

Estimate of P/Shoemaker–Levy nucleus size

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The problem of disintegration of the cometary nuclei due to the tides produced by the major planets is considered. The dynamics of the comet Shoemaker–Levy 9 (SL9) is studied in details in this connection. 13 fragments of SL9 having 50 and more positional observations have been selected. We computed orbital solution for this fragments with impact times, based on the timing of observed impact phenomena in July, 1994 [1,2]. Using this solution the estimates of orbital parameters and nucleus dimensions before the disintegration of the comet have been obtained. The motion of the nucleus fragments has been traced numerically taking into account perturbations due to the gravitation of the Sun, major planets, Galilean satellites, and the second zonal harmonic of the Jovian gravitational field. The mutual gravitation between the separated fragments is investigated. This effect involves the changes of the size of the parent body by only 1 %. Therefore, the mutual gravitation interaction has been neglected when integrating the equations of motion. The orbit of this fragment H is considered as that of the maternal body. We have supposed that all fragments were formed due to the tidal breakup of a parent object. Accepting such a supposition the size of the parent body has been evaluated using the observations of the separate fragments. It was admitted all fragments had the same velocities but they were arranged at different distances from each other at the breakup instant. We have estimated the diameters of the maternal body for the different moments of disintegration. The results of calculations are given in Table 1.

Table 1. The diameters (D) of the maternal body for the different moments of disintegration (t).

| t | $t_0 - 2^h$ | $t_0 - 1^h$ | t_0 | $t_0 + 1^h$ | $t_0 + 2^h$ |
|----------|-------------|-------------|-------|-------------|-------------|
| D (km) | 9.73 | 3.50 | 1.24 | 3.73 | 8.67 |

Here $t=2448811.34$ JD is the time of the perijove passage of the fragment H. The errors of diameter values represented in the table are about 1 meter. The

computations show that the maternal body of the nucleus was of 1.24 km in diameter, if its disintegration happened at the closest approach of the comet to Jupiter, and of 9.73 km, if the nucleus had been disintegrated two hours before the moment of approach. The possibility of disintegration of the maternal body by stages is investigated. For this aim the positions of other fragments on the phase portrait of H are considered. Estimates of positions of each fragments in radial (r) and normal (n) components with respect to the fragment H are shown in Figure 1. The results of our investigation allows to assume that fragments A and B have been separated about one hour before the moment of approach. Therefore the diameter of maternal body can be estimated about 3.50 km.

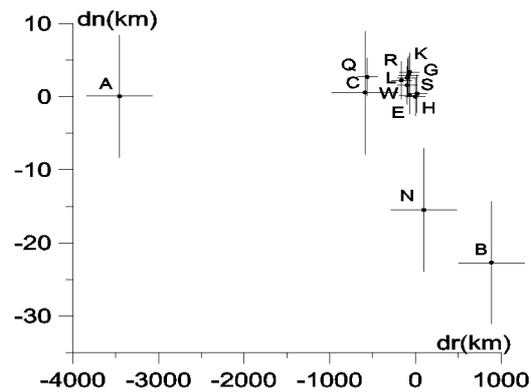


Fig. 1

The positions of fragments on the phase portrait of H.

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References

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