

## GEOMETRY & ELASTICITY: FOLDING OF A CONTINUUM, DRIPPING OF A ROD AND SELF-OSCILLATING SYSTEMS

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### ABSTRACT

How forms can emerge during loading of an elastic solid or an elastic structure? Buckling and instability has been advocated as a possible explanation of morphogenesis, describing the emergence of brain convolutions, of geological structures, and of the undulations of marine shells. Folding is a process in which bending localizes into sharp corners separated by almost undeformed elements. This process is rarely encountered in nature and is difficult to be described within the realm of the Cauchy theory of elasticity. On the other hand, it is shown that folding can be understood as a constitutive instability of a constrained-Cosserat elastic material occurring at the elliptic boundary [1, 2].

The nonlinear theory of elastic rods is a framework for describing bifurcation and instabilities of a number of interesting structures, showing for instance configurational forces analogous to those acting on dislocations in solids. We address the self-encapsulation problem, namely, how the rod can be loaded to assume the shape of a drop, which is suggested by the fact that elastica governs not only bifurcation of rods, but also the oscillating pendulum and the shape of a pendant drop [3].

Self-oscillating mechanical systems reach a limit-cycle oscillation when subject to steady input of energy. An example of this behaviour will be presented as related to the flutter instability of an elastic structure loaded by a force generated through dry friction [4].

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### REFERENCES

- [1] P.A. Gourgiotis, D. Bigoni (2015) Stress channelling in extreme couple-stress materials Part I: Strong ellipticity, wave propagation, ellipticity, and discontinuity relations. *J. Mech. Phys. Solids*. In press; doi:10.1016/j.jmps.2015.09.006.
- [2] P.A. Gourgiotis, D. Bigoni (2015) Stress channelling in extreme couple-stress materials Part II: Localized folding vs faulting of a continuum in single and cross geometries *J. Mech. Phys. Solids*. In press; doi:10.1016/j.jmps.2015.09.005
- [3] F. Bosi, D. Misseroni, F. Dal Corso, and D. Bigoni (2015) Self-encapsulation, or the ‘dripping’ of an elastic rod. *Proc. Royal Soc. A*, 471, 20150195.
- [4] D. Bigoni and G. Noselli (2011) Experimental evidence of flutter and divergence instabilities induced by dry friction. *J. Mech. Phys. Solids*, 59, 2208–2226.