ORIGIN AND EVOLUTION OF THE SUNGRAZING COMETS. P. R. Weissman[1], E. Asphaug[2], N. Movshovitz[2] and E. D. Rosenberg[1] [1]Planetary Science Section, Jet Propulsion Laboratory, Mail stop 183-301, 4800 Oak Grove Drive, Pasadena, CA 91109 USA, paul.r.weissman@jpl.nasa.gov, [2]Dept. of Earth and Planetary Sciences, University of California Santa Cruz, 1156 High Street, Santa Cuz, CA 95064, USA.

Introduction: The sungrazing comets are unique in that they have orbital perihelion distances of only ~0.01 AU or ~2 solar radii. This is within the solar Roche limit for estimated cometary nucleus bulk densities in the 0.3-0.6 g/cm^3 range. Thus, tidal disruption almost certainly plays a major role in their evolution. Indeed, in 1965 comet Ikeya-Seki (1965 S1) was observed to break into four large pieces after passing perihelion at a distance of ~1.7 solar radii [1,2].

Most sungrazing comets are members of the Kreutz group with semi-major axes of ~60-100 AU and orbital inclinations of ~140-144^o. Nine major Kreutz sungrazers visible to the naked eye or in telescopes were discovered between 1843 and 2011. Beginning in 1979 space-based coronagraphic observations have revealed a near continuous stream of small Kreutz-group comets with estimated diameters of a few to tens of meters. These small objects typically do not survive perihelion passage. Over 1,950 such objects have now been observed. Three other orbital groups of small sungrazers, the Meyer, Marsden and Kracht groups, have also been found [3,4].

Background: In 1993 comet Shoemaker-Levy 9 (1993 F2, hereafter SL9) was discovered as a string of 21 individual nuclei. Dynamical investigations showed that the comet had been captured into orbit around Jupiter and that it passed within Jupiter's Roche limit at a distance of 1.31 R_J in 1992 [5]. The resulting fragments subsequently impacted Jupiter in July 1994.

The tidal disruption of the SL9 nucleus was modeled very successfully using an N-body code and assuming that the nucleus was an aggregate (rubble pile) of 500-2,000 particles (cometesimals) held together by their own self-gravity [6,7]. As the initially spherical nucleus passed close to Jupiter, it stretched into a cigar shape and then farther into a long stream of cometesimals. But as the stream moved away from Jupiter, the cometesimals began to re-assemble into larger bodies due to their self-gravity. Interestingly, the final number of re-assembled comets was shown to be a function of the bulk density of the progenitor nucleus. To obtain ~21 re-assembled nuclei, the SL-9 progenitor had to have had a bulk density of 0.5-0.6 g/cm^3.

Investigation: We are modeling the disruption of a sungrazing comet nucleus composed of ~8,000 particles using an advanced version of the code used to model SL9 [8]. An example of results from this code for SL9 is shown in Figure 1. A valuable feature of the new code is that it uses non-spherical particles for the

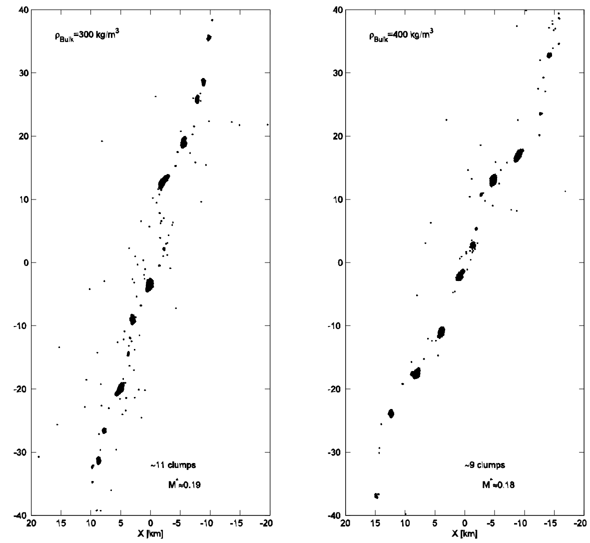

Figure 1. Dynamical simulation of the re-assembly of comet Shoemaker-Levy 9 using an advanced code that includes irregularly-shaped cometesimals [8]. The two panels are for initial nucleus bulk densities of 0.3 (left) and 0.4 g/cm^3 (right).

cometesimals, a fact that strongly affects the disruption of the progenitor nucleus and its subsequent evolution.

We will investigate whether we can duplicate the observed features of the Kreutz group, in particular the size distribution of the re-assembled comets and their distribution along the Kreutz orbit.

An interesting fact about the Kreutz group is that it has only been observed for ~170 years, as compared with the ~500-1,000 year orbital periods of its major members. Thus, we do not know if the Kreutz group extends all the way around around its orbit, or if we are fortunate in observing a swarm that has spread over less than one-third of the orbit.

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