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HALLEY AT OPPOSITION

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RESUMO. Foram digitalmente analisadas 45 imagens fotográficas do Halley obtidas na época da oposição de 18 de novembro de 1985. Na coma interna foram detectadas inomogeneidades medindo 10^3 - 10^4 km. Aparentemente elas são constituidas de gás ionizado, mas não possuem características morfológicas de "raios". Implicações deste resultado são discutidas num modelo de formação de "raios".

ABSTRACT. Digital analysis was made on 45 photographic images of Halley obtained around the opposition of November 18, 1985. Structures with sizes 10^3 - 10^4 km have been disclosed in the inner coma. Apparently they are ion formations, but they do not possess morphological characteristics of cometary rays. Implications of this result for a model of rays' formation are briefly discussed.

Key words: COMETS

. INTRODUCTION

Morphological structures of the inner coma are investigated under he geometrical situation brought about by the opposition. Other authors (Meech nd Jewitt, 1987; Liu, 1987; Gammelgaard and Thomsen, 1988) have also studied alley near the opposition but for different purposes. The observations were arried out at Brazilian National Laboratory for Astrophysics (Matsuura et al., 986) with the Cometary Camera described by Laporte et al. (1986). 45 images btained in the period November 13-19, 1985, make up the present data base. ooking for a rough discrimination between cometary dust, neutral gas (C_2) and onized gas (CO^+), the following combinations of Kodak plate with Schott filter ere used, respectively: "F"+ OG 570, "D"+ GG 435 and "O"+ OG 395.

I. DATA

The log of observations can be found in Table 1 of Matsuura et l. (1986). For the plates analysed herein the phase angle varied from 1.4 to .7 degrees and the geocentric distance of the comet from 0.67 to 0.78 AU Edberg, 1985).

II. ANALYSIS

An area around the photometric center of each image was scanned ith the PDS 1010A Microdensitometer at National Observatory, Rio de Janeiro.

The area (12' x 12') comprised 200 x 200 pixels, each one measuring 20 μm x 20 μm. The data acquired in tape record through the operational system ONSAD (Rité et al., 1987) have been converted into FITS format at Centro de Computação Eletrônica, USP, and then transferred to floppy-disks. With the software PATI (Anjos et al., 1988), the image analysis was performed on a IBM-XT endowed with the graphic card CGA.

Pictures taken on light scattered by dust exhibited smooth and circular isophotes. This was not the case for pictures taken on light emitted by ions. Bright knots measuring several thousands of km disturbed severely the isophote contours over about 10^4 km, at projected cometocentric distances between 4×10^3 and 10^5 km. Each structure exceeded significantly the spatial resolution. The variation of brightness over each structure was significantly larger than the noise level. The possibility that such structures were due to background stars could be ruled out in most cases through the examination of tracks left by stars and/or star countings. After all these considerations it seems sound to conclude that most of such structures are objective.

These structures appeared more conspicuously whenever the images were taken with plate and filter combination contrived to catch the ion light. But this does not suffice to guarantee that they are made up of ionized gas because of poor spectral resolution. From the ground, a cloud of dust or neutral gas is seen as a coherent structure extending over the whole coma. Yet the individual inhomogeneities described above are of a much smaller size, embedded in a more ample and regular structure of the inner coma. They are more akin to kinks and knots, which are ion formations of Type I tails. So the morphological properties argue favorably that the structures might be ion cloudlets.

Also space probes have detected plasma inhomogeneities (estimated size: 640 km) containing heavy cometary ions mixed with solar wind ions between 5×10^4 km and 8×10^4 km from the nucleus (Gringauz et al., 1987).

The result reported here is surprising if one considers the classical Alfvén's (1957) model for Type I tail and expects to find ray-like structures lying on a plane containing the vectors of velocity and magnetic field of the solar wind. The observed individual structures were not elongated. Collectively they did not outline a pattern showing a preferential direction referrable to a preferential plane. This however does not mean necessarily that structures like newborn rays did not exist. They could well exist hidden under a bright background. Several photographs taken on ion light out of opposition disclosed arches or parabolic envelopes which were interpreted as newborn rays (Voelzke and Matsuura, 1989). Visual inspection of these photographs also revealed structures like those found on plates of opposition. It seems that arches or parabolic envelopes may coexist with the structures observed at opposition.

IV. DISCUSSION

Russell et al. (1987) analysed measurements of Halley obtained in situ and discovered depressions of magnetic field intensity correlated with plasma density enhancements. They suggested that such phenomenon could be elated to rays, and ascribed the plasma density enhancements to mirror nstability (Hasegawa, 1975) which requires pressure perpendicular to the agnetic field larger than the parallel one. This condition is more favorably ulfilled in the outer magnetosheath, where the pick-up of cometary ions is perating. Rapidly the distribution function of the ions in the velocity space cquires the ring shape, which is prone to suffer instabilities, among them the irror instability. However according to the present result it seems that rays o not result directly from the mirror instability. This instability produces iscrete ion cloudlets which convect towards the contact surface. A further ompressive phase, perhaps aided by a thermal instability, should still be equired in order to generate rays. It is suggested that the observed structures re manifestations of discrete ion cloudlets.

. CONCLUSION

In order to test the present interpretation, future opportunities f opposition of forthcoming comets should be explored for morphological studies n the inner coma, resorting to CCD cameras and more selective filters, and otaining more closely spaced temporal sequence of images.

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