Dust tail striae: Lessons from recent comets

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Striae are features rarely observed in cometary dust tails. These are near-linear structures that, unlike synchronic bands, are not aligned with the nucleus position, and have only been clearly observed in a few high-production-rate comets, including C/1957 P1 (Mrkos), C/1962 C1 (Seki-Lines), C/1975 V1 (West), and C/1996 O1 (Hale-Bopp).

The formation of striae is difficult to explain, but several scenarios for their creation have been proposed [1]. These include that of Sekanina & Farrell [2], who proposed that striae are the result of a two-step fragmentation process, where parent particles are released from the nucleus which, after a delay, all fragment over a very short period of time. The fragmentation products then separate according to their β parameter, i.e., the degree to which the particles are influenced by radiation pressure force compared to gravitational force, to form the linear structures we observe as striae. Although there are issues with identifying a process through which many particles will collectively delay their break-up and then fragment within a short period, this scenario does fit many observations well [3]. Other proposed scenarios are more complex, including the formation of striae through a continuous cascade of fragmentation to ever smaller particle sizes [4].

As these formation scenarios result in different distributions of dust-particle sizes within individual striae, the processes occurring may therefore be identifiable if these distributions can be inferred. If the fragmentation processes taking place can be identified, then, in turn, more could be learnt about the structure of the original dust grains that go on to form these sometimes beautiful tail structures.

Here, we present the analysis of striae in several comets observed from space by the SOHO LASCO coronagraph [5] and SECCHI heliospheric imagers aboard the twin STEREO spacecraft [6]. The comets studied are C/2002 V1 (NEAT) in January 2002, C/2006 P1 (McNaught) during its perihelion passage in January-February 2007, and the complex striae of C/2011 L4 (Pan-STARRS) in March 2013. We simulate the formation of individual striae in these comets, and successfully reproduce many aspects of their morphology and dynamics. The results are compared to those of other striae models, and we attempt to gauge the influence on non-gravitational forces acting on these comets' dust populations. The inferences that can be drawn regarding the comets' dust populations are discussed.

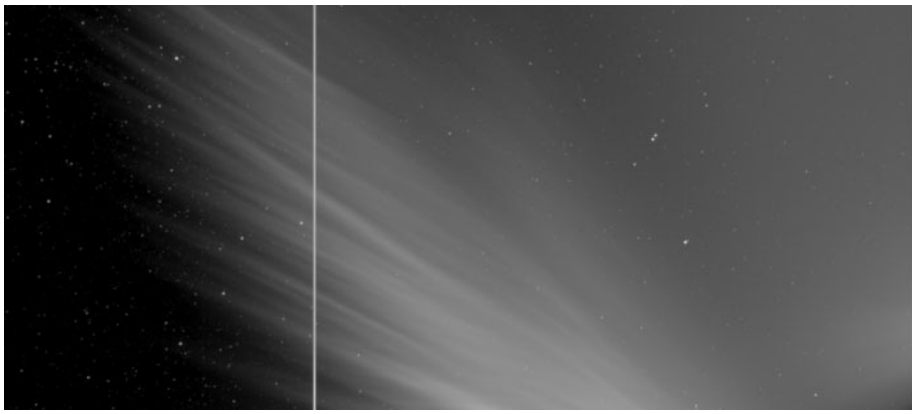

Figure: Striae in a portion of the dust tail of C/2006 P1, imaged by STEREO SECCHI.

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References: [1] Notni, P., and W. Thaenert, Astron. Nachr. 309, 2, 133–146, 1988. [2] Sekanina, Z., and J. A. Farrell, Astron. J. 85, 11, 1538–1554, 1980. [3] Pittichova, J., et al., Earth, Moon and Planets 78, 329–338, 1997. [4] Nishioka, K., Icarus 134, 24–34, 1998. [5] Brueckner, G. E., et al., Solar Physics 162, 357, 1995. [6] Howard, R.A., et al., Space Sci. Rev. 136, 67. 2008.