ON THE ANTI-TAIL OF COMET BRADFIELD (1987XXIX)

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ABSTRACT. The anti-tail of comet Bradfield 1987XXIX (= 1987s) was observed when the earth passed through the orbital plane of this comet on December 20, 1987. The time variation of this phenomenon was monitored continuously by Japanese amateur astronomers. Analyzing these photographs by using the Bessel-Bredkhin theory, we deal with the dust particles in the anti-tail.

1. Observations

Many photographs which contributed to "Gekkan-Tenmon (Monthly Astronomical magazine in Japan)" by 10 amateur astronomers were used for this work. The anti-tail was shown on twelve photographs as listed in Table 1. These observations were carried out from December 14 through December 24. It should be noted that the sharp edge of one side in the anti-tail was recognized on eight photographs among them.

Table 1. Observational data

No.	UT Date 1987 Dec.	Exposure (min.)	Observer	Instrument	Emulsion	Δ	r	phase
1	14.40	15	M.Tsumura	300mm F2.8	TP2415	0.834	1.097	59.5
2	18.43	15	M.Tsumura	300mm F2.8	TP2415	0.844	1.140	57.1
3	18.45	13	K.Iwakami	528mm F3.3	TP2415	0.844	1.140	57.1
4	18.50	10	M.Yamashita	300mm F2.8	TP2415	0.844	1.140	57.1
5	19.45	2.5	K.Nishioka	400mm F2.5	X-ray	0.847	1.151	56.5
6	20.40	10	S.Kashiwagi	800mm F4	GX3200	0.851	1.163	55.9
7	21.41	15	Y.Kushida	200mm F4	Tmax400	0.855	1.174	55.3
8	21.42	19	S.Maeda	768mm F4.8	Try-X	0.855	1.174	55.3
9	22.39	8	K.Nagashima	400mm F4	TP2415	0.861	1.186	54.7
10	22.44	3	K.Yoshioka	350mm F2.8	Tmax400	0.861	1.187	54.7
11	23.42	15	M.Tsumura	300mm F2.8	TP2415	0.867	1.198	54.1
12	24.49	10	M.Ohkura	300mm F2.8	TP2415	0.873	1.209	53.6

A.C. Levasseur-Regourd and H. Hasegawa (eds.), Origin and Evolution of Interplanetary Dust, 269–272.

2. Measurements

Two or three combinations of comparison stars were selected on each photograph. The position angle of the anti-tail was measured by using these selected S.A.O. stars. The error of these measurements is about ± 1 or less degrees.

Fig. 1 shows the observed position angle of the anti-tail versus UT date. Clearly, the positional angle of the anti-tail turned over about the solar direction from south to north side at the time when the earth passed through the orbital plane of this comet. Moreover, the direction of sharp-edge side in the anti-tail changed from north to south side. This phenomenon indicates that we, on the earth, observed the anti-tail from both sides within this short period.

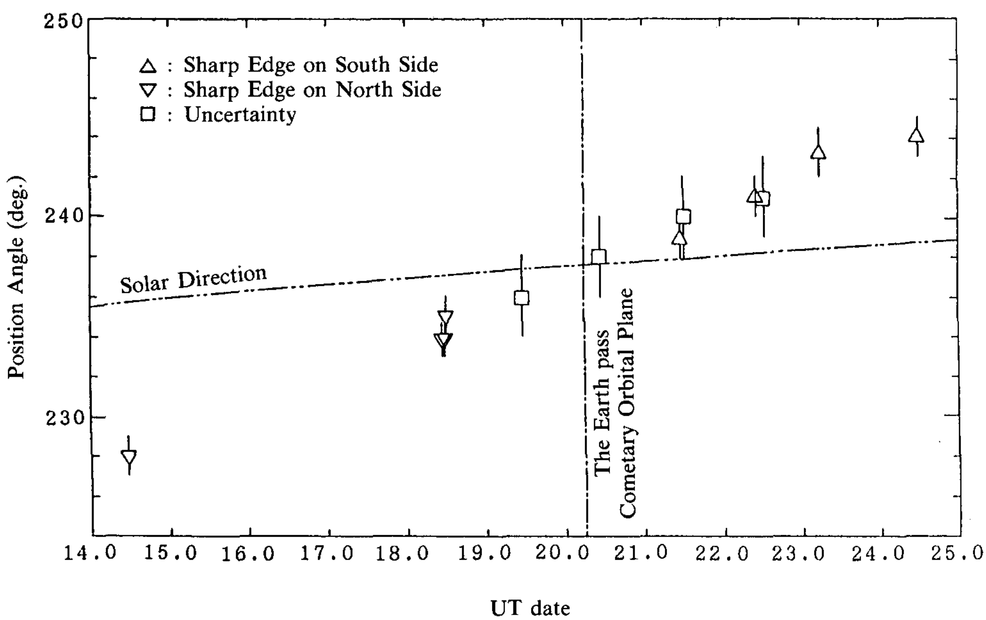

Figure 1. Time variation of the solar direction and the observed position angle of the anti-tail of comet Bradfield 1987s in December 1987.

3. Analysis

Some examples of the comparison between the observed anti-tail and the calculated synchrones using Bessel-Bredkhin dynamical theory are shown in fig. 2. The relation of the synchrones to the observed sharp-edge in the anti-tail with the variable inclination between the earth and the orbital plane of this comet is also shown in fig. 3. Careful measurements of the sharp edge in photographs on Dec. 14.40 and Dec. 24.49 give these position angles as 228 and 244 ± 1 degrees.

Fig. 4 shows the measured position angle at the time of observation (top), the ratio of the radiation pressure to the gravitation β at 15 arc min from the nucleus at the time of observation (center), and the heliocentric distance at the time of ejection (bottom) versus the time of dust

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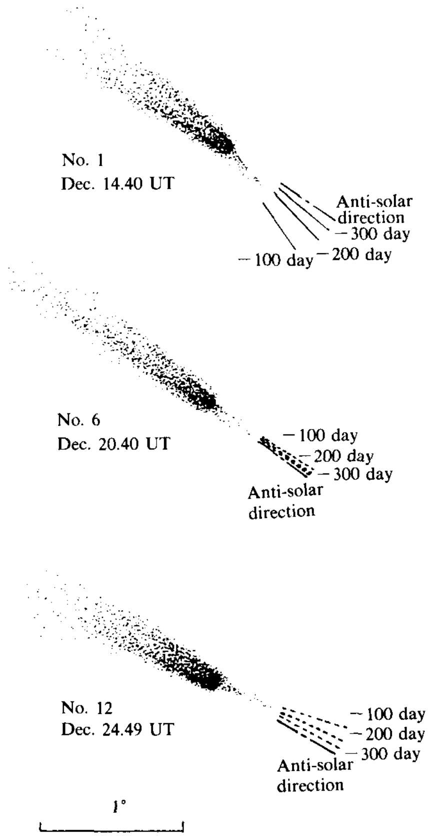

Figure 2. Comparison of the observed anti-tail with the calculated synchrones.

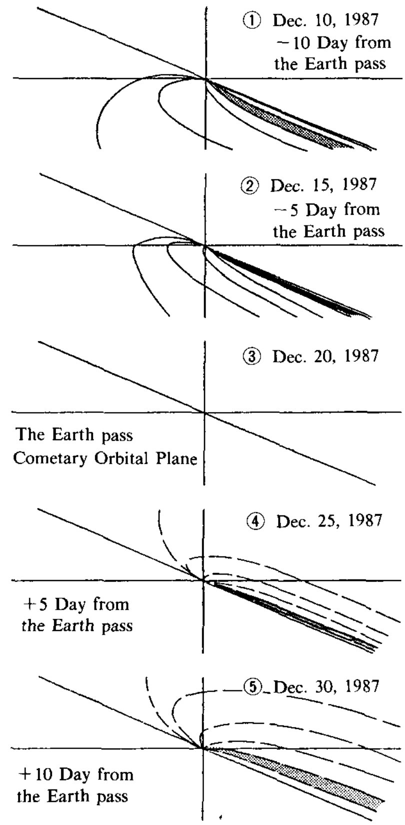

Figure 3. Schematic view of the edge variation in the anti-tail along with calculated synchrones.

particle ejection (synchrones). The solid curves refer to the computed synchrones, and the x axis refers to the ejection time from the nucleus. The little marks near the y axis give the observed quantities, and the two + marks on the curves give the limits on the observed quantities, including the uncertainty. Judging from this figure, we concluded that the dust particles were ejected about −200 days before the perihelion passage.

