

RESULTS OF THE HALLEY AND GIACOBINI-ZINNER COMETS OBSERVATIONS AT THE BELGRADE OBSERVATORY

V. Protitch-Benishek and D. Olević

Astronomical Observatory, Volgina 7, 11050 Belgrade, Yugoslavia

(Received: January 22, 1995)

SUMMARY: With more than fifty years experience and tradition in comet observations and research the Belgrade Observatory joined The International Halley Watch as soon as the comets got within the reach of its instruments.

Comet Halley observations were carried out from September 1985 through June 1986, 75 plates in all having been acquired during this period. The resulting precise astrophotographic positions were immediately communicated to the IHW Centre.

The periodic comet Giacobini-Zinner was also systematically observed during the period June-September 1985, the observations having particularly been intensified in the interval just preceding the ICE spacecraft's closest approach to it.

On 9 December 1985 the occultation of BD +6°5207 by comet Halley was observed. The results of observing this event are briefly reviewed in the present paper.

1. INTRODUCTION

At the Belgrade Observatory particular attention to the Comet Halley observations would have been paid even if the IHW cooperation had not been organized. Namely, the astrophotographic photography of the comets as separate class of celestial bodies, not only forms a part of the Observatory's regular activity ever since its foundations in the thirties, but acquired the longest tradition: more than half a century since the earliest successful photographs have been secured.

2. IHW AT THE BELGRADE OBSERVATORY

Deciding on the international programme of the Comet Halley observation (IHW) on the part of the Belgrade Observatory implied not only more intense observations, but also squeezing to a minimum the time needed for the extensive calculus to derive the precise comet positions in the sky at particular times and for timely communicating them to the International Centre.

From among all the suggested and recommended programmes, covering various fields of comet researches, it was the astrometric one that was chosen by this Observatory owing, in the first place, to the circumstance that this variety of researches fitted best its instrumental equipment.

3. HALLEY AND GIACOBINI-ZINNER COMETS OBSERVATIONS

Thanks to favourable weather conditions the Observatory was able to successfully implement the observing programmes concerning both the Halley and Giacobini-Zinner comets.

The latter comet was observed over a nearly two months period, from 22 July to 14 September 1985, mostly with the 125/1000 mm Askania photo-visual equatorial. According to the number of its observations this Observatory stood at the 27th place among 61 participants in the Giacobini-Zinner comet imaging. These astrographic positions, together with observations of other observatories, served for establishing accurate comet's orbit (IHW orbit No 31), shortly before its encounter with the ICE spacecraft.

A curious event took place on 14 September: the comet Giacobini-Zinner approached apparently Halley as closely as 2° . However, since it was Halley that we tracked, a diffuse Giacobini-Zinner comet's trail appears on our photograph in consequence of its apparent motion having been considerably faster.

Since Comet Halley, understandably, was the more interesting one, efforts have been made at this Observatory to start its observation as early as possible. Unfortunately, in spite of substantially prolonged exposure and following-up its theoretical motion in the course of its imaging, it was only on a plate taken on 11 September 1985 that the comet was first discerned, the finding being confirmed on a plate taken on 14 September. From then on, until 27 May 1986, it was observed as many as 75 times (in this paper all the positions of comet Halley are not published). A number of the latest plates necessitated extra exertion, not so much at imaging since the comet's brightness was sufficient (4.7 magnitude), but on account of the necessity of securing more than usual number of reference stars for deriving its precise positions. These, however, were hard to select owing to the comet being situated low above the Belgrade's horizon in the western sky, covered by strato-cumuli, by full-moonshine. Moreover, the time interval between the evening twilight and the comet's setting was getting ever shorter, to the extent that the last plate could be taken a mere 20 minutes before the comet disappeared behind the horizon.

As with the Giacobini-Zinner comet, but a great deal more intensely and within 10 to 12 hours, the results of observation were forwarded to the International Centre in Pasadena, USA.

According to this Centre's reports, a total of 104 observatories took part in the astrometric IHW campaign in the pre-perihelion period, beginning 16 September 1982. By the number of its observations this Observatory assumed the 47th place. Among the 2604 positions provided by all participant observatories taken together, ours have also been used at deriving the comet's orbitalelements (IHW Orbit No 34) immediately before its perihelion passage.

4. STAR OCCULTATION BY COMET HALLEY

Within the framework of the astrometric campaign envisaged were also, as a separate task, observations of the occultations of stars by the comets Giacobini-Zinner and Halley. Accessible to observations from our territories, within a very narrow strip at that, were but a few of them.

On 9 December successfully observed and photographed was the occultation of BD +6°5207, apparent magnitude 9.1. It clearly transpires from the plate that the Comet Halley in its apparent transit in front of this star eclipsed it by its coma and not by its nucleus. This, however, was what one should have expected since the preliminary data and the ground track plot by E. Bowell and L. Wassermann let it surmise the central occultation were to be visible only from the north areas of the African continent (Bowell, Wassermann, 1985).

This induced us to use two astrographic plates of ours, taken in the night 9/10 December 1985, the one 10 minutes before and the other 10 minutes after the predicted time of occultation (totaling 20 min exposure) for determining the shortest separation (d_{min}) of the star and the comet, as well as the time of its occurrence (T_{min}).

The comet's accurate positions, derived from these plates, corrected previously for the values of the mean residuals (O-C), arrived at with the aid of several surrounding observations and their comparison with the ephemeris by D. K. Yeomans (1986), furnished the minimum separation and the time of its onset as:

$$d'_{min} = 14.5 \text{ arcsec}$$

$$d_{min} = 9.5 \text{ arcsec}$$

$$T'_{min} = 20^{\text{h}}06^{\text{m}}03^{\text{s}}.9 \text{ UTC}$$

$$T_{min} = 20^{\text{h}}07^{\text{m}}41^{\text{s}}.9 \text{ UTC}$$

where d'_{min} , T'_{min} , d_{min} and T_{min} are topocentric and geocentric values, respectively.

Quite independently, from the BD +6°5207 star's trail length as measured on the 20 minutes exposure plate (i.e. the mean value of trails of several nearby stars of nearly the same brightness and spectral class), and from the relative Comet Halley's positions with respect to the trail, we found:

$$d'_{min} = 13.4 \text{ arcsec}$$

$$T'_{min} = 20^h 06^m 05^s.3 \text{ UTC,}$$

which is in good agreement with the preceding result, bearing in mind that the star concerned has not been used in the previous calibrations of the comet's positions.

On the other hand the theoretical topocentric and geocentric positions, derived by employing corresponding corrections to the positions as observed on 9/10 December 1985 (corrections associated with IHW orbit No 34; Yeomans' report), furnish:

$$d'_{min} = 11.3 \text{ arcsec}$$

$$d_{min} = 6.2 \text{ arcsec}$$

$$T'_{min} = 20^h 06^m 04^s.0 \text{ UTC}$$

$$T_{min} = 20^h 07^m 42^s.1 \text{ UTC,}$$

the differences:

$$\Delta d'_{min} = +3.2 \text{ arcsec}$$

$$\Delta d_{min} = +3.1 \text{ arcsec}$$

in all-likelihood being a consequence of the change of orbital elements (IHW orbit No 34 vs. No 22).

Proceeding from this conclusion it seemed of interest finding out from what strip on the Earth's surface the central occultation of the BD +6°5207 star could have been visible. It could, without excessive difficulties, be established by making use of the well known parallax effect that this strip was stretching a good deal more to the south than predicted, mainly over the South Atlantic waters, far away from the continent. The centrality line, as one moves eastward by 1 hour in longitude towards Belgrade meridian, turns sharply northward, passing roughly through the points: -59°5, -50°2 and -27°1. Therewith the answer was provided to the question why no information whatever is reported thereon.

* * * * *

In the next two Tables the precise astrographic positions of the Halley and Giacobini-Zinner comets are given. The (*) denotes the observations carried out by D. Olevic with Zeiss astrograph 160/800 mm and all others were performed by V. Protitch-Benishek with Askania refractor 135/1000 mm.

