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OPTICAL IMAGING OBSERVATION OF COMET HALLEY AT THE KISO OBSERVATORY

By

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Abstract

Fifty-eight photographic plates (14×14 inches; 6°×6°) of Comet Halley were taken with the 105 cm Schmidt telescope at the Kiso Observatory during the period of its appearance in 1985/86 as a result of cooperative work by 30 observers. Observing dates were distributed from February 1985 to May 1986. This paper presents reproductions of 30 representative plates of good quality together with isophotes in relative intensity unit to show large scale phenomena and eruptive phenomena observed during this recurrence of Comet Halley.

Key words: Comet Halley; Photographic atlas; Isophotes.

1. Introduction

The Kiso Observatory was interested in observing Comet Halley well prior to its appearance in 1985/86. After some discussions, a guide line was suggested to take more than one direct photographs every night whenever possible, hopefully in each of the blue and the red color bands. Photographs taken successively within one hour would be valuable to see turbulent phenomena in the ion tail in relation to interplanetary magnetic field and eruptive phenomena ejected into the coma from the nucleus. The blue color band was chosen to see mainly the molecular emission from ionized gas, while the red color band the light reflected by dust.

All the staff members of the Kiso Observatory as well as visiting observers offered a part of their telescope times and observed Comet Halley as in case of a newly discovered object like a supernova. For such a newly discovered object, every observer at the Kiso Observatory is encouraged to carry out observations for confirmation.

As a result of the cooperative work by 30 observers, 58 plates were taken successfully during the period from 8 April 1985 to 12 May 1986. This paper presents a list of the plates, reproductions of 30 representative plates together with isophotes in relative intensity unit.

A set of sheet film copies of the 58 plates was sent to the Large Scale Phenomena Net of the International Halley Watch (IHW).

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2. Observations

The Kiso Schmidt (Takase et al. 1977) is one of the largest Schmidt telescopes available to the observation of Comet Halley. It is located at $\lambda=137°38'$ ($9^h10^m30^s$), $\varphi=+35°47'38''$, and 1130 m above sea level. The diameters of the corrector plate, main mirror, and the focal length of the Kiso Schmidt are 105 cm, 150 cm, and 330 cm, respectively, giving a focal ratio of 3.1. A 6°×6° field is covered by a 14×14-inch plate (scale=62.5 arcsec/mm), and the vignetting-free field is 4° in diameter.

The journal of the plates is shown in table 1 together with the parameters of plate measurement and data reduction. The effective bandpasses for the color bands used for the observations are shown in figure 1. Some plates were hypersensitized by baking

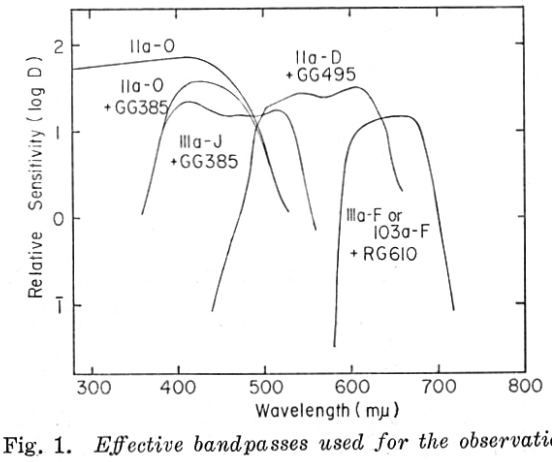


Fig. 1. *Effective bandpasses used for the observations of Comet Halley.*

Table 1. *List of Plates.*

KL No	Beginning of Exposure		Exp.	Band	Observers	α (1950)	δ	Δ	r	θ	β	PDS scan		Parameters of Isophotes		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
4655	Apr.08.44113	10:35:14	40	J+	1,12,30	4 52.1	+15 11	4.83	4.34	55.9	11.0	..	..	.....	....	....
4656	Apr.08.46821	11:14:13	40	J+	1,12,30	4 52.1	+15 11	4.83	4.34	55.9	11.0	..	..	.....	....	....
4657	Apr.09.43627	10:28:14	70	J+	7,12,27,30	4 52.3	+15 13	4.83	4.34	54.8	10.9	..	..	.....	....	....
4749	Sep.13.75267	18:03:51	20	B	5,20,28	6 12.3	+19 34	2.59	2.56	77.1	22.5	..	..	.....	....	....
4760	Sep.20.72307	17:21:13	25	B'	12,17,30	6 13.0	+19 43	2.37	2.47	84.0	23.8	..	..	.....	....	....
4761	Sep.20.75156	18:02:15	31	B'	12,17,30	6 13.0	+19 43	2.37	2.47	84.0	23.8	..	..	.....	....	....
4768	Oct.24.77601	18:37:27	35	B	2,21	5 44.2	+21 13	1.29	2.02	124.3	24.0	..	..	.....	....	....
4773	Nov.08.56890	13:39:13	20	B'	2, 8,12	4 45.7	+22 13	0.87	1.81	152.9	14.5	42	30	31.25*31.25	3.75	G1.0
4774	Nov.08.59529	14:17:13	07	B'	2, 8,12	4 45.7	+22 13	0.87	1.81	152.9	14.5	..	..	.....	....	....
4775	Nov.08.61543	14:46:13	25	R	8,12,29	4 45.7	+22 13	0.87	1.81	152.9	14.5	42	30	15.96*15.96	1.87	M3
4781	Nov.09.64182	15:24:13	36	B'	8,12,17	4 38.6	+22 14	0.85	1.80	155.4	12.8	42	30	31.25*31.25	3.75	M2
4785	Nov.10.71150	17:07:59	10	B'	12,17,25	4 31.4	+22 13	0.83	1.78	158.2	11.7	42	30	31.25*31.25	3.75	G1.0
4794	Nov.15.69802	16:45:09	11	B'	4,16,19	3 51.5	+21 50	0.73	1.71	172.2	4.5	..	..	.....	....	....
4797	Nov.19.45598	10:56:37	10	B'	18,23	3 14.1	+20 53	0.66	1.65	172.5	3.4	..	..	.....	....	....
4798	Nov.19.62123	14:54:34	10	B'	18,23	3 14.1	+20 53	0.66	1.65	172.5	3.4	42	30	42.67*42.67	5.0	G1.0
4808	Nov.29.38125	09:09:00	11	B'	16,23	1 23.4	+14 58	0.62	1.51	137.8	26.2	42	30	42.67*42.67	5.0	G1.0
4809	Nov.30.37240	08:56:15	15	R	16,23	1 12.1	+14 10	0.63	1.49	134.1	28.3	42	30	15.96*15.96	1.87	M3
4810	Dec.01.41065	09:51:20	03	V	16,23	1 01.2	+13 18	0.63	1.48	130.2	30.6	..	..	.....	....	....
4811	Dec.03.39569	09:31:14	60	R	1,20	0 40.2	+11 44	0.66	1.43	119.3	36.9	95	80	42.67*42.67	5.0	G1.0
4812	Dec.03.45278	10:52:00	40	V+	1,20	0 40.2	+11 43	0.66	1.43	119.3	36.9	95	80	42.67*42.67	5.0	G1.0
4813	Dec.03.49153	11:47:48	20	B'+	1,20	0 40.2	+11 41	0.66	1.43	119.3	36.9	95	80	42.67*42.67	5.0	G1.0
4814	Dec.03.51317	12:18:58	20	B'+	1,20	0 40.2	+11 40	0.67	1.43	119.3	36.9	..	..	.....	....	....
4818	Dec.08.48280	11:35:14	30	B'+	3,12,13	3 57.5	+ 7 43	0.71	1.37	106.5	44.1	95	80	42.67*42.67	5.0	G1.0
4819	Dec.08.52376	12:34:13	40	R	3,12,13	3 57.5	+ 7 42	0.71	1.37	106.5	44.1	95	80	42.67*42.67	5.0	G1.0
4820	Dec.10.38940	09:20:44	20	B'	22,25	3 43.7	+ 6 26	0.74	1.34	101.0	46.2	95	80	42.67*42.67	5.0	G1.0
4827	Dec.12.47597	11:25:24	08	B'	22,25	3 30.3	+ 5 04	0.78	1.31	95.3	48.6	95	80	42.67*42.67	5.0	G1.0
4828	Dec.12.50204	12:02:56	20	B'	22,25	3 30.3	+ 5 04	0.78	1.31	95.3	48.6	..	..	.....	....	....
4831	Dec.18.42796	10:16:16	04	B'	11,13,27	2 59.2	+ 1 56	0.89	1.22	80.7	53.0	..	..	.....	....	....
4832	Dec.18.44640	10:42:49	03	B'	11,13,27	2 59.2	- 1 56	0.89	1.22	80.7	53.0	..	..	.....	....	....
4836	Dec.24.38971	09:21:11	06	V+	7,16,17,23	2 36.4	- 0 24	1.01	1.12	68.5	54.6	95	80	42.67*42.67	5.0	M2
4837	Dec.24.40634	09:45:08	05	B'+	7,16,17,23	2 36.4	- 0 24	1.01	1.12	68.5	54.6	..	..	.....	....	....
4838	Dec.24.41667	10:00:06	05	B'+	7,16,17,23	2 36.4	- 0 24	1.01	1.12	68.5	54.6	..	..	.....	....	....
4840	Dec.26.37128	08:54:39	20	V+	7,17	2 30.0	- 1 02	1.05	1.09	65.0	54.7	95	80	42.67*42.67	5.0	G1.0
4841	Dec.27.36433	08:44:38	40	R+	1, 7,17	2 27.3	- 1 19	1.07	1.08	63.3	54.6	95	80	42.67*42.67	5.0	G1.0
4842	Dec.31.38575	09:15:29	10	B'	1	2 16.5	- 2 25	1.15	1.02	56.0	53.6	95	80	42.67*42.67	5.0	G1.0
4843	Dec.31.40296	09:40:16	10	B'	1	2 16.5	- 2 25	1.15	1.02	56.0	53.6	95	80	42.67*42.67	5.0	G1.0
4845	Jan.02.36547	08:46:17	10	B'	7,23	2 11.7	- 2 53	1.19	0.99	53.1	52.8	95	80	42.67*42.67	5.0	G1.0
4846	Jan.02.38381	09:12:41	43	R+	7,23	2 11.7	- 2 53	1.19	0.99	53.1	52.8	95	80	42.67*42.67	5.0	G1.0
4851	Jan.07.38413	09:13:09	10	B'	6,12,17	2 0.7	- 3 56	1.28	0.91	45.1	49.9	95	80	42.67*42.67	5.0	G1.0
4852	Jan.07.39718	09:31:56	20	B'	6,12,17	2 0.7	- 3 56	1.28	0.91	45.1	49.9	95	80	42.67*42.67	5.0	G1.0

KL No	Beginning of Exposure		Exp.	Band	Observers	α (1950)	δ	Δ	r	θ	β	PDS scan		Parameters of Isophotes		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
4853	Jan.07.41699	10:00:28	05	B'	6,12,17	2 0.7	- 3 56	1.28	0.91	45.1	49.9	..	..	.....	....	....
4987	Mar.07.82313	19:45:18	05	B'	7,10,14,25,27,29	0 14.0	-18 59	1.11	0.82	44.9	59.6	..	..	.....	....	....
4997	Mar.08.82241	19:44:16	07	B'	10,14,17,25	0 12.0	-19 26	1.09	0.83	46.5	60.6	95	80	42.67*42.67	5.0	G1.0
4998	Mar.11.81926	19:39:44	10	B'	5, 7,22,28	0 5.7	-20 52	1.01	0.87	51.3	63.0	95	80	42.67*42.67	5.0	G1.0
5005	Mar.12.82211	19:43:50	10	B'	5, 7,28	0 3.3	-21 21	0.99	0.89	52.9	63.7	..	..	.....	....	....
5006	Mar.16.82169	19:43:14	10	B'	5,20	9 52.7	-23 43	0.90	0.95	59.8	65.5	95	80	42.67*42.67	5.0	G1.0
5009	Mar.17.81604	19:35:06	08	B'	20,21	9 49.7	-24 23	0.87	0.96	61.7	65.8	..	..	.....	....	....
5010	Mar.19.80748	19:22:46	10	B'	1,23	9 42.9	-25 48	0.82	0.99	65.4	66.1	..	..	.....	....	....
5029	Apr.05.80476	19:18:51	10	B'	23,28	7 1.9	-45 7	0.45	1.26	113.9	46.9	..	..	.....	....	....
5035	Apr.07.80340	19:16:54	08	B'	23,24,26,28	6 18.5	-46 53	0.43	1.29	122.2	41.3	..	..	.....	....	....
5050	Apr.13.63631	15:16:17	10	B'	20,25	3 50.0	-44 13	0.43	1.37	140.6	25.4	..	..	.....	....	....
5054	Apr.16.63002	15:07:14	05	B'	21,25	2 50.6	-39 06	0.46	1.42	149.1	21.3	95	80	42.67*42.67	5.0	G0.5
5059	Apr.24.51019	12:14:40	10	B'	5, 7	1 25.2	-25 35	0.63	1.54	140.3	24.7	95	80	77.50*51.50	10.0	G0.5
5060	Apr.24.52532	12:36:28	05	B'	5, 7	1 25.1	-25 33	0.63	1.54	140.3	24.7	..	..	.....	....	....
5061	Apr.24.54201	13:00:30	10	B'	5, 7	1 25.0	-25.32	0.63	1.54	140.3	24.7	..	..	.....	....	....
5073	May.09.53078	12:44:19	15	B'	15,17,24,26	0 35.6	-12 3	1.07	1.76	115.7	31.2	95	80	83.33*52.17	10.0	G1.0
5076	May.10.47639	11:26:00	15	B'	23,24,25,26	0 34.3	-12 11	1.10	1.77	114.3	31.2	..	..	.....	....	....
5078	May.12.46907	11:15:28	10	B'	23,24,25,26	0 31.9	-11 19	1.16	1.80	111.8	31.4	..	..	.....	....	....

EXPLANATION OF COLUMNS

Column (1): Kiso Schmidt plate number.
Column (2): Beginning of exposure in dates.
Column (3): Beginning of exposure in UT.
Column (4): Duration of exposure in minutes.
Column (5): Color band code; B'=IIa-O(no filter), B=IIa-O+GG385, J=IIIa-J+GG385, V=IIa-D+GG495, R=103a-F or IIIa-F+RG610. The code '+' means that the emulsion is hypersensitized.
Columns (7) and (8): Approximate 1950 coordinates.
Column (9): Geocentric distance of Comet Halley in AU.
Column (10): Heliocentric distance of Comet Halley in AU.
Column (11): Sun-Earth-Comet angle in degrees.
Column (12): Sun-Comet-Earth angle in degrees.
Column (13): Aperture size in microns.
Column (14): Sample pitch in microns.
Column (15): Frame size of isophotal map in arcmin.
Column (16): Pixel size in arcsec.
Column (17): Type of smoothing applied; Gn.m and Mn mean the Gaussian beam of a standard deviation n.m pixels and the median filter with box size of (2n+1) pixels.

Column (6): Observers (TAO=Tokyo Astronomical Observatory);

(1) Aoki, Tsutomu	Kiso, TAO.	(17) Okamura, Sadanori	Kiso, TAO.
(2) Hamabe, Masaru	Kiso, TAO.	(18) Sasaki, Goro	TAO.
(3) Hamatake, Hisashi	Tokyo Univ.	(19) Sasaki, Minoru	Kyoto Univ.
(4) Hanaoka, Yoichiro	Kyoto Univ.	(20) Soyano, Takao	Kiso, TAO.
(5) Ichikawa, Shin-ichi	Tokyo Univ.	(21) Tanaka, Wataru	Kiso, TAO.
(6) Ichikawa, Takashi	Kyoto Univ.	(22) Taniguchi, Yoshiaki	Tohoku Univ.
(7) Ishida, Keiichi	Kiso, TAO.	(23) Tarusawa, Ken-ichi	Kiso, TAO.
(8) Ito, Masanao	Tokyo Univ.	(24) Wakamatsu, Ken-ichi	Gifu Univ.
(19) Izumiura, Hideyuki	Tokyo Univ.	(25) Watanabe, Masaaki	TAO.
(10) Kanbe, Eiji	Tokyo Univ.	(26) Watanabe, Toshio	Tokyo Kogei Univ.
(11) Kogure, Tomokazu	Kyoto Univ.	(27) Wiramihardja, Suhardja D.	Kyoto Univ. and Bosscha Obs.(Indonesia)
(12) Kosai, Hiroki	TAO.		
(13) Maehara, Hideo	Kiso, TAO		
(14) Murata, Yasuhiro	Tokyo Univ.	(28) Yamagata, Tomohiko	TAO.
(15) Nishida, Mitsugu	Kobe Jogakuin.	(29) Yoshida, Shigeomi	Kyoto Univ.
(16) Noguchi, Takeshi	Kiso, TAO.	(30) Yoshikawa, Makoto	Tokyo Univ.

Fig. 2. *A photographic atlas of Comet Halley. North is top and east is left. The scale bar in the photographs is 30 arcmin in length. Scale of the isophotes can be computed from the pixel size given in table 1. The interval between two tick marks on the side corresponds to 20 pixels. Contour levels are expressed in units of both relative intensity and magnitude relative to unknown sky brightness, which is assumed to be 0.0 mag arcsec^{-2}. NG (neglected) means the maximum number in pixel units to make closed contours.*

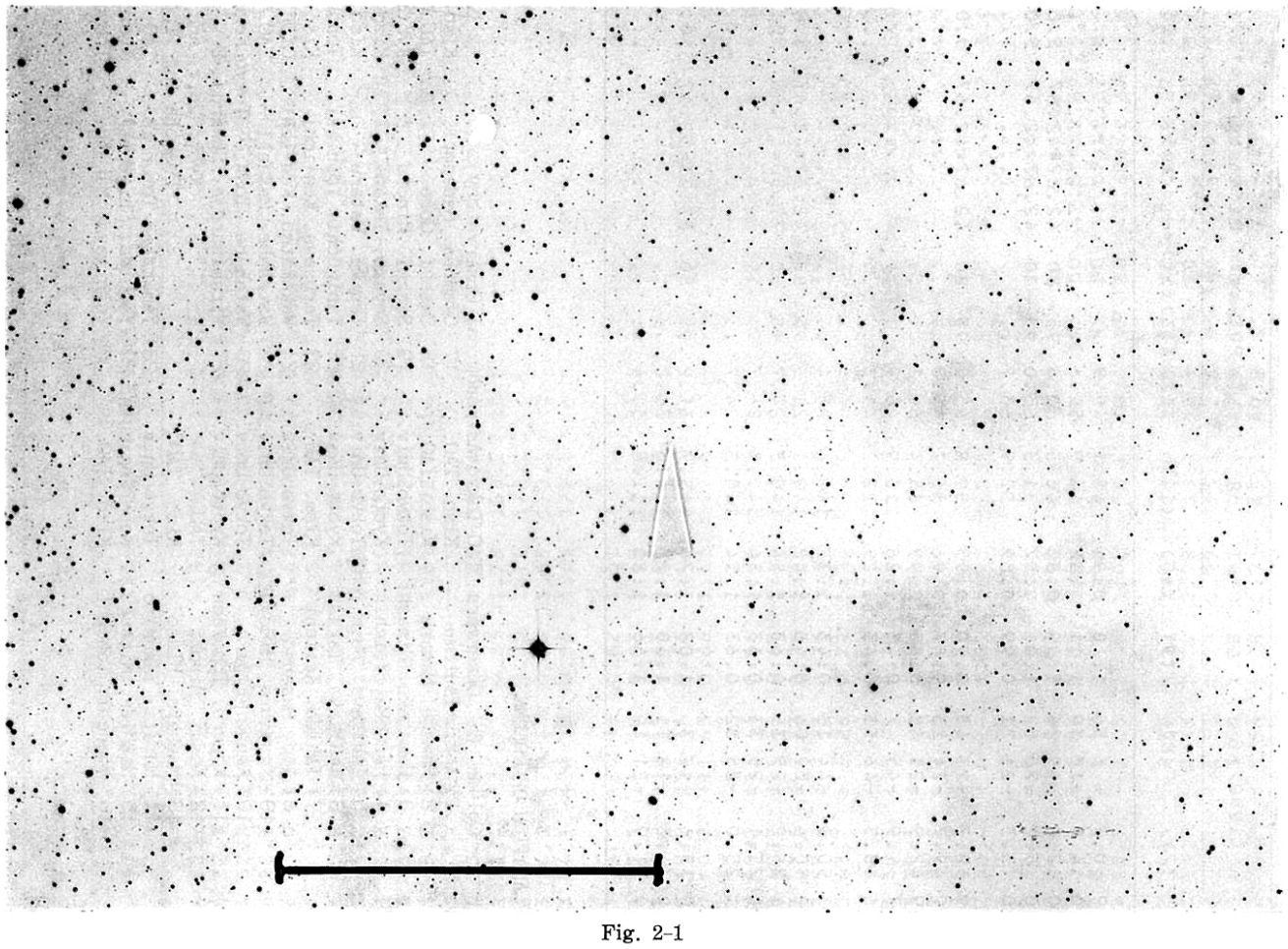
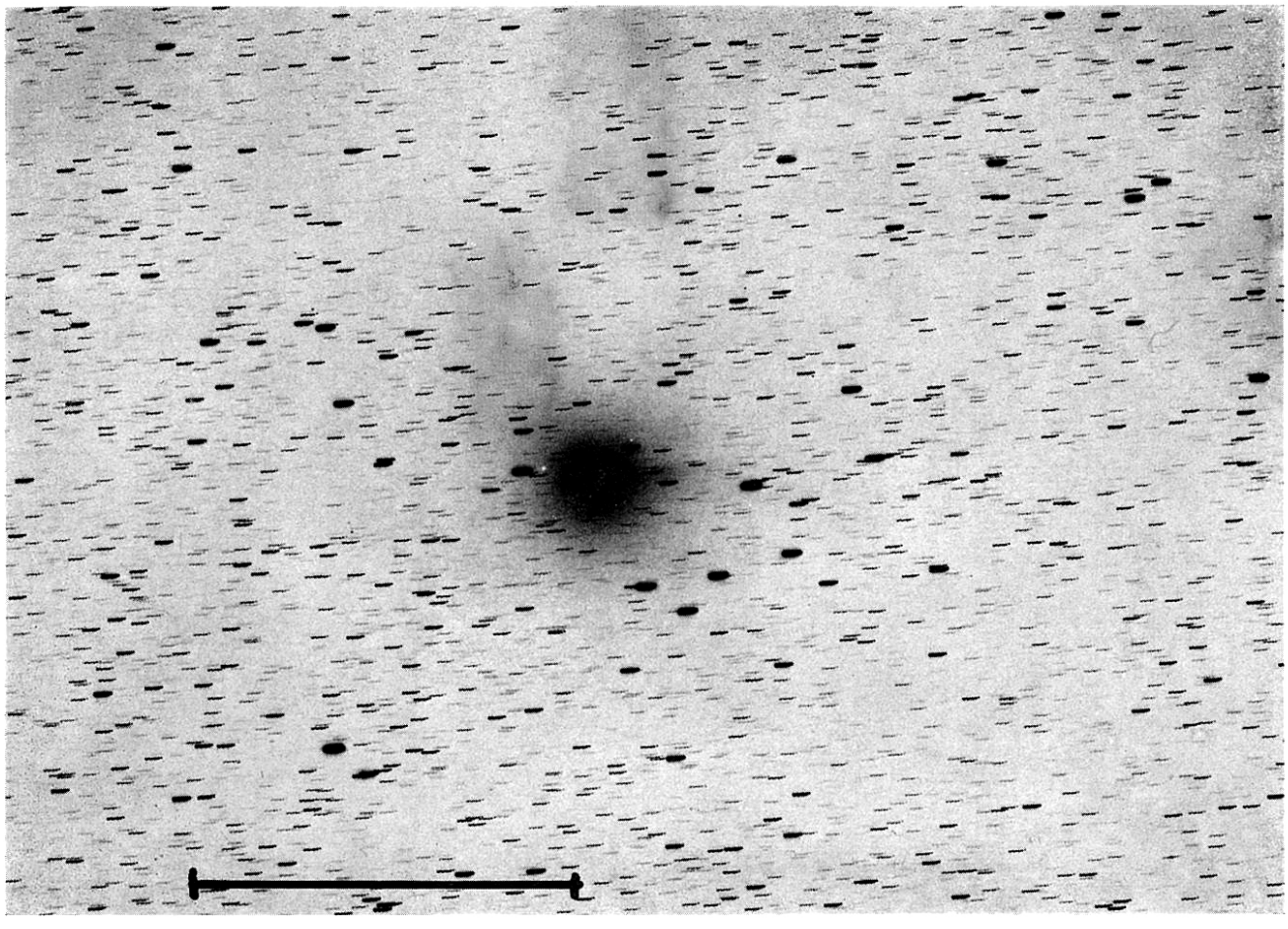
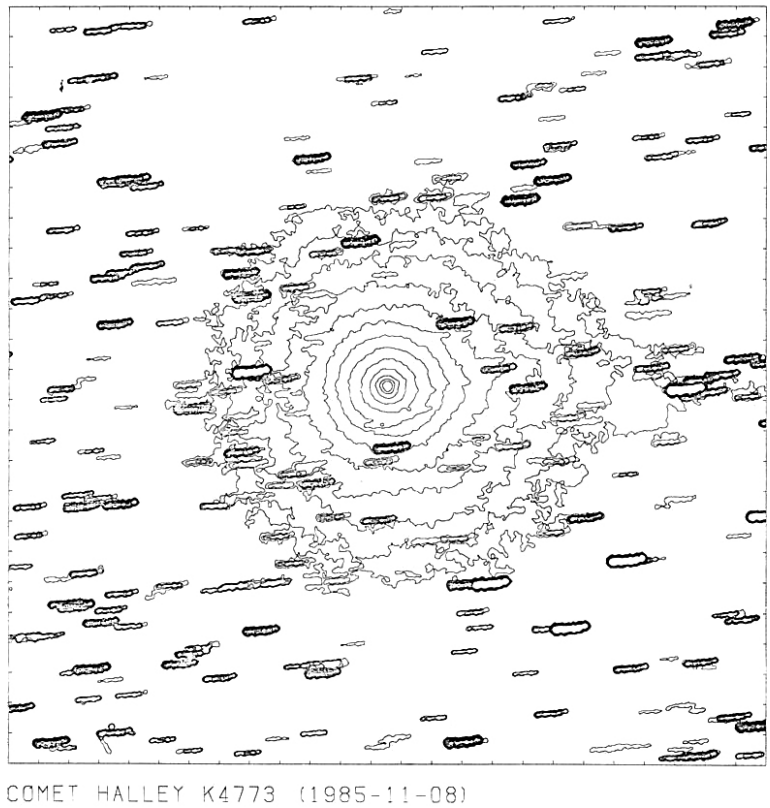


Fig. 2-1

COMET HALLEY K4657 (1985 04 09)
First detection of the Comet at Kiso Obserbatory.
The Comet indicated by arrow is about 19.5 in B-magnitude.





