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PHOTOGRAPHIC AND PHOTOELECTRIC OBSERVATIONS OF COMET P/HALLEY IN 1985–86*

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Abstract

A total of 80 photographs on 29 nights and another total of 44(22 each in *B* and *V*) photoelectric observations on 6 nights are secured for *P/Halley(1982 i)* for seven months before and after the perihelion passage. The photographic observations have been made at different places depending on the position of the comet and the development of the tail, while the photoelectric observations were made only with the 61-cm reflector at Yonsei University Observatory(YUO).

Four most representative photographs are presented only to illustrate the remarkable features of the comet. The second one of these shows a coma with a possible flash activity on 1985 SEPT. 18.56 UT. The third one shows the largest tail recorded among our plates, and the last one represents unusual record made on a northern hemisphere at a latitude as high as about 33°12′ N on the occasion of the comet's second perigee on 1986 APR. 11.6 UT.

Photoelectric observations, on the other hand, determine the *V* and *B-V* of the total and the coma of the comet before its perihelion passage, and exhibit the light variations of $0^m.6$ in *V* in an hour and a half. Two new sets of m_0 and n, one before and the other after the perihelion passage, are determined based on the collected data, but the values are dissimilar one another significantly.

I. Introduction

Among many celestial events of our time the return of the Comet Halley may certainly be recognized as a highlight of all. The earliest detection of the comet by the collaboration of Jewett and Danielson(1984) in October 16, 1982, at the Palomar Observatory was possible

* Yonsei University Observatory Contribution No. 65.

with the advanced technology of our time. The comet was as faint as 24.2 magnitude. which is about the limiting magnitude of the detector system they applied and the comet displaced from the Yeomans'(1981) prediction only by 0.6 arc-seconds at the geocentric distance of 10.93 AU or the heliocentric distance of 11.04 AU.

Successive detections of P/Halley since the first recovery in 1982 by Jewett and Danielson are followed by many observers around the world, among them by West and Pederson (1984) and by Seki(1984) are worth to mention here. The former observed the irregular light variations of the comet in its early stage of apparition at a heliocentric distance of 8 AU and the latter detected the comet with the 61-cm reflector, the small size telescope. All of these early rediscoveries of the returning comet were only possible with the accurate positions calculated by Yeomans who mobilized data available since the earliest records in B.C. in China.

Our primary purposes were to take the photographs of Comet Halley at this rare occasion and to secure the light variations of the comet when it reaches to a brightness for the accurate measurement by the photoelectric photometer in the standard *BV* pass-bands at Ilsan Station of Yonsei University Observatory. To observe the comet in this way the comet has to be identified in the photographic plate in advance, because the visual identification among neighboring stars was not easy with a 15-*cm* finder telescope. As the trial photographic observations progressed it became clear that the fast motion and the faintness of the comet prevent the photoelectric observation with our small size telescope, the 61-*cm* aperture with *f*/15. In the mean time, the photographic plates made by various types of telescopes at different locations from the Ilsan Station were accumulated. This report is, therefore, aimed to present the photographs and the photoelectric observations of Comet Halley in 1985-1986, which is the first attempt in Korea for this historical event in over 200 years since Royal court observers left us wonderful pieces of observation records in 1759(Nha 1982).

Table I. Geographical locations where the photographic observations are made.

Place	λ ° ′	φ ° ′	h* (meter)
Ilsan Station, YUO	126 49	37 41	60
Mountain top in Mungyung area	128 01	36 49	470
Sea coast of Seoguipo City	126 35	33 14	10

* Elevations from the sea level are estimated on the map.

Ⅱ. Photographic Observations

A total of 80 photographs listed in Table Ⅱ has been secured in seven months since the first detection of Comet Halley in Korea in September 25, 1985. Instruments used for the observations were subjected to change according to the development of the comet. Fast motion of the comet with the orbital inclination, $i=162°$, made the observers to search suitable places in the east, west, and south coasts and in midland of Korean peninsula.

Successive photographic observations after the first detection of the comet in Korea showed that the prediction by Yeomans for the position of the comet was so accurate that the positioning of the telescope at the comet released difficulty in the mountain. Among 80 photographs a small flash-like spot was recorded on a plate taken on November 18, 1985 UT(lower photograph of Figure 1). This spot is certainly not a trail of a faint background star, because stellar trails recorded on photographs (Fig. 1) are all longer than the diameter of the image of comet. The distances from the earth and the sun to the comet at this time were 0.9 AU and 1.8 AU, respectively. Figure 2 is a photograph, which was taken when the comet was near perihelion on 1986 March 11 UT. The angular size of tail was about 2 arc-degree. It was one of the longest tail recorded on our plates.

