Modelling and Simulations for Cavitation and Fracture in Nonlinear Elasticity

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Cavitation is an important material failure phenomenon in rub-ber like nonlinear elastic materials. As shown by J. Ball, cavitation can be described by bifurcation of global minimizers of the total elastic energy. Math-ematically, the energy functional is polyconvex and exists the Lauvrentiev phe-nomenon, which means that the minimum of the functional in $W^{1,\infty}$ is strictly larger than that in $W^{1,p}$ when $p < \infty$. This makes standard numerical meth-ods which search for minimizers in $W^{1,\infty}$ cannot detect the cavitation solution which is in $W^{1,p}$. In the talk, we will introduce some numerical approaches to the cavitation problem. In particular, we illustrate a new variational model, which utilizes a phase-field function to capture material failure areas. The model is relatively easy to implement numerically and can simulate both cavitation and fracture occurred in these materials. The $\Gamma-$convergence result of the model is presented. The efficiency of the approach is shown by some numerical examples.