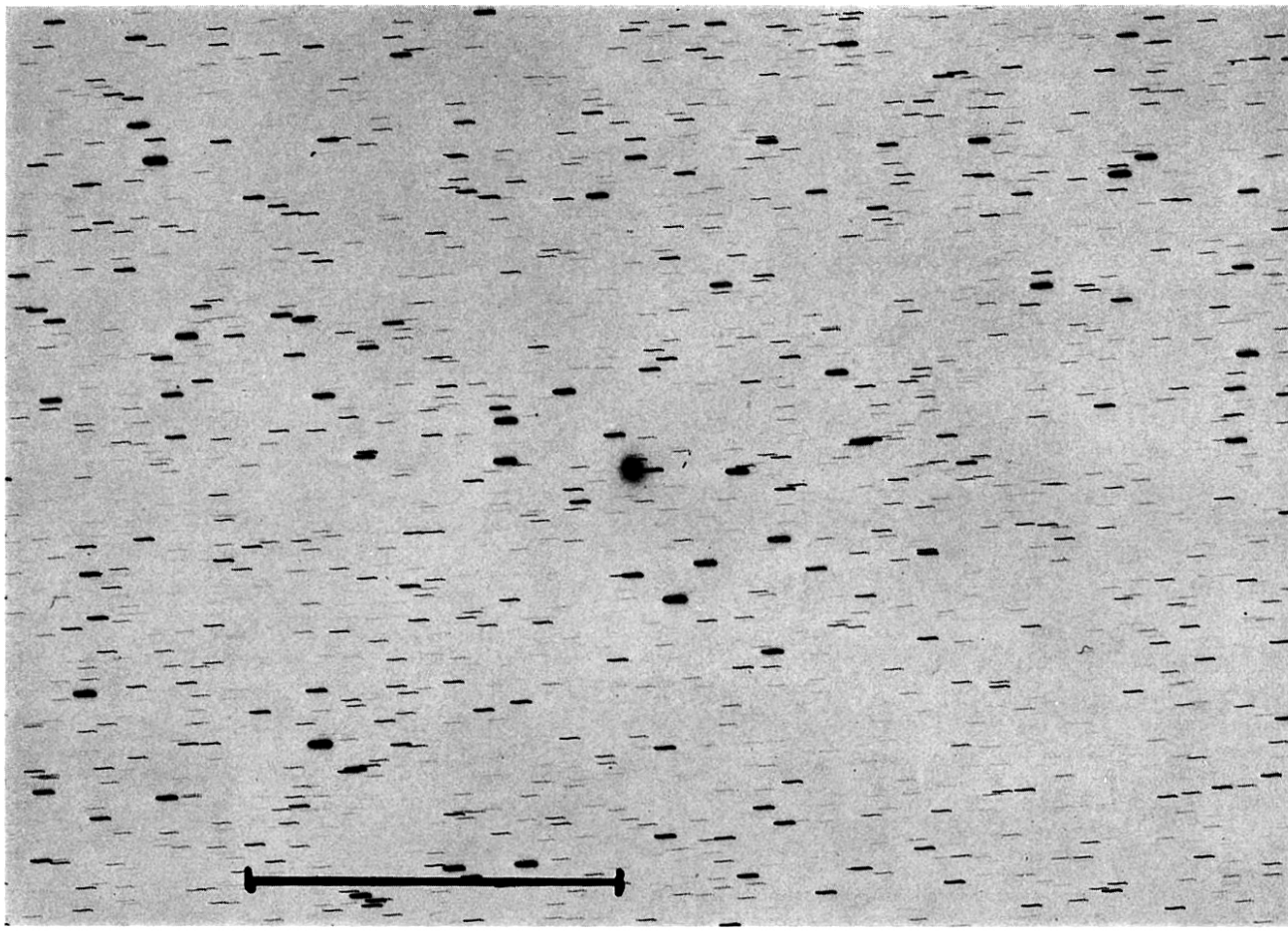
COMET HALLEY K4773 (1985-11-08)

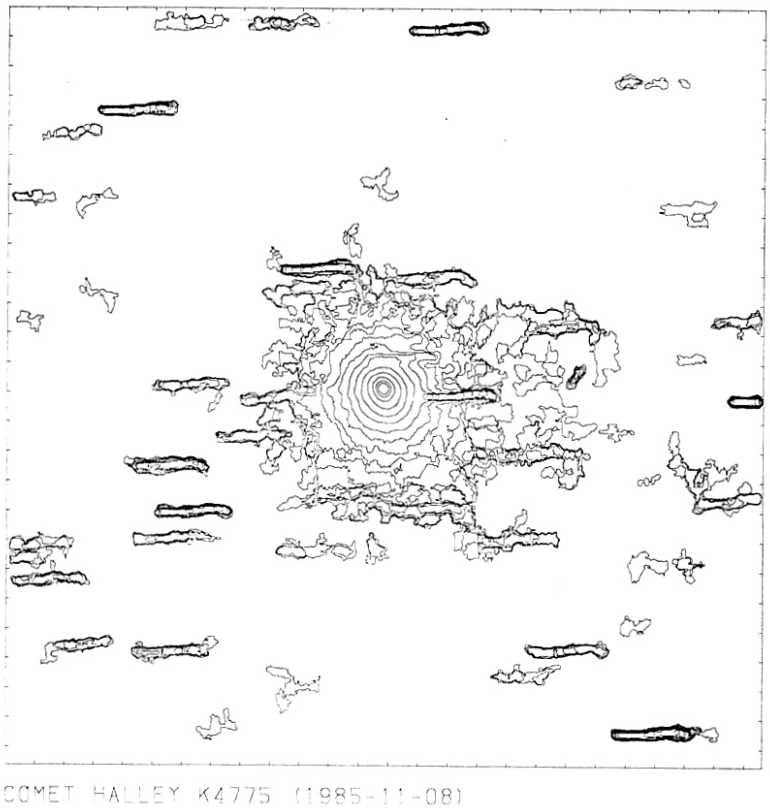
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	30
4	0.251	1.50	30
5	0.398	1.00	20
6	0.631	0.50	20
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3

Fig. 2-2





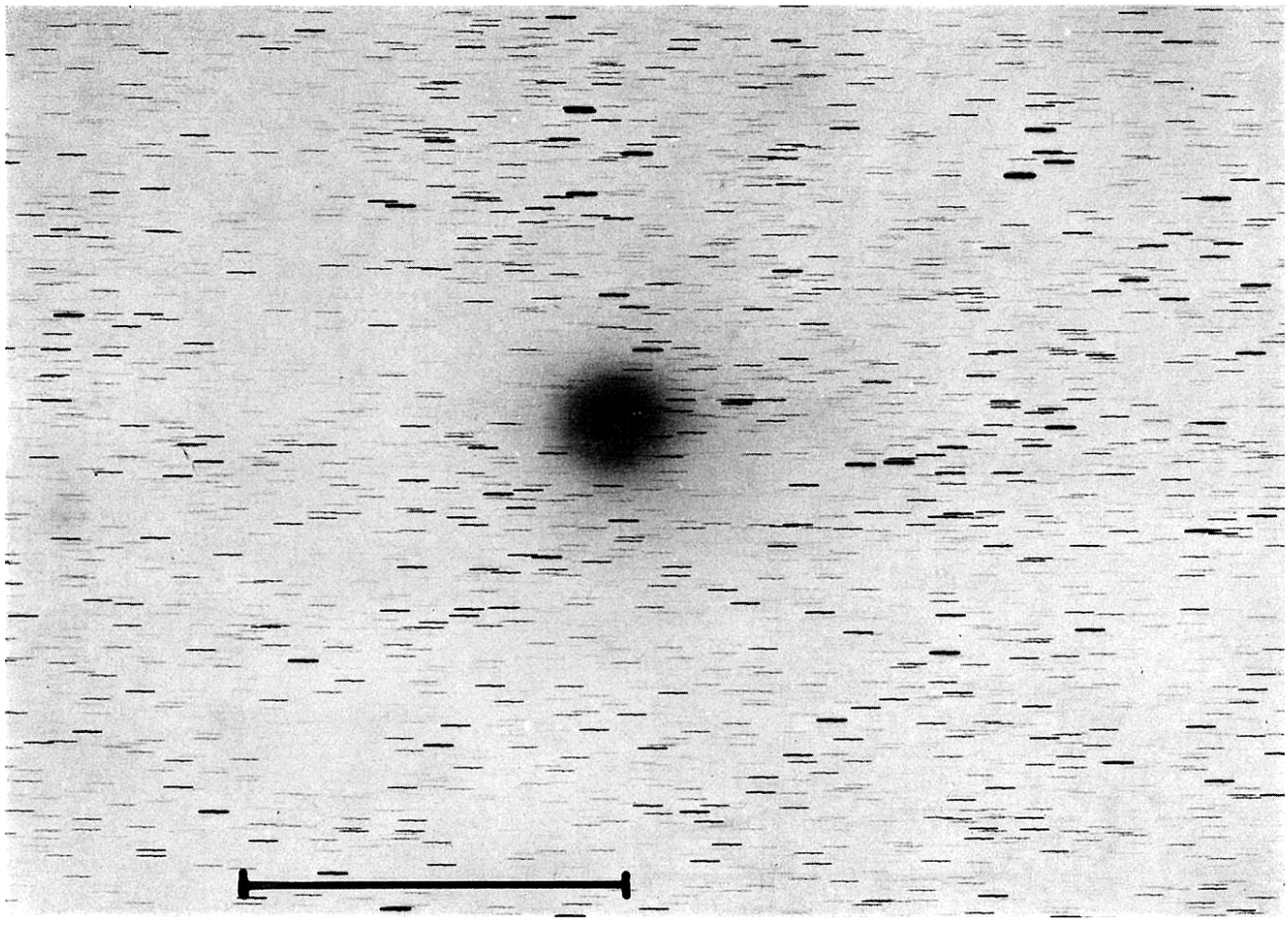
**** CONTOUR LEVELS ****

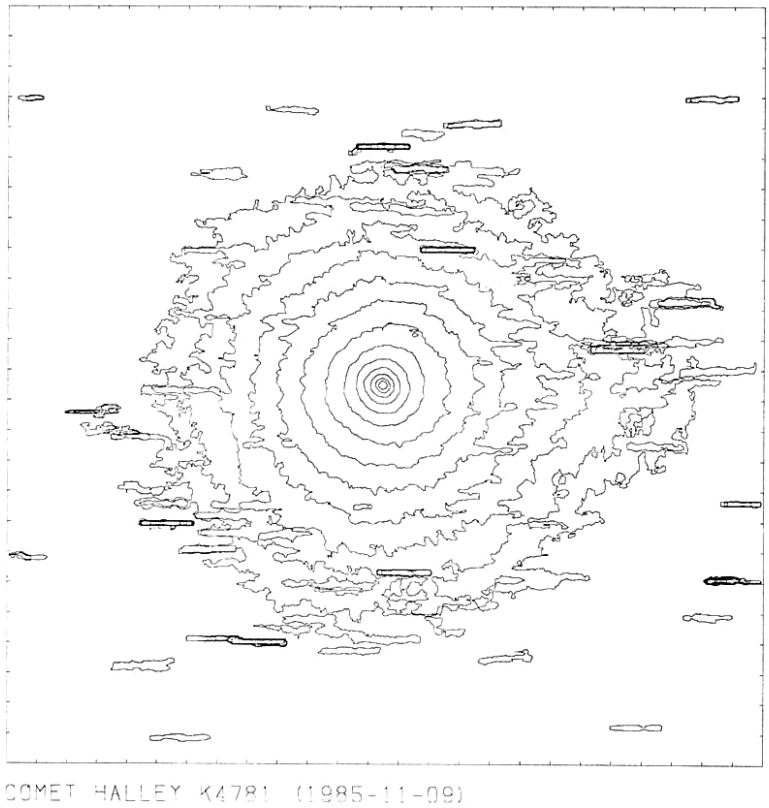
SKY= 0.0

	REL. INT.	MAG.	NG
1	0.100	2.50	500
2	0.159	2.00	100
3	0.251	1.50	50
4	0.398	1.00	30
5	0.631	0.50	20
6	1.000	0.0	10
7	1.585	-0.50	3
8	2.512	-1.00	3
9	3.981	-1.50	3
10	6.310	-2.00	3
11	10.000	-2.50	3
12	15.849	-3.00	3
13	25.119	-3.50	3
14	39.811	-4.00	3

COMET HALLEY K4775 (1985-11-08)

Fig. 2-3



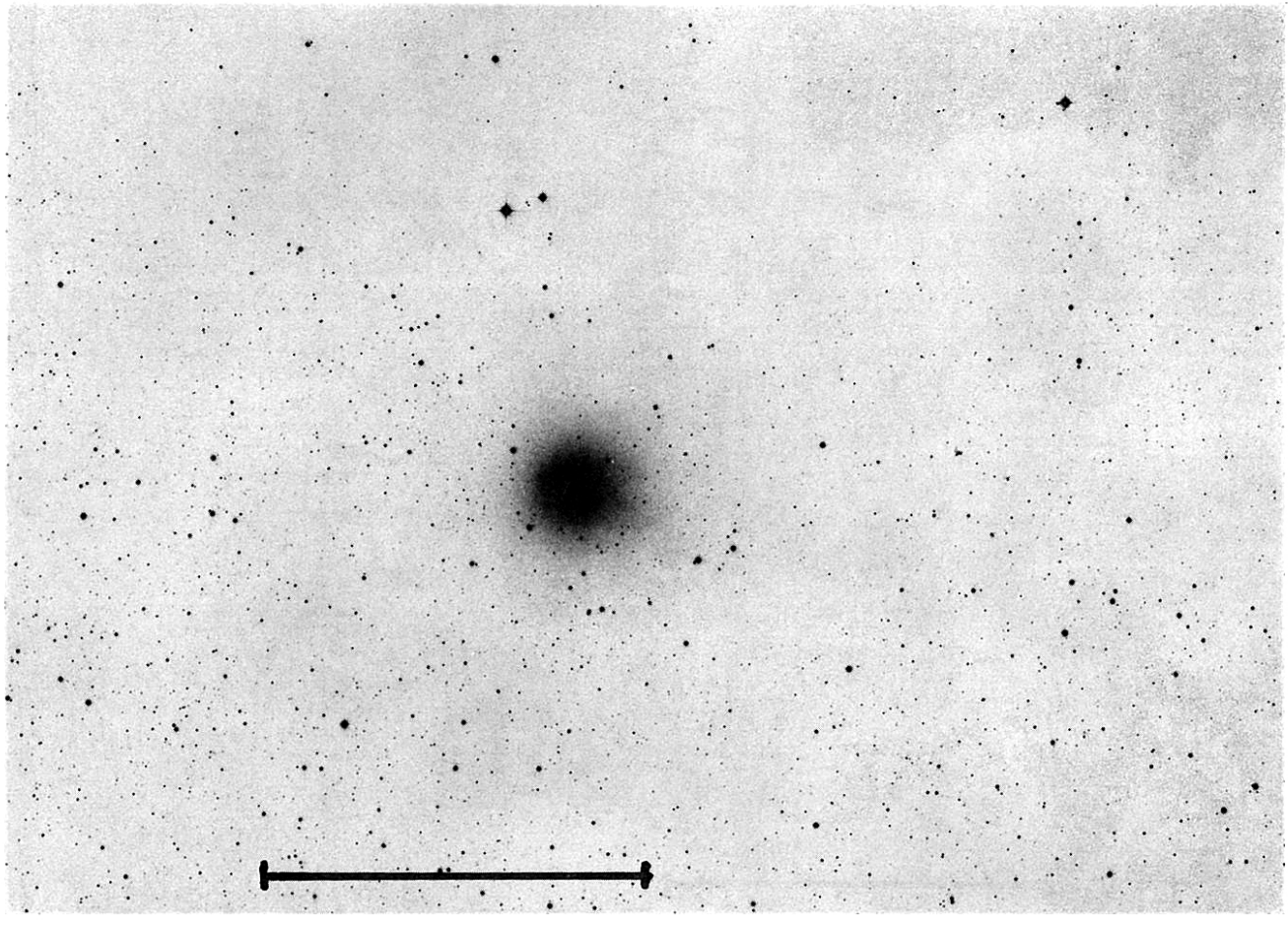


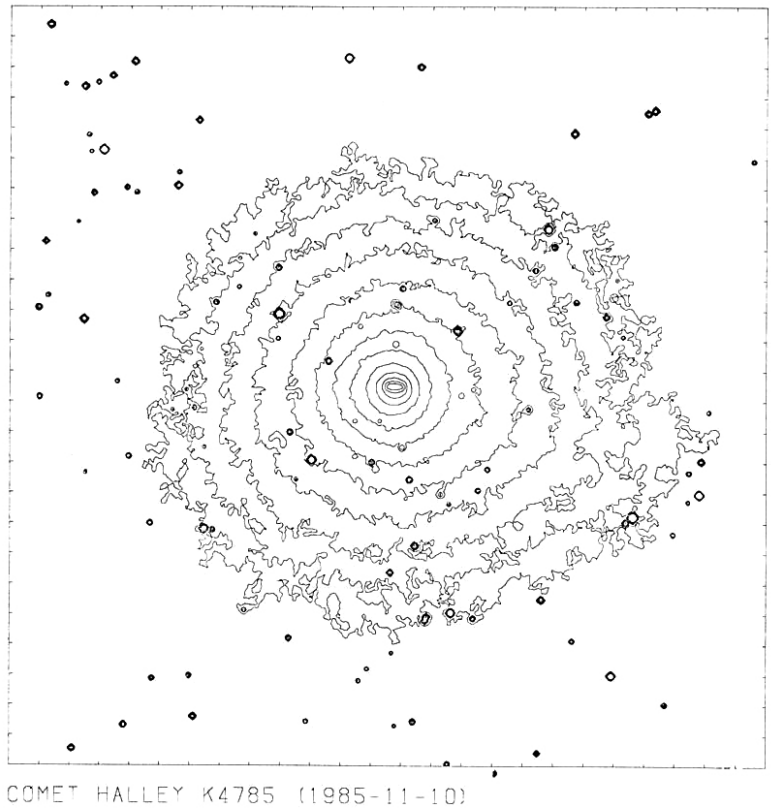
COMET HALLEY K4781 (1985-11-09)

**** CONTOUR LEVELS ****

	SKY= 0.0 REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.158	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3

Fig. 2-4





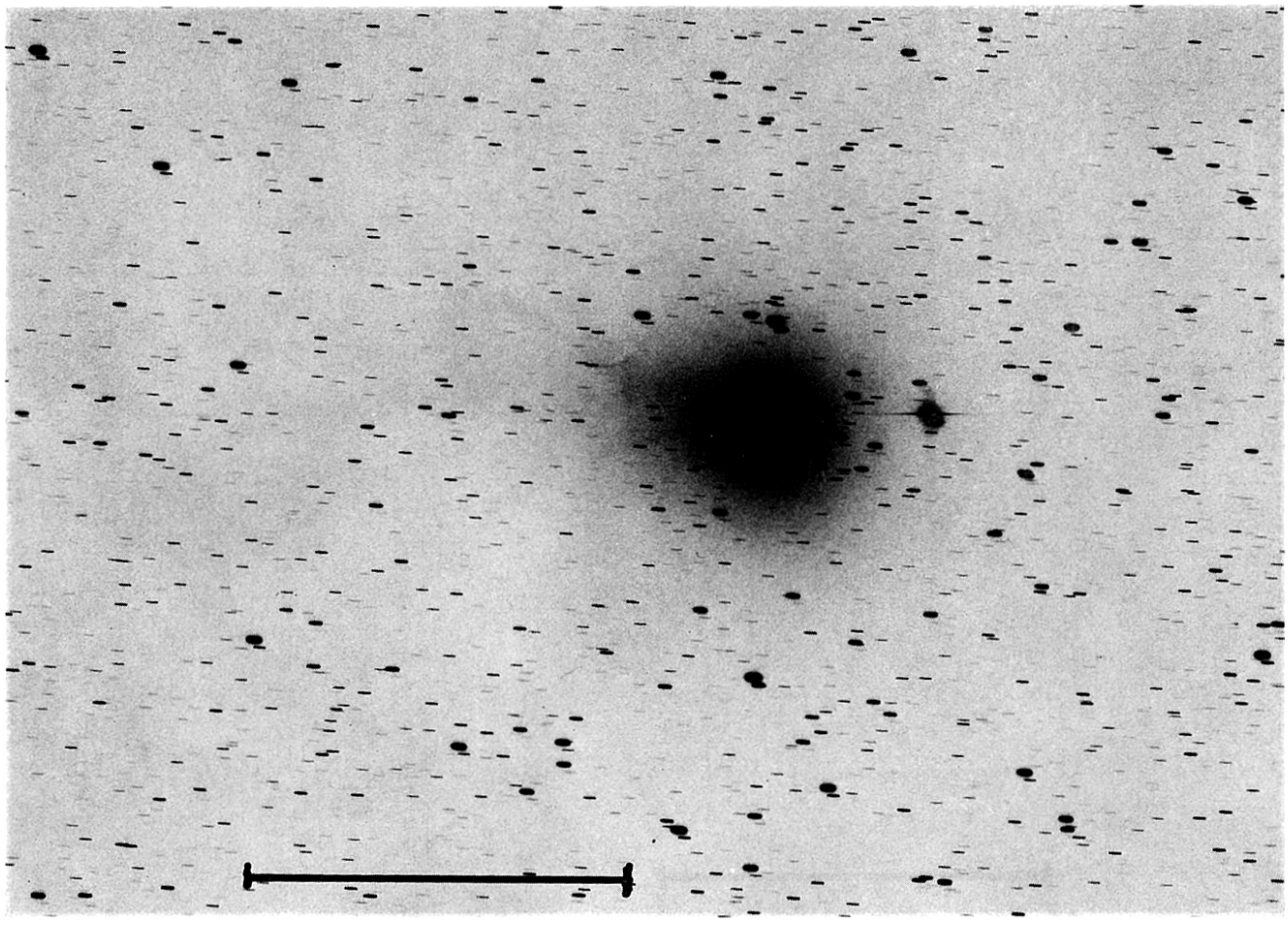
COMET HALLEY K4785 (1985-11-10)