When the comet was at the second perigee, 1986 April 11 UT, the declination of the comet was unfavorable to be observed at anywhere in Korean peninsula. Our attempt was, thus, made at the sea coast of Seoguipo City in Cheju Island, which is the southernmost part in Korea. Altogether 16 plates in three nights were made there. Figure 3 is the one obtained on 1986 Apr. 11, 16:45 - 16:55 UT when the comet was nearest to the perigee. The comet at this time was only about 10° above southern horizon, and recorded north of α Lup($2^m.9$, B2) as a white fuzzy object but brighter than α Lup. Two bright trails, a bright fuzzy light and a bright long trail, at the bottom of the photograph are the artificial lights on the sea.

Table Ⅱ. Journal of the photographic observations of Comet P/Halley

Date (UT)	Exposure Time(UT) Start	End	Telescope/Camera Type	*f*(mm)	Film Speed	Type*	Size	Location**
1985 IX 24	162200	164200	Goto 61-L	8400	ASA 400	N	120	Ilsan S.
1985 X 13	164400	170400	Goto 61-L	8400	ASA 400	N	120	Ilsan S.
	175030	182030						
1985 X 17	172600	174600	Goto 61-L	8400	ASA 400	N	35	Ilsan S.
	180100	183100	Goto 61-L	8400	ASA 400	N	120	Ilsan S.
1985 XI 14	145200	151200	Celest. 8	2000	ASA 400	P	35	Ilsan S.
	152400	154400						
1985 XI 15	125400	130400	Celest. 8	2000	ASA 1000	N	35	Ilsan S.
	131500	133500						
	135300	135800						
1985 XI 17	154100	154600	Celest. 8	2000	ASA 1000	N	35	Ilsan S.
	155500	155800						
1985 XI 18	131000	132000	Celest. 8	2000	ASA 1000	N	35	Ilsan S.
	132800	134300						
	145900	150400	Goto 61-L	8400	ASA 1000	N	35	Ilsan S.
1985 XI 28	125600	130100	Celest. 8	2000	ASA 400	P	35	Ilsan S.
	130700	131200						
1985 XI 29	125300	130300	Celest.δ	2000	ASA 400	P	35	Ilsan S.
	130900	131400						
	131900	132900						
1985 XI 30	134800	135300	Celest. 8	2000	ASA 1000	N	35	Ilsan S.
	135700	140200						
	140600	141300						
1985 XII 02	112300	114300	Celest. 8	2000	ASA 1000	N	35	Ilsan S.
	114700	120700						
	121600	122600						
	125300	125600						
1985 XII 04	122100	122800	Nikon	600	ASA 400	P	35	Ilsan S.
	124300	130300	Celest. 8	2000	ASA 1000	N	35	Ilsan S.
	131000	132600						
1985 XII 06	135800	142800	Celest. 8	2000	ASA 1000	N	35	Ilsan S.
	144100	145600						
1985 XII 08	121400	125400	Celest. 8	2000	ASA 1000	N	35	Ilsan S.
	130700	132700						
	121400	125400	Goto 61-L	8400	ASA 400	P	35	Ilsan S.
	130700	132700						

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Table II. Continued

Date (UT)			Exposure Time(UT) Start	End	Telescope/Camera Type	f(mm)	Film Speed	Type*	Size	Location**
1985	XII	09	122800	135800	Celest. 8	2000	ASA 400	P	35	Ilsan S.
			130800	132800						
			130900	132900	Nikon	600	ASA 1000	N	35	Ilsan S.
			134800	140100						
1985	XII	12	120900	121900	Nikon	600	ASA 1000	N	35	Ilsan S.
1985	XII	13	095300	101500	Nikon	600	ASA 1000	N	35	Ilsan S.
			101800	102400						
1985	XII	14	121300	124300	Goto 61-L	8400	ASA 400	N	120	Ilsan S.
1985	XII	15	113130	115130	Nikon	600	ASA 1000	N	35	Ilsan S.
			120330	122330						
1985	XII	23	095130	100630	Nikon	600	ASA 1000	N	35	Ilsan S.
1985	XII	31	093400	093800	Pentax	420	ASA 400	P	35	Ilsan S.
			094500	100500						
1986	I	01	101000	103000	Pentax	420	ASA 400	P	35	Ilsan S.
1986	I	08	100700	102200	Pentax	420	ASA 400	P	35	Ilsan S.
1986	I	13	095300	100800	Pentax	105	ASA 400	P	35	Ilsan S.
			101500	102000						
1986	I	15	101600	102600	Pentax	105	ASA 400	P	35	Ilsan S.
1986	III	11	201600	202600	Nikon	50	ASA 400	N	35	Mungyung
			203330	203730						
			203900	204100						
			204130	204230						
			204400	204600						
			201800	202800	Pentax	420	ASA 1000	N	35	Mungyung
			203330	203830						
			203900	204100						
			204130	204230						
			204330	204530						
1986	VI	11	161930	162430	Bronica	75	ASA 400	P	120	Seoguipo
			162500	163515						
			163600	164330						
			164500	165500						
			161930	162430	Pentax	420	ASA 1000	N	35	Seoguipo
			162500	163515						
			163600	164330						
			164500	165500						
1986	VI	13	152200	153200	Bronica	75	ASA 400	P	120	Seoguipo
			152230	153200	Nikon	170	ASA 1000	N	35	Seoguipo

