Geometrical evolution during the collapse of soap-film catenoids

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ABSTRACT

Since the pioneering work of Joseph Plateau [1], a soap-film catenoid is still the paradigm for a topological transition triggered by area minimization. A soap-film catenoid is supported between two rings of equal radius and becomes unstable once the half-separation becomes too great. The catenoid collapses with a dynamics driven by the competition between interfacial effects to minimize the surface energy and the inertia of the surrounding air that needs to be displaced during the process [2]. Here we investigate geometrical aspects of the collapse both experimentally and theoretically. In particular, the transition to the final state requires a change of the sign of the Gaussian curvature. In Fig. 1c, we observe that the system passes through a Martini-glass configuration (with a zero Gaussian curvature almost everywhere) as the soap film pinches off. These aspects are studied for free standing catenoids, as well as for half-catenoids in contact with a wall. For the latter, friction is expected to play a major role. This study should help understanding the geometry and dynamics of other topological transitions [3], and the effects of external dissipation.

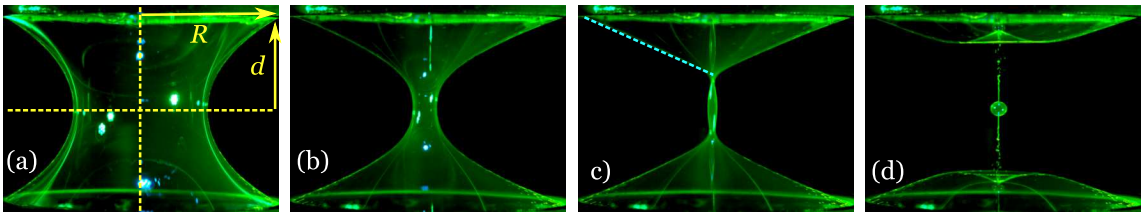

Figure 1: Image sequence of a collapsing catenoid.

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