The Tidal Disruption of Comets

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Of the 34 comets that have been observed to fragment, only 4 are considered to have split as a result of tidal interactions. The Great September Comet (1882 R1) split into 4 components and comet Ikeya-Seki (1965 S1) split into 2 components after their close solar passages to within 2 solar radii. Periodic comet 16P/Brooks 2 split into 9 fragments after its close approach to Jupiter in 1886 to within 2 Jupiter radii. According to Sekanina (1996), comet D/Shoemaker-Levy 9 (D1993 F2) split into 12 primary components and another 13 secondary components after its 1.3 Jupiter radii close approach in July 1992. All of these fragments then collided with Jupiter in July 1994. Apart from noting the lack of a particularly close planetary or solar approach, a distinguishing feature for a non-tidally split comet is the largest, or primary, component leads the fragments along the orbital path whereas for a tidally split comet, this is not generally true. In the latter case, the placement of the fragments along the orbital path is a function of the circumstances of the breakup. Tidal splitting depends upon the tensile strength of the comet along with its size and proximity to the planet or sun that is responsible for the tidal splitting. For the few comets that have split tidally, constraints on the tensile strength and bulk density of the comet suggest very low values for each. Hence tidal effects may simply be a contributing factor in these fragmentation events. For the 90% of split comets that have broken apart without tidal influences, there is no obvious mechanism for the breakup but the effects of rotation and thermal stresses may be contributors. Even for those few comets that have been identified with tidal fractures, these rotation and thermal stresses may have come into play. It seems likely that the continual fragmentation of cometary nuclei plays a significant role in the lifetimes of some, perhaps most, comets. The disintegration of comets via fragmentation may well compete with deactivation as the principal process by which comets are lost.

Sekanina (1996). In "The Collision of Comet Shoemaker-Levy 9 and Jupiter," edited by K.S. Noll, H. A. Weaver, and P.D. Feldman, Cambridge University Press, pp. 55-80.

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