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Table Ⅱ. Continued

Date (UT)	Exposure Time(UT) Start	End	Telescope/Camera Type	*f*(mm)	Film Speed	Type*	Size	Location**
1986 VI 15	143230	144850	Bronica	75	ASA 400	P	120	Seoguipo
	145330	150345						
	150500	151650						
	143230	145230	Nikon	500	ASA 1000	N	35	Seoguipo
	145330	150345						
	150500	152500						

* P : Positive film, N : Negative film

** See the details in Table Ⅰ.

Ⅲ. Photoelectric Observations

A total of 44 observations(30 for total magnitude and 14 for coma magnitude) for Comet Halley in *B* and *V* for six nights in October and November, 1985, with the 61-*cm* reflector is made at YUO. *U* observation was not attempted due to its small deflections on the chart recorder paper. The photomultiplier tube was uncooled RCA 1P21 phototube and filters are those similar to Johnson system. Details of the photometer system and the reduction procedures applied are given elsewhere(Nha *et al.* 1986)

Because of the fast motion of Comet Halley in those months near its perihlion passage, three different comparison stars depending upon the positions of the comet were used to make differential instrumental magnitudes in the sense of $\Delta m = m(comet) - m(comp.*)$. These comparision stars are χ_2 Ori for Oct. 17 and 20, χ_1 Ori for Oct. 22. and 87 Psc for Nov. 28-30. The observed differential magnitudes were standardized into *BV* magnitudes according to the scheme developed by us(Kim 1983), and the *V* and *B-V* magnitudes are listed in Table Ⅲ.

Magnitudes given in Table Ⅲ are either total magnitudes or coma magnitudes. An hour and a half monitoring was made in 1985 Oct. 22 UT, and the *V* and *B* curves are given in Figure 4. The light variations are significant both in *V* and *B* but neither similarity in the shape of the variations nor periodicity of the variations is found with the observations of this short time span.

Table Ⅲ. *VB* observations and the geocentric and heliocentric distances of P/Halley(1982*i*)

JD Hel	Total mag.		Coma mag.		Δ	r
244000+	V_T	$(B-V)_T$	V_c	$(B-V)_c$	(AU)	(AU)
6336.2044	11.03	0.64			1.536	2.130
6336.2132	11.09	0.66				
6359.2110	10.71	0.75			1.442	2.090
6359.2202	10.84	0.45				
6361.1645	10.74	0.92			1.379	2.064
6361.1801	11.15	0.45				
6361.1898	11.28	0.54				
6361.2004	11.23	0.56				
6361.2120	10.96	0.59				
6361.2155	10.96	0.63				
6361.2271	10.84	1.01				
6398.0709			8.46	0.73	0.621	1.533
6398.0800			8.43	0.70		
6399.0830			8.47	0.82	0.629	1.518
6399.0866	7.44	0.63				
6399.0923	7.10	1.00				
6399.0956			8.49	0.87		
6399.1022	7.33	0.95				
6399.1055			8.45	0.88		
6400.1057			8.78	0.71	0.624	1.503
6400.1112			8.69	0.81		
6400.1209	7.24	0.92				

Photoelectric V observations of P/Halley available in the *IAU Circulars* are collected and listed with the geocentric and heliocentric distances of the comet in Table Ⅳ. The observed V light curve of P/Halley is then illustrated in Figure 5, in which large discrepancies from the predictions by Yeomans(dashed curve in the figure),

$$\begin{aligned} m &= m_o + 2.5\ n\ log\ r + 5\ log\ \Delta \\ &= 5.0 + 13.1\ log\ r + 5\ log\Delta, \end{aligned}$$

