

OBSERVATIONS OF COMET ALCOCK (1963b)

Nota di GUIDO CHINCARINI (*) (**)

(NASA, Manned Spacecraft Center, Houston, Texas and Wesleyan University,
Middletown, Connecticut)

RIASSUNTO. — Nel corso dell'esplosione della Cometa Alcock 1963b si sono osservati alcuni « halos » con velocità di espansione di circa 0.6 km/sec. Dopo alcuni giorni si è sviluppata una coda di tipo I che è durata per circa un giorno. Alcuni raggi erano visibili all'interno della Coma ad una distanza $\leq 1.8 \cdot 10^4$ km dal nucleo. In seguito si è sviluppato un caratteristico getto (jet) costituito, con ogni probabilità, da grani di polvere che si allontanavano dal nucleo ad una velocità di 45 m/sec. Tale jet unidirezionale può essere spiegato come originatosi da un nucleo solido o costituito da materiale solido.

SUMMARY. — During the outburst of Comet Alcock 1963b some halos with an expansion velocity of about 0.6 km/sec were visible. After a few days a rather detailed type I tail appeared which lasted about one day. Rays were visible in the Coma to a distance $\leq 1.8 \cdot 10^4$ km from the nucleus. A particular and very intense jet developed afterwards, the observed velocity of the dust grains was 45 m/sec. This is easily explained if the nucleus consists of solid blocks (or one block) which permit that dust clouds can be thrown out in a certain direction.

Between May 27 and May 29 a strong flare up of Comet Alcock (1963b) occurred, amounting to about 3^m (see *Sky and Telescope*, **26**, 33). The flare has been followed by the author and Margoni (Asiago) using the 122 cm reflector (scale 34.3" per mm at the Newtonian focus) and the small Schmidt telescope 40/50/100 cm (scale 200" per mm) of the Astrophysical Observatory of Asiago, Italy. For the reflector blue sensitive Kodak 103-a-0 or Ferrania LS-61 plates have been used. All the Schmidt photos are on Kodak Royal Panchro film. A few spectroscopic observations in the range λ 3700 — λ 6700 Å (103 a F Kodak emulsion) were secured on the nights May 23, 30 and June 7 1963 using the spectrograph BII at the Newtonian focus of the reflector. The height of the slit was about 45" of arc.

A preliminary report was given by WURM et al. (1964).

(*) Ricevuta il 25 Novembre 1969.

(**) Formerly at the Astrophysical Observatory of Asiago.

TABLE I - Halo diameters (in seconds of arc).

Date (May 1963) Plate N. U.T. h:m	27/28 3990 - S 22:31	28/29 3993 - S 0:43	28/29 5829 - N 0:55	30/31 3997 - S 0:36	30/31 5830 - N 22:27	31/ June 1 3999 - S 0:29
Halo 1	24*	0.67	51	27*	33*	61
Halo 2	81		235	186	152	245
Halo 3			521?	692	604	

? very uncertain

S Schmidt photos

N 122 cm Newtonian focus

Figures above arrows give velocities, between mean values, in km/sec

* Nucleus not resolved from halo

1. - HALOS AND THEIR EXPANSION VELOCITY

The plates listed in Table I (film N. 3999 is of lower quality) show a series of halos in the coma of the Comet Alcock (Fig. 1a and 1b). In a few pictures the nucleus seems not to be in the geometrical center of the innermost halo as in the film obtained on May 30/31, Fig. 1b.

The diameter of the halos has been measured:

- a) using a micrometer on the eyepiece of the Zeiss binocular microscope;
- b) on the microdensity tracings obtained with a Zeiss Schnell photometer.