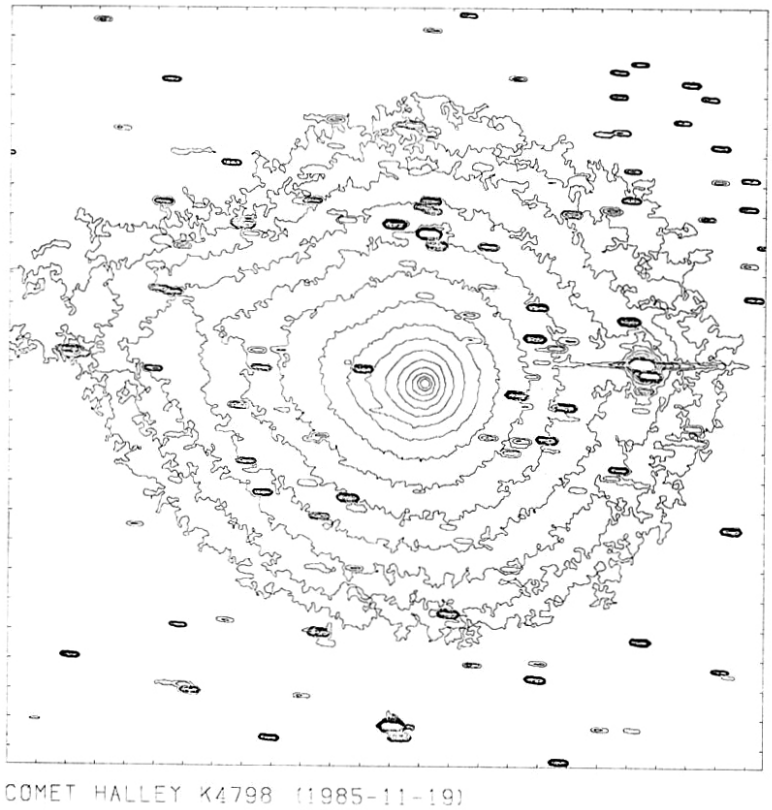
×××× CONTOUR LEVELS ××××

SKY= 0.0

	REL. INT.	MAG.	NC
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-5





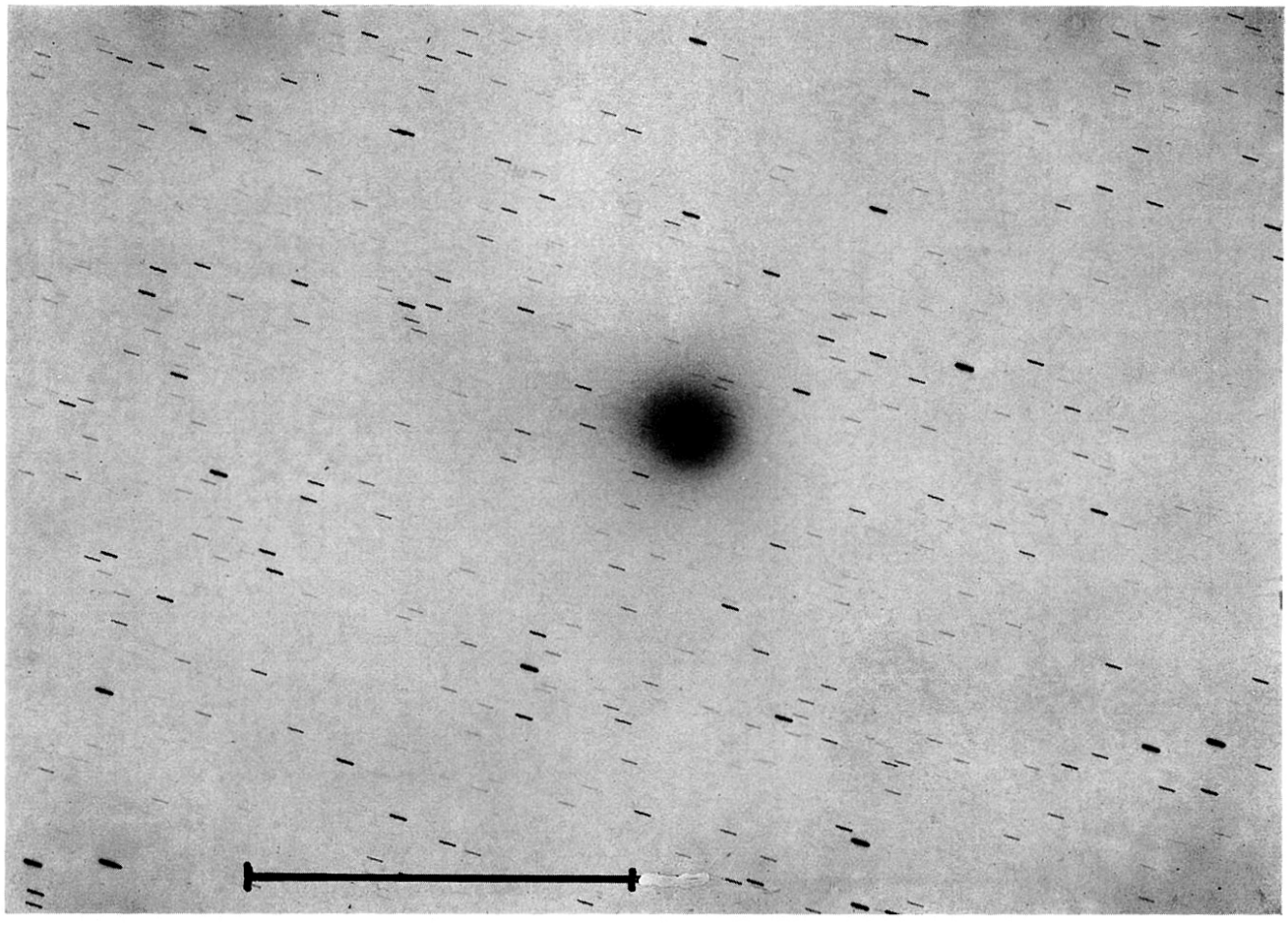
×××× CONTOUR LEVELS ××××

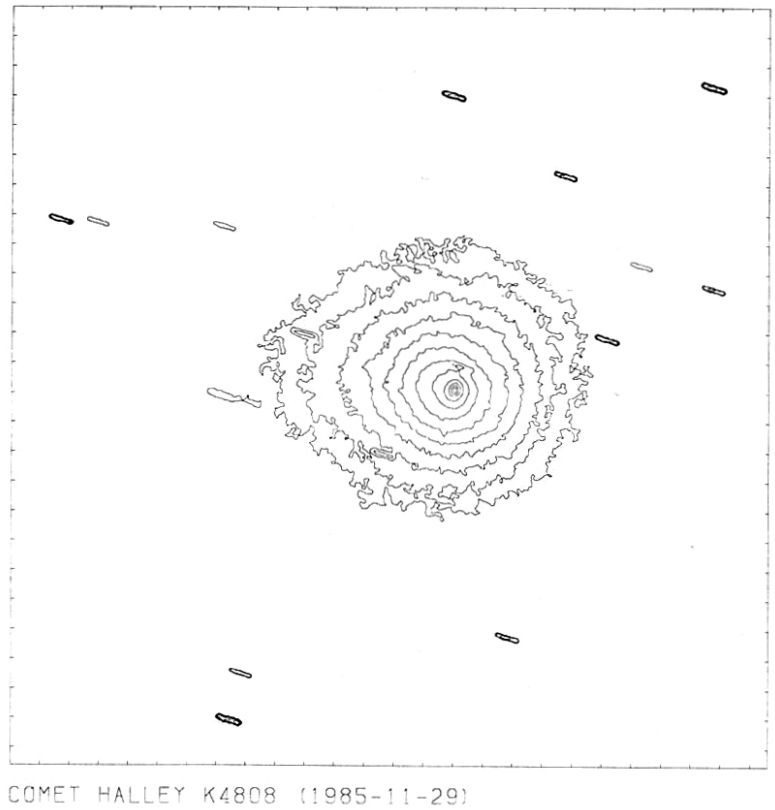
SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

COMET HALLEY K4798 (1985-11-19)

Fig. 2-6





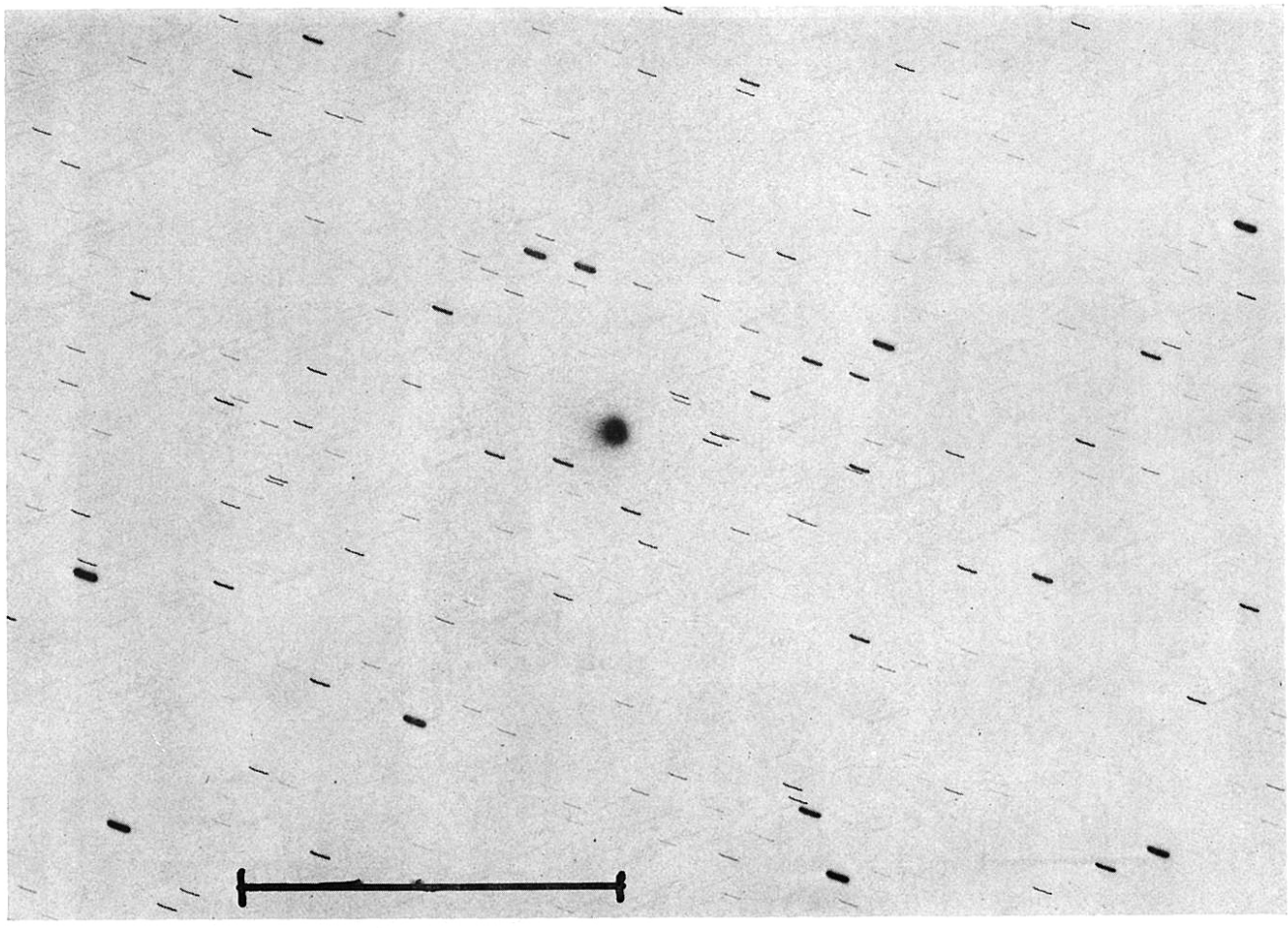
**** CONTOUR LEVELS ****

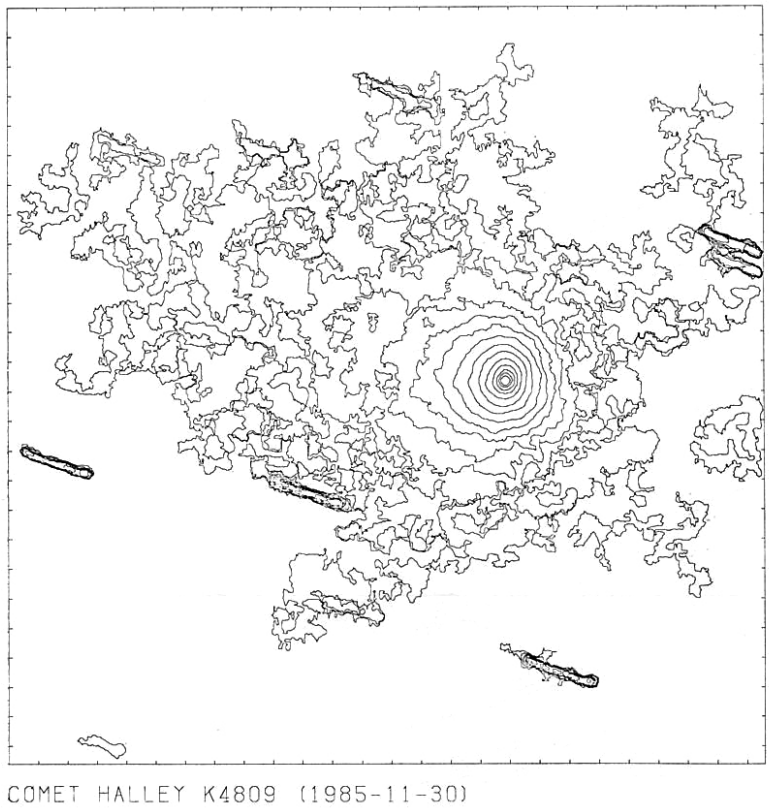
SKY= 0.0

	REL. INT.	MAG.	NC
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3

COMET HALLEY K4808 (1985-11-29)

Fig. 2-7





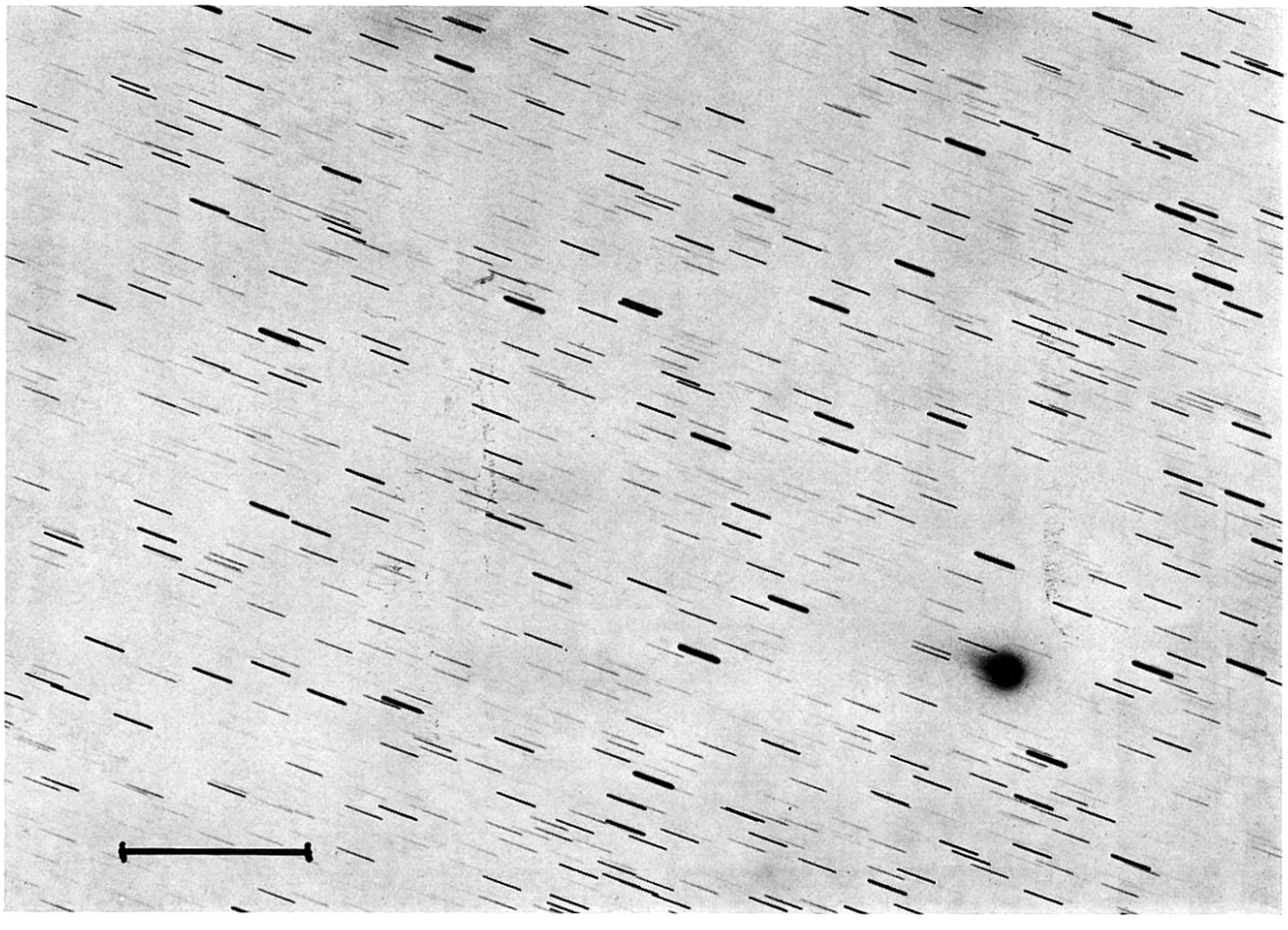
COMET HALLEY K4809 (1985-11-30)

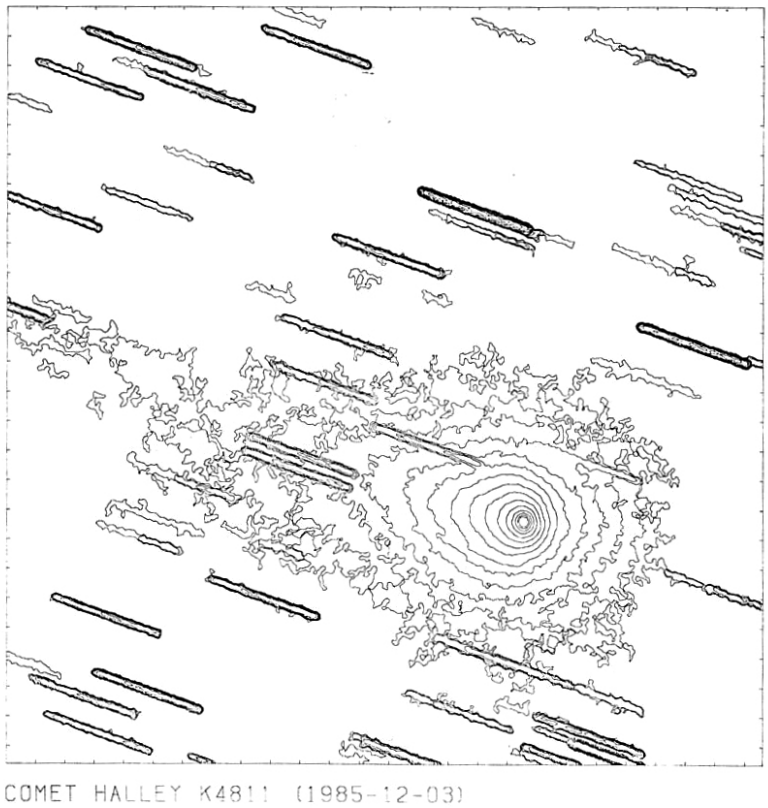
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	500
2	0.100	2.50	200
3	0.159	2.00	100
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-8





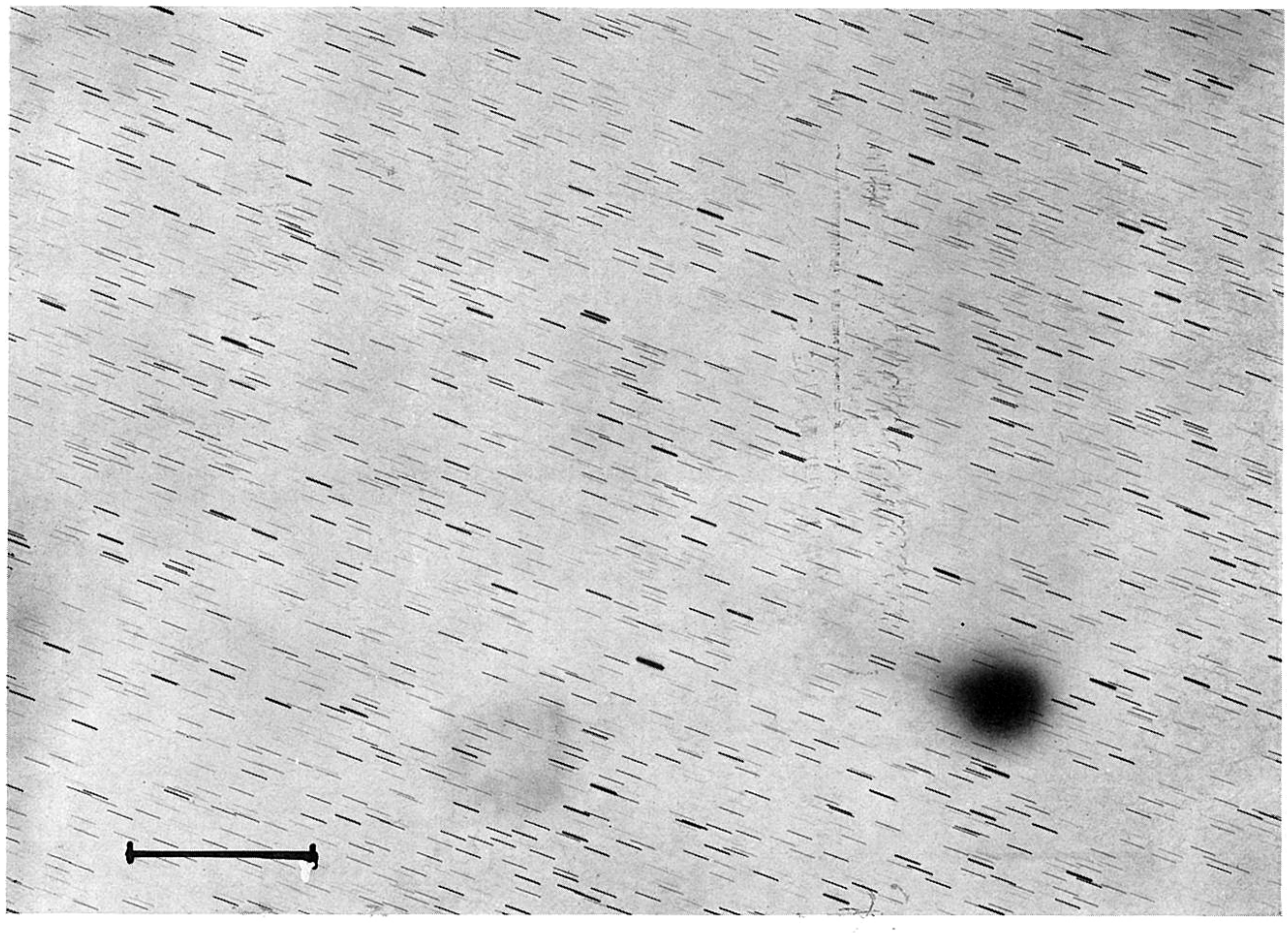
****** CONTOUR LEVELS ******

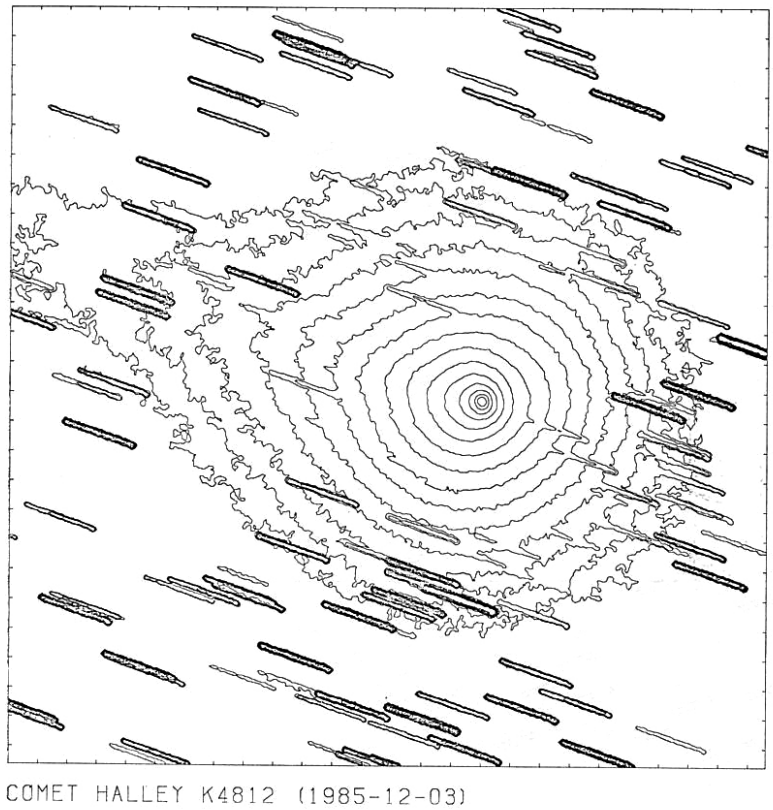
SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

