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Breaking up of a comet by Jupiter

How often does a comet come close to Jupiter (or a massive planet) and gets captured and/or breaks up into pieces — very rarely. However such an event seems to have occurred recently. An unusual comet which was broken up by its encounter with Jupiter was discovered by C. S. Shoemaker, E. H. Shoemaker and D. H. Levy from the films observed with 18 inch Palomar Schmidt on March 24.43, 1993 and is designated as P Shoemaker-Levy 9 = 1993e. The comet was first seen as a dense linear bar of 1 arcmin long consisting of multiple nuclei followed by a fainter wispy tail. Soon the linear bar was seen to consist of a train of 5 (on March 26.3, 1993) to 11 (on March 28.4, 1993) nuclei as seen by Scotti from his CCD scans from the Spacewatch telescope. Observations of Lau and Jewitt using 2.2 m telescope at Mauna Kea, resolve about 17 condensations 'strung out like pearls on a string', aligned to the position angle (p.a.) 77°-257° (International Astronomical Union Circular (IAUC) 5730). The nuclear part is followed by dusty tails of length 4.2 and 6.89 arcmin at p.a. 74° and 260° respectively. The spectrum of the comet showed no emission lines, but a continuous spectrum (IAUC 5732) indicating the dusty nature.

The observations of the comet at VBO started towards the end of May 1993. The images were obtained using CCD cameras with 1 meter and 2.3 meter Vainu Bappu Telescope (VBT) by Y. D. Mayya, T. P. Prabhu and B. Eswar Reddy. Figure 1 shows one of the images taken with VBT prime focus CCD camera in the R filter on May 27, 1993. About 8 to 9 nuclei can be seen prominently on the bar (figure 2) extending in length to ~ 76 arcsec and

Figure 1. The CCD image obtained with VBT on May 27, 1993. Note the nuclear bar and the faint wispy tails. The west is towards left and south towards top.

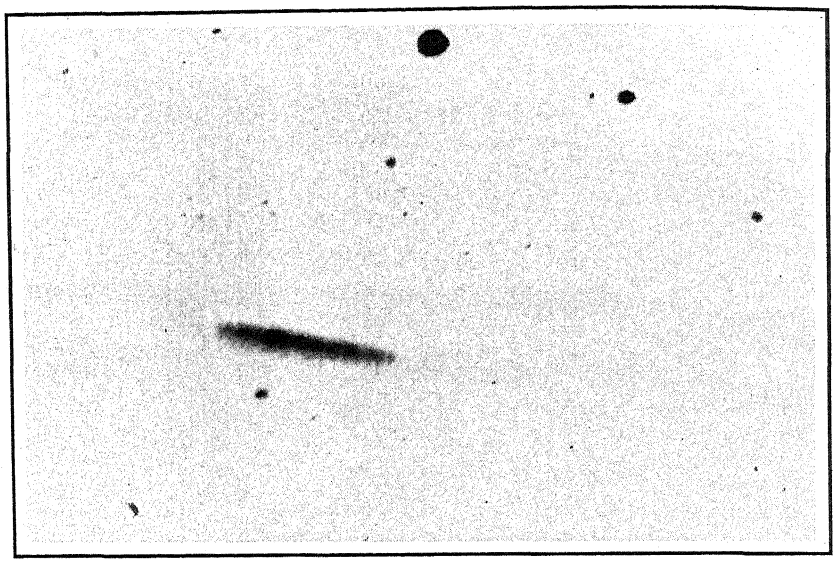

Figure 2. The central bar resolved into several nuclei. Orientation is same as in figure 1.

width ranging ~ 10-16 arcsec. The southern edge of the bar is sharper than the northern side which is more fuzzy. In addition, the wispy dust tail extends out to the edge of the CCD frame in the south-west, the north-eastern tail is fainter and extends to about 1 arcmin (figure 1). The separation of the knots as measured relative to the brightest one, starting from south-west towards north-east are 17, 10, 0, 9.4, 14.7, 21, 27.6 and 37 arcsec. The centre of the bar is about 11 arcsec east of the brightest condensation. The p.a. of the bar seem to be ~ 80° (± 1°). These are similar to the separations measured on March 26, 1993 by Scotti.

The orbital parameters determined from the positional measurements of the centre of the nuclear train by Marsden, Nakano and others indicate that the comet was in joviocentric orbit before 1992 and had its closest encounter on July 8.8, 1992 when it was at a minimum distance of 1.6 Jupiter radii, R_J (within the Roche limit; tidal breakup apparently requires a separation of about $2R_J$). The breakup into several nuclei might have occurred then (as apparently happened on an earlier occasion to comet P/Brooks 2 in 1886).

Further computations by Marsden, Nakano, Carusi, Yeomans and Chodes (IAUC 5800) indicate that the cometary nuclear train will collide with Jupiter during 1994 July 23-27 when it is expected to come as close as 0.6 R_J. Their computation also indicate that shortly before the 1994 encounter, the nuclear train would be 20 arcmin long at p.a. 61°-241°. The remnants are predicted to orbit Jupiter. It would certainly be very interesting to follow this remarkable phenomenon.

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