Variational phase-field modeling of fracture: toward second-generation models

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Lecture of

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March 06, 2026, 2 pm

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Variational phase-field models of brittle fracture are powerful tools for studying Griffith-type crack propagation in complex scenarios. However, as approximations of Griffith's theory—which does not incorporate a strength criterion—these models lack flexibility in prescribing material-specific strength surfaces. Consequently, they struggle to accurately capture crack nucleation under multiaxial stress conