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COMET P/TEMPEL - SOME HIGHLIGHTS AND CONCLUSIONS FROM THE 1988 APPARITION *

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Abstract: From the brightness development and a sequence of imaging observations of the coma activity onset of comet P/Tempel 2 in 1988, it is concluded that there might have happened eruptive events of strong dust and gas outburts during May and June 1988. A comparison of dust coma modelling calculations with CCD observations of the coma widely confirms Sekanina's nucleus model for the comet.

1. Introduction

During the 1988 apparition of comet P/Tempel 2 a series of observations were performed by a team of the Bamberg observatory and some external collaborators (in total 11 team members). The team work was supplemented by amateur observers who contributed the visual brightness estimations of the comet. The scientific aims of the observations were to estimate the nucleus size, to monitor the coma activity and its morphology, to derive some characteristic values of the gas productions of C2, C3 and CN together with basic data on molecular physics of C2 and to provide position measurements for an improved orbit determination of the comet. The results of this research project on P/Tempel 2 (except the astrometry) are published in Boehnhardt et al. (1990).

In this paper we present some further conclusions on possible eruptive events during the preperihelion activity phase of P/Tempel 2 and a comparison of the coma imaging observations with dust coma model calculations of the comet.

2. Eruptive events in the lightcurve and the coma development

From the published imaging and photometry of comet P/Tempel 2 during the transition phase of marginal to significant coma activity (see Jewitt and Luu, 1990: 9-15/4/88 = probably no coma; Boehnhardt et al., 1990: 4/5/88 = no coma; Wisniewski, 1990: 8-9/5/88 = faint coma; West, 1988: 17/5/88 = significant coma) we conclude that the onset of major gas and dust production of the cometary nucleus took place between 135 to 131 days before perihelion, i.e. at the rather close solar distance of 1.9 AU. At similar solar distances most comets have already developed prominent comae. At the same time interval preperihelion the visual lightcurve of the comet showed an instantaneous increase of about 3 magnitudes (from 16.5 mag nuclear to 13.5 mag coma brightness; see Weiss, 1989). The temporal coincidence of both phenomena could have been caused by an eruptive onset of gas and dust emission from a large and highly active surface area of the nucleus. The weak gas emission of P/Tempel 2 observed by Cochran (1991) from February 1988 onwards may therefore resemble either the moderate outgassing of the inactive surface of the nucleus or it may indicate the eventual "smoke" of the activity centre of the May eruption. Before early May 1988 this active region seemed to have been protected against sunlight (either by a surface crust or by shadowing effects due to surface geometry). After the activity onset in May 1988 the cometary brightness remained constant for about 50 days. Thereafter, a second rapid brightness increase can be seen in the reported lightcurve (Boehnhardt et al., 1990). A similar behaviour of P/Tempel 2 , i.e. a brightness plateau with a successive eruptive brightness increase, can also be inferred from the 1967 lightcurve of the comet (Weiss, 1989). It would be interesting to look for similar features of eruptive events and for their temporal repetition or non-repetition during the forthcoming apparitions of P/Tempel 2.