COMET HALLEY K4811 (1985-12-03)

Fig. 2-9





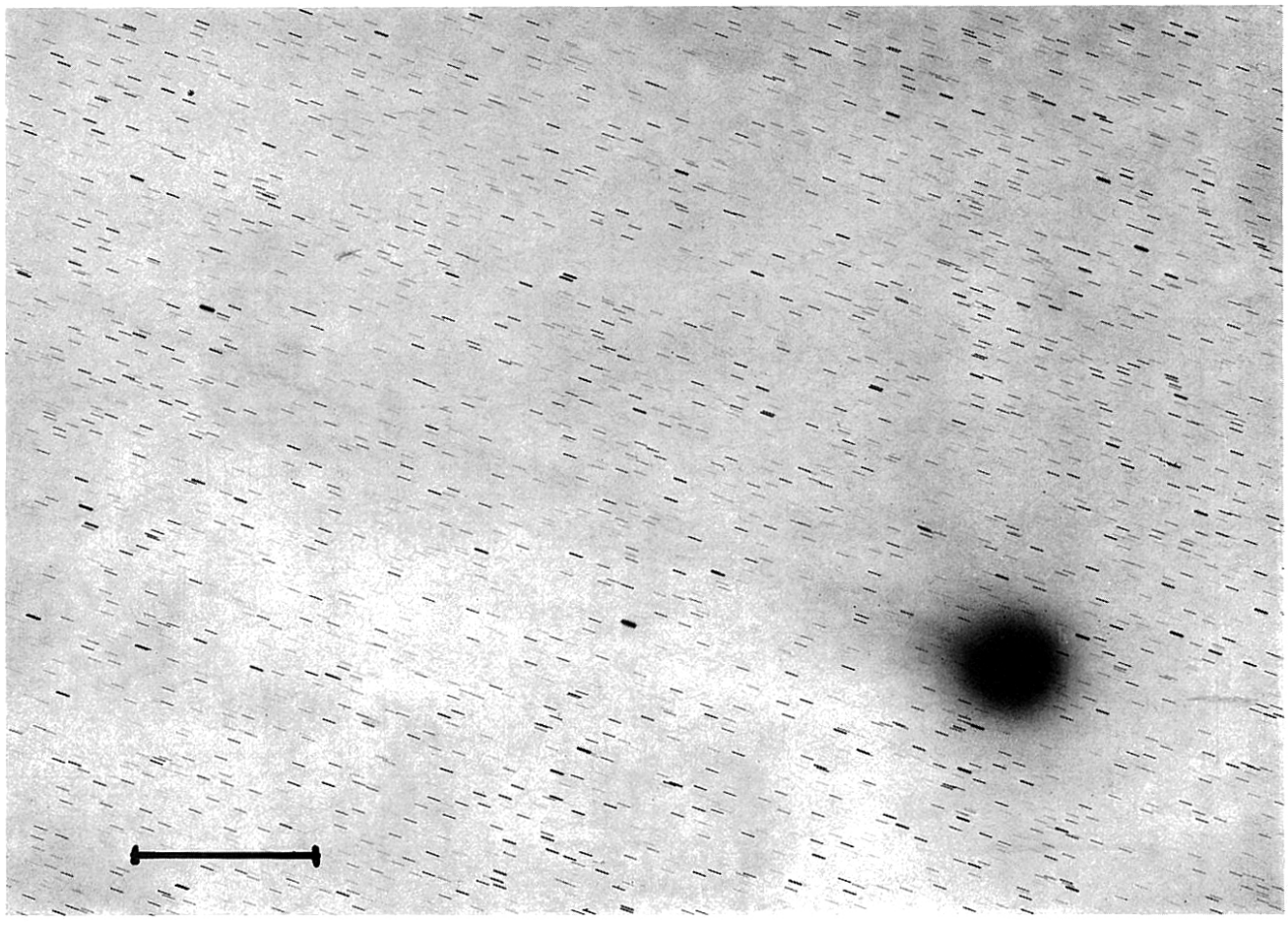
COMET HALLEY K4812 (1985-12-03)

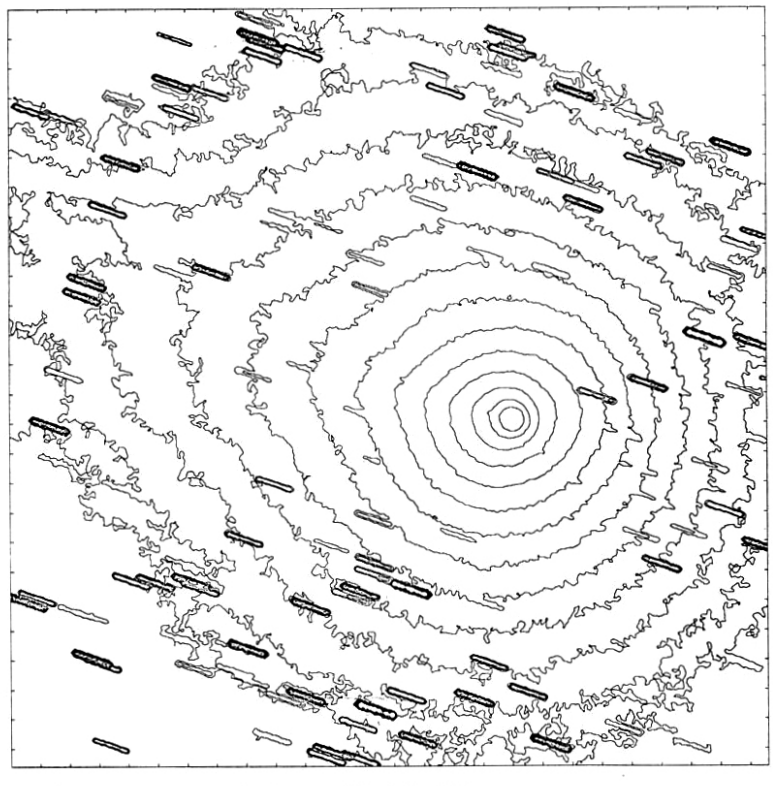
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-10





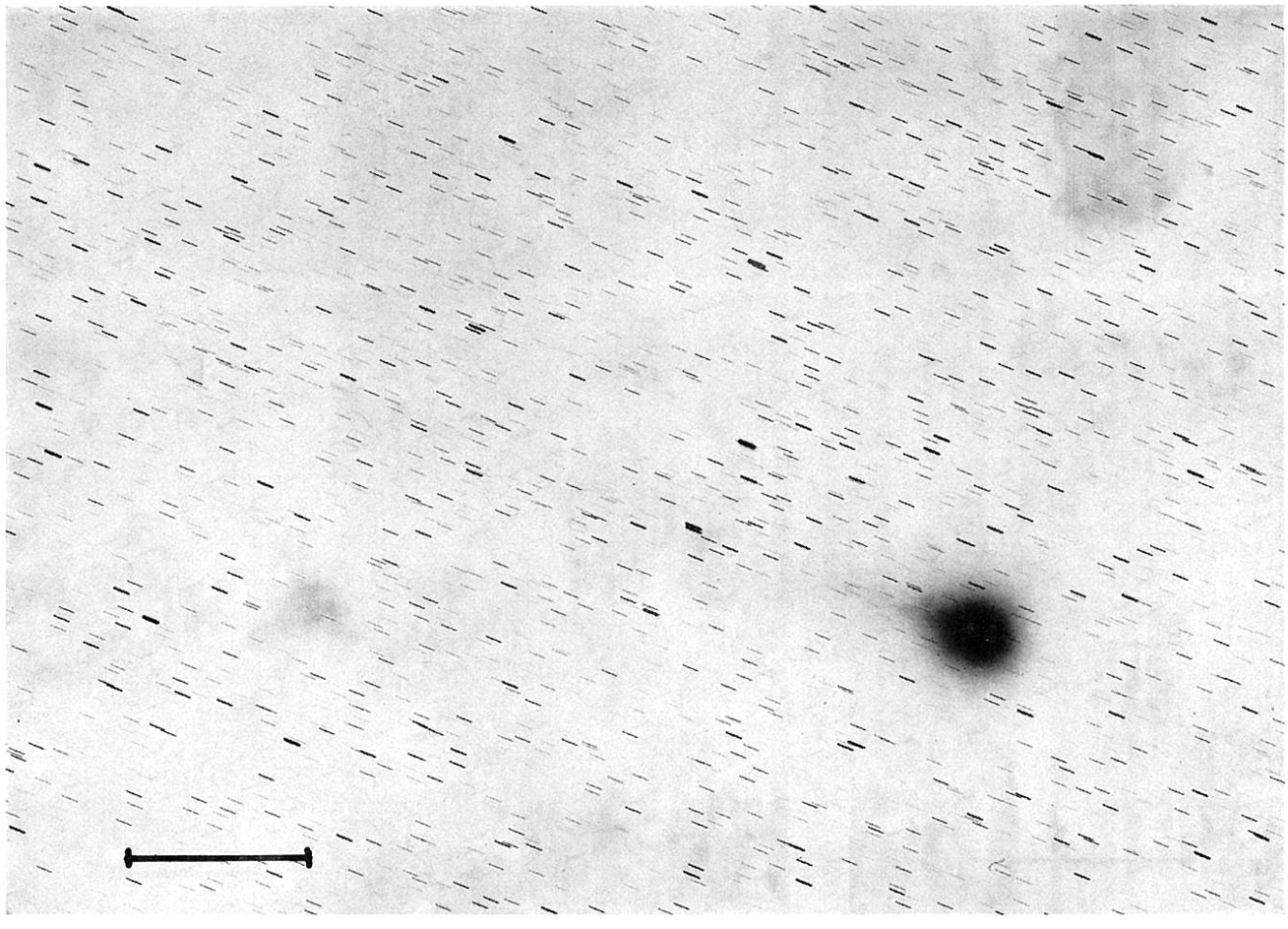
**** CONTOUR LEVELS ****

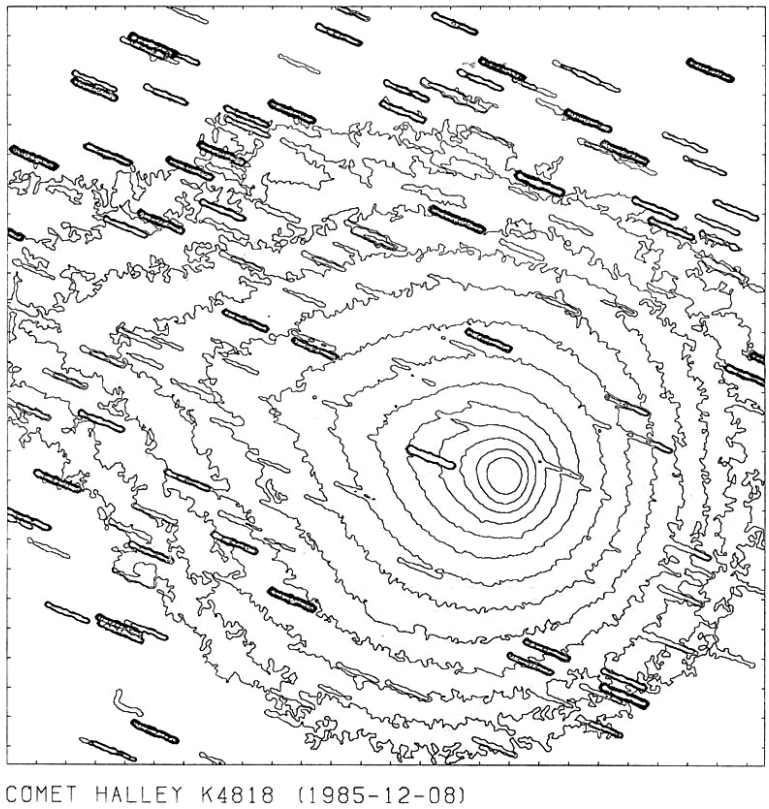
SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3

COMET HALLEY K4813 (1985-12-03)

Fig. 2-11





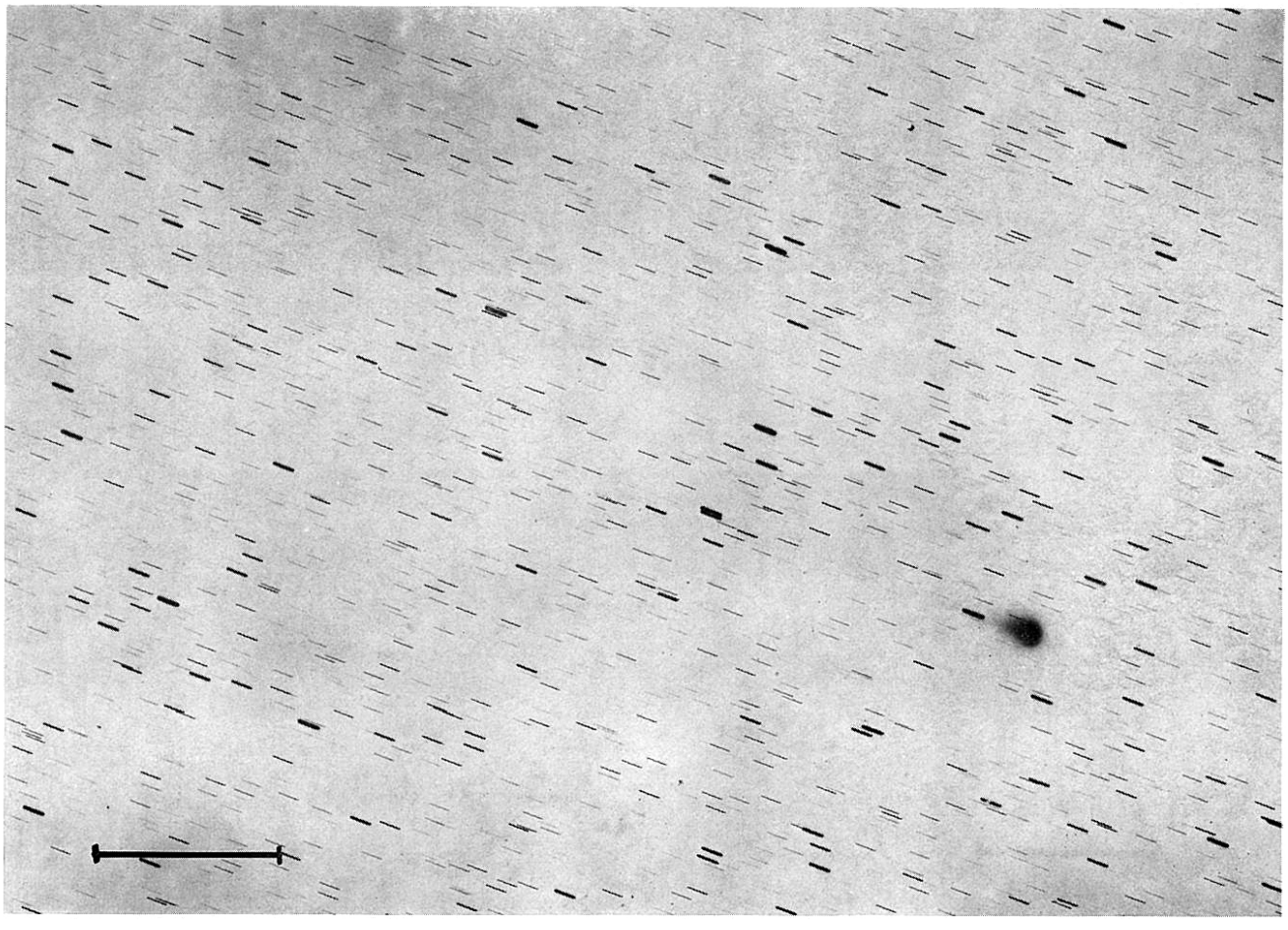
****** CONTOUR LEVELS ******

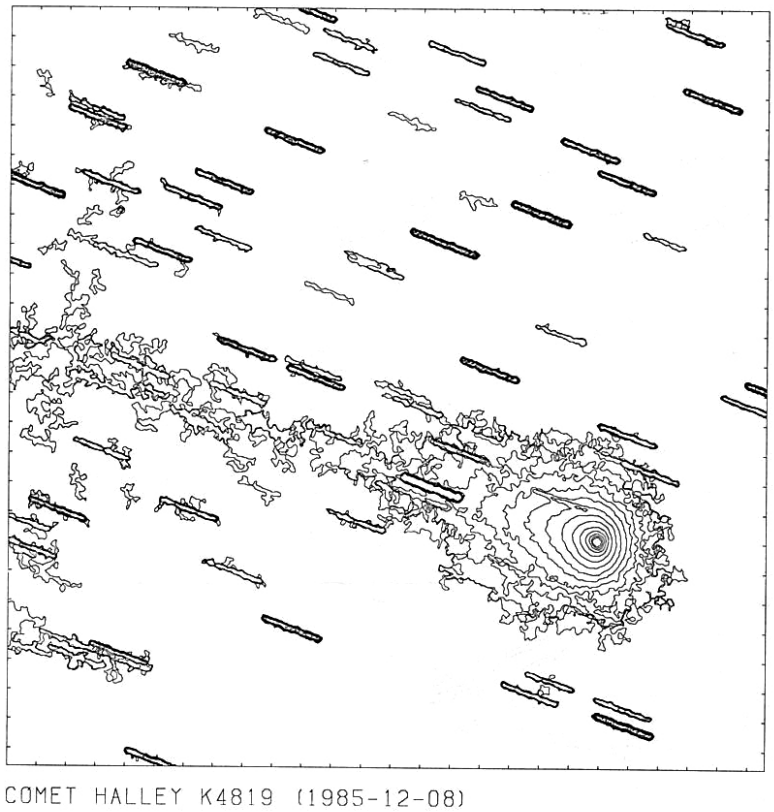
SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3

COMET HALLEY K4818 (1985-12-08)

Fig. 2-12





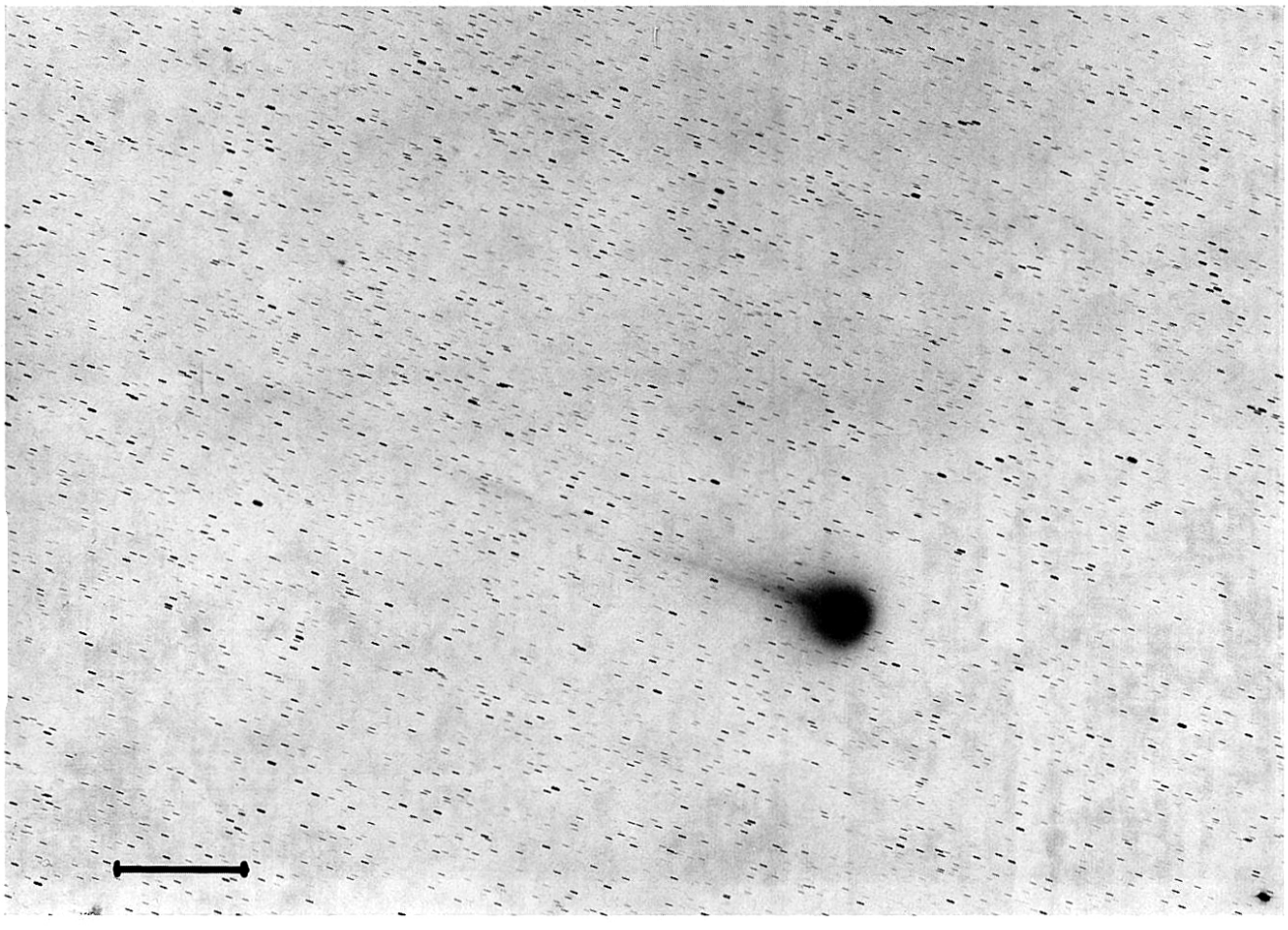
COMET HALLEY K4819 (1985-12-08)

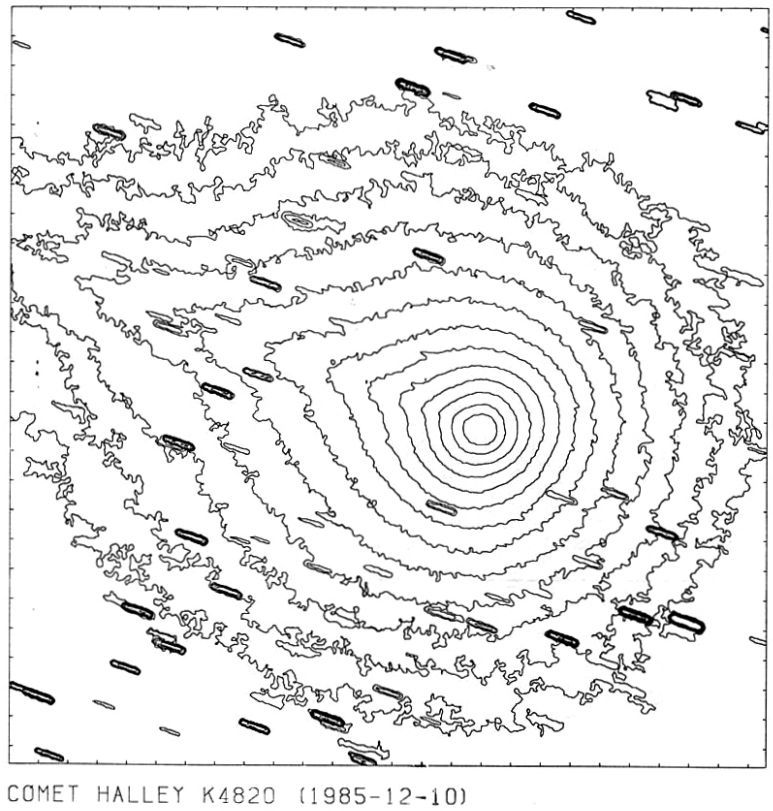
×××× CONTOUR LEVELS ××××

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-13





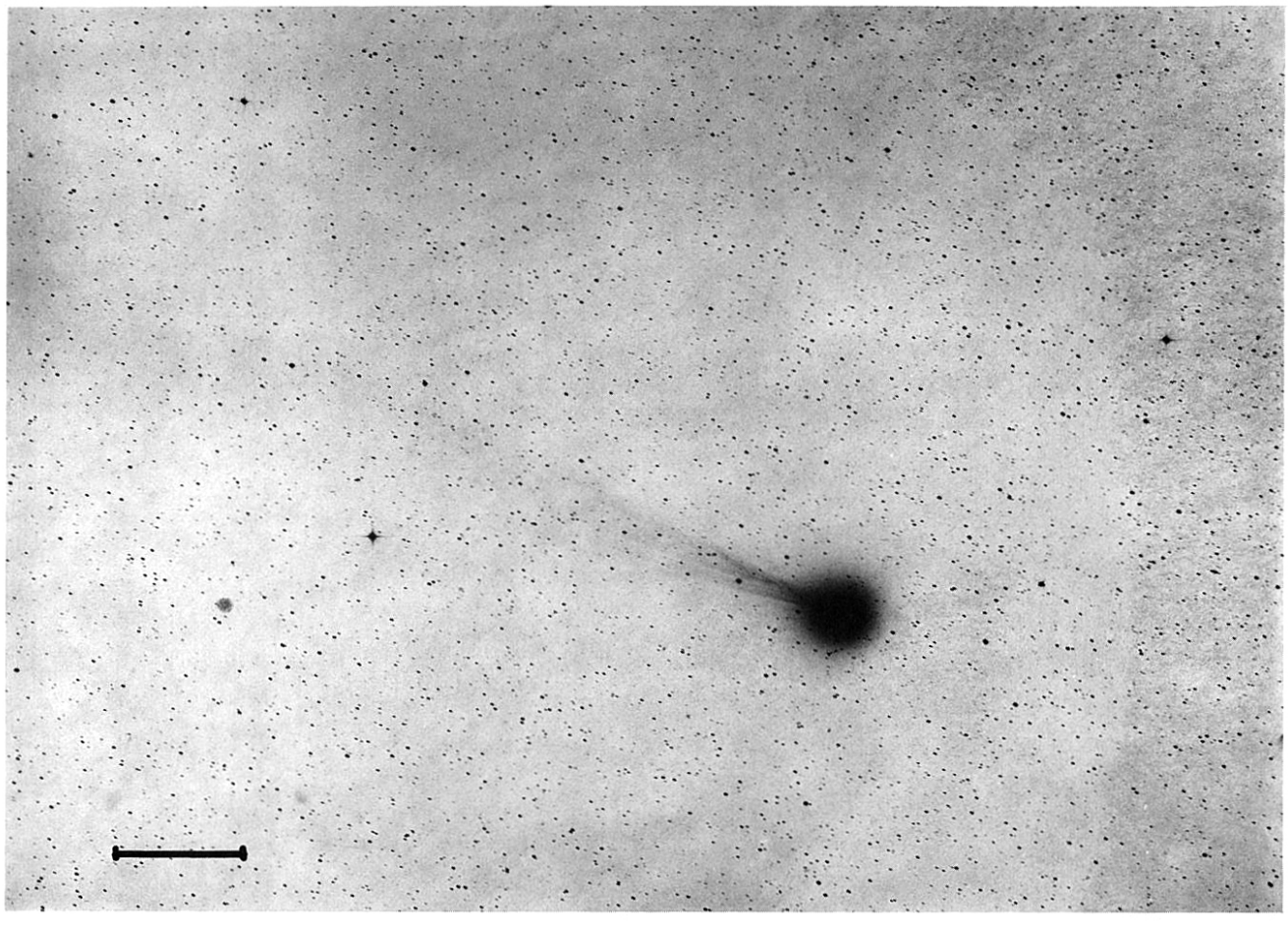
COMET HALLEY K4820 (1985-12-10)

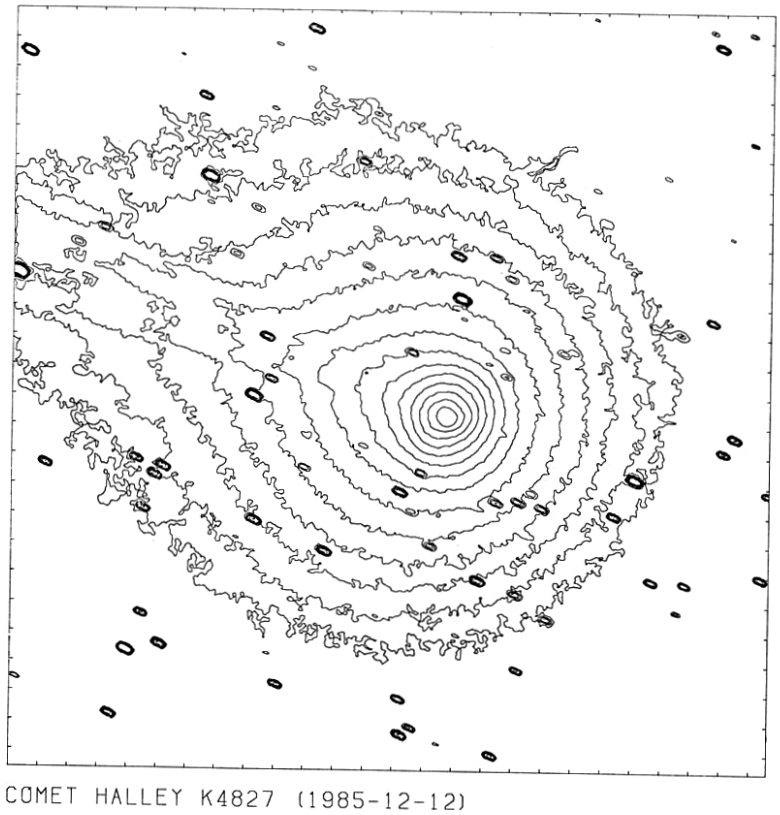
×××× CONTOUR LEVELS ××××

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3

Fig. 2-14





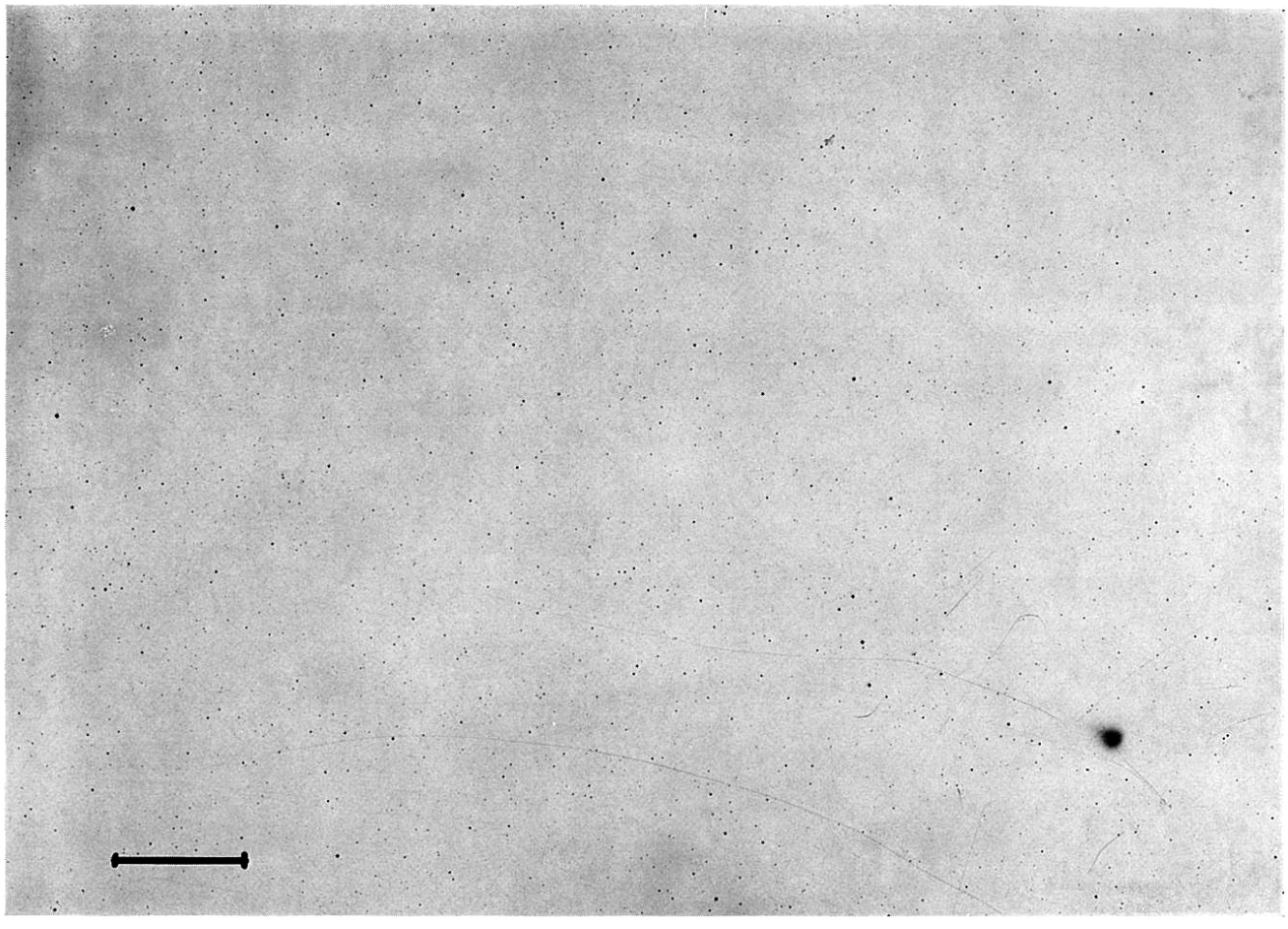
COMET HALLEY K4827 (1985-12-12)

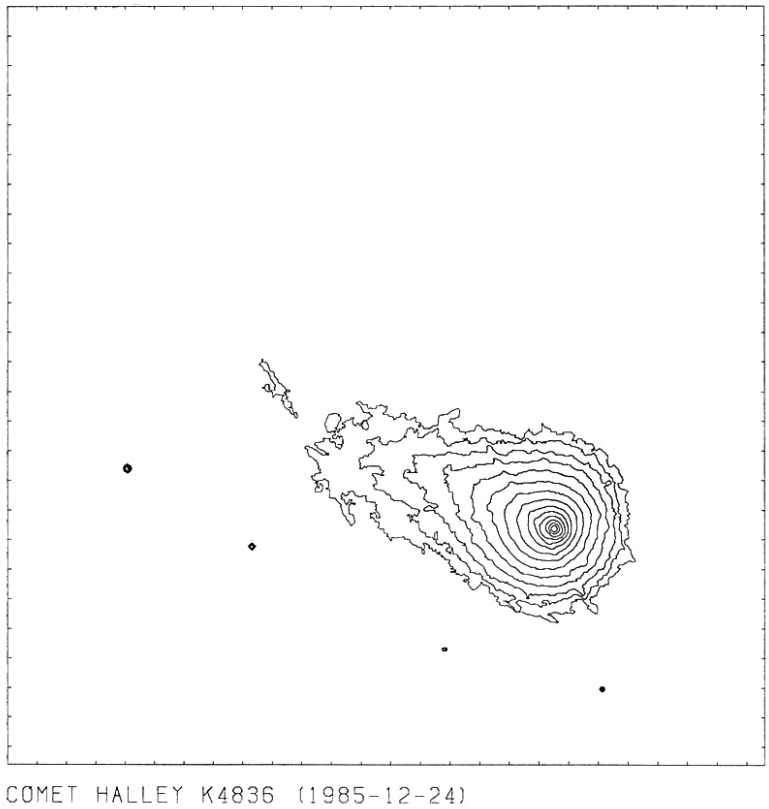
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.100	2.50	80
2	0.158	2.00	60
3	0.251	1.50	60
4	0.398	1.00	30
5	0.631	0.50	30
6	1.000	0.0	10
7	1.585	-0.50	3
8	2.512	-1.00	3
9	3.981	-1.50	3
10	6.310	-2.00	3
11	10.000	-2.50	3
12	15.849	-3.00	3
13	25.119	-3.50	3
14	39.811	-4.00	3

Fig. 2-15





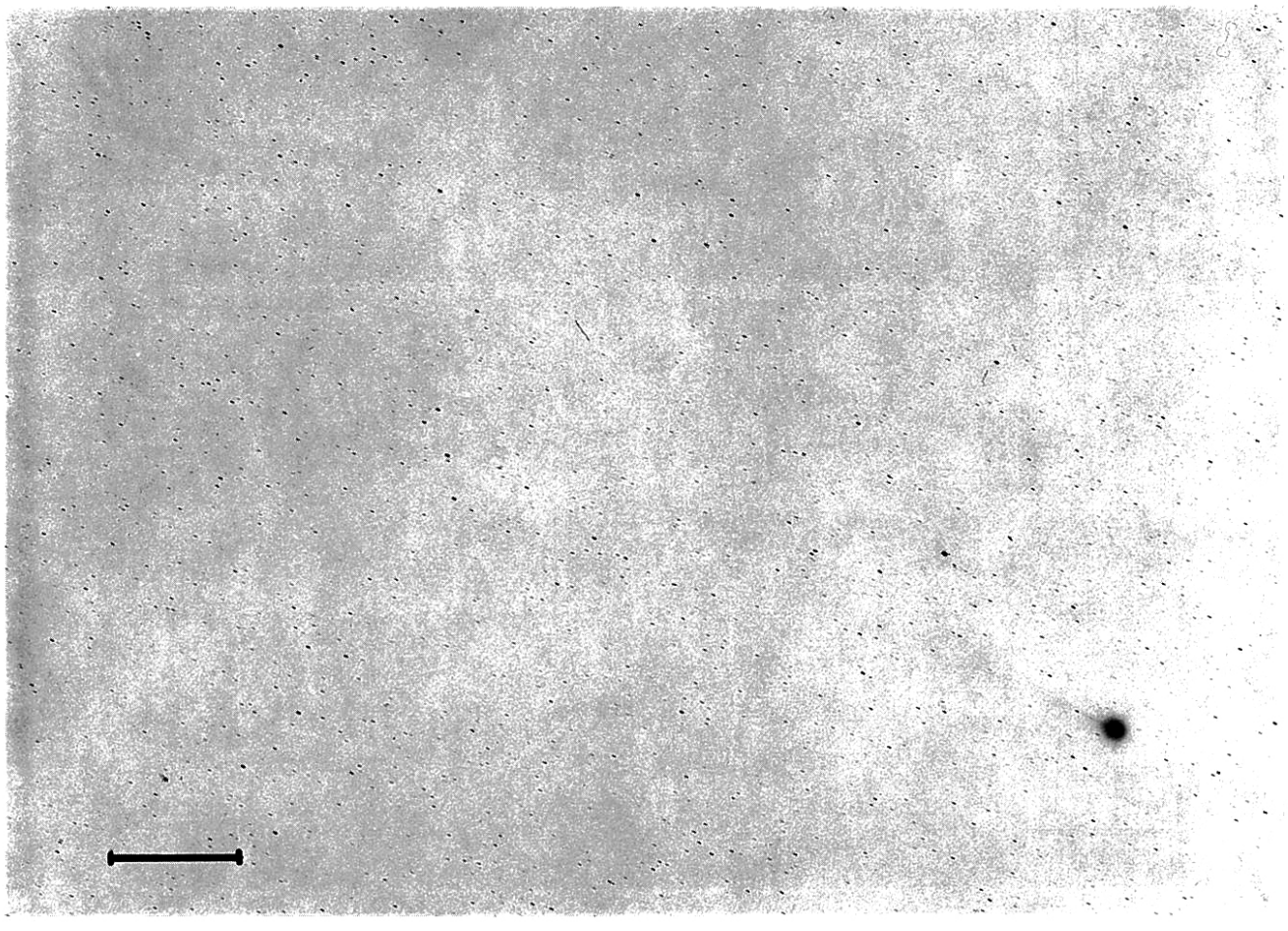
COMET HALLEY K4836 (1985-12-24)

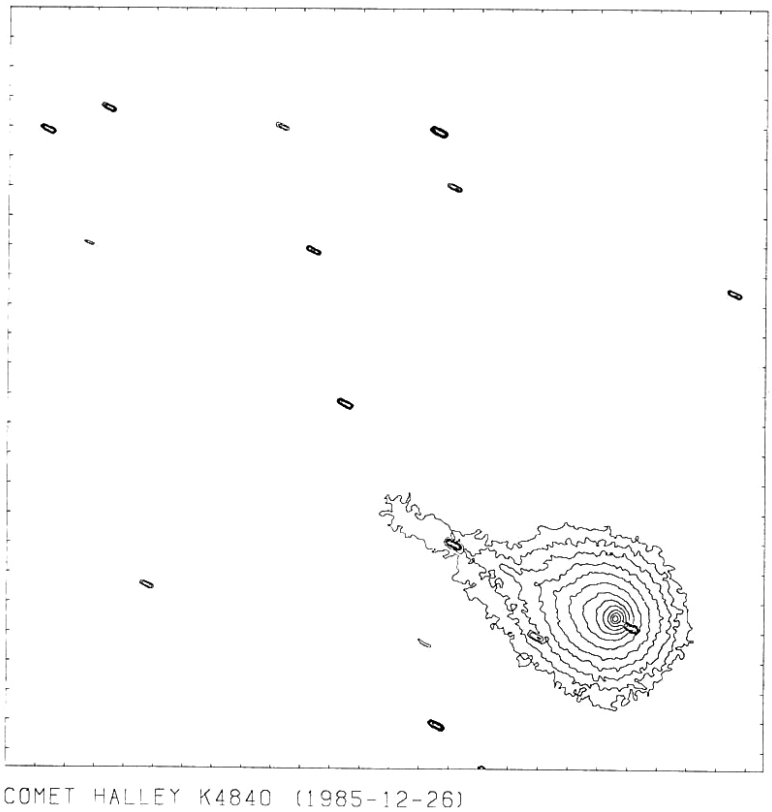
×××× CONTOUR LEVELS ××××

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3

Fig. 2-16



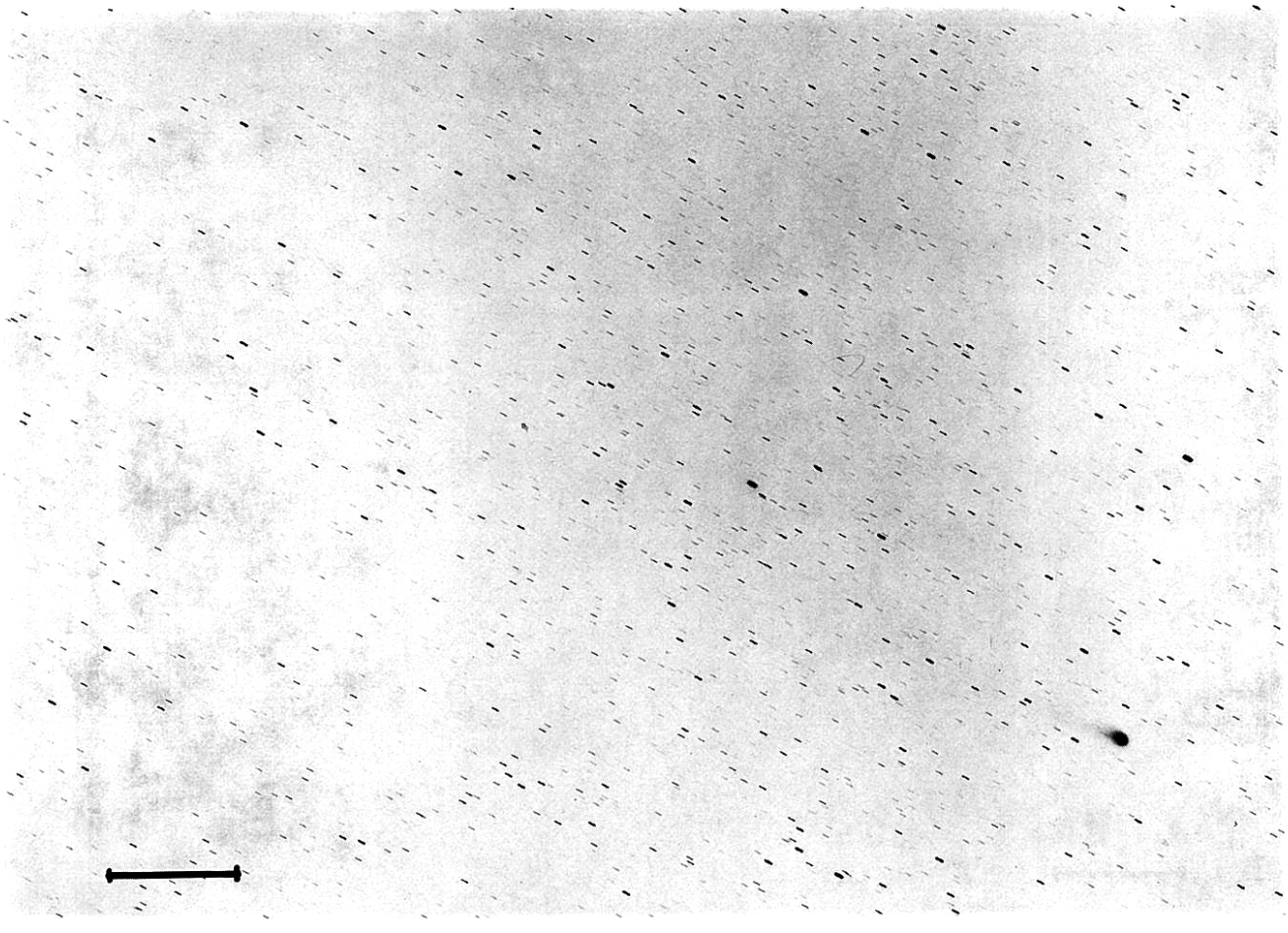


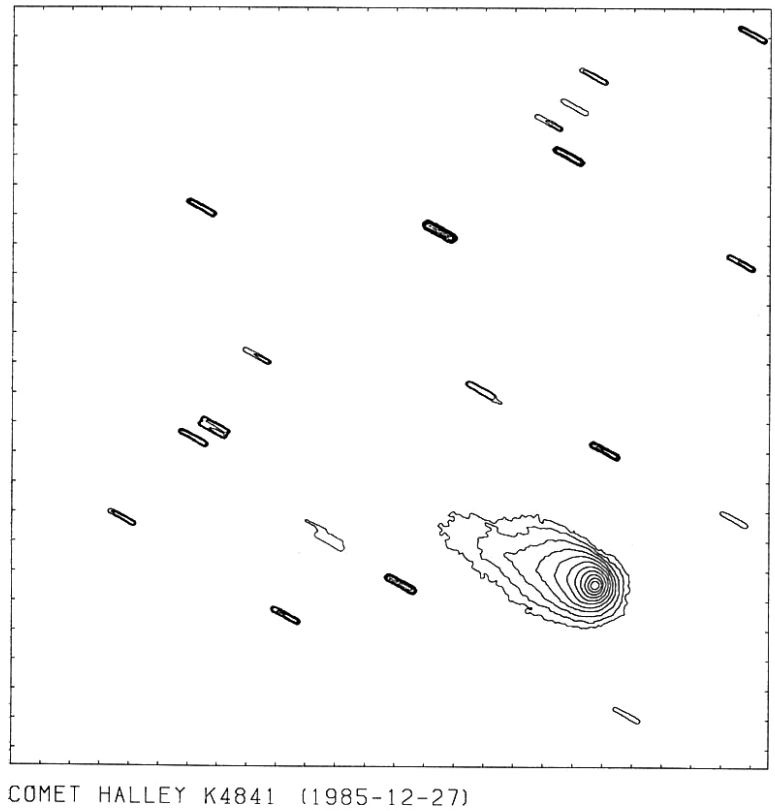
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NC
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3