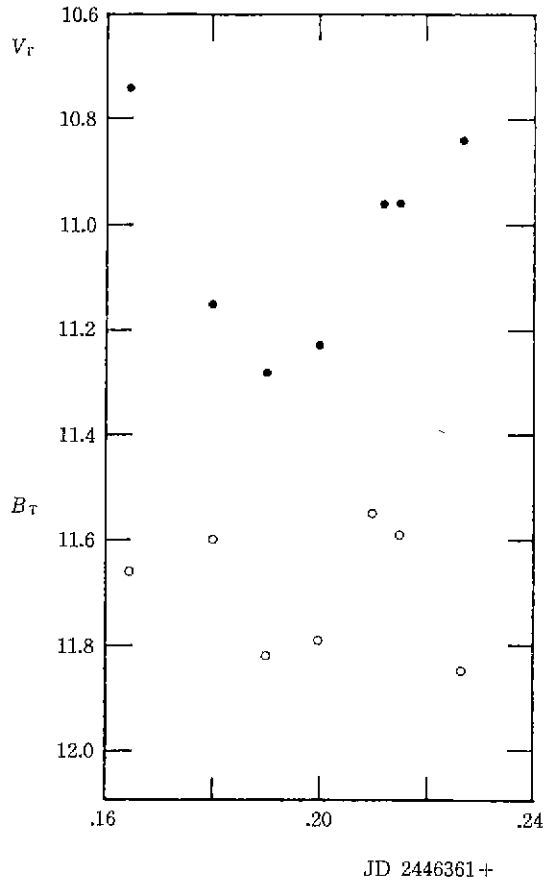

Fig. 4. V(dots) and B(open circles) light curves of P/Halley on 1985 Oct. 22(JD 2446361.1645− .2271).

before perihelion passage and a fair agreement after perihelion passage of the comet are clear.

In order to find improved values of m_o and n, computations by the least squares method using the data in Table Ⅳ are made. Two sets of new values given in Table Ⅴ, each set before and after the perihelion passage, are resulted, and with these values the V (Δ=1 AU)s are calculated and listed in the sixth column of Table. Ⅳ.

Table Ⅳ. Collected V observations for P/Halley

Date			UT (h)	V_T	Δ (AU)	r (AU)	V (Δ=1AU)	Ref[1]
1982	X	16		24.20	10.03	11.04	19.19	
1985	VII	19	10.36	16.50	4.08	3.25	13.45	4090
1985	VII	27	11.52	15.00	3.91	3.16	12.04	4094
1985	VII	28	11.52	15.00	3.89	3.14	12.05	4094
1985	VII	29	5.76	16.20	3.88	3.14	13.26	4090
1985	VII	30	2.64	14.00	3.83	3.11	11.08	4094
1985	VIII	01	18.09	16.00	3.79	3.09	13.11	4090
1985	VIII	04	18.95	16.00	3.72	3.06	13.15	4090
1985	VIII	10	11.52	14.50	3.57	2.99	11.74	4094
1985	VIII	11	11.52	14.50	3.55	2.98	11.75	4094
1985	VIII	12	11.52	14.30	3.52	2.97	11.57	4094
1985	VIII	14	2.88	15.20	3.48	2.95	12.49	4106
1985	VIII	14	2.88	14.50	3.48	2.95	11.79	4106
1985	VIII	17	8.16	14.10	3.39	2.91	11.45	4094
1985	VIII	18	2.88	14.50	3.37	2.90	11.86	4106
1985	VIII	18	11.52	13.90	3.36	2.90	11.27	4094
1985	VIII	19	11.76	13.90	3.34	2.88	11.28	4094
1985	VIII	21	11.76	13.90	3.28	2.86	11.32	4106
1985	VIII	23	9.36	13.40	3.23	2.84	10.85	4106
1985	VIII	25	10.80	13.60	3.17	2.81	11.09	4106
1985	VIII	28	1.92	13.40	3.09	2.78	10.95	4106
1985	IX	11	2.40	12.80	2.67	2.60	10.67	4106
1985	IX	12	2.26	13.80	2.64	2.59	11.69	4112
1985	IX	12	11.76	13.20	2.63	2.59	11.10	4106
1985	X	17	18.00	11.06	1.53	2.13	10.14	YUO[2]
1985	X	20	17.28	10.77	1.43	2.09	9.99	YUO[2]
1985	X	22	17.04	11.02	1.37	2.06	10.34	YUO[2]
1985	XI	29	14.16	7.29	0.62	1.51	8.33	YUO[2]
1985	XI	30	14.64	7.24	0.63	1.50	8.24	YUO[2]
1986	III	21	11.52	2.50	0.77	1.01	3.07	4198
1986	III	22	12.48	2.80	0.75	1.03	3.42	4198
1986	III	23	9.60	3.00	0.72	1.04	3.71	4198
1986	III	25	0.24	2.80	0.69	1.07	3.61	4198
1986	III	26	1.68	3.70	0.66	1.09	4.60	4198
1986	III	26	9.36	2.70	0.66	1.09	3.60	4198
1986	III	28	23.28	2.90	0.59	1.13	4.05	4198
1986	IV	02	0.00	2.80	0.51	1.19	4.26	4203
1986	IV	03	4.08	2.90	0.49	1.21	4.45	4203
1986	IV	08	12.48	2.80	0.42	1.30	4.68	4203

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Table Ⅳ. Continued

Date			UT (h)	V_T	Δ (AU)	r (AU)	V (Δ=1AU)	Ref[1]
1986	IV	10	20.88	2.70	0.42	1.33	4.58	4203
1986	IV	12	13.68	3.10	0.42	1.36	4.98	4205
1986	IV	12	16.32	3.70	0.42	1.36	5.58	4203
1986	IV	13	13.68	3.10	0.43	1.37	4.93	4205
1986	IV	14	12.48	2.90	0.44	1.39	4.68	4205
1986	IV	15	12.00	3.00	0.45	1.40	4.73	4205
1986	V	04	3.60	4.80	0.89	1.68	5.05	4212
1986	V	06	18.72	5.50	0.98	1.72	5.54	4212
1986	V	07	17.76	5.70	1.00	1.73	5.70	4226
1986	V	12	2.88	6.20	1.15	1.79	5.90	4226
1986	V	16	1.44	6.40	1.28	1.85	5.86	4226
1986	V	19	16.80	6.80	1.40	1.90	6.07	4226
1986	V	26	8.64	7.60	1.61	2.00	6.57	4226
1986	VI	01	1.20	7.60	1.80	2.08	6.32	4226
1986	VI	07	4.80	7.40	2.00	2.16	5.89	4226
1986	VI	12	4.56	7.60	2.17	2.22	5.92	4226
1986	VI	25	2.16	8.90	2.56	2.40	6.86	4236
1986	VI	28	1.20	8.10	2.65	2.44	5.98	4236
1986	VII	02	4.32	9.00	2.77	2.49	6.79	4236
1986	VII	09	17.28	10.20	2.99	2.59	7.82	4236
1986	VII	22	16.80	11.50	3.34	2.75	8.88	4241
1986	VII	26	16.80	11.40	3.44	2.80	8.72	4241
1986	VII	28	17.28	11.20	3.49	2.83	8.49	4241
1986	VII	30	17.04	10.90	3.53	2.85	8.16	4241
1986	VIII	02	17.04	11.10	3.59	2.88	8.32	4267
1986	VIII	07	16.80	11.60	3.70	2.94	8.76	4267
1986	VIII	09	16.80	11.90	3.75	2.96	9.03	4267
1986	X	27	12.00	11.50	4.62	3.85	8.18	4267
1986	X	28	12.00	11.50	4.62	3.86	8.18	4267
1986	X	29	12.72	12.00	4.62	3.88	8.68	4267
1986	X	31	12.00	11.50	4.62	3.90	8.18	4267
1986	X	31	12.24	12.00	4.62	3.90	8.68	4267
1986	X	31	12.48	12.00	4.62	3.90	8.68	4267
1986	XI	03	1.92	13.40	4.61	3.93	10.08	4281
1986	XI	04	19.92	13.10	4.61	3.94	9.78	4281
1986	XI	10	19.92	12.90	4.60	4.00	9.59	4281
1986	XI	28	12.72	11.60	4.52	4.19	8.32	4281
1986	XI	30	20.16	12.50	4.50	4.21	9.23	4281
1986	XII	03	12.96	11.80	4.49	4.24	8.54	4281
1986	XII	04	19.92	12.30	4.48	4.25	9.04	4281

