Photographic astrometry of comet Halley

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Abstract. Apparent geocentric positions of comet Halley have been computed using the photographic plates obtained with the 20-cm astrograph of the Nizamiah and Japal-Rangapur Observatories during the 1985–86 apparition. Our results agree very well with the revised predicted values published by the international Halley watch.

Key Words : comet Halley—astrometry

1. Introduction

Astrometry forms an important part of cometary observations as it provides information about the orbit of the comet around the sun and various perturbations experienced by it in its journey. During its recent 1985–86 apparition using the 20 cm astrograph of the Nizamiah and Japal-Rangapur Observatories, we photographed comet Halley before and after its perihelion passage, Between 1985 October and 1986 April, about 60 plates were exposed for different times in its orbit, and have been used to estimate the orbital elements.

2. Observations and reductions

Telescopes with focal ratios between f/15 and f/20 are normally used for photographic astrometry. Our 20-cm astrograph has a focal ratio of f/17 and a plate scale of one arcmin per mm. Kodak IIa-D plates of size 16 × 16 cm were used without any filters. The exposure times varied from 5 min to 1 hr, An atlas of these photographs has been published by Sanwal *et al.* (1988).

Plates with good image quality were selected for the determination of Halley's positions. For this purpose about 10 standard stars were identified on each plate with the help of SAO charts. The positions of these stars were taken from the SAO catalogue.

The relative positions of the standard stars and the comet on each plate were measured using the Gaertner measuring machine with direct and reverse readings. A few plates were also measured on the Carl-Zeiss X-Y coordinate measuring machine at the Indian Institute of Astrophysics, Bangalore. Both these machines give a positional accuracy of one micron on the plate. The mean length and breadth of the star trails were taken as the position of the star on the plate at the time of mid-exposure. Thus the computed cometary positions correspond to mid-exposure time in each case.

The measured X-Y positions of the comet and standard stars were reduced by Turner's least square method (Smart 1960, Marsden & Roemer 1982) and also by Comrie's (1929) three star dependences method in order to obtain the apparent geocentric equatorial positions of the comet. The reductions were verified on each plate by treating the positions of one or more reference stars as unknown. The differences between the computed and the catalogued positions of these stars were always less than 0.5 arcsec.

3. Comparison with the predicted positions

International Halley watch (IHW) had published through IHW newsletters, the predicted ephemeride of comet Halley prepared by Dr Yeomans on the basis of orbit 16 (EP16) and later, on the basis of improved orbit 33 (EP 33). EP16 covers the period from 1984 October to 1986 December while EP33 covers the period from 1986 January to June. As the more accurate EP33 does not cover the entire period of our observations we have compared the computed values of the positions with both the predicted ephemerides. Apparent positions at the times of mid-exposure along with the interpolated EP16 and EP33 values are given in table 1. Our values are in good agreement with the improved predicted values based on orbit 33 parameters. The rms error with respect to EP33 is 0.12 arcmin in R.A. and 0.21 arcmin in Dec.

Table 1. Apparent geocentric positions of comet Halley

Date	Julian date Mid-exposure	R.A. 1950.0	Diff. (2–1) & (3–1)	Dec. 1950.0	Diff (2–1) & (3–1)
	2446000.0+	h m	m	° ′	′
14.11.1985	384.24653	1 : 03 59.968		21 57.85	
		2 : —		—	
		3 : 03 59.920	—.048	21 58.10	0.25
06.12.1985	406.20312	1 : 00 11.589		09 04.75	
		2 : —		—	
		3 : 00 11.488	—.101	09 02.29	—2.46
17.12.1985	417.15278	1 : 23 02.600		02 19.31	
		2 : —		—	
		3 : 23 02.621	.021	02 17.01	—2.30
25.12.1985	425.12468	1 : 22 32.476		—00 46.94	
		2 : —		—	
		3 : 22 32.397	—.079	—00 47.72	—0.78

(Continued)

Table 1—*Continued*

Date	Julian date Mid-exposure 2446000.0+	R.A. 1950.0 h m	Diff. (2–1) & (3–1) m	Dec. 1950.0 ° ′	Diff. (2–1) & (3–1) ′
27.12.1985	427.11988	1 : 22 26.512		—01 23.68	
		2 : —		—	
		3 : 22 26.441	—.071	—01 23.96	—0.28
02.01.1986	433.11319	1 : 22 11.202		—02 56.14	
		2 : 22 11.210	.008	—02 56.13	0.01
		3 : 22 11.127	—.075	—02 56.51	—0.37
09.01.1986	440.08889	1 : 21 56.633		—04 23.40	
		2 : 21.56.639	.006	— 04 23.36	0.04
		3 : 21 56.559	—.074	—04 23.73	—0.33
16.01.1986	447.06771	1 : 21 43.863		—05 40.06	
		2 : 21 43.869	.006	—05 40.04	0.02
		3 : 21 43.790	—.073	—05 40.42	—0.36
17.01.1986	448.06354	1 : 21 42.111		—05 50.70	
		2 : 21 42.116	.005	—05 50.68	0.02
		3 : 21 42.036	—.075	—05 51.07	—0.37
18.01.1986	449.06424	1 : 21 40.354		—06 01.39	
		2 : 21 40.362	.008	—06 01.39	0.00
		3 : 21 40.283	—.071	—06 01.78	—0.39
08.03.1986	498.48785	1 : 20 11.754		—19 30.54	
		2 : 20 11.778	.014	—19 30.09	0.45
		3 : 20 11.676	—.078	—19 30.86	—0.32
13.03.1986	503.48451	1 : 20 00.540		—22 01.44	
		2 : 20 00.532	—.008	—22 00.89	—0.55
		3 : 20 00.429	—-.111	—22 01.69	—0.25
20.03.1986	510.46111	1 : 19 38.663		—26 40.70	
		2 : 19 38.645	—.018	—26 40.69	0.01
		3 : 19 38.495	—.168	—26 41.74	—1.04
24.03.1986	514.49514	1 : 19 19.567		—30 18.18	
		2 : 19 19.567	.000	—30 18.17	0.01
		3 : 19 19.424	—.143	—30 18.89	—0.71
23.04.1986	544.20729	1 : 11 30.574		—26 43.12	
		2 : 11 30.572	—.002	—26 43.12	0.00
		3 : 11 30.405	—.169	—26 42.38	0.74
28.04.1986	549.13819	1 : 11 03 427		—20 34.58	
		2 : 11 03.425	—.002	—20 34.59	—0.01
		3 : 11 03.411	—.016	—20 33.87	0.71

1 : Computed values   2 : EP33 values   3 : EP16 values

Table 2. Orbital elements of comet Halley

Element	Computed value	EP33 values
q	0.591 AU	0.5871013 AU
e	0.916	0.9672750
i	162°.259	162°.23921
Ω	58°.300	58°.14341
ω	112°.593	111°.84652
T	1986 Feb. 10.085	1986 Feb. 9. 45862

The computed values of the positions of comet Halley were used to determine the orbital elements without taking planetary perturbations into account. The

values of the orbital elements thus computed are compared with   those of
orbit 33 elements in table 2.

Acknowledgements

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