Fig. 2-17





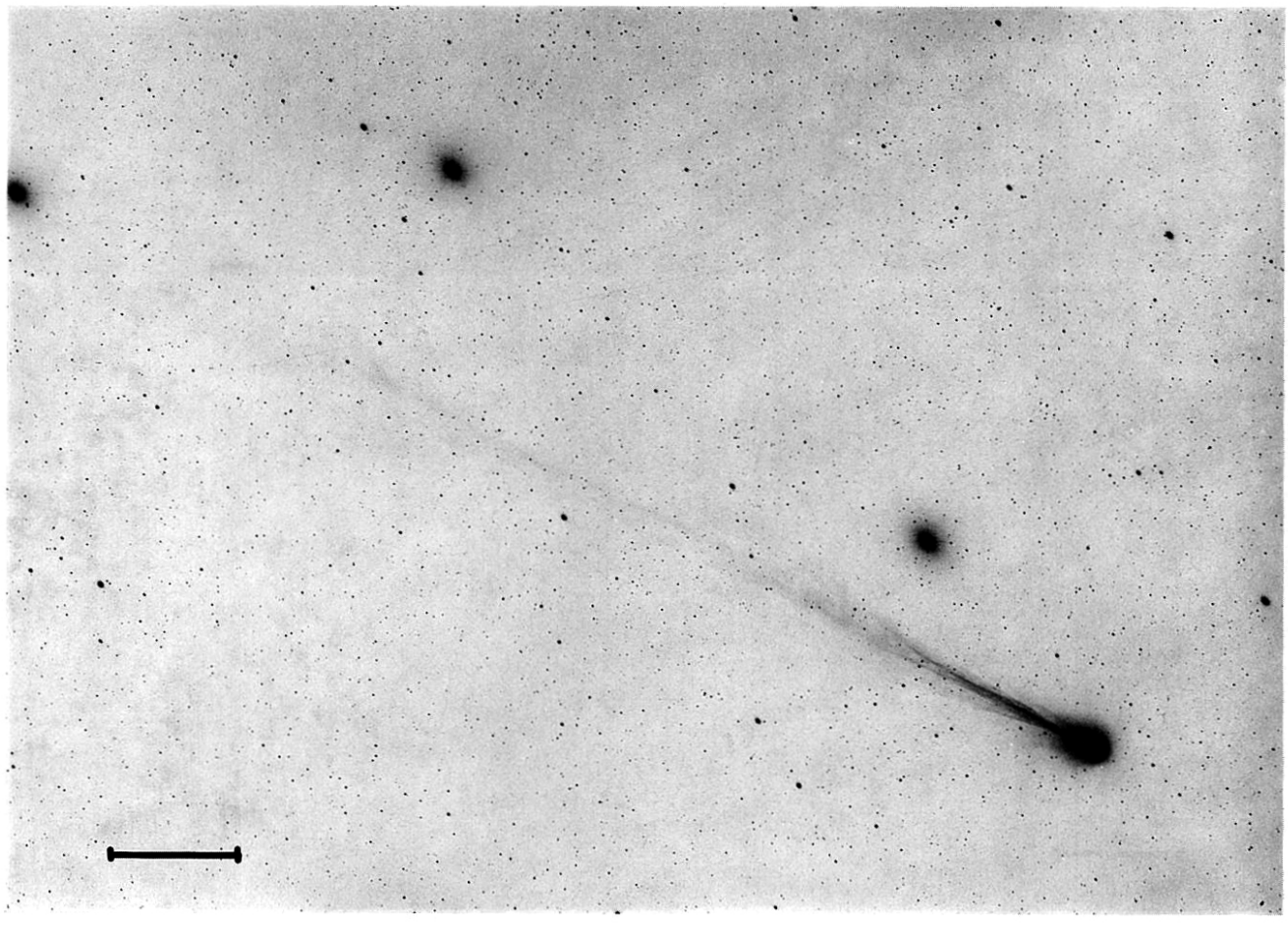
****** CONTOUR LEVELS ******

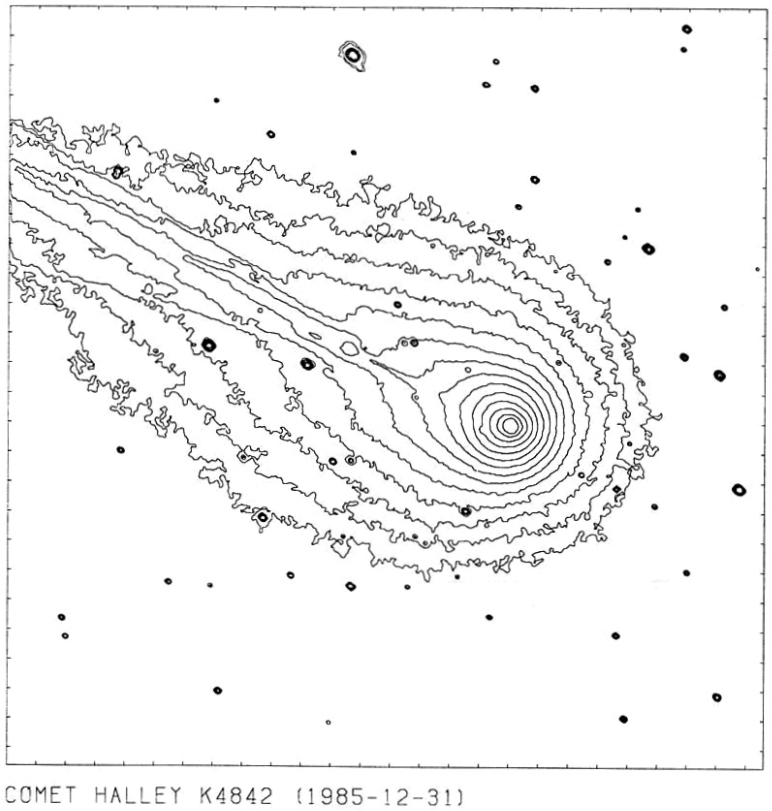
SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3

COMET HALLEY K4841 (1985-12-27)

Fig. 2-18





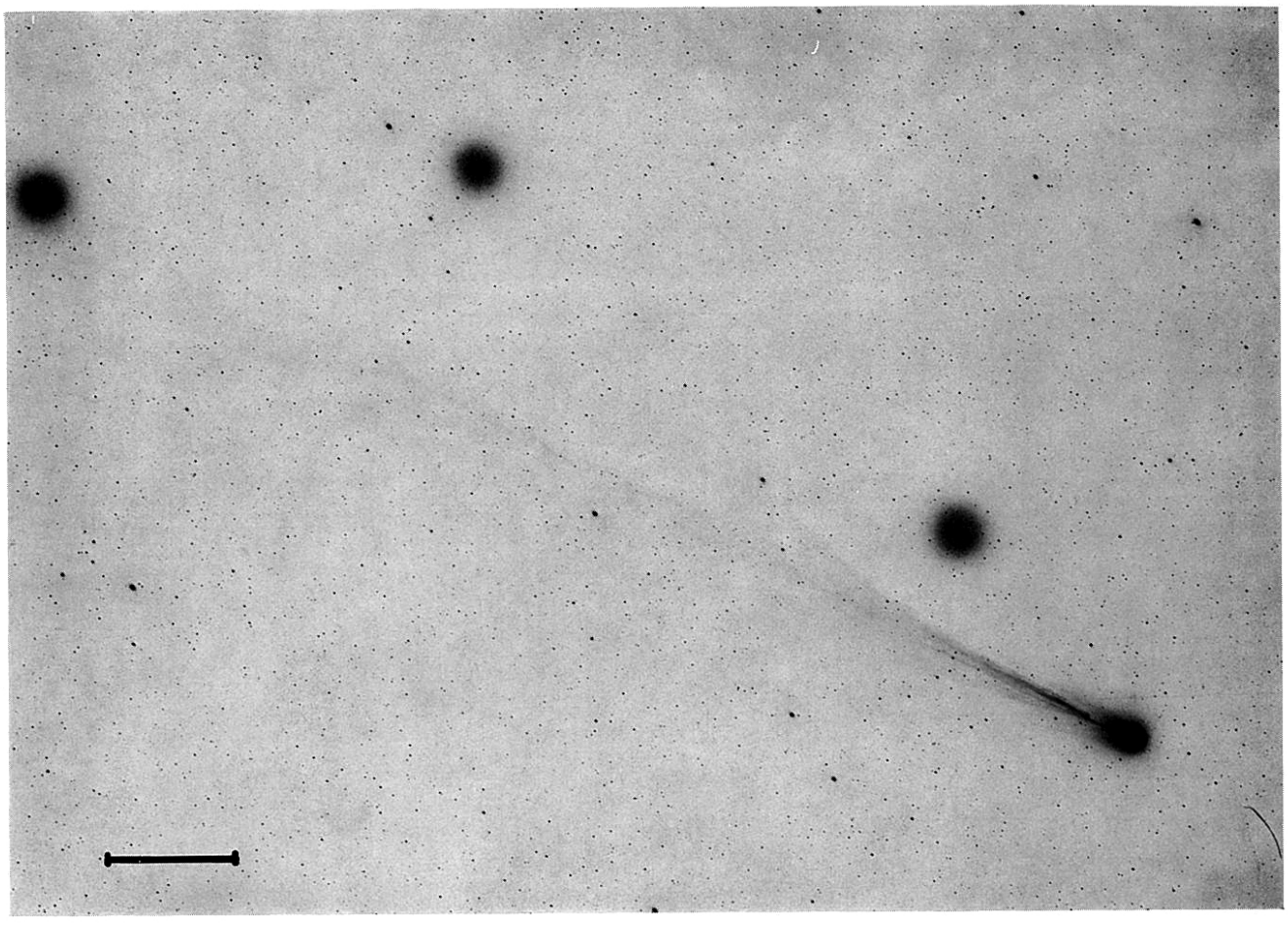
COMET HALLEY K4842 (1985-12-31)

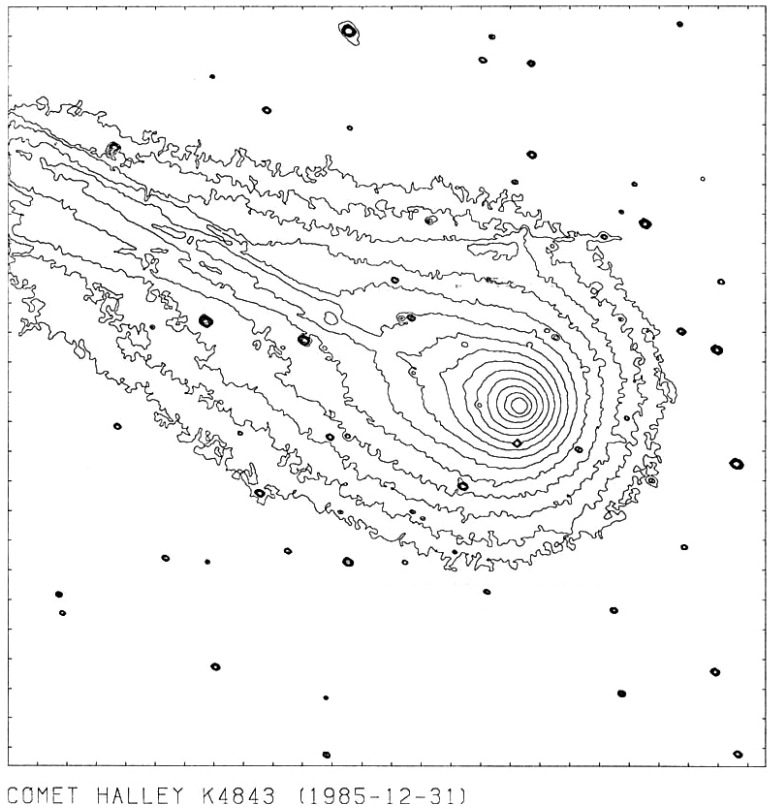
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.100	2.50	80
2	0.159	2.00	60
3	0.251	1.50	60
4	0.398	1.00	30
5	0.631	0.50	30
6	1.000	0.0	10
7	1.585	-0.50	3
8	2.512	-1.00	3
9	3.981	-1.50	3
10	6.310	-2.00	3
11	10.000	-2.50	3
12	15.849	-3.00	3
13	25.119	-3.50	3
14	39.811	-4.00	3

Fig. 2-19



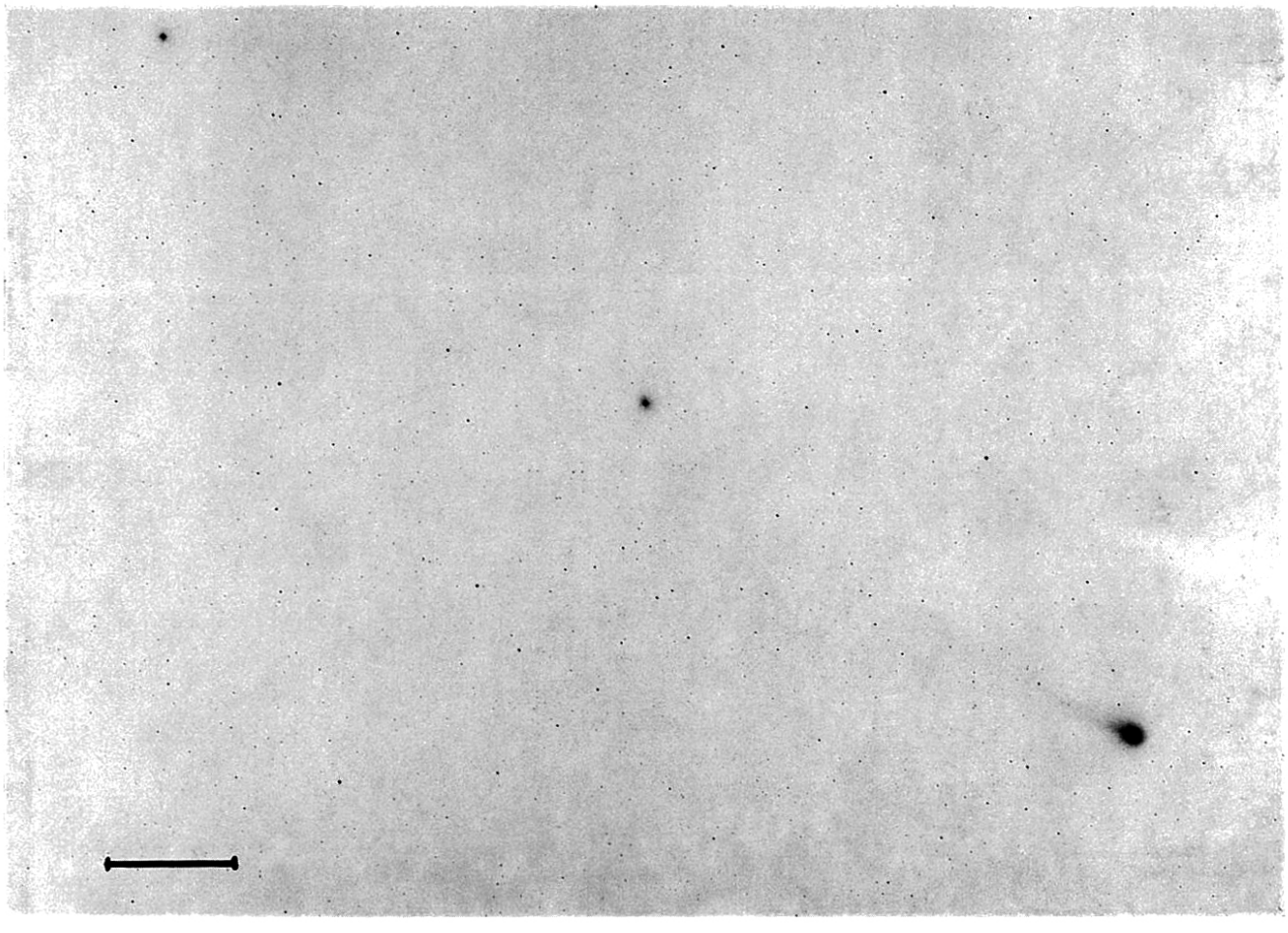


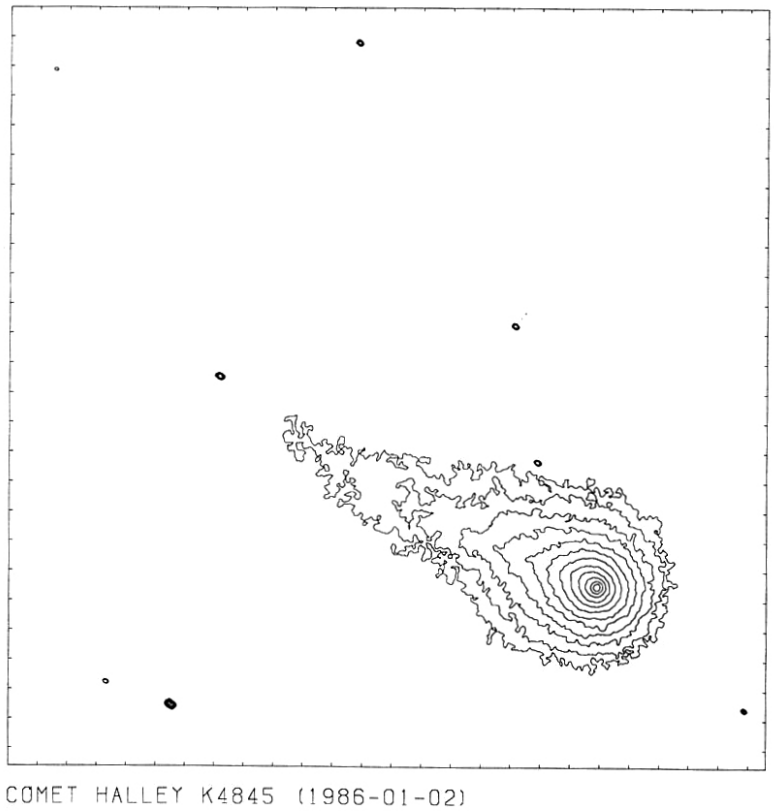
COMET HALLEY K4843 (1985-12-31)

**** CONTOUR LEVELS ****

	SKY= 0.0 REL. INT.	MAG.	NG
1	0.100	2.50	80
2	0.159	2.00	60
3	0.251	1.50	60
4	0.398	1.00	30
5	0.631	0.50	30
6	1.000	0.0	10
7	1.585	-0.50	3
8	2.512	-1.00	3
9	3.981	-1.50	3
10	6.310	-2.00	3
11	10.000	-2.50	3
12	15.849	-3.00	3
13	25.119	-3.50	3
14	39.811	-4.00	3

Fig. 2-20





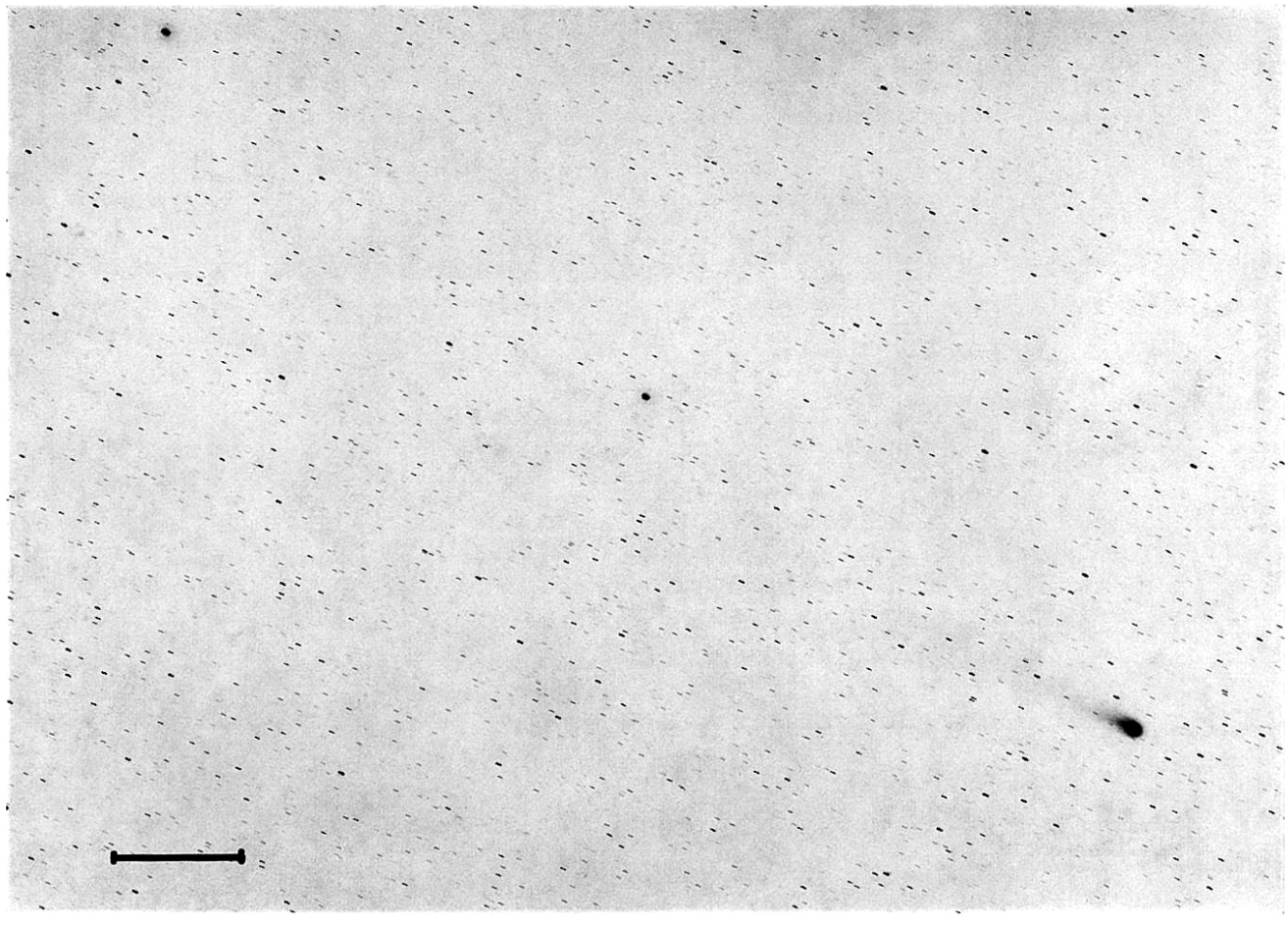
COMET HALLEY K4845 (1986-01-02)

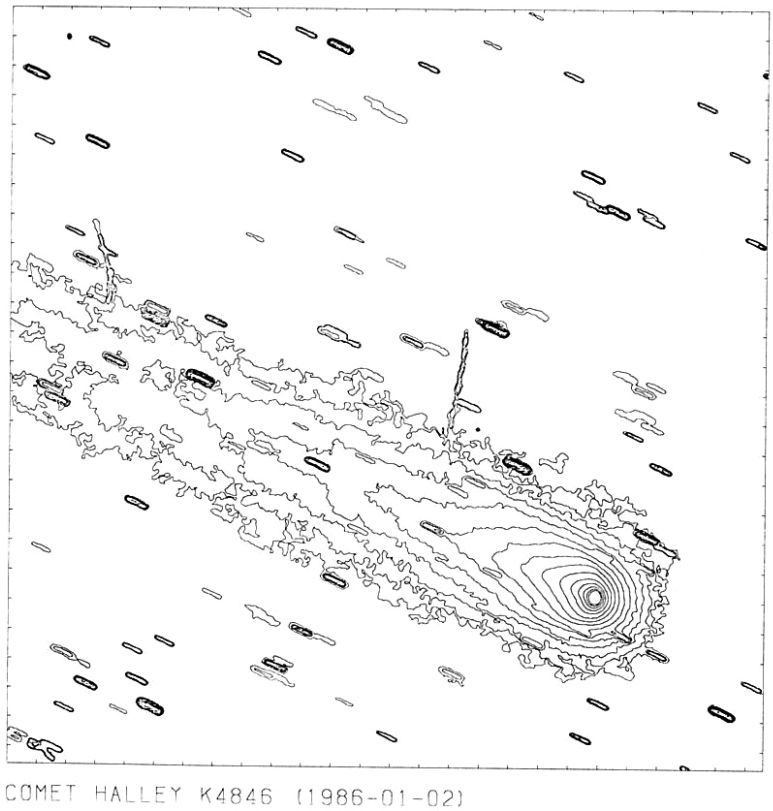
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NC
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3

