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Elastic theory of unconstrained non-Euclidean plates and shells
EFI EFRATI, RAZ KUPFERMAN, ERAN SHARON, Hebrew University of Jerusalem — Non Euclidean bodies possess no stress free configuration, thus exhibit residual stress and a rich variety of non-trivial equilibrium configurations in the absence of external constraints. An appropriate hyper-elastic treatment of such bodies is achieved by measuring strain with respect to a reference metric rather than a reference configuration. Applying this formalism to thin sheets, we derive a reduced 2D elastic theory, which enables us to treat thin bodies which are neither plates nor shells in the classical sense. In this reduced theory the elastic energy is given as a function of the mid-surface properties (first and second fundamental forms). We show how prescribing a reference metric for a three-dimensional thin body, corresponds to setting a reference first fundamental form (2D metric) and a reference second fundamental form (curvatures) on the mid-surface. When the prescribed reference curvatures and 2D metric do not comply with one another, the system is frustrated (non-Euclidean). Such systems exhibit various phenomena such as spontaneous buckling and the emergence of a boundary layer.

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