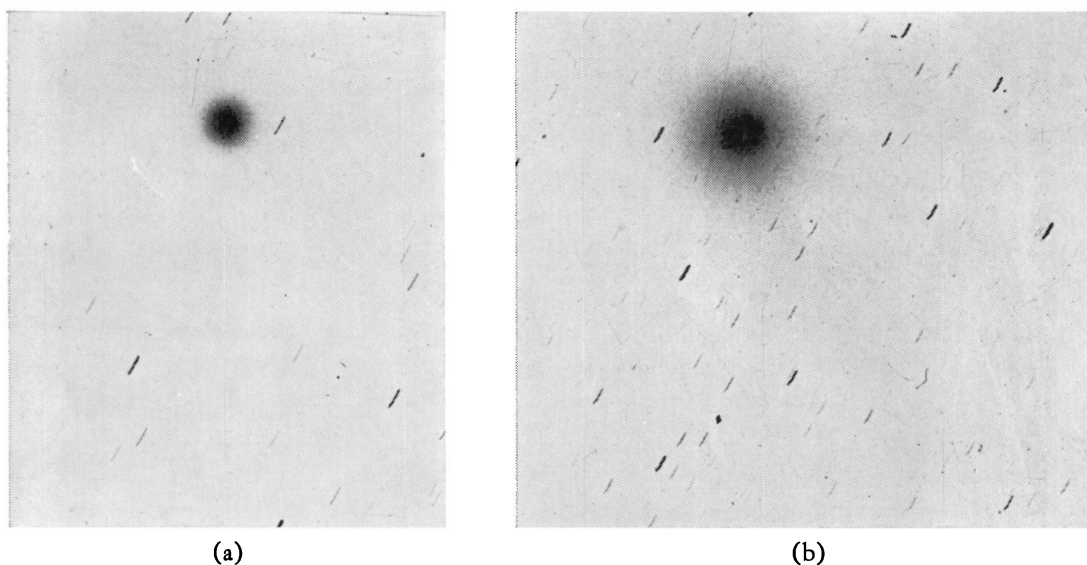


FIG. 1

Halos are visible in the coma.

(a) May 28/29

(b) May 30/31

Scale 50"/mm. North at the top.

Measurements of the reflector plates are in good agreement with those of the Schmidt films (within 10-20%, the error is mainly due to the difficulty to measure the limit between two rather diffuse regions in the coma). The diameter of the observed halos in seconds of arc is given in Table I. In the different lines we have the diameter of the halos visible in the same photograph. If the halos developed as shown by the arrows, then, assuming a constant outflow of matter from the center, we derive an average velocity of $\bar{v} = 0.60 \pm 0.14$ km/sec. Somewhat larger velocity is obtained using the intensity profiles (referred to the sky) and assuming a projected intensity proportional to R^{-1} . When so, at least four

different outflows have been observed and the outburst seems to be mainly characterized by discontinuous outbreaks of matter from the nucleus. According to the isodensity tracings (Fig. 2a) the outflows are rather symmetric, asymmetries in the Coma are present later on (Fig. 2b).

The diameter of the outermost Coma has been also measured on different dates. These were estimated on the tracings perpendicular to the tail as the distance between the two points where the signal of the sky + comet is not any more discernible from the sky background (see Fig. 3). The coma can be traced, adopting a geocentric distance of 0.86 a.u. (Marsden I.A.U.C. 1829), to a distance of $0.6 - 0.7 \cdot 10^6$ km from the nucleus.

2. - THE TAIL

Since the tail of Comet Alcock is rather faint on the Schmidt films, lack of accuracy in the position angles arises because of its faintness and diffusiveness. In a few photographs (five) the tail was not detectable. When rays were present, the average direction of the two brightest ones was used. In Fig. 4 the variations of P.A. are shown, defined by the brightest feature or from the axis of rays when present. Among the most important features observed was the development of a bright type I tail during the outburst. On May 27th, at the onset of the outburst, only a rather faint and diffuse tail is present. One day later a well developed type I tail is visible, whose axis is at P.A. = 120°. Six symmetric rays are present and well defined on the photograph up to a distance $\geq 2 \cdot 10^6$ km from the nucleus. The outermost rays can be followed in the coma at a distance of $\sim 30'' = 1.85 \cdot 10^4$ km all around the nucleus. On the 30th a new tail, completely different from the first one and very rich in details, is visible (see Fig. 5). More than 20 rather sharp and faint rays can be observed, unfortunately not all the details are visible in the print. The outermost rays meet in the coma, where zones of different density are visible and seem to be tangent to different halos (appearance of three or more separated parabolic envelopes). The two innermost rays meet at a distance of $\sim 4 \cdot 10^4$ km (the central part of the coma is too dark to distinguish fine details). On May 31st no bright tail is present, however the picture is of much lower quality. The tail changes completely its structure or appears and disappears in times of the order of one day. Such structured tails are visible only during the outburst and follow very closely the development of it.

3. - THE DUST JET

The spectra of the comet obtained at Asiago and those obtained by other astronomers (see for instance CHALONGE and BLOCK 1966) show that the nucleus of the comet always presented a rather intense continuous emission (scattered light). The spectrum we obtained on the night June 7/8 shows not only a very

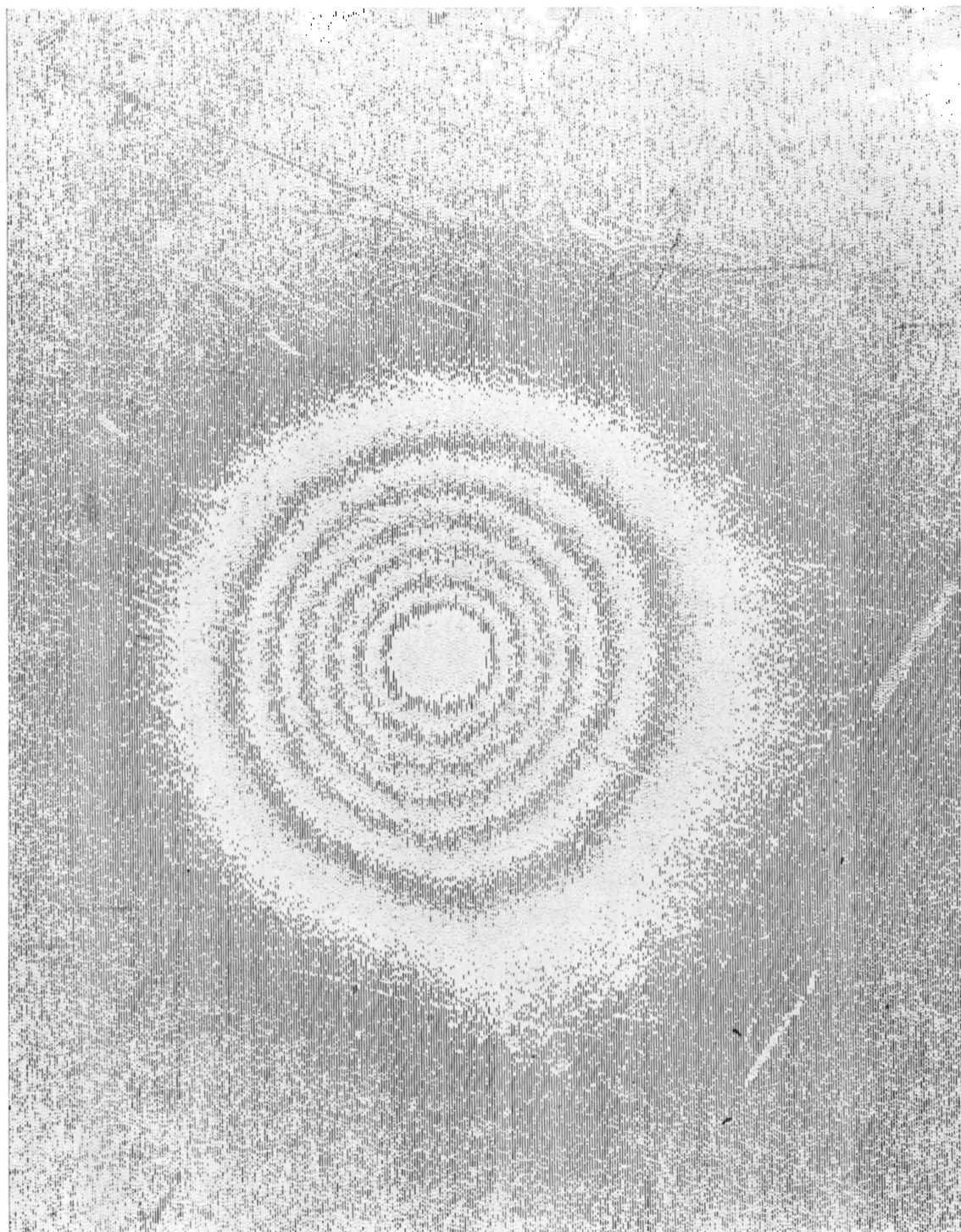


FIG. 2 (a)
Isodensity tracings. Scale 5.5"/mm.
(a) May 28/29
(b) May 30/31

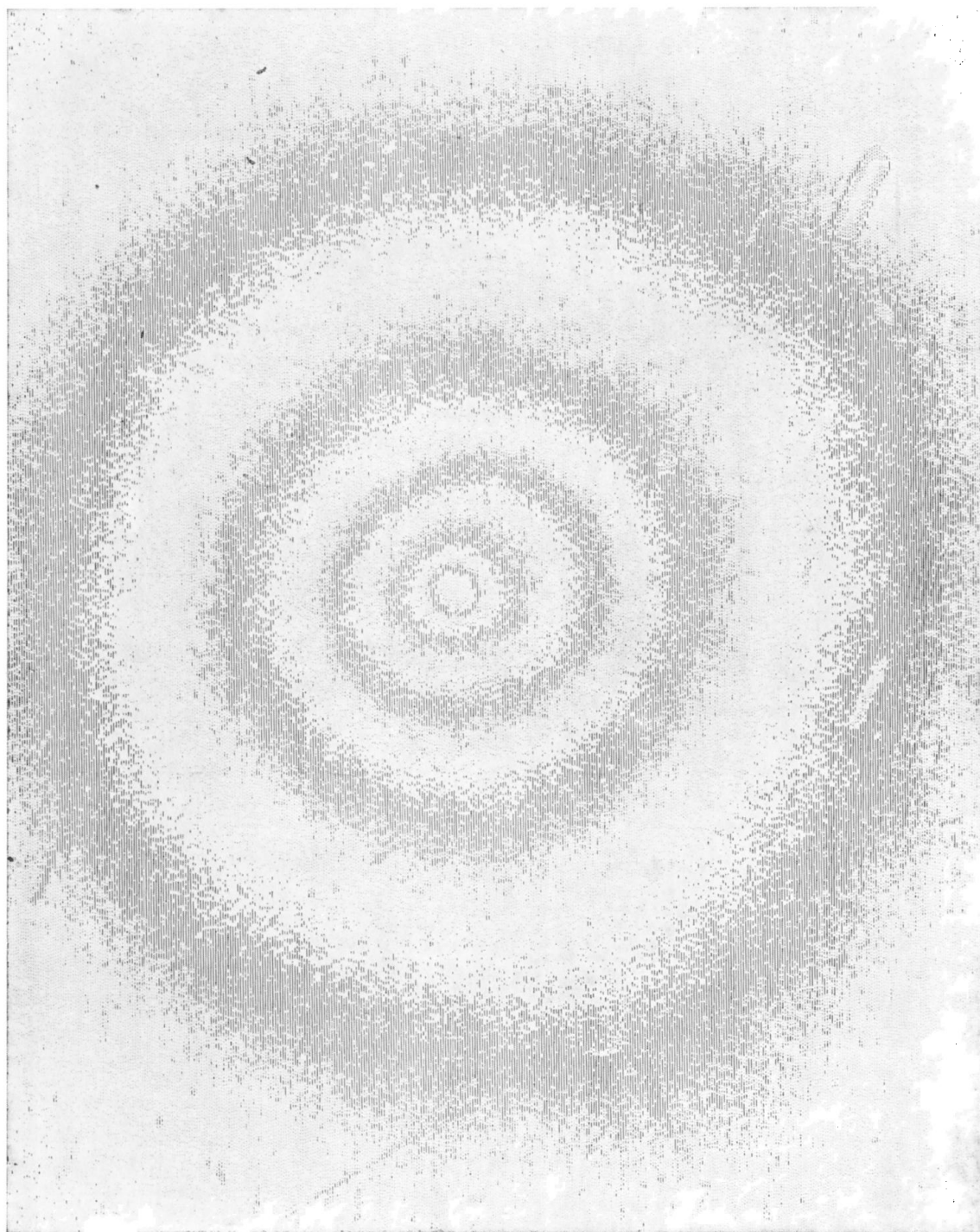


FIG. 2 (b)

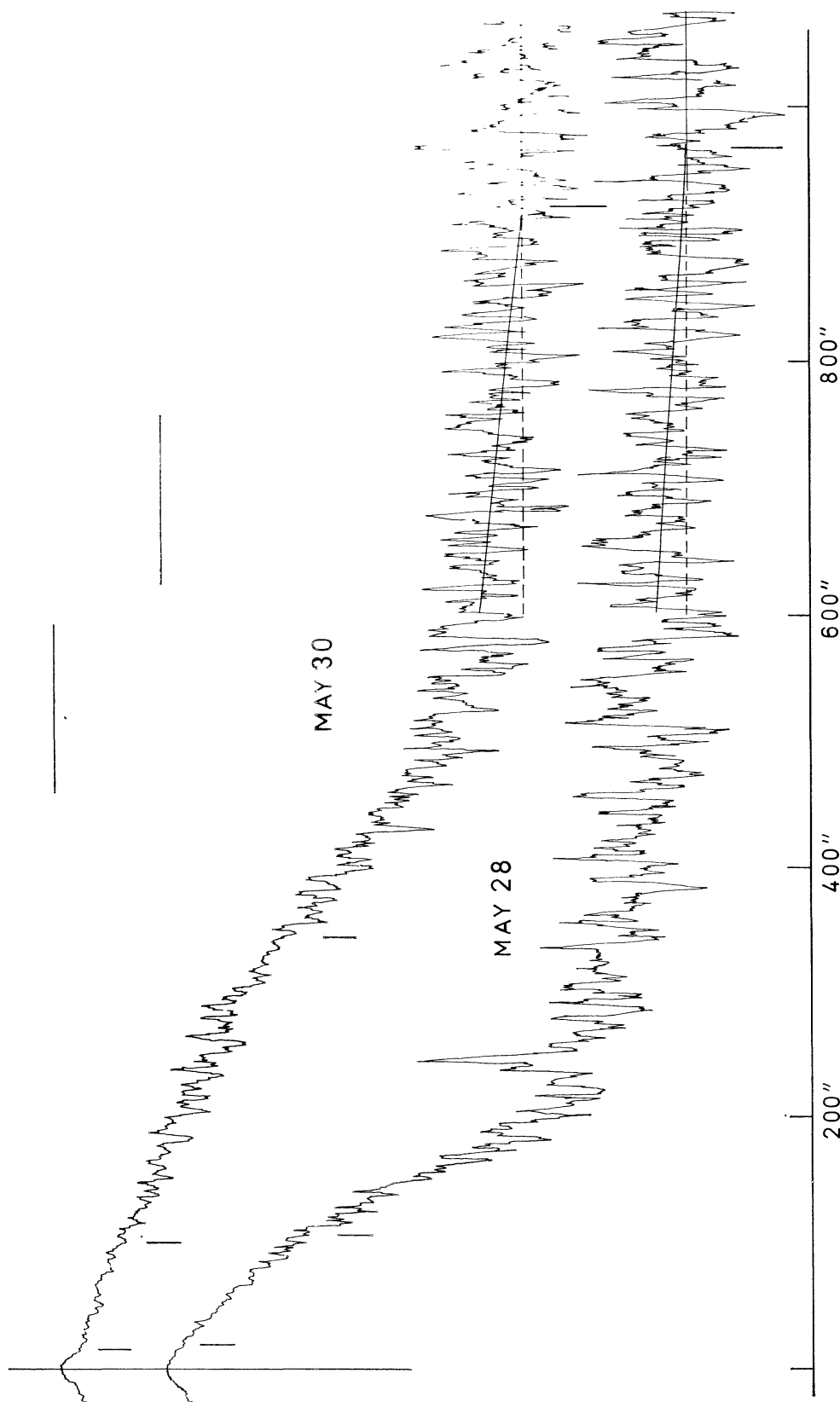


FIG. 3

Microdensity tracings of the coma in the direction perpendicular to the tail. The vertical lines mark the size of the observed halos as given in Table I (on the tracings is visible the change in the slope of the curve) and the extension of the coma. The sky background and the zero level have been also marked for both tracings.

bright continuous emission in the nucleus but also along the jet in the part which was covered by the slit (the slit was oriented in the *E W* direction). Sky contaminations on the spectrum are, very likely, to be excluded.

The development of the bright jet is shown in Fig. 6 and 7. A fainter jet seems to be present in the direction perpendicular to the main one. The size of

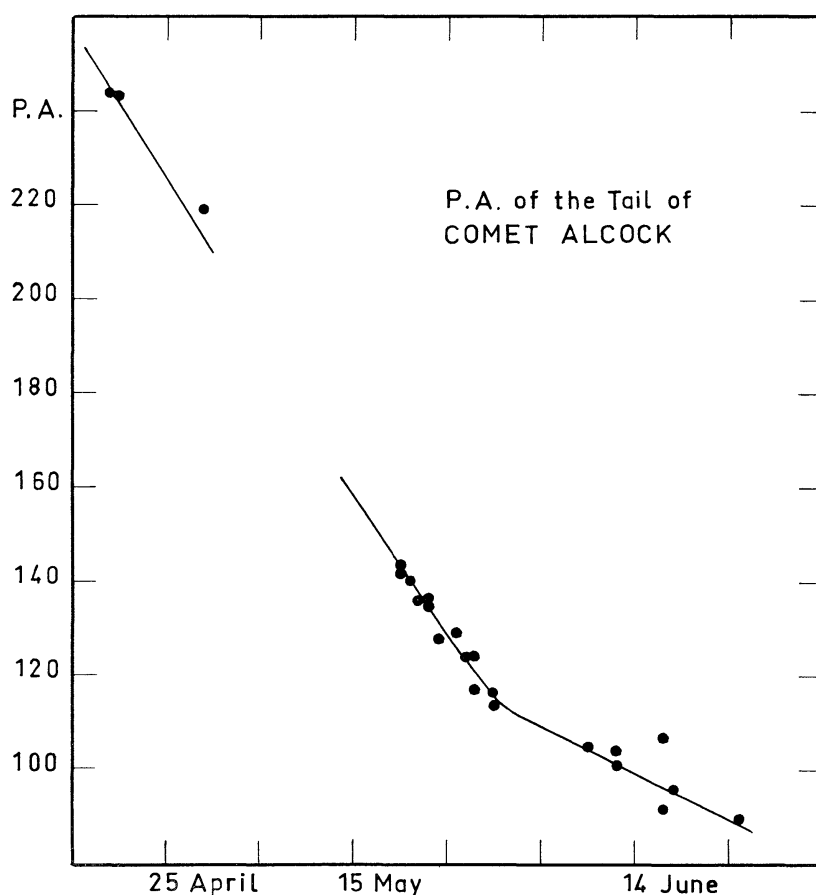


FIG. 4

Variations in P.A. of the tail with time. In June the direction of the extended faint tail seems to be different from that of the jet. The tip of the jet departs lightly from the direction of tail in the NE direction.

the main jet has been measured on different plates and films in order to set the order of magnitude of the dust grain velocity. From the average of the photographs obtained on June 9th, 12th and 17th we get a length of about 90'' when no foreshortening effect is present. It seems rather reasonable to assume that the appearance of the halos between May 27th and May 31st on the one hand, and the appearance of the dust jet on the other, are connected and are the results of the same events. The later appearing big jet may possibly be consisted from

several outbursts in the same direction. If such a point of view is accepted, then we find for the dust particles in the tip of the jet a mean velocity of 45 m/sec.

