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Singularities in Thin Extensible Sheets : Twisted Ribbon and Liquid Blister Test

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Thin elastic sheets undergoing large displacement can localize deformations and exhibit singularities such as point-like defects and ridges as it can be commonly noted in crumpled paper and indented ping-pong ball. These defects results from a subtle interplay between the geometry and elasticity and affect dramatically the mechanical response of the material. Considerable experimental and theoretical challenges exist to identify and model the emergence of such defects and their dynamics under external forcing.

I will present two model experiments exploring the nonlinear and singular behavior of thin extensible sheets. In a first experiment, I will consider the blistering of a thin elastic disk adhering to a hard substrate by a liquid layer. We find new blister patterns including radial wrinkles, conical and faceted shapes that we characterize experimentally and theoretically [1]. In a second experiment, we investigate the formation of topological defects with a ribbon shaped elastic sheet which is stretched and twisted [2-4]. Singularities are found to spontaneously arrange in a triangular lattice in the form of vertices connected by stretched. Interestingly, the vertices are shown to be negative disclinations or e-cones which occur in sheets with negative Gaussian curvature, in contrast with d-cones and ridges as in crumpled paper. We will discuss the nucleation of the defects, their growth and detailed structure using x-ray computed tomography and compared these results with current theories.

References

[1] J. Chopin, D. Vella and A. Boudaoud, Proc. Roy. Soc. London A **464**, 2887 (2008)

[2] J. Chopin and A. Kudrolli, Phys. Rev. Lett. **111**, 174302 (2013)

[3] J. Chopin, V. Demery, and B. Davidovitch, J. Elast. **119**, 137 (2015).

[4] J. Chopin and A. Kudrolli, in preparation (2015)

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