→

Table Ⅳ. Continued

Date			UT (h)	V_T	Δ (AU)	r (AU)	V (Δ=1AU)	Ref[1]
1986	XII	06	10.56	11.90	4.46	4.27	8.65	4299
1986	XII	12	12.96	11.90	4.42	4.33	8.67	4299
1986	XII	30	12.96	12.30	4.28	4.51	9.14	4299
1986	XII	31	20.16	13.30	4.27	4.52	10.15	4299
1987	I	06	0.24	13.50	4.23	4.58	10.37	4299
1987	I	08	12.72	12.20	4.21	4.60	9.08	4299
1987	I	09	12.24	12.20	4.21	4.61	9.08	4299
1987	I	10	12.24	13.20	4.20	4.62	10.08	4299
1987	I	28	19.20	13.00	4.11	4.79	9.93	4314
1987	I	31	1.44	13.80	4.10	4.82	10.74	4314
1987	II	06	12.00	11.80	4.09	4.88	8.74	4314
1987	II	07	11.04	13.10	4.09	4.89	10.04	4314
1987	II	12	2.64	13.70	4.09	4.94	10.64	4314
1987	IV	05	21.60	14.20	4.64	5.42	10.87	4371
1987	IV	18	18.72	14.50	4.91	5.53	11.04	4371
1987	IV	20	5.04	13.30	4.95	5.55	9.83	4371
1987	IV	21	19.92	13.60	4.98	5.56	10.11	4371
1987	IV	23	4.80	12.70	5.02	5.58	9.20	4371
1987	IV	25	5.52	13.50	5.07	5.60	9.97	4386
1987	IV	26	2.88	13.60	5.09	5.60	10.07	4386
1987	IV	27	19.92	13.70	5.12	5.61	10.15	4386
1987	IV	30	21.84	13.80	5.19	5.64	10.22	4400

[1] IAU Circular numbers.

[2] Daily averages from the values listed in Table Ⅲ. Coma magnitudes are excluded.

Table Ⅴ. Photometric constants of Comet P/Halley in 1983–1987

	Pre-perihelion passage	Post-perihelion passage	Yeomans (1981)
m_o	5.89	3.59	5.0
	±24	±10	
n	5.09	3.60	5.24
	±20	±08	

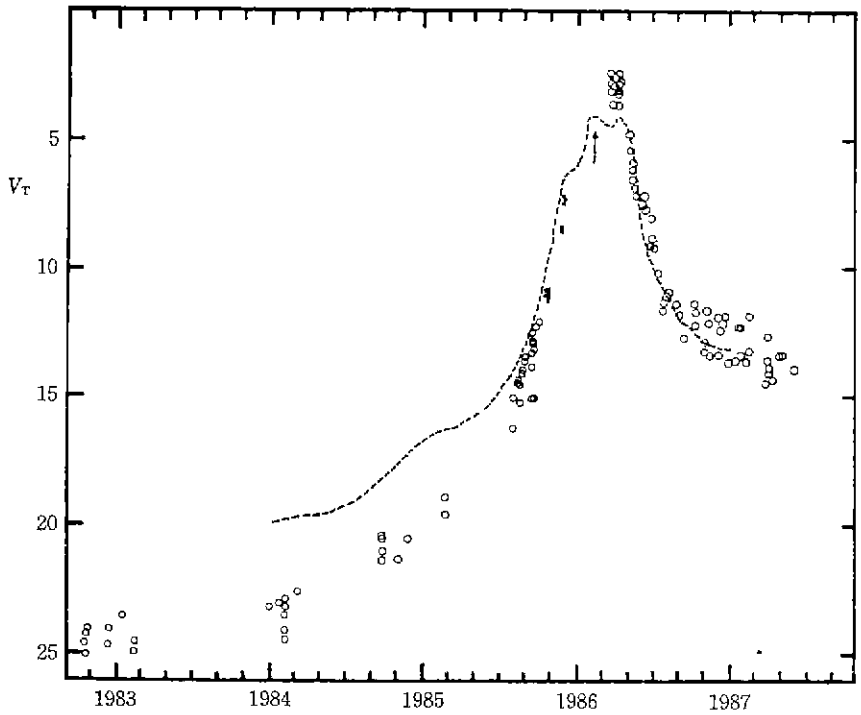

Fig. 5. Long term light variations of P/Halley. Open and filled circles represent collected and our observations, respectively. The dashed curve represents the magnitude variation predicted by Yeomans(1981).

Ⅳ. Discussion and Results

Due to its low altitudes to observers at high latitudes of the northern hemisphere for most of time between Fall 1985 and Spring 1986, Comet Halley had been remained as a unfavorable object to those poorly equipped, and thus not much of the meaningful investigations were warranted to them. With the restrictions faced, however, some of the results deduced by the present monitoring of the comet are worth of scrutiny.