Table 1. PRECISE ASTROGRAPHIC POSITIONS OF COMET HALLEY

Date UTC			R.A. (1950.0)			DEC (1950.0)			RA (O-C) cos D	Dec (O-C)	
y	m	d	h	m	s	°	'	"			
1985	11	07.97854	04	48	56.06	+22	12	09.6	5.64	-1.17	
1985	11	09.94451	04	36	36.70	+22	13	57.8	-0.24	-2.28	
1985	11	10.87576	04	30	15.61	+22	13	27.8	1.63	-1.25	
1985	11	29.82995	01	17	55.86	+14	36	26.5	5.63	1.47	
1985	12	02.93273	00	45	45.93	+12	03	39.3	6.46	1.23	
1985	12	03.73134	00	38	03.65	+11	24	18.2	2.98	3.58	
1985	12	04.84454	00	27	43.30	+10	30	07.4	-0.34	0.24	
1985	12	05.77118	00	19	31.07	+09	46	02.3	-1.14	-7.90	(*)
1985	12	08.75150	23	55	28.56	+07	31	29.4	-1.35	-15.30	(*)
1985	12	08.77579	23	55	17.76	+07	30	26.1	1.79	-2.64	
1985	12	09.80635	23	47	48.68	+06	47	11.5	-0.27	-4.00	
1985	12	09.83343	23	47	37.11	+06	46	00.9	-0.68	-7.80	
1985	12	21.74351	22	45	44.28	+00	33	30.2	7.67	0.94	
1985	12	22.74733	22	42	04.00	+00	11	02.6	-0.37	-0.96	
1985	12	22.76192	22	42	00.81	+00	10	46.4	-1.05	-0.11	
1985	12	23.67396	22	38	51.04	-00	08	37.8	-0.60	-11.20	(*)
1985	12	23.68659	22	38	47.90	-00	08	52.8	-0.56	0.72	
1985	12	23.77650	22	38	29.14	-00	10	47.0	-4.17	-1.51	
1985	12	24.81122	22	35	03.98	-00	31	39.2	2.30	0.96	
1985	12	25.72372	22	32	10.33	-00	49	19.0	-3.22	-1.57	
1985	12	27.77998	22	26	04.10	-01	26	30.1	0.38	-4.17	
1986	01	03.69387	22	08	45.97	-03	10	52.3	0.21	0.26	
1986	01	03.71332	22	08	43.18	-03	11	08.1	-2.32	-0.01	
1986	01	05.69179	22	04	27.10	-03	36	47.8	-0.60	-4.61	

Table 1. continued

Date UTC			R.A. (1950.0)			DEC (1950.0)			RA (O-C) cos D	Dec (O-C)
y	m	d	h	m	s	°	'	"		
1986	01	08.70221	21	58	21.55	-04	13	09.4	4.02	0.62
1986	01	10.70013	21	54	31.09	-04	36	07.2	0.44	-1.52
1986	01	13.69309	21	48	59.82	-05	09	13.8	0.99	-3.57
1986	01	13.70351	21	48	59.23	-05	09	23.0	9.24	-6.00
1986	01	14.70351	21	47	10.72	-05	20	10.3	1.36	-3.94
1986	01	15.70421	21	45	23.75	-05	30	55.9	2.65	-3.85
1986	01	15.71080	21	45	22.84	-05	30	56.8	-0.38	-0.53
1986	01	16.70421	21	43	37.30	-05	41	34.2	-1.53	0.47
1986	01	17.70074	21	41	52.25	-05	52	13.8	0.28	0.17
1986	01	21.69866	21	34	53.41	-06	35	16.4	0.20	-1.08
1986	01	21.70734	21	34	52.43	-06	35	24.8	-0.80	-3.83
1986	04	25.86667	11	16	52.23	-23	46	37.1	-0.23	-33.10 (*)

Table 2. PRECISE ASTROGRAPHIC POSITIONS OF GIACOBINI-ZINNER COMET

1985	07	22.93270	23	58	50.31	+58	29	28.2	1
1985	07	22.95111	23	58	58.03	+58	29	49.6	1
1985	08	06.07642	01	54	06.14	+59	09	55.8	
1985	08	11.93342	02	46	12.47	+57	00	27.9	
1985	08	11.95564	02	46	24.00	+56	59	45.8	
1985	08	12.90287	02	54	36.02	+56	29	16.9	
1985	08	13.91258	03	03	14.41	+55	53	47.7	
1985	08	16.90079	03	27	53.94	+53	51	12.6	
1985	08	19.92371	03	51	18.26	+51	21	00.8	

Note: Comet diffuse without central condensation.

Acknowledgments - This work has been supported by Ministry for Science and Technology of Serbia through the project "Physics and Motions of Celestial Bodies".

REFERENCES

- Bowell, E., Wassermann, L. H.: 1985, *IHW Newsletter*, No 6, 43-46.
 Protitch-Benishek, V.: 1986, *Proc. 20th ESLAB Symp. on the Exploration of Halley's Comet*, Heidelberg, ESA SP-250, 265-266.

**РЕЗУЛТАТИ ПОСМАТРАЊА ХАЛЕЈЕВЕ И ЂАКОБИНИ-ЦИНЕР КОМЕТЕ
СА БЕОГРАДСКЕ ОПСЕРВАТОРИЈЕ**

В. Протић-Бенишек и Д. Олевић

Астрономска опсерваторија, Волгина 7, 11050 Београд, Југославија

УДК 523.642
Претходно саопштење

У раду су дати астрографски положаји Халејеве комете, посматране у интервалу од септембра 1985. до јуна 1986. Подаци су редовно слати у међународни центар IHW.

Такође, дати су и астрографски положаји периодичне комете Ђакобини-Цинер праћене у ин-

тервалу јуни — септембар 1985. године. Посебно су посматрања била интензивна у периоду приближавања космичке летелице ISE комети.

9. децембра 1985. посматрана је окултација звезде BD +6°5207 са Халејевом кометом.