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Defect-driven shape instabilities in cohesive filament bundles[1]
ISAAC BRUSS, University of Michigan, GREGORY GRASON, University of Massachusetts — When defects are incorporated into the lattice of a flexible 2D crystalline membrane, it buckles into a new configuration. Specifically, 5- and 7-fold disclinations produce conical- and saddle-like geometries respectively. For bundles composed of a crystalline array of cohesive flexible filaments, we propose a similar phenomena of defect-induced buckling. This revelation is fueled by a recently discovered mapping between the metric properties of a curved surface, and the inter-filament spacing within a deformed bundle. Using a combination of continuum elasticity theory and numerical simulations, we investigate the effects of defects in the cross section on a bundle's global structure. We find that positive disclinations promote the twisting of filaments around a central axis within the bundle, while negative disclinations promote twisting around two parallel axes simultaneously. Both instabilities are interpreted by means of their equivalent Gaussian curvature, and map appropriately to the the corresponding membrane responses. Additionally, for 5-fold disclinations we uncover a new equilibria structure, torsional wrinkling, with the intriguing ability to focus gradients in filament tilt much like curvature-focusing for the analogous membrane.

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