Large Deformation of Slender Structures: Prestrained and Bilayer Plates

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Slender structures that undergo large deformations with minor (thermal, electrical or chemical) actuation are ubiquitous in the construction of micro and macro devices in engineering and medicine. Their reduced 2d models consist of minimizing a second order bending energy subject to a nonconvex metric constraint. The former involves the second fundamental form of the middle plate surface and the latter is a restriction on its first fundamental form. We discuss a formal derivation of reduced models for bilayer and prestrained plates along with equivalent formulations that make them amenable to computation. We propose a local discontinuous Galerkin (LDG) finite element approach that hinges on the notion of reconstructed Hessian, and discuss its properties including Gamma-convergence. We design discrete gradient flows to minimize the ensuing nonconvex problems and to find suitable initial configurations. We present several insightful simulations, some of practical interest. This work is joint with A. Bonito (Texas A&M University), D. Guignard (University of Ottawa) and S. Yang (Beijing Institute of Mathematical Sciences and Applications).