-C value of the visual observations of the campaign is -0.15 minutes.

Introduction

Since 1973, the mutual phenomena of Jovian satellites have been systematically predicted, observed and the results evaluated. The French astronomer J.E. Arlot has planned, managed and evaluated the observation campaigns since then. He also introduced the term PHEMU as an abbreviation of "phénomènes mutuels". The observations obtained are accessible in the "Natural Satellites Data Center".

Of course, such events, for which the name PHEMU will be used in the following, also took place before 1973. The author has been searching for observation reports (all evaluated observations are listed in Table 1) from the "pre-Internet time" in the literature for a long time and presents first results here. The oldest mention of such phenomena dates from the time of the discovery of Jupiter's moons: Simon Marius, who discovered Jupiter's moons independently of Galileo Galilei, observed them regularly and frequently.

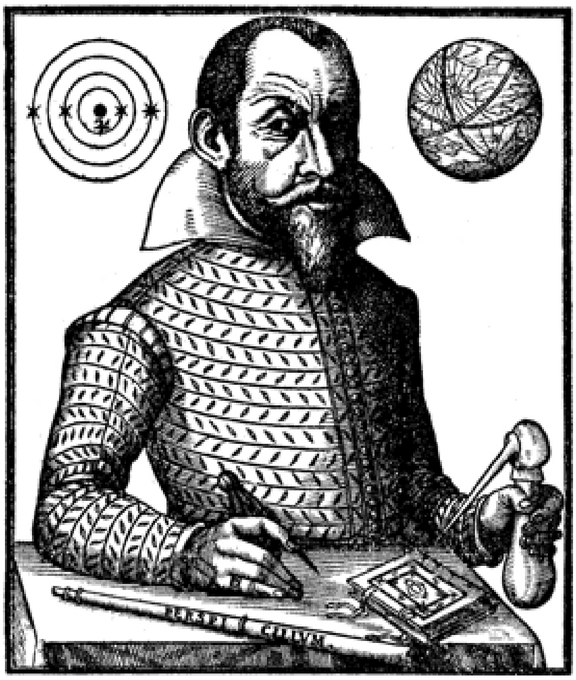

Figure 1. Simon Marius (1573 – 1624), (credit: Simag-ev)

He reports a perception of Jupiter's moon IV as darker than usual. Marius explains this with a shadow (eclipse) cast by Moon II or III [1]. This observation is dated 1613 February 17.

A check by N. Emelyanov of the Sternberg Astronomical Institute (SAI) in Moscow unfortunately revealed no such event for that day [2]. The conclusion that mutual eclipses of satellites are possible, published in [1], 1614 is an erratic conclusion for that time.

Early Observations

The first documented observation was made by the German amateur astronomer Ch. Arnold in 1693. Christian Arnold (1650-1695) was a farmer in Sommerfeld, a village near Leipzig. He observed, among other things, the comet Halley, a Mercury transit and also Jupiter moon occultations or eclipses. Secondary literature [3] reports that Arnold saw the occultation of moon II by III. This observation of 1.11.1693, as well as the observations of Luthmer [4] and [5] of 1819, 1820 and 1822, happened to be made during Jupiter's satellites observations. Both Arnold and Luthmer knew of their rarity and therefore published them. An analysis of these observations with the IMCCE Internet program MULTISAT [21] showed that they were very close conjunctions that could not be resolved with the instruments of the time.

First Analyses

In the 2nd half of the 19th century more attention was paid to the observations of Jupiter's satellite phenomena and also a PHEMU was noticed: The observation of F. Jackson [6] was evaluated and discussed by A.C.D. Crommelin in [7] with the help of Mr. Marth: The graphics from [7] are reproduced in Figure 2.

Crommelin came to the following conclusion: "*It will be seen that an error of 2" in the difference of the latitudes of the satellites, as given by the Tables, would suffice to bring II partially within the penumbra of III. Such an error is larger than we should expect, but perhaps not wholly inadmissible. I am, however, by no means confident that an eclipse actually occurred; though, if not, the almost perfect agreement in time between this observation and conjunction with the shadow would be curious coincidence.*"