Fig. 2-21





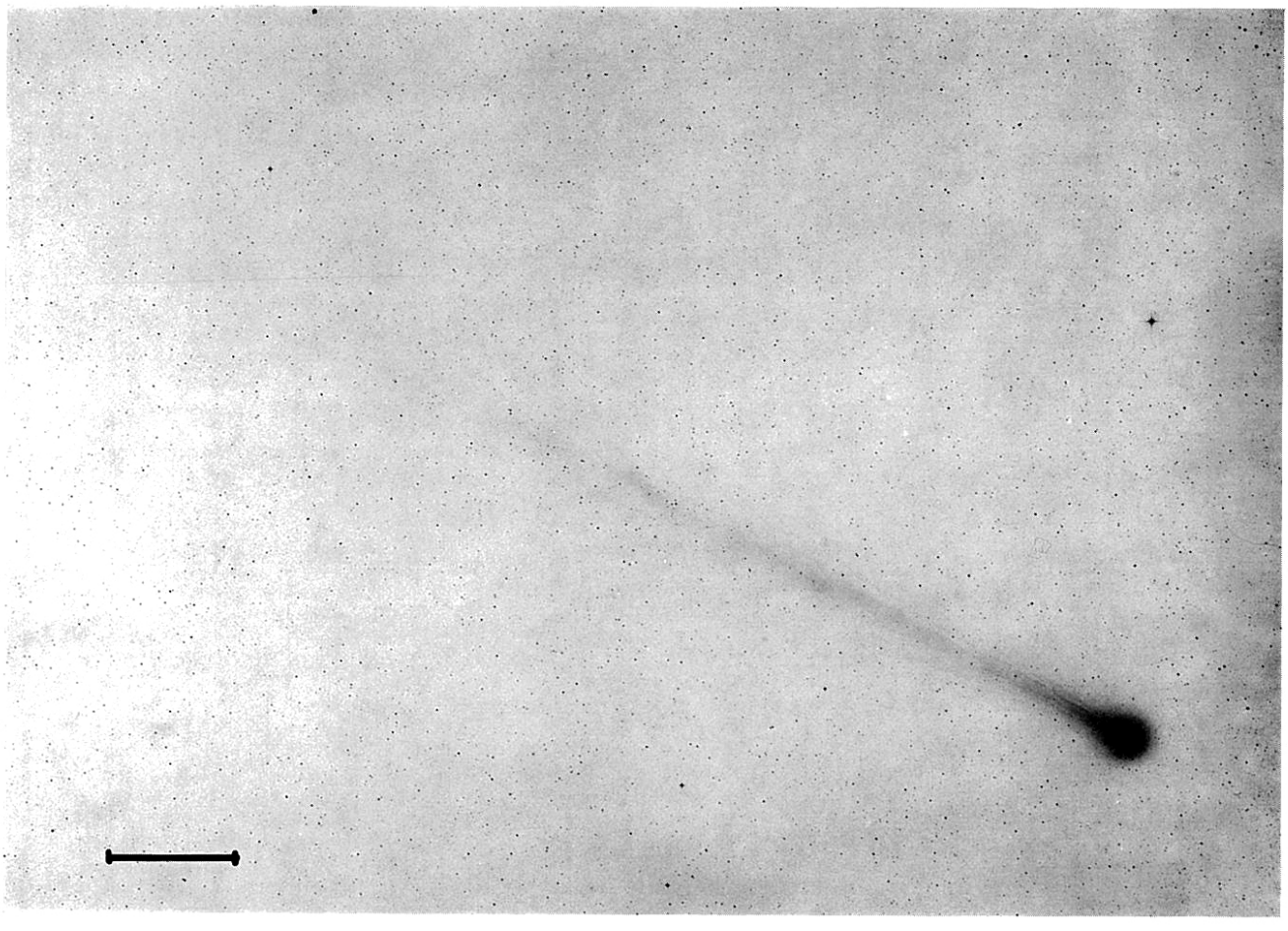
COMET HALLEY K4846 (1986-01-02)

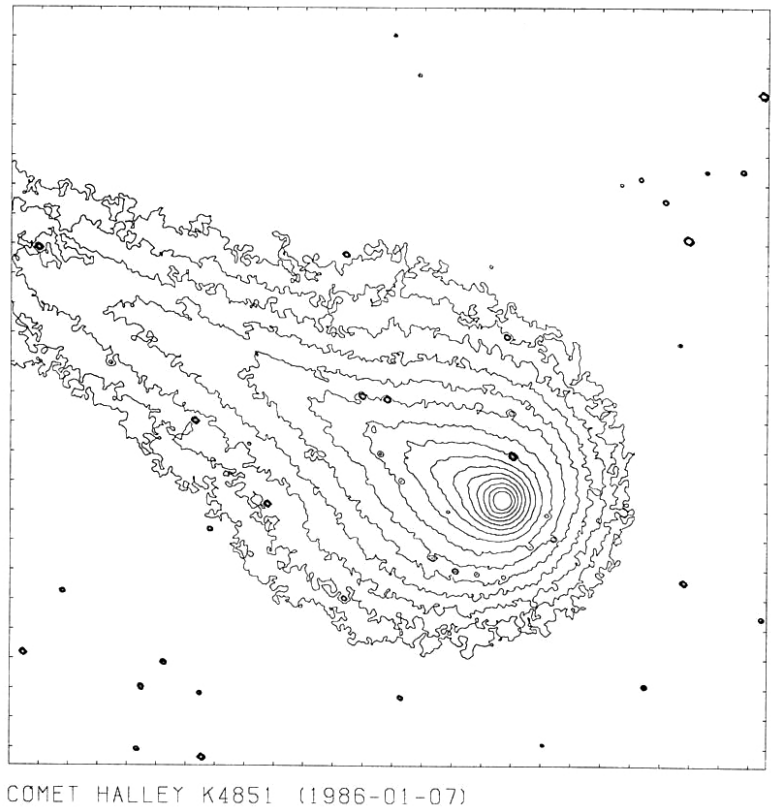
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-22



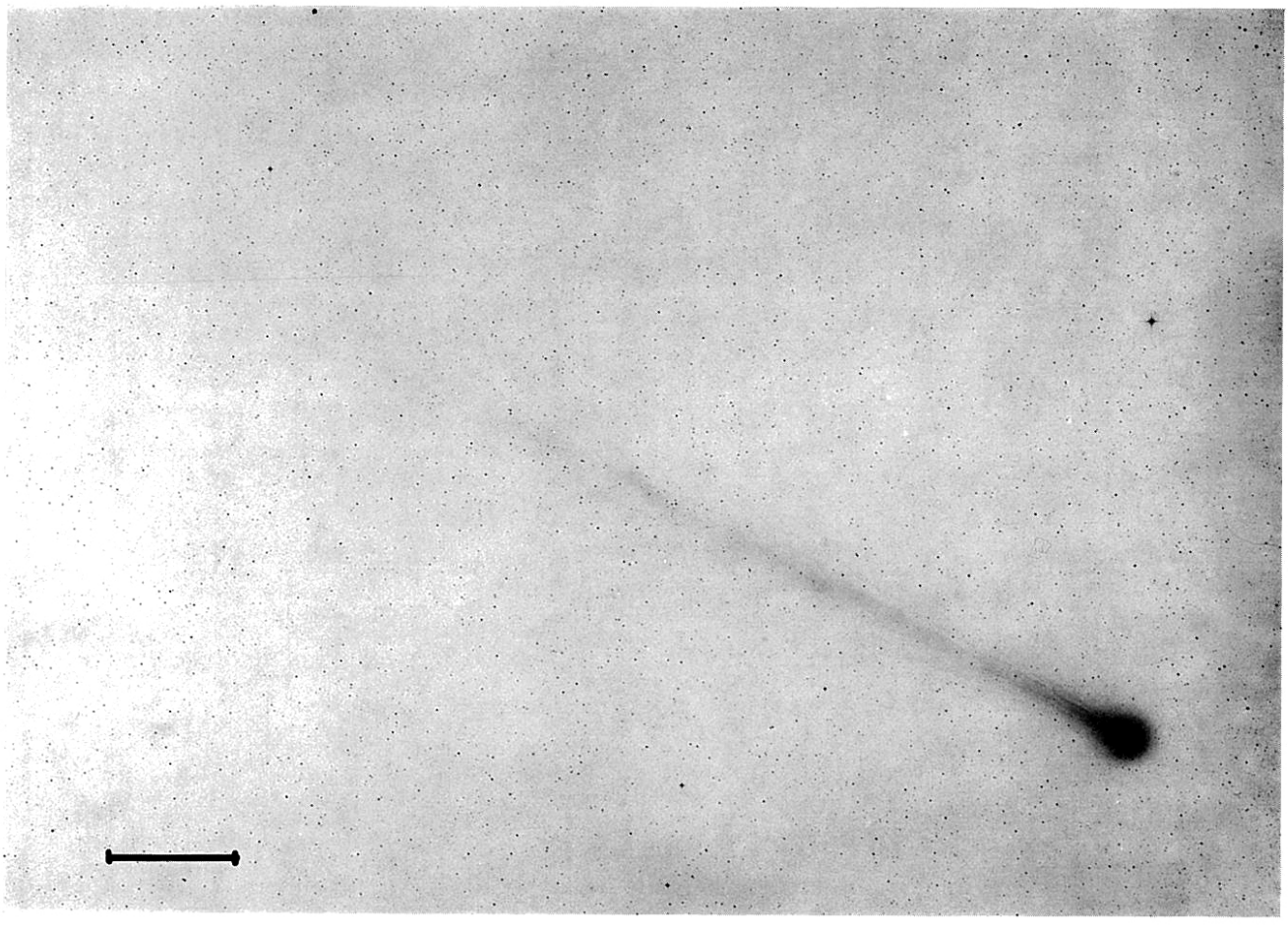


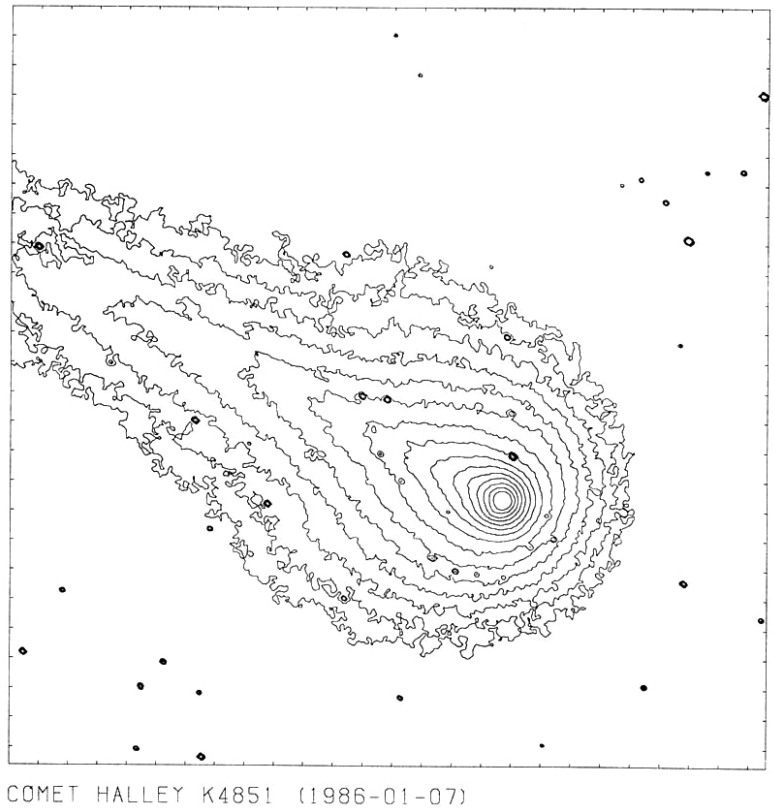
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.158	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-23



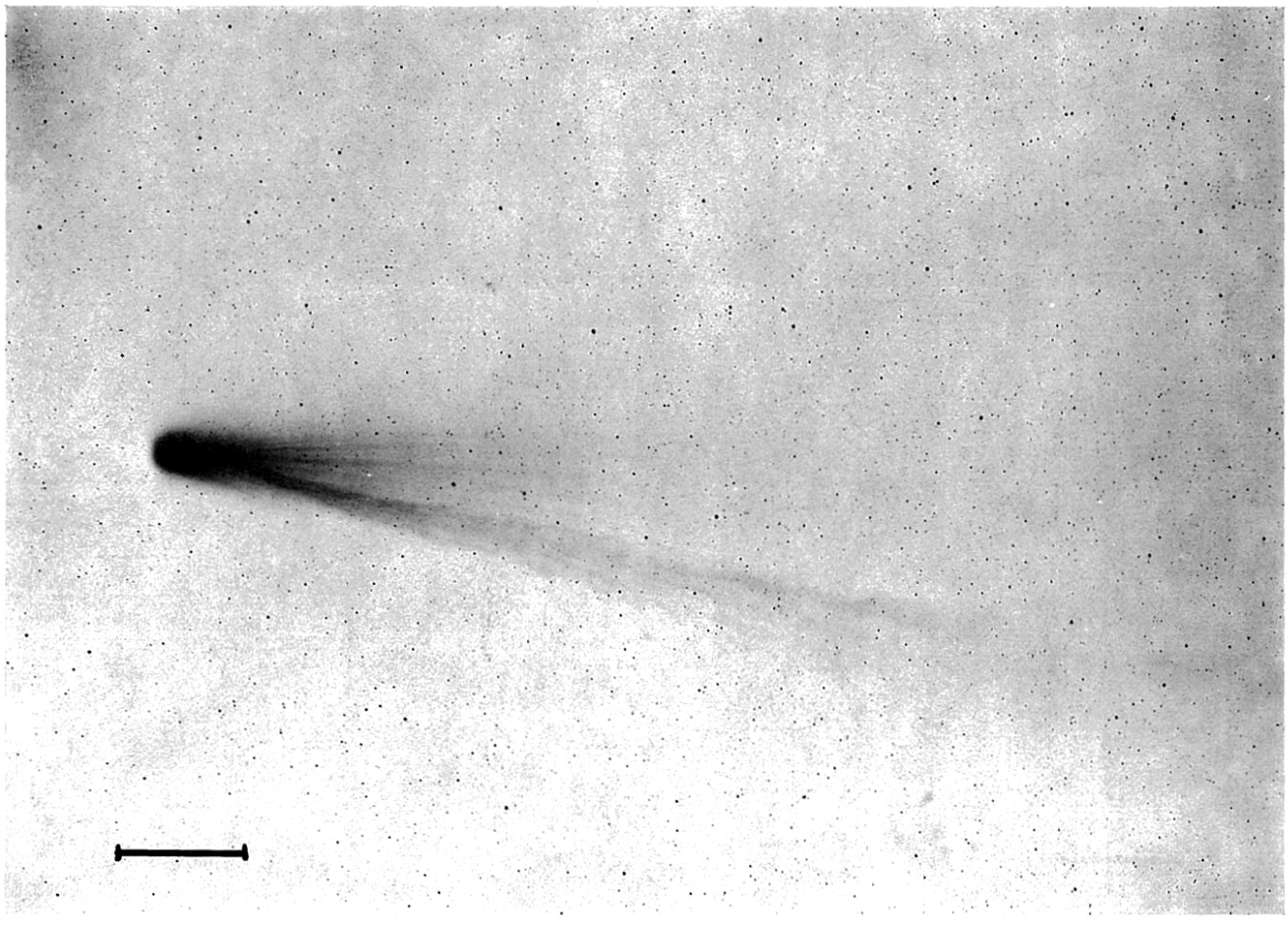


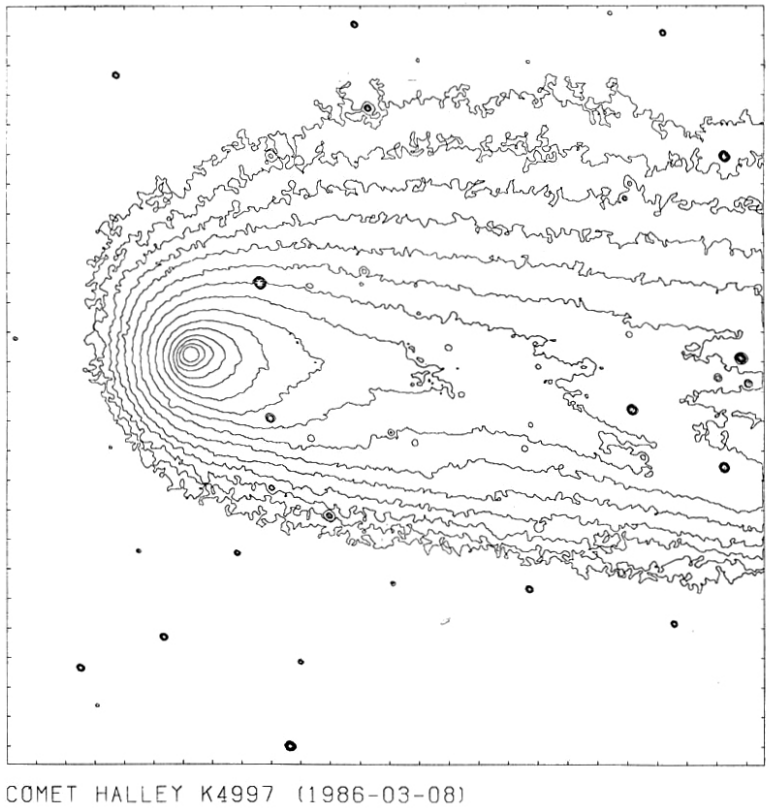
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.158	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-23





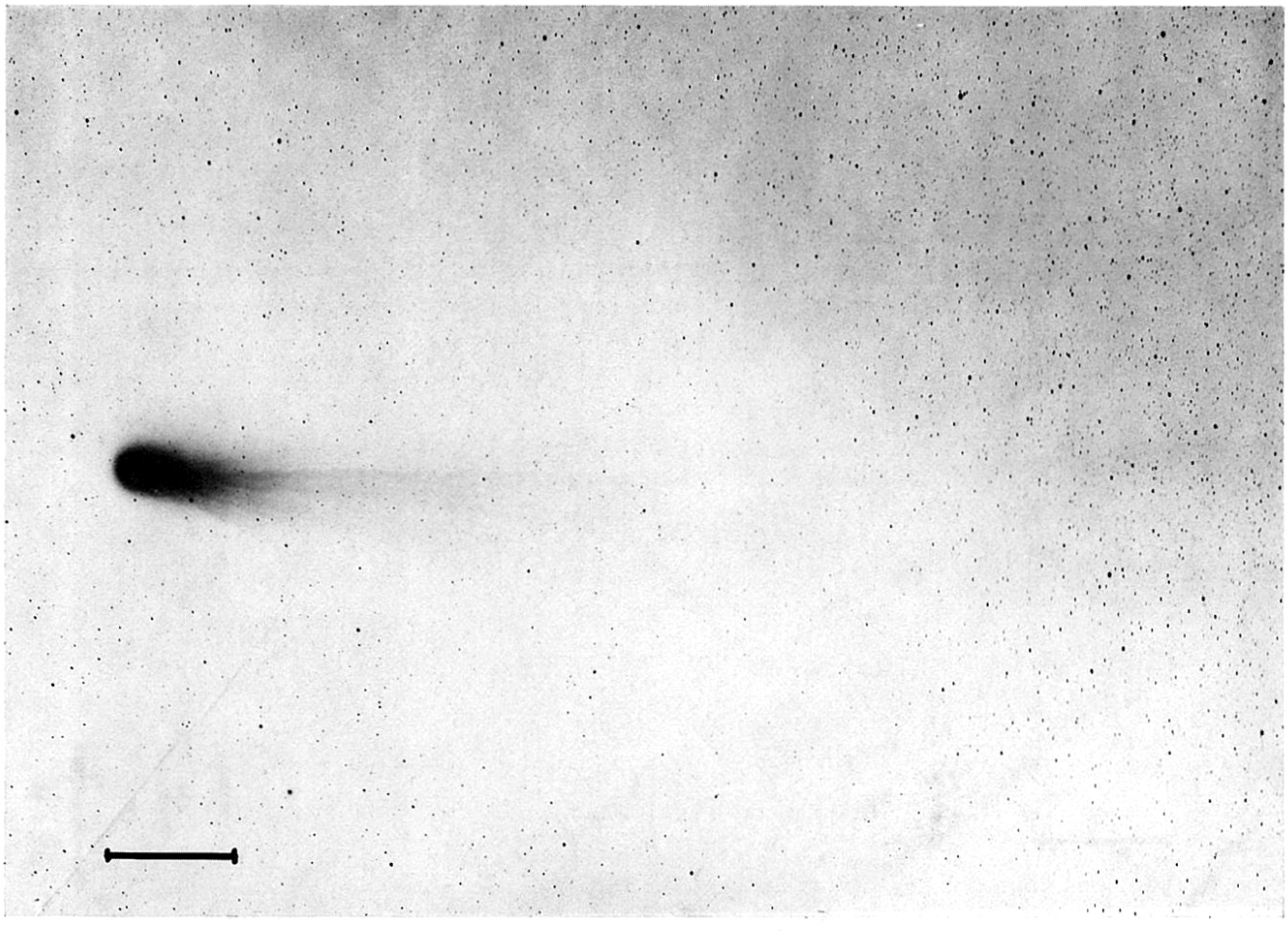
COMET HALLEY K4997 (1986-03-08)