As stated above the discontinuous outbreaks of matter from the nucleus

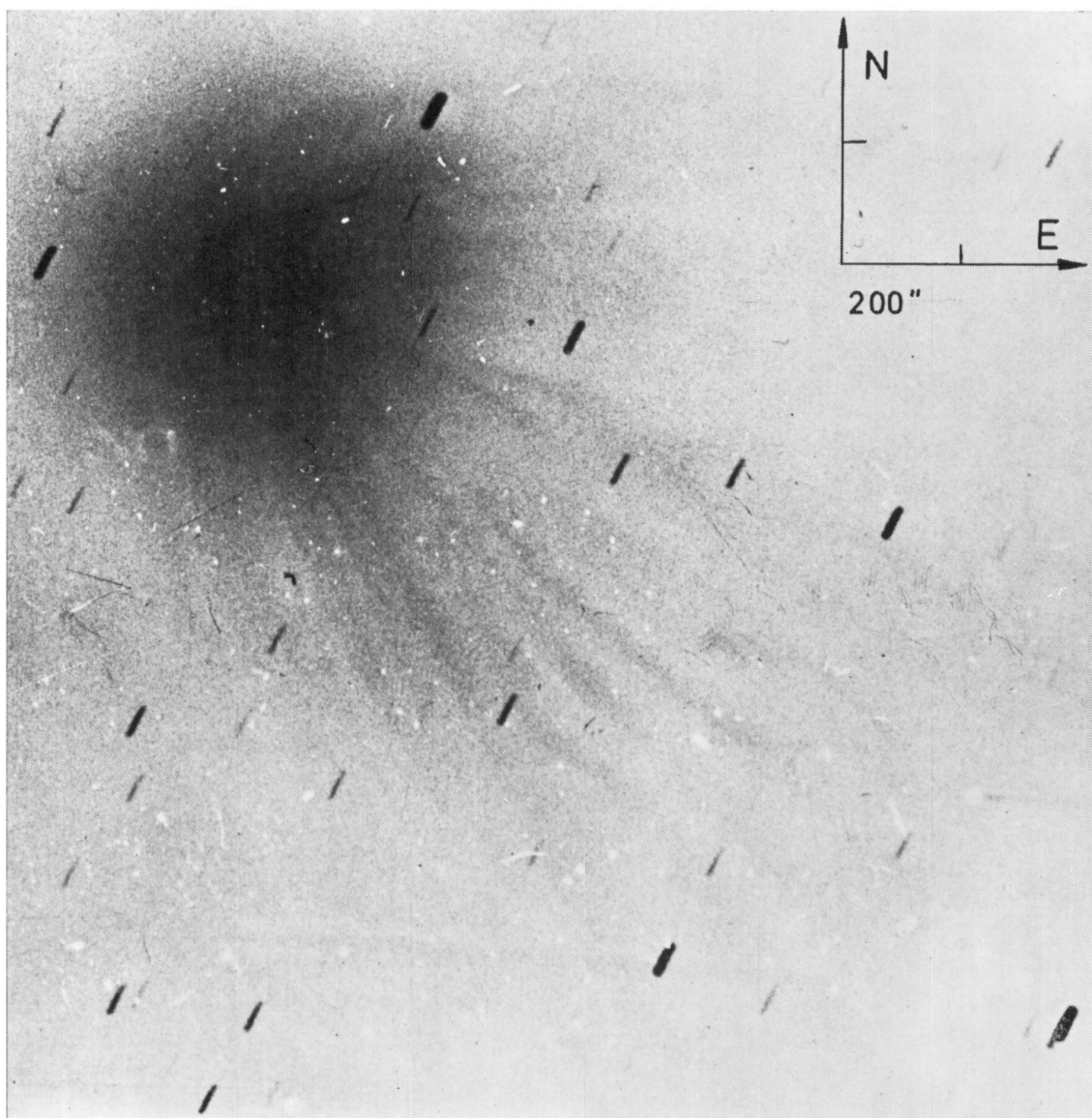


FIG. 5

Coma and type I tail observed on May 30, 1963 (Plate N. 5830-N). Envelopes with departing rays are visible in the print.

seem to be connected with a high production of dust particles which are too large to be influenced by light pressure. While the halos expansion velocity was probably determined by the temperature of the material the dust velocity was determined

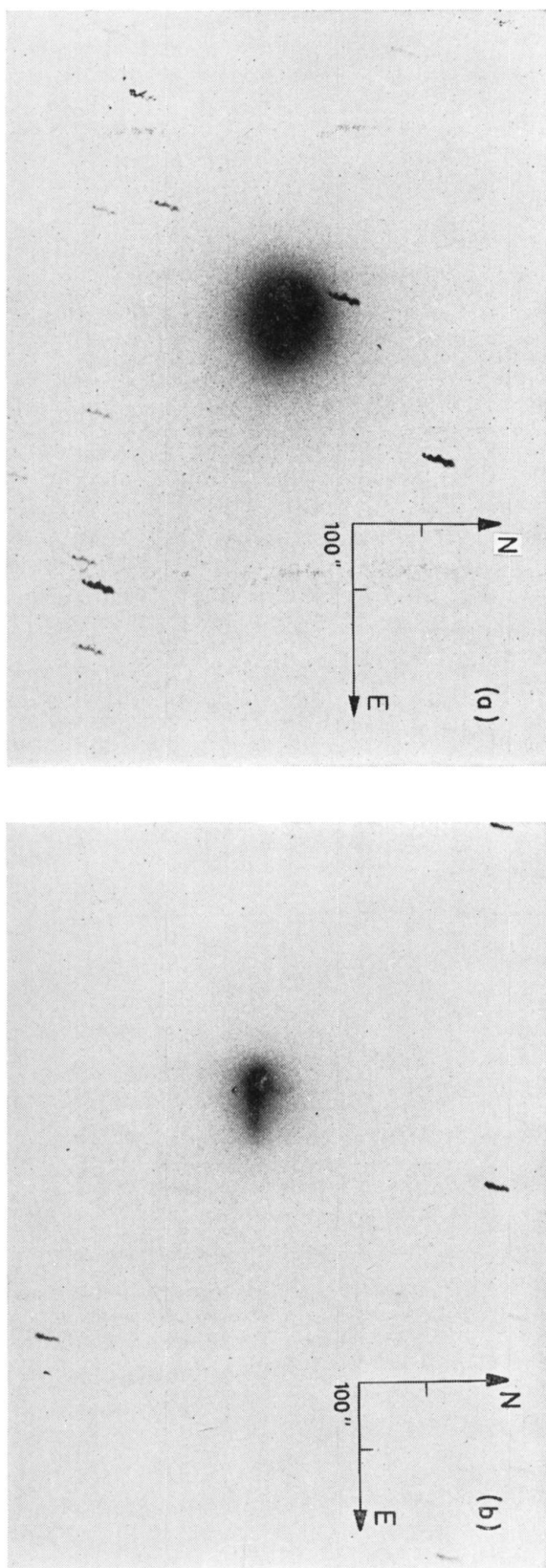


Fig. 6

Further evolution of the comet with its characteristic jet or cigar-shaped central part. (a) June 12 1963, 20^m exposure on LS 61 (b) June 17, 20^m exposure on LS 61. See also figures in: Wurm K. *Nature et Origine des Comètes*, Colloques de Liège vol. 37 pag. 119 (1966).

by the impulse which the ejection process was able to transfer to the whole mass.

The asymmetry of the dust jet seems also to be rather important. Such a dust burst with a rather sharp and limited direction cannot originate out of a

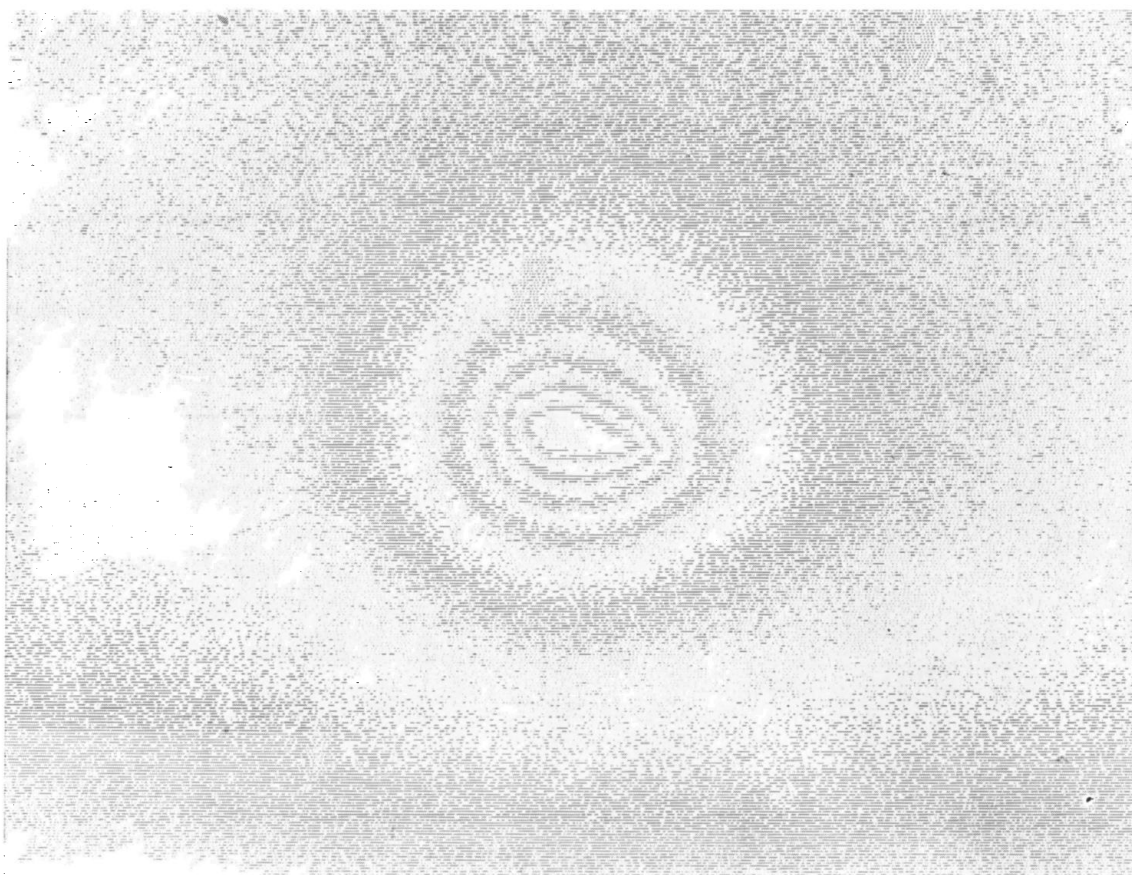


FIG. 7

Isodensity tracing of the plate taken on June 12, Fig. 6a. Scale 5.5"/mm. North at the top.

dust cloud. In this case we would expect a symmetrical emission. One way to explain it easily is if we were dealing with large blocks, or one block, assuming a somewhat irregular distribution of the ices or irregular heating of the nuclear region. In both cases an increase of the temperature will cause differential expansions in the nuclear region. Stresses, which can be disruptive, develop in the nucleus or over its surface. In such conditions cracking and outflow of matter sharply directed are to be expected.

ACKNOWLEDGEMENTS

It is a pleasure to thank Prof. Wurm for the suggestions he gave to me. Mr. Pertile (Asiago) used his skill in acquiring the observations with the Schmidt telescope.

Most of this material was reduced at the Observatory Hoher List (University of Bonn). The isodensity tracings have been made using the isodensity recording at the Manned Space-craft Center.

REFERENCES

- CHALONGE, D., BLOCK, M. (1966), *Nature et Origine des Comètes*, Colloques de Liège vol. **37**.
WURM, K., CHINCARINI, G., MARGONI, R. (1964), *Structure and development of cometary tails*.
Final Report AF 61 (052) 583 - Air Force Cambridge Research Laboratories.