We determined β_{max} on the synchrone of −200 day. The lower limit of the dust size was calculated as

$$\beta = \frac{1.74 \times 10^{-4} Q_{pr}}{\rho \ d}$$

where Q_{pr} is the scattering efficiency of the particle; for the large particles under consideration, $Q_{pr} \leqq 1$. ρ and d are density and the diameter of the particle, respectively.

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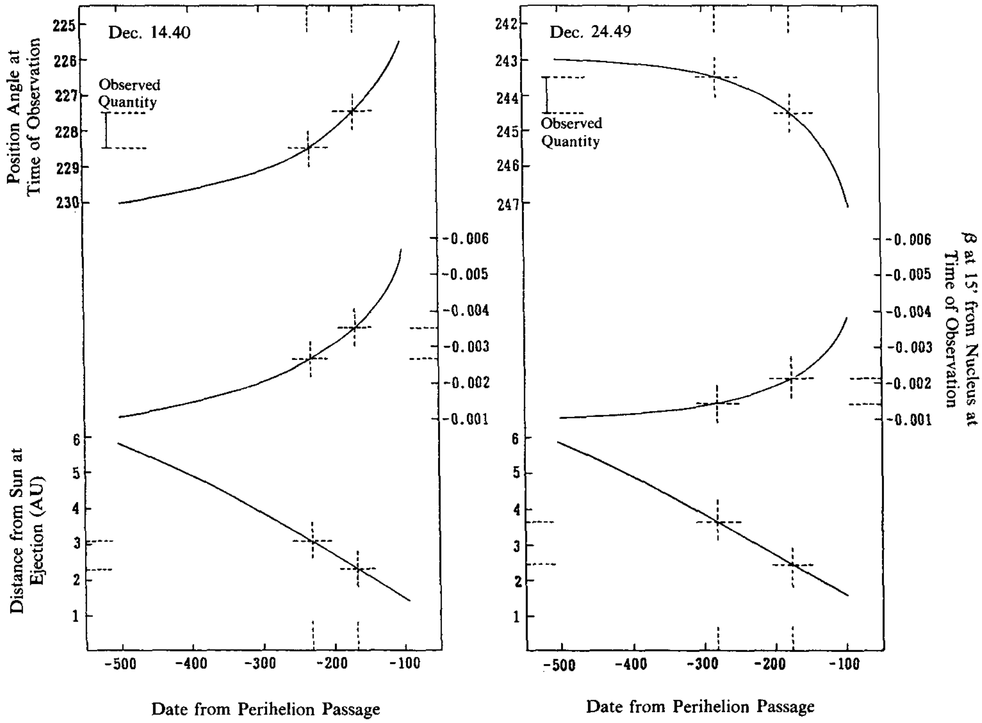

Figure 4. The relation between the position angle and fitted synchrones (upper), β at 15 arc min from the nucleus (middle) and heliocentric distance at ejection (bottom).

4. Conclusions

We found the following results.

(1) The anti-tail direction and the direction of the sharp-edge side were turned over at the time when the earth passed through orbital plane. The sharp-edge always existed in the side toward the solar direction where the old synchrones were crowded in narrow space.

(2) The dust size on 15 arc min from nucleus are estimated as 0.4 – 0.3 mm on Dec. 14.40, and as 0.8 – 0.5 mm on Dec. 24.49 observations. The estimated size might be uncertain because the synchrone curves were too crowded to be distinguished. In eiter case, the conclusion on the size of dust in anti-tail is approximately order of 10^{-1} mm. The diameter of dust particles derived from the β_{max} in the syndyne curves is $>$ 0.2 mm, which is also consistent with the above estimated values.

(3) The dust particles in the anti-tail were ejected at -170 to -280 days before the perihelion passage, *i.e.* the heliocentric distance was about 2 – 3 AU. Therefore, the life-time of the dust particles in the anti-tail is approximately $>$ 207 – 328 days.