Shape and Shape Fluctuations of incompatible Ribbons

Doron Grossman[1,*]

[1] *Racah Institute of Physics, Hebrew University, Jerusalem 91904, Israel*

(Dated: April 27, 2017)

Abstract

Geometrically incompatible ribbons are ubiquitous in nature, from the growing of biological tissues, to the self assemblies of peptides and lipids. These exhibit unusual characteristics such shape bifurcations, and abnormal mechanical properties. When considering nano and micro ribbons, thermal fluctuations convert these properties into nontrivial statistics. We derive a reduced quasi-one-dimensional theory, which describes a wide range of incompatible elastic ribbons, and can be integrated into statistical mechanics formalism [1]. We then use it to compute equilibrium configurations and statistical properties of two types of incompatible ribbons, with experimental significance: ribbons with positive spontaneous curvature, and ribbons with negative spontaneous curvature. The former, above a critical width, has a continuous family of degenerate configurations. In turn this causes the ribbons to behave as random coils. The latter, however, which exhibits a twisted-to-helical transition at a critical width, behaves as an abnormal coil. Its persistence length is non-monotonic in the ribbon width and vanishes at a critical width, and its principal modes of deformation differ from those of compatible ribbons. Measuring shape fluctuations of twisted ribbons made of chiral peptides, we confirm some of the model's predictions.

* doron.grossman@mail.huji.ac.il

[1] D. Grossman, E. Sharon, and H. Diamant, Phys. Rev. Lett. **116**, 258105 (2016).