

Derivation of Membrane Models in Nonlocal Hyperelasticity

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Abstract

Motivated by the analysis of thin structures, we study the variational dimension reduction of hyperelastic energies involving nonlocal gradients to an effective membrane model. When rescaling the thin domain, initially isotropic interaction ranges naturally become anisotropic, which leads us to develop a theory of anisotropic nonlocal gradients with direction-dependent interaction ranges. In contrast to existing nonlocal derivatives with finite horizon, which are typically defined via interaction kernels supported on balls of positive radius, our formulation employs ellipsoidal interaction regions whose principal radii may vanish independently. This yields a unified framework interpolating between fully nonlocal, partially nonlocal, and purely local models. Using these tools, we establish a Γ -convergence analysis for the associated nonlocal thin-film energies. The limit functional retains the structural form of the classical membrane energy, and the classical local model is recovered exactly when all interaction radii vanish.

This talk is based on joint work with Dominik Engl and Hidde Schönberger.