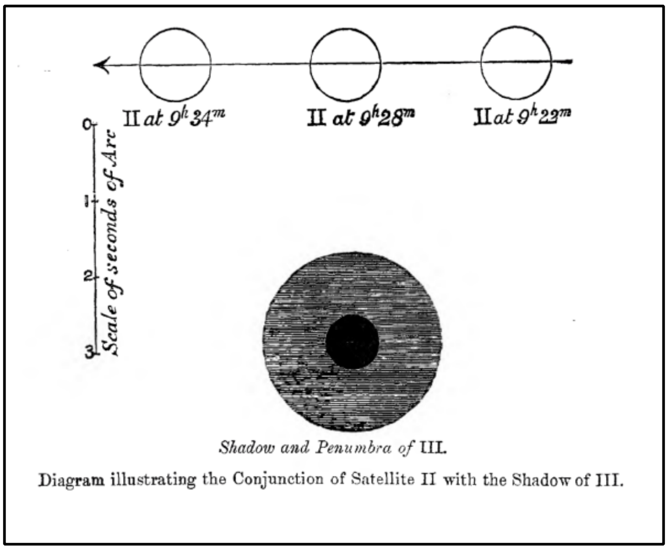

Figure 2. Simulation following analysis from Crommelin [7]

Figure 3. J. A. C. Oudemans (credit: Wikipedia, public)

Crommelin's doubts are justified, no PHEMU event could be found by the author for the observation.

Nijland calculated the diameters of the moons from the duration of the occultation of Ganymede (III) by Europa (II) on 1902 July 16 [11]. He calculated the sum of both diameters to be 2.38" from the observed duration of the occultation of 10m20s = 0.172 h and the relative motion of 13.86"/h. This is in excellent agreement with the values known at the time of 0.87" for Europa and 1.51" for Ganymede.

The First PHEMU Campaign

The moon and planet observer Ph. Fauth (1867-1941) wrote after first, accidental observations [9] of PHEMUS in 1902 and 1903: *"It must be possible to obtain from exact tracing of the mutual occultation of two moons... the most accurate test of the orbital elements..."*[8]

He called for ephemerides and observations for the time of the next equinox on Jupiter. Thus, the value of observations, the precise determination of orbits, was recognised!

The ephemerides for the coming equinox in 1908 were then calculated and published by J. A. C. Oudemans [10]. Jean Abraham Chrétien Oudemans was a Dutch astronomer. In his long life as a scientist and explorer he spent 18 years in the Dutch Indies. There he conducted extensive geodetic operations and published his work on the triangulation of the island of Java (today: Jawa, Indonesia) in six volumes. On 1874 December 9, he and his expedition members observed a transit of Venus from Reunion Island. Oudemans retired in 1898 and continued to be engaged in astronomical and geodetic work.

In his introduction to [10] he explicitly refers to Fauth's request. He reports and analyses all PHEMU observations known to him (observations 1, 5-8, 10,11, 13-16 in Table 1) and calculates 72 geocentric conjunctions for the months of June and July 1908 for the prediction of mutual eclipses. Furthermore, he publishes 81 heliocentric conjunctions for possible mutual eclipses for April and May of that year. The observers Kostinsky (Pulkovo, Russia), Pidoux (Geneva, Switzerland), Innes (Johannesburg, South Africa) and Whitmell (Leeds, UK) refer to these predictions in their reports. For the other observations of 1908, it can be assumed that Oudeman's prediction was the basis. Oudemans did not live to see the success of his ephemeris - he died in December 1906. The author found 26 observational results obtained in this campaign (no. 18-43, Table 1). When comparing the observations with the simulations, the following discrepancies arise in the 1908 campaign:

- **Whitmell:**
No simulation could be found for the reported event.
- **Phillips:**
The observer reports in [15] as observation time 28.03.1908 12h00 to 12h07 Greenwich time. In this time the European observers had the day begin at noon to avoid the date change at night. The observation is therefore 29.03.1908 00h00 to 00h07. Phillips reports he observed the PHEMU IIOI. Such an event is to be simulated for 29.03.1908 from 01h01m06s to 01h06m 57s [21]. Since the event and minute fit, an error in the hour is assumed.
- **Innes:**
In observation No. 30, Innes observes at the right time, but fails to notice a 0.45 mag drop in brightness.
- **Milowanow and Khowanski:**
Observations no. 37 and 38 do not belong to the phenomenon Io eclipses Callisto (IEIV), as reported in [12]. This event only had a brightness drop of 0.09mag. The two observers observed the eclipse of Callisto by Europa (IIEIV) in which the brightness drop during total phase was 0.512mag. Curiously: The event IIEIV is explicitly described as having been observed but not registered by Milovanov (observation no. 39).
- **Pidoux:**
The observed events are predicted by Oudemans but they do not fit into any simulation according to [21].

No.	Date YYYY MM DD	Time	Event	Simulation Event (UT) YYYY MM DD HH MM SS – HH MM SS	Observer	Source
1	1693 11 01	10h47m local	IIIOII	Close conjunction	Arnold	[3]
2	1819 08 22	11h10m local	IOII (?)	Close conjunction	Luthmer	[4]
3	1820 11 12	From 07h00m local	IIOI	No result	Luthmer	[4]
4	1820 12 20	05h30m local	IIOIII	Close conjunction	Luthmer	[4]
5	1822 10 30	6h55m	IIIOIV	No result	Luthmer	[5]
6	1885 03 27	12h20m	IIIOI	Close conjunction	Williams	[10]
7	1891 08 14	23h49m - 23h59m	IIEI	1891 8 14 23 21 28 - 23 49 47 2E1	Comas Solà	[10]
8	1891 08 15	00h00m - 00h04m	IIEI	1891 8 14 23 21 28 - 23 49 47 2E1	Williams	[10]
9	1896 03 30	21h20m	IIIEII	No result	Jackson	[7]
10	1902 07 16	01h52m	IIOIII	1902 7 16 1 49 53 - 1 59 30 2O3	Williams	[10]
11	1902 07 16	01h54m50s	IIOIII	1902 7 16 1 49 53 - 1 59 30 2O3	Nijland	[11]
12	1902 09 03	21h51.5m	IIOIII	1902 9 3 21 48 5 - 21 54 10 2O3	Worthington	[20]
13	1902 10 07	20h16m	IIOI	1902 10 7 20 13 38 - 20 18 9 1O2	Fauth	[8]
14	1902 10 23	19h07m03.5s	IIOIII	1902 10 23 19 5 19 - 19 9 10 2O3	Fauth	[8]
15	1902 11 10	18h33m20s	IIIOI	1902 11 10 18 29 52 - 18 37 42 3O1	Fauth	[8]
16	1902 12 24	17h24m30s	IOIV	1902 12 24 17 22 4 - 17 27 59 1O4	Fauth	[8]
17	1903 01 14	17h02m (start)	IIIOII	1903 1 14 17 12 35 - 17 32 32 3O2	Fauth	[8]
18	1908 01 24	00h51m +/- 5s	IOII	1908 1 23 23 49 35 - 23 53 56 1O2	Fauth	[6]
19	1908 01 25	22h05m first contact	IIOIII	No result	Whitmell	[14]
20	1908 02 20	19h17m55s	IIIOIIP	1908 2 20 19 15 50 - 19 20 46 3O2	Fauth	[18]
21	1908 02 20	19h15m06s - 19h20m55s	IIIOIIP	1908 2 20 19 15 50 - 19 20 46 3O2	Knopf	[18]
22	1908 02 24	20h44.2m	IOII	1908 2 24 20 43 50 - 20 47 23 1O2	Kostinsky	[17]
23	1908 02 24	20h45m32s	IOII	1908 2 24 20 43 50 - 20 47 23 1O2	Hartmann	[19]
24	1908 02 24	20h45m23s	IOII	1908 2 24 20 43 50 - 20 47 23 1O2	Innes	[16]
25	1908 02 27	22m05m59s	IIIOII	1908 2 27 22 4 7 - 22 7 48 3O2	Innes	[16]
26	1908 03 14	20h43.8m	IIOI	1908 3 14 20 40 36 - 20 45 56 2O1	Phillips	[15]
27	1908 03 21	22h52m	IIOI	1908 3 21 22 49 36 - 22 55 10 2O1	Phillips	[15]
28	1908 03 29	00h03.8m	IIOI	1908 3 29 1 1 6 - 1 6 57 2O1	Phillips	[15]
29	1908 04 03	21h51.0m	IEIIP	1908 4 3 21 49 14 - 21 53 27 1E2	Kostinsky	[17]
30	1908 04 03	No dimming from 21h40m to 22h	IEII	1908 4 3 21 49 14 - 21 53 27 1E2	Innes	[16]
31	1908 04 08	18h25m52s	IIEI	No result	Milowanow	[12]
32	1908 04 08	No dimming	IIEI	No result	Innes	[16]
33	1908 04 08	16h26m29s	IIOI	1908 4 8 16 23 49 - 16 30 9 2O1	Innes	[16]
34	1908 04 15	18h46m18.4s	IIOI	1908 4 15 18 42 42 - 18 49 26 2O1	Innes	[16]
35	1908 04 22	21h07m20s	IIOI	1908 4 22 21 5 6 - 21 12 17 2O1	Baranow	[12]
36	1908 05 05	Observed, nothing notice	IEIII	1908 5 5 19 8 25 - 19 15 11 1E3	Milowanov	[12]
37	1908 05 07	18h37m03s	IEIV	1908 5 7 18 26 0 - 18 32 15 1E4	Milowanov	[12]
38	1908 05 07	18h37m43s	IEIV	1908 5 7 18 26 0 - 18 32 15 1E4	Khowanski	[12]
39	1908 05 07	Observed, not notice	IIEIV	1908 5 7 18 33 1 - 18 42 46 2E4	Milowanow	[12]
40	1908 05 08	19h03m16s	IIIEIV	No result	Milowanov	[12]
41	1908 06 01	18h10m19s	IIOI	1908 6 1 18 3 33 - 18 16 9 2O1	Innes	[16]
42	1908 06 17	20h32m GMT	IIOIV	20h38m by Oudemans	Pidoux	[13]
43	1908 07 03	19h52m GMT	IIIOIV	19h58.5m by Oudemans	Pidoux	[13]

