Striated Features in the Dust Tail of Comet C/2006 P1 (McNaught)

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The results of dynamic modeling of the dust tail formation of comet C/2006 P1 (McNaught) are presented. The comet is known for well defined transversal striae in its tail which were observed during post perihelion passage. The presence of local active areas on the surface of the rotating nucleus is proposed as a possible explanation of this phenomenon. In this scenario the bright striae can be caused by different dust production rate depending on that if the active areas are located on the sunlit or shaded side of the rotating nucleus. The tail of comet McNaught was modeled under assumption that there is not only the uniform outflow of dust from the nucleus but also the considerable fraction of dust streams out from three active local sources. The period of comet C/2006 P1 (McNaught) was found to be 21 hours.

Introduction

Comet C/2006 P1 (McNaught) was discovered on August, 23, 2006 by Robert McNaught, when it was 17^m. The comet passed perihelion on January, 12, 2007 at the distance 0.17 a.u. from the Sun. There is no doubt that the most remarkable phenomenon observed during the comet post perihelion observations was the well defined transversal striae in its tail. The explanation of this phenomenon is the purpose of presented study.

Modeling

The used dynamic model of a dust tail is based on a Monte-Carlo method. It was developed by Korsun P. P. for study of comets showing considerable activity at large distances from the Sun [4]. This model was modified in order to reproduce dust comet tails on near-Sun distances and was applied to the comet Hale-Bopp [3]. To simulate the dust tail the trajectory of each individual particle was traced from the ejection moment to the moment of observation. Time, direction, velocity and also radius of particle ejected from collision zone were calculated using Monte Carlo method. Then the system of the differential equations of motion under the solar gravitation and the pressure of solar radiation forces was solved for each particle. Obtained cometocentric coordinates of particles were projected on the sky plane. The results were compared with the observations made by David Headland [1], New Zealand on January, 24, 2007.

Striated features

The fitting of the striated tail structure presented here was carried out by the modeling of activity of three local areas placed on the rotating nucleus. The level of dust production is significantly different when an area is on the sunlit side and on the shaded side. This cause the irregularities in the comet tail.

The size distribution of the particles ejected from the active areas was taken from [2]:

$$n(a) = (1 - a_0/a)^M (a_0/a)^N, \tag{1}$$

where a is the size of the particle in microns, a_0 is the minimal size of the particle, M and N are model parameters. According to our best-fit model the period of comet C/2006 P1 (McNaught) is 21 hours. The set of corresponding model parameters is listed in Table 1. The resulting modeled image of comet C/2006 P1 (McNaught) is also shown below.

Table 1: The resulted parameters to fit the tail of comet McNaught

Parameters:	Active areas which form upper system of striae	Active area which forms lower system of striae	Escape of dust from nucleus as uniform source
Age of particles, days	12	12	11.2
Range of radii, m^{-6}	0.2 - 0.48	0.33 - 0.77	0.35 - 65.0
Index power of exponential size distribution	-	-	-3.5
V_{dust}, m/sec	390 - 604	317 - 470	33 - 456
Most probable radius	0.34	0.49	-

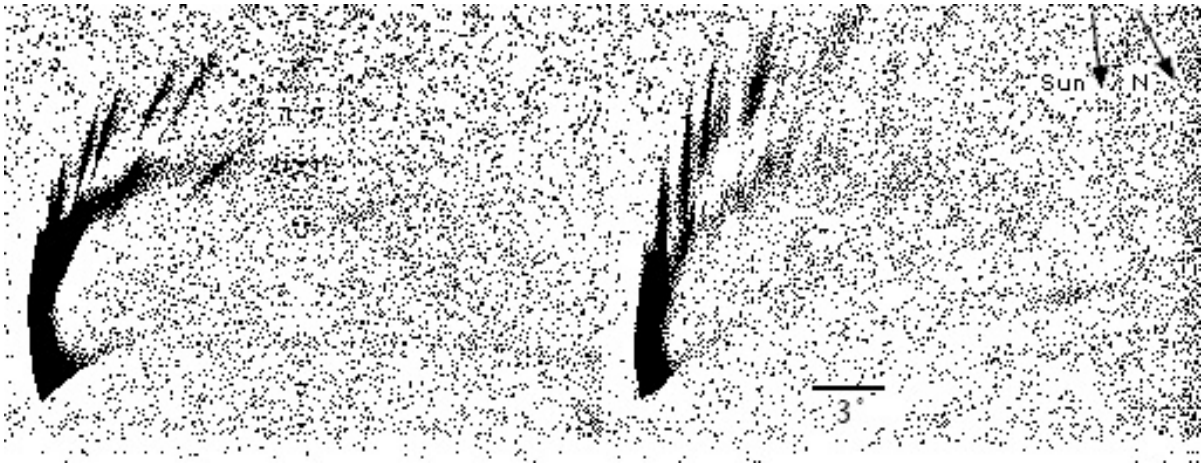

Figure 1: The modeled (left) and observed (right) images of comet McNaught

Conclusions

1. We have successfully modeled the surface brightness distribution in the comet C/2006 P1 (McNaught) tail and reproduced its striated structure.
2. Activity of the local areas located on the surface of the rotating nucleus is suggested as the possible explanation of the striated tail phenomenon.
3. The velocities of ejected dust, the range of particle radii, the maximal age of particles and a power index of the dust size distribution were obtained from the modeling.
4. The axial rotation period of comet C/2006 P1 McNaught was found to be 21 hours.

References

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