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Elasticity and Fluctuations of Incompatible Nanoribbons[1]
DORON GROSSMAN, ERAN SHARON, Racah Institute of Physics, Hebrew University, Jerusalem., HAIM DIAMANT, Raymond and Beverly Sackler School of Chemistry, Tel Aviv University, Tel Aviv. — Geometrically incompatible ribbons are ubiquitous in nature, from the growing of biological tissues, to 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. Using it, we 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 a random coils. The latter, however, exhibits a twisted-to-helical transition at a critical width, and behaves as an abnormal coil. It's persistence length is non-monotonic in the ribbon width and vanishes at a critical width, with principal modes of deformation different than compatible ribbons. Measurements of twisted ribbons made of chiral peptides, confirm some predictions of the model.

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