Table 1. Historical observations up to 1908

Remarks for Table 1:
Unless otherwise stated, the times given in the third column of the table are converted to longitude 0° (GMAT - Greenwich Mean Astronomical Time) from the zone time or local time given by the observer. The events are uniformly designated O for Occultation or E for Eclipse. IEIII means moon I eclipses moon III. Where possible, the simulation has been calculated with [21]. Where this software did not find an event, it is assessed whether the observation can be explained by a close conjunction or whether there is a prediction by Oudemans [10]. If no close conjunction or phenomena of the moons could be found at the time of observation, "No result" is entered.

Accuracy of the Visual Observations

For further evaluation, the above-mentioned unclear observations are not considered further and the evaluated observations are listed in Table 2.

Tab 1 no.	Date YYYY MM DD	Observation time	Calculated time [21]	O-C in minutes	Observer
10	1902 07 16	01h52m	01h 53m48s	-1.8	Stanley Williams
11	1902 07 16	01h54m50s	01 h53m48s	+1.03	Nijland
12	1902 09 03	21h51.5m	21h51m07s	+0.38	Worthington
13	1902 10 07	20h16m	20h15m53s	+0.12	Fauth
14	1902 10 23	19h07m03.5s	19h07m44s	-0.67	Fauth
15	1902 11 10	18h33m20s	18h33m47s	-0.45	Fauth
16	1902 12 24	17h24m30s	17h25m02s	-0.53	Fauth
17	1903 01 14	17h02m (start)	17h12m35s	-9.42	Fauth
18	1908 01 23	23h51m +/- 5s	23h51m45s	-0.75	Fauth
20	1908 02 20	19h17m55s	19h18m17s	+0.91	Fauth
21	1908 02 20	19h17m36s	19h18m17s	+0.68	Knopf
22	1908 02 24	20h44.2m	20h45m57s	-1.75	Kostinsky
23	1908 02 24	20h45m32s +/- 5s	20h45m57s	-0.41	Hartmann
24	1908 02 24	20h45m23s	20h45m57s	-0.57	Innes
25	1908 02 27	22m05m59s	22h05m57s	0	Innes
26	1908 03 14	20h43.8m	20h43m26s	-0.37	Phillips
27	1908 03 21	22h52m	22h52m23s	-0.38	Phillips
28	1908 03 29	00h03.8m	01h04m06s	0.3	Phillips
29	1908 04 03	21h51.0m	21h51m21s	-0.35	Kostinsky
33	1908 04 08	16h26m29s	16h26m59s	-0.5	Innes
34	1908 04 15	18h46m18.4s	18h46m04s	0.24	Innes
35	1908 04 22	21h07m20s	21h08m42s	-1.34	Baranow
37	1908 05 07	18h37m03s	18h36m47s	+0.27	Milowanow
38	1908 05 07	18h37m43s	18h36m47s	+0.93	Khowanski
41	1908 06 01	18h10m19s	18h09m46s	0.55	Innes

Table 2. O-C for usable observations from Table 1

The mean value of the O-C value of the remaining 24 measured values is -0.55 min. An astonishingly low value that speaks for the care and skill of the observers of visual astronomy.

Of the 25 observations in Table 2, 17 were carried out in the "PHEMU08" campaign. The mean value for O-C for these observations is -0.15 min.

Conclusion

International campaigns in observational astronomy were also successfully carried out in the pre-internet age. Modern simulations allow us to check the accuracy of the above-mentioned observations and to determine the value of visual observations of this era on the basis of the low O-C values. This is an important indication for the evaluation of historical observations when no verifications are possible.

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Further Reading

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