Bi-lobed Shape of Comet 67P from a Collapsed Binary

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The Rosetta spacecraft observations revealed that the nucleus of comet 67P/Churyumov-Gerasimenko consists of two similarly sized lobes connected by a narrow neck. Here we evaluate the possibility that 67P is a collapsed binary. We assume that the progenitor of 67P was a binary and consider various physical mechanisms that could have brought the binary components together, including small-scale impacts and gravitational encounters with planets. We find that 67P could be a primordial body (i.e., not a collisional fragment) if the outer planetesimal disk lasted <10 Myr before it was dispersed by migrating Neptune. The probability of binary collapse by impact is 30% for tightly bound binaries. Most km-class binaries become collisionally dissolved. Roughly 10% of the surviving binaries later evolve to become contact binaries during the disk dispersal, when bodies suffer gravitational encounters to Neptune. Overall, the processes described in this work do not seem to be efficient enough to explain the large fraction (~67%) of bi-lobed cometary nuclei inferred from spacecraft imaging.