Compaction and Buckling of a Sheet Confined by Rigid Walls

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Abstract

DNA in viral capsids, plant leaves in buds, and geological folds are natural examples of tightly packed low-dimensional structures. Modeling the deformations and stresses in such confined systems remains a significant challenge. We report experimental and theoretical studies of an elastic sheet compressed within rigid walls -a model system conceptualized as a one-dimensional line confined in a two-dimensional rectangular box. In this setup, the ends of a planar sheet are brought closer together while its sides are constrained by walls separated by a fixed gap. Previous studies have demonstrated that the sheet undergoes successive buckling events, resulting in uniformly distributed quasi-periodic patterns. Beyond this initial regime, we observe a spontaneous instability leading to the localization of the sheet into a single Yin-Yang pattern. By applying the linearized Euler's Elastica theory for rods (equivalent to the von Kármán approximation for plates) and global energy considerations, we predict certain scaling laws. However, to capture the symmetry breaking and to explore regimes of larger compression, the non-linear Euler's Elastica theory is required.

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