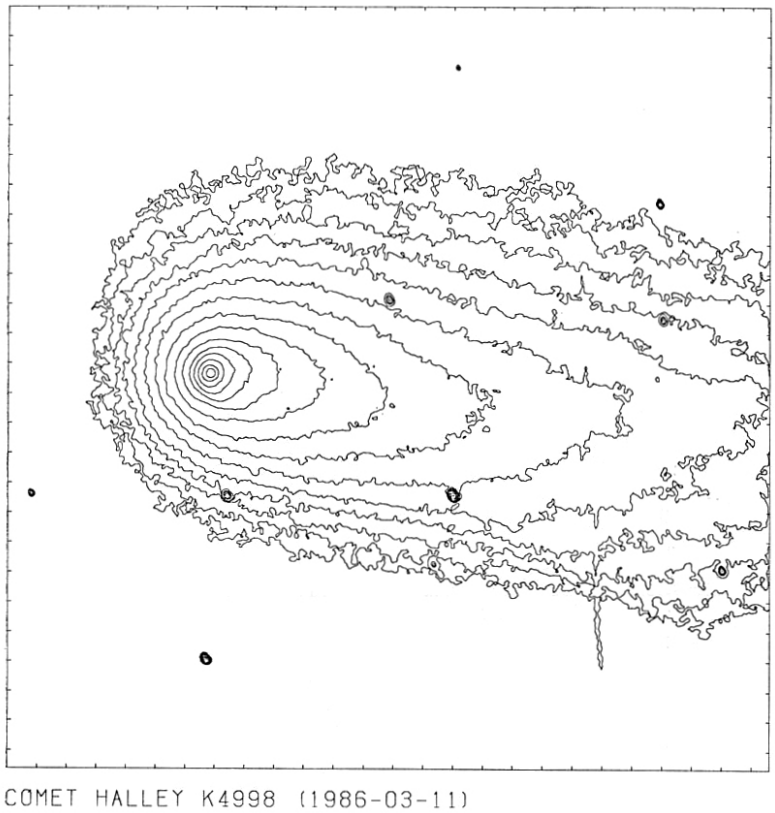
×××× CONTOUR LEVELS ××××

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-25



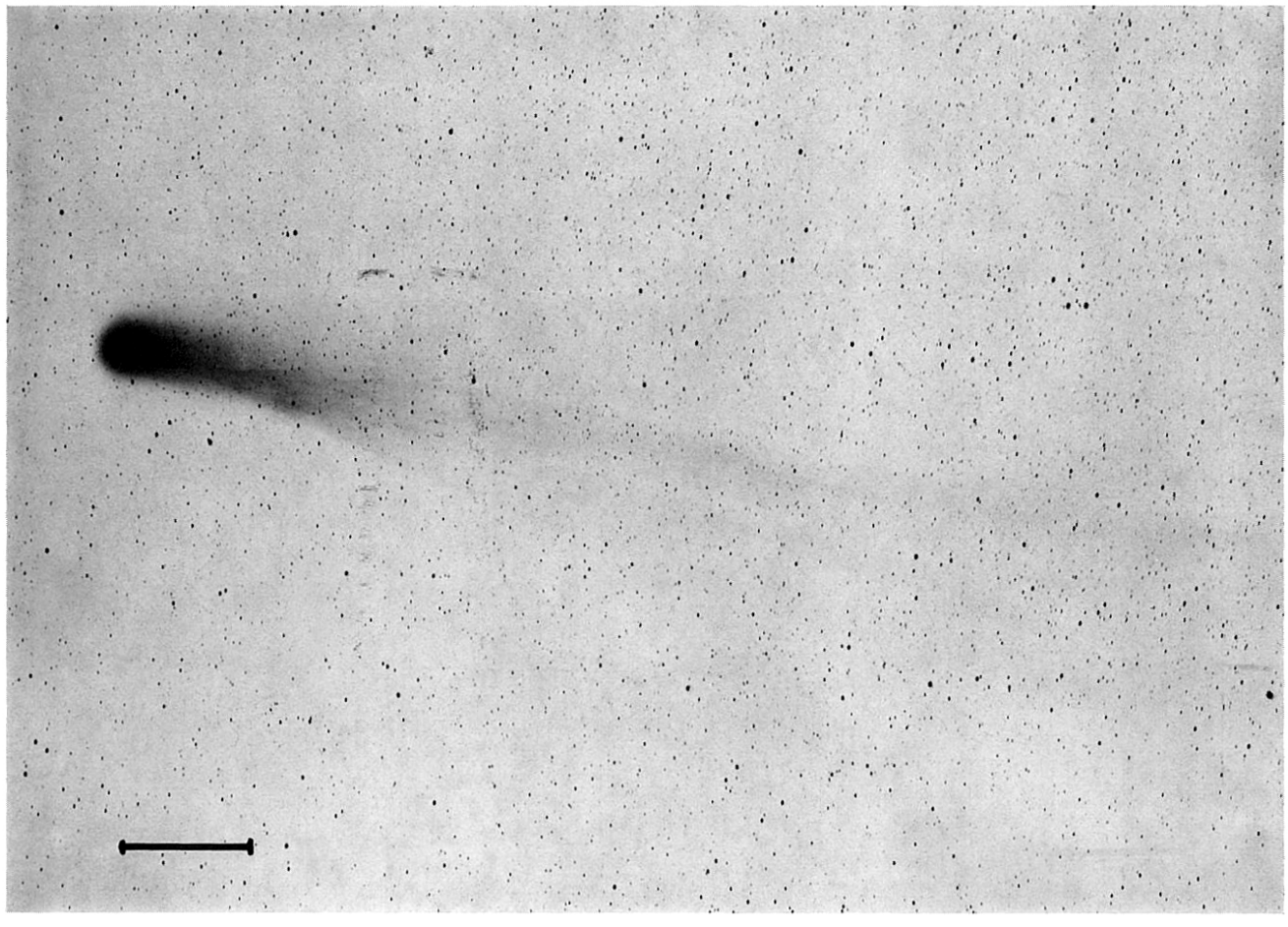


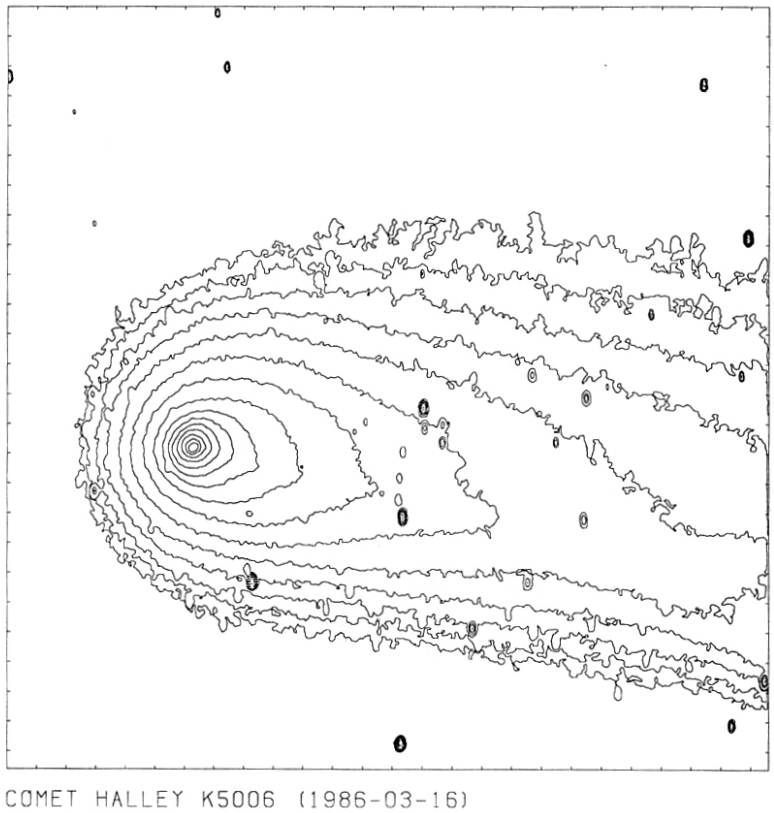
COMET HALLEY K4998 (1986-03-11)

**** CONTOUR LEVELS ****

	SKY= 0.0 REL. INT.	MAG.	NC
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-26





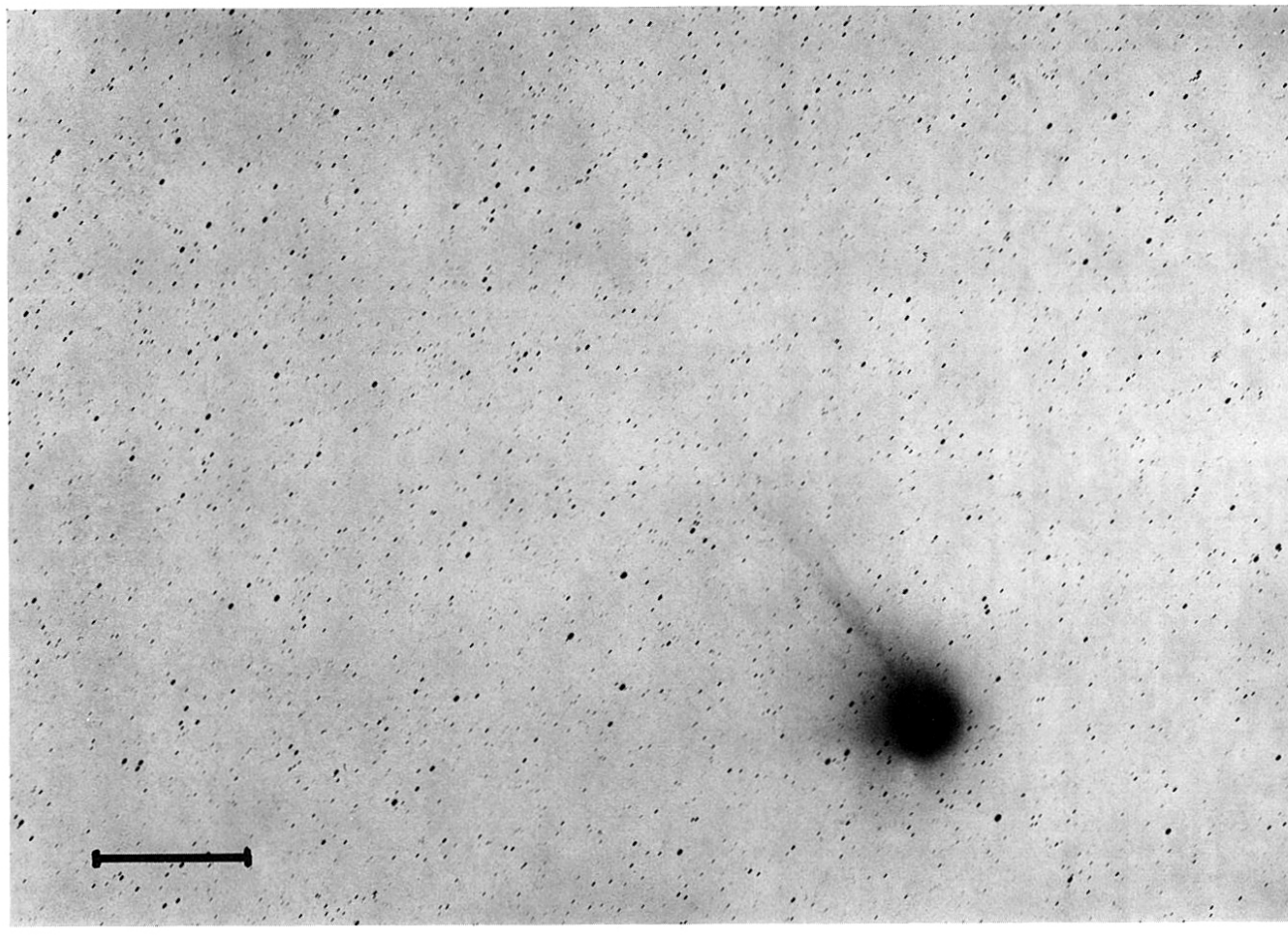
COMET HALLEY K5006 (1986-03-16)

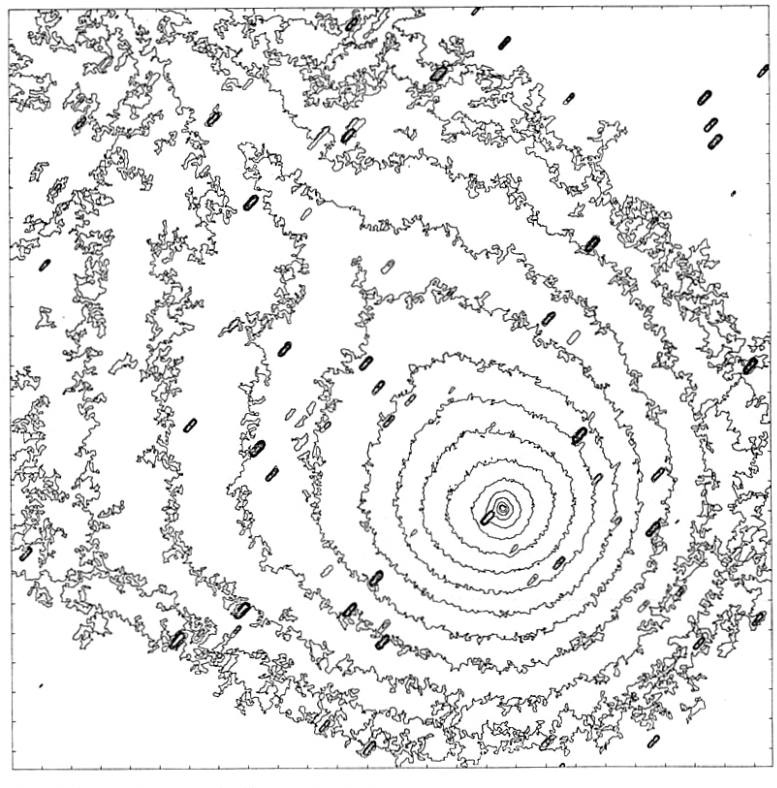
***** CONTOUR LEVELS *****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-27





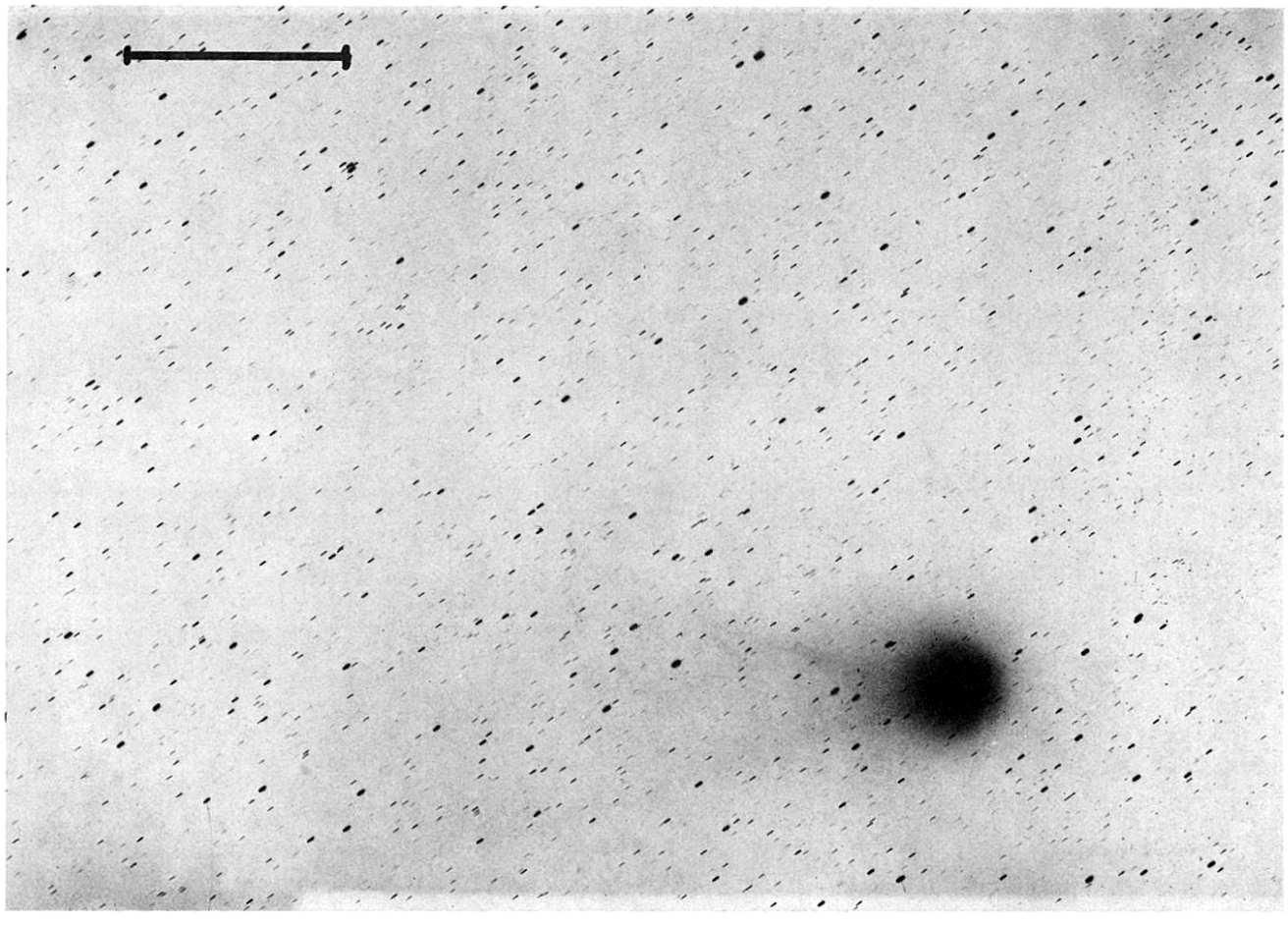
COMET HALLEY K5054 (1986-04-16)

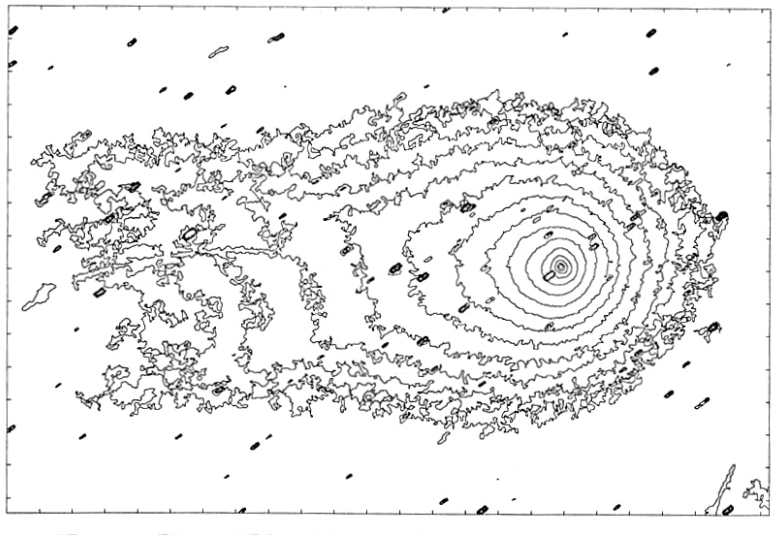
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-28





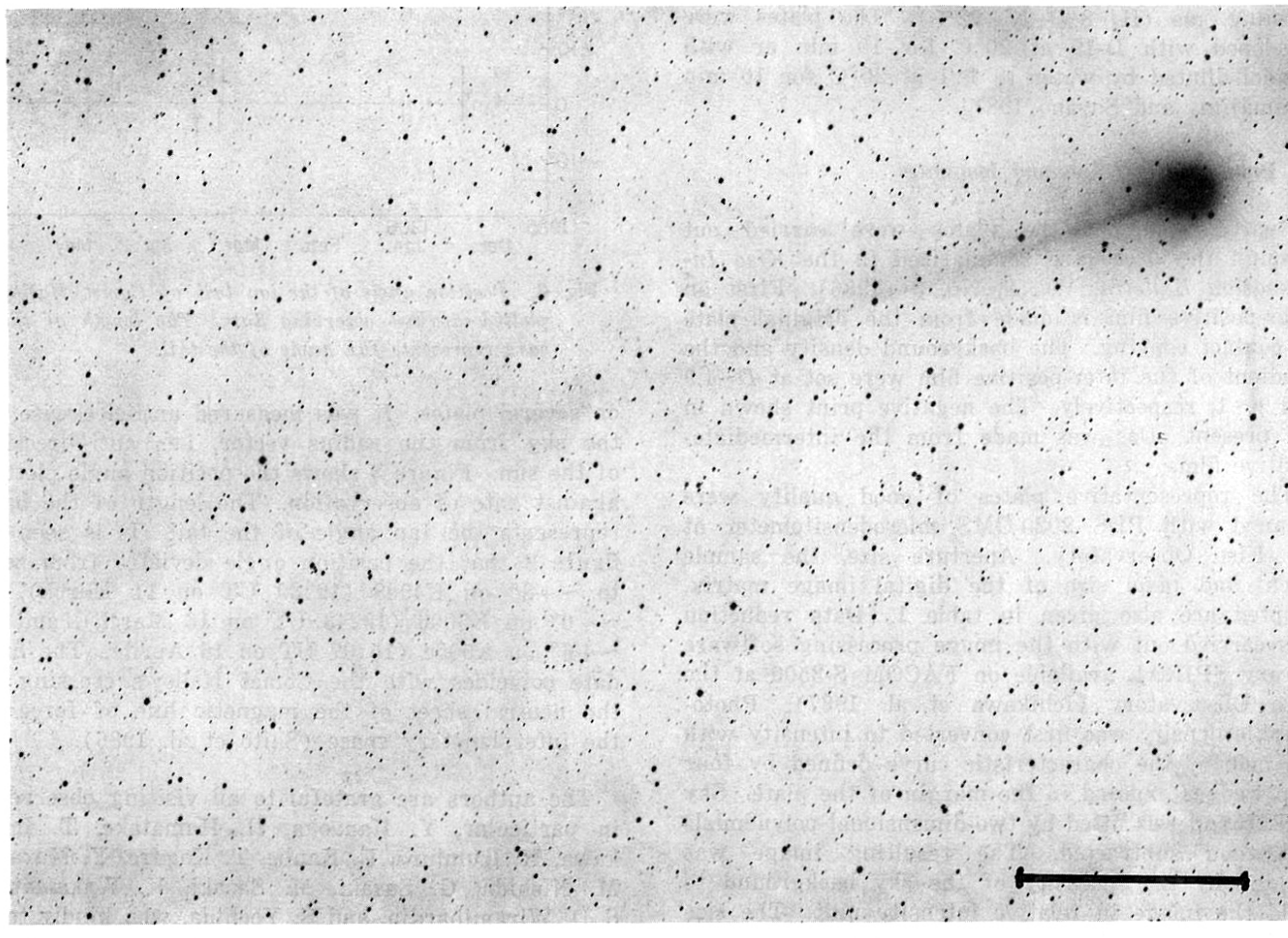
COMET HALLEY K5059(1986-04-24)

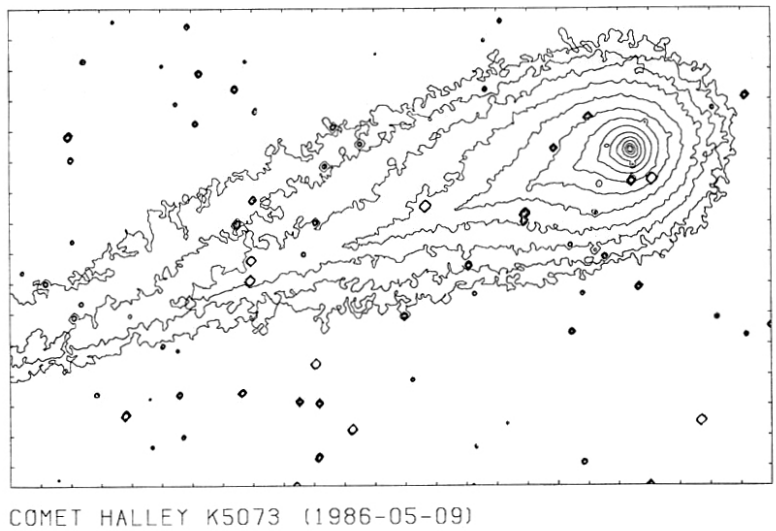
**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-29





COMET HALLEY K5073 (1986-05-09)

**** CONTOUR LEVELS ****

SKY= 0.0

	REL. INT.	MAG.	NG
1	0.063	3.00	80
2	0.100	2.50	80
3	0.159	2.00	60
4	0.251	1.50	60
5	0.398	1.00	30
6	0.631	0.50	30
7	1.000	0.0	10
8	1.585	-0.50	3
9	2.512	-1.00	3
10	3.981	-1.50	3
11	6.310	-2.00	3
12	10.000	-2.50	3
13	15.849	-3.00	3
14	25.119	-3.50	3
15	39.811	-4.00	3

Fig. 2-30

them at 60°C for 2 hours in intermittent flow of forming gas (H_2 8%+N_2 92%). The plates were developed with D-19 at 20°C for 10 min or with Pandol diluted by water to 1:1 at 20°C for 10 min (Hamajima and Soyano 1981).

3. Plate Reproduction and Isophotes

Reproductions of the plates were carried out through the procedure summarized in the *Kiso Information Bulletin*, Vol. 2, No. 3 (1986). First an inter-positive film is made from the original plate by contact copying. The background density and the gradient of the inter-positive film were set at $D\sim1.9$ and $\gamma\sim1$, respectively. The negative print shown in the present atlas was made from the intermediate-positive film.

The representative plates of good quality were scanned with PDS 2020 GMS microdensitometer at the Kiso Observatory. Aperture size, the sample pitch, and pixel size of the digital image matrix, adopted are also given in table 1. Data reduction was carried out with the image processing software library SPIRAL available on FACOM S-3500 at the Kiso Observatory (Ichikawa et al. 1987). Photographic density was first converted to intensity with the help of the characteristic curve defined by four step wedges exposed in the margin of the plate. Sky background was fitted by two-dimensional polynomials and then subtracted. The resulting image was divided by the intensity of the sky background to yield the image in relative intensity unit. The size of the relative intensity image matrix can be computed from the frame size of isophotes and pixel size given in columns (15) and (16) of table 1. The relative intensity image matrix was smoothed by either the gaussian beam or the median filter as indicated in column (17) of table 1. The isophotes shown in the atlas were made from the smoothed relative intensity image.

Photographs and isophotes of Comet Halley produced from the 30 representative plates are shown in figure 2 as an atlas.

4. A Hint of Interaction between Comet Halley and the Interplanetary Magnetic Field

The position angle of the ion tail was measured on several plates. It was measured anti-clockwise on the sky from the radius vector, i.e., anti-direction of the sun. Figure 3 shows the position angle plotted against date of observation. The length of the bars represents the fan angle of the tail. It is seen in figure 2 that the position angle deviates from zero to $\sim+8°$ on K4998 (19:39 UT on 11 March), to $\sim-6°$ on K5006 (19:43 UT on 16 March), and to $\sim+6°$ on K5054 (15:07 UT on 16 April). The first date coincides with the Comet Halley's crossing of the neutral sheet of the magnetic line of force in the interplanetary space (Saito et al. 1986).

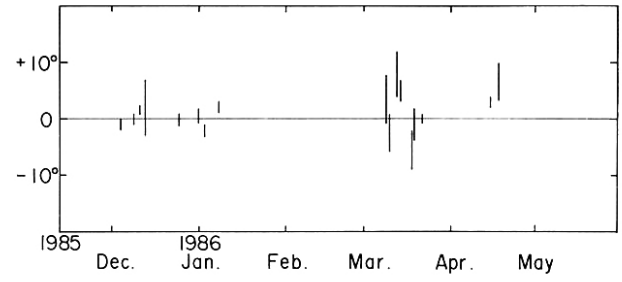


Fig. 3. *Position angle of the ion tail of Comet Halley plotted against observing date. The length of the bars represents fan angle of the tail.*

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