Among 80 photographs four are illustrated in Figures 1-3. In Figure 1 a flash-like spot on the lower left edge of the comet head is recorded only on a photograph taken on 1985 Nov. 18, 13 : 28−13 : 43 UT. The comet tail which is insignificant on this photograph directs toward east and parallel to trails of stars. But the bright spot is slight off from

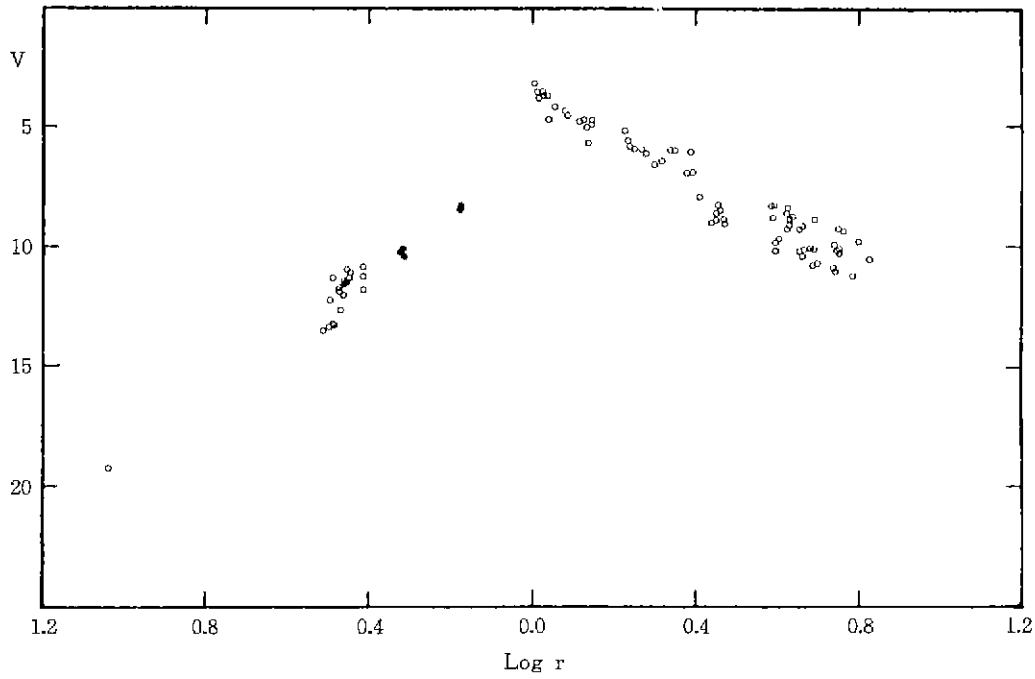

Fig. 6. *V-log r* diagram of P/Halley 1986*i*. The slope(n) and zero point(m_0) before and after the perihelion passage are clearly different. Open and filled circles represent collected and our observations, respectively.

the east-west direction of the center of comet's head. Therefore, this indicates that the spot cannot be the result of the image jump which could be occured by the inaccurate tracking in 15 minute exposure. The spot cannot be a trail of a faint background star either, because the stellar trails shown on the same photograph are larger than the diameter of the image of the comet as already mentioned in Section Ⅱ. The olny possible interpretation of this bright spot is, thus, that the comet had a flash activity towards slightly off-direction of the tail. This interpretation may be reinforced by the fact that no trace of a flash activity can be found in a preceding photograph of ten-minute exposure(13 : 10−13 : 20 UT). Attempt to find this flash has not been, however, made on the third plate(14 : 59−15 : 04 UT) taken with the 61-cm reflector at its Cassegrain focus, because the image of the comet is deformed by the inaccurate tracking.

Figure 3 is a unusual photograph of Comet Halley for its extremely low altitude at the time close to the comet's second perigee. This observation was made at the sea coast of Seoguipo City in Cheju Island, which is the southern-most part in Korea. During the

exposure, 16 : 45−16 : 55 UT, the hour angle of the comet was about 45^m, therefore, the location of the comet above southern horizon was only about 10°.

Photoelectric *VB* observations made at YUO using the 61-cm reflector are considered insufficient to search clues of rotation of the P/Halley 1986*i* nucleus, which was proposed by Le Fevre *et al.*(1984) and others thereon. Nevertheless, our observations at the heliocentric distance 2.13~1.50 AU supplement the observations by others before the perihelion passage.

Two sets of m_o and n, one before and the other after the perihelion point of the comet, are dissimilar one another significantly, as are given in Table V. Nominal interpretation for this difference is that the comet P/Halley has lost its material by the solar radiation and reformed its shape afterward.

Acknowledgements

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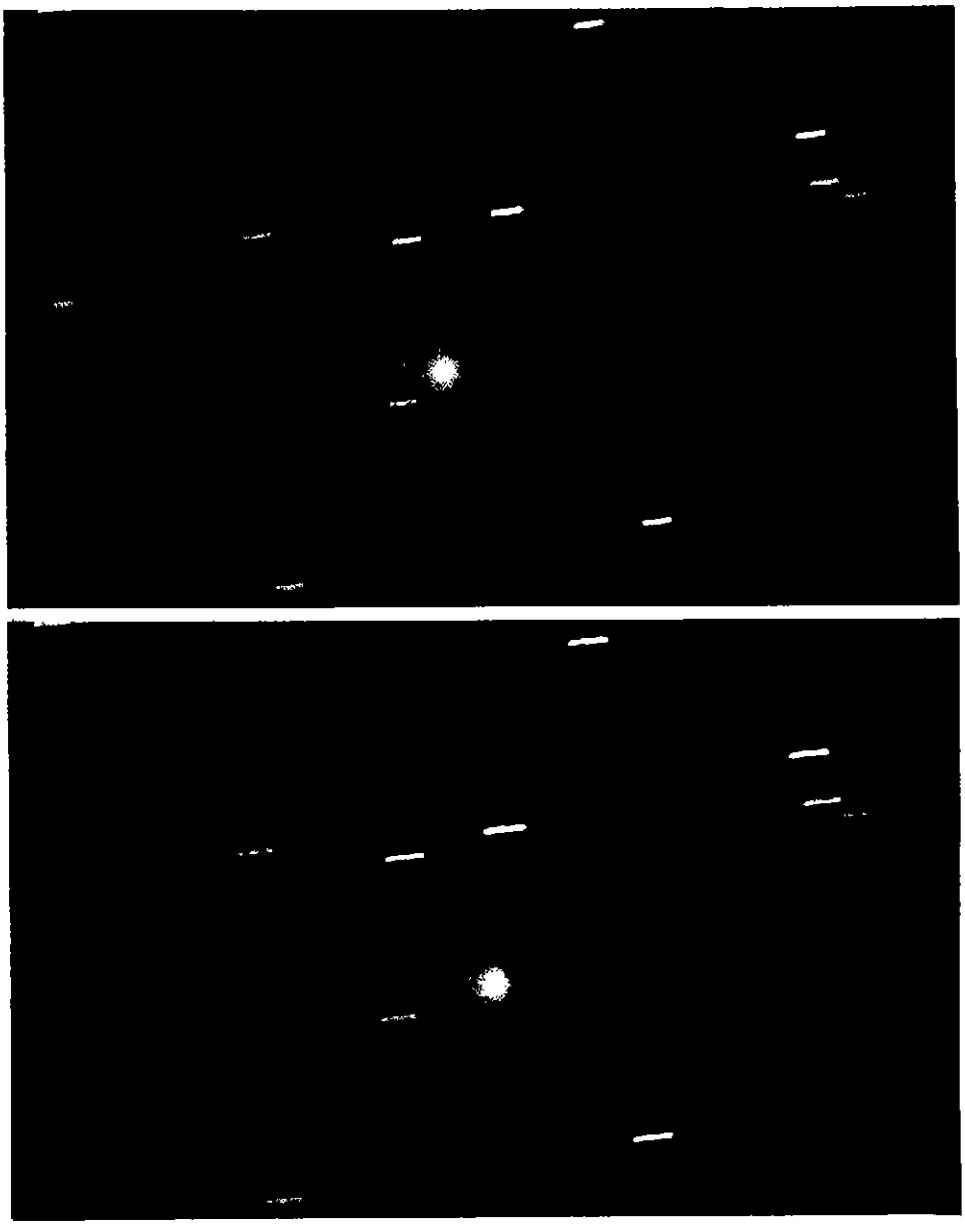

Fig. 1. Two photographs of P/Halley on 1985 Nov. 18 UT. The exposure times are 10 minutes(upper) and 15 minutes(lower 13:28-13:43 UT), during which the comet has changed its position toward west. A flash-like spot is visible on the lower left edge(east) of the comet head only on a lower photograph.

Fig. 2. P/Halley near its perihelion point on 1986 Mar. 11, 20:33.5-20:37.5 *UT*. The tail of the comet is the longest(~2°) among the photographs taken by authors.

Fig. 3. P/Halley near its second approach on 1986 Apr. 11, 16:45-16:55 UT. The comet at this time was just about 10° above the southern horizon visible at the southern-most sea coast of *Cheju Island*.