3. Coma morphology - observations and modelling

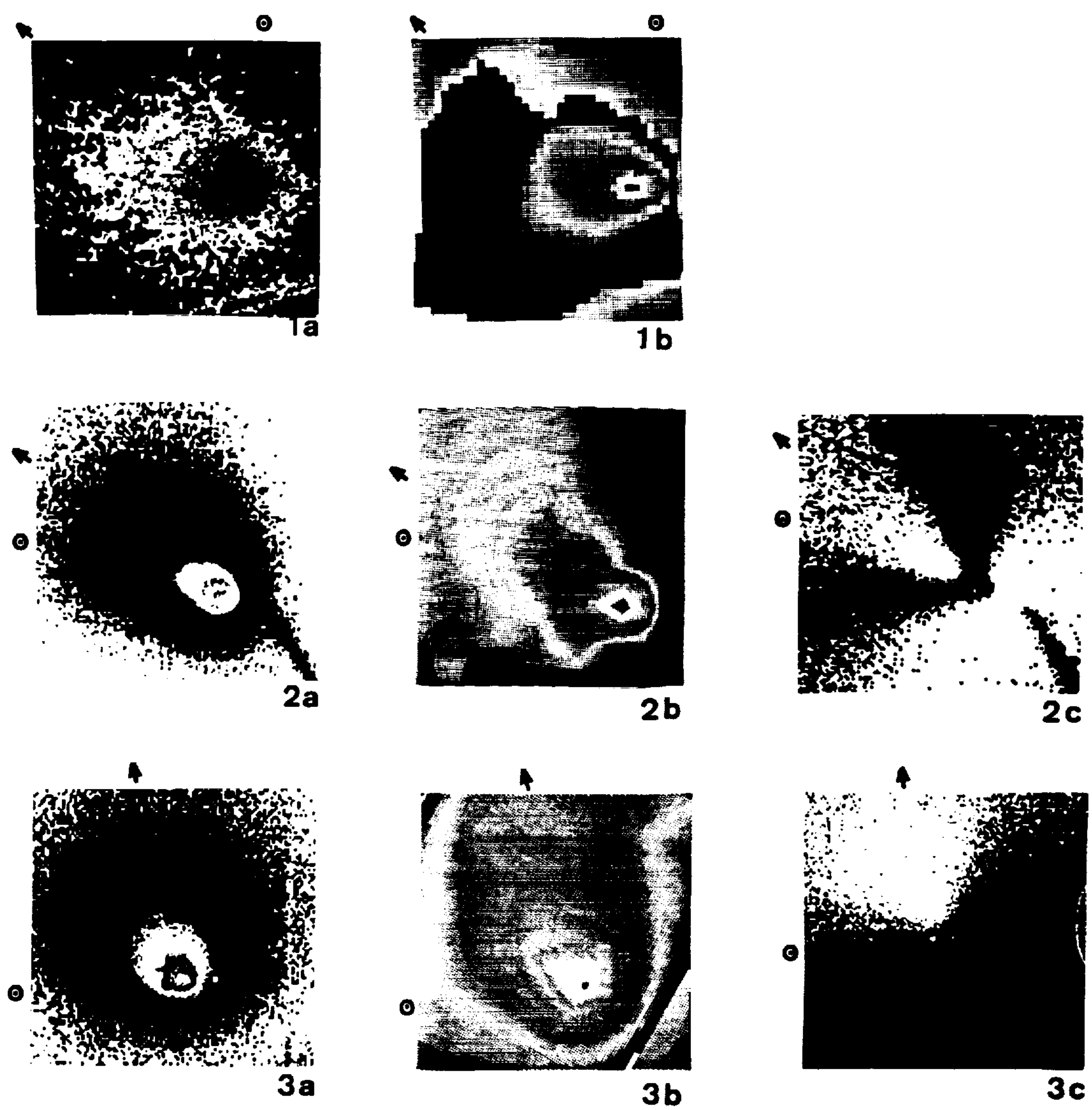
Figs. 1-3a show V-filter CCD exposures of comet P/Tempel 2 obtained on 17/5/88 (West, 1988), on 24/7/88 (Boehnhardt et al., 1990) and on 7/11/88 (Richtler, 1989, so far unpublished), respectively. All images exhibit a prominent fan-shaped coma, which can basically be interpreted as due to a jet of dust and gas emitted from a very active region located at high cometographic latitude. Since the V-filter transmission is dominated by reflected sunlight from the cometary dust, we assume that the coma images widely resemble the dust distribution as seen from Earth. The jet was smeared by the rotation of the nucleus which finally resulted in the fan-shaped coma of the comet. Sekanina (1979, 1987) has proposed a nucleus model for P/Tempel 2 which claimes an activity centre at about 60 deg cometographic latitude as source for the coma fan. This centre rotates in about 9 hours (Jewitt and Luu, 1989) about the rotation axis at right ascension 147 deg and declination +55 deg (epoch 1950). The nucleus was found to be of size 16 x 8 x 8 km (see for instance Sekanina, 1988). According to Sekanina (1987) the fan axis observed should roughly indicate the direction of the projected rotation axis. In order to assess the fan axis more accurately the observations on 24/7/88 and 7/11/88 were computer-processed by the so called radial renormalisation method: this method reduces the general coma background and enhances faint inherent coma structures. It is comparable to the method successfully applied by A'Hearn et al. (1986) for the CN

<u>Figure 1 to 3</u> P/Tempel 2 - a comparison of observed (a), calculated (b) and renormalized (c) coma images North is up and East to the right. the Sun is indicated by o, the direction of the projected rotation axis of the nucleus by an arrow.

1 P/Tempel 2 on 1988/05/17 (from West, 1988)
- a CCD image (42000 km x 42000 km)
- b computer simulation (25000 km x 25000 km)

2 P/Tempel 2 on 1988/07/24
- a CCD image (30000 km x 30000 km)
- b computer simulation (190000 km x 190000 km)
- c renormalized coma image (17000 km x 17000 km)

3 P/Tempel 2 on 1988/11/07
- a CCD image (60000 km x 60000 km)
- b computer simulation (200000 km x 200000 km)
- c renormalized coma image (58000 km x 58000 km)



jets in comet P/Halley. For both observing dates the alignment of the fan axis with the predicted direction of the projected rotation axis is rather good (see figs. 2c, 3c). However, for the observation on 17/5/88 a significant discrepancy between fan axis and projected rotation axis can be found (see fig. 1a).

In order to check Sekanina's model for P/Tempel 2 more thoroughly computer simulations were performed using the ESOC dust coma modelling software. The physical principles and the computer programs of the software package are described in Massonne (1986). The results of this computer simulations for the dust coma of P/Tempel 2 are presented in figs 1-3b. The figures show the dust density distribution as seen from Earth for the three observation dates from above. Though in the present software version some simplified assumptions are made (spherical nucleus, fixed rotation axis, dust size distribution of P/Halley), the modelling verifies at least qualitatively Sekanina's nucleus model of P/Tempel 2. Even the coma morphology observed on 17/5/88 was reproduced remarkably well, although in this case the fan axis does not coincide with the projected rotation axis direction.

An even more realistic modelling (based on the updated nucleus model of P/Tempel 2; Sekanina, 1991) may lead to a better quantitative agreement (isophote pattern) of the observed and simulated coma images. The software may also be applied to predict interesting viewing geometries of the coma of P/Tempel 2 which can be used to check the long-term stability of Sekanina's nucleus model during forthcoming apparitions.

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