Analysis and Applied Mathematics Seminar

New 1D models for localisation in slender structures

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Abstract: Slender structures are subject to various localised instabilities: necking of bars under traction, bulging of cylindrical party balloons, beading in cylinders made up of soft gels, or folding of tape-springs. In all these examples, distinct states of deformation may coexist and classical one-dimensional (1D) models predict singular solutions. In particular, classical 1D models fail to describe interfaces or finite size effects. The most common remedy is to use full structural models based on 3D finite elasticity or nonlinear shell/membrane equations. However, this is computationally costly and often impracticable: simpler 1D regularised models depending on the strain and the strain gradient are therefore attractive.

There is a recent effort to rigorously establish 1D higher-order models for the analysis of localisation in slender structures. I will introduce a systematic method to derive such models by a formal expansion, starting from a variety of full structural models for slender elastic structures. The expansion is performed near a finitely pre-strained state and therefore retains all sources of nonlinearity, coming from the geometry and the constitutive law. I will illustrate the method in the case of bulging and beading and demonstrate its accuracy by comparing solutions of the 1D gradient model with solutions of the original structural model.

Monday, March 8 at 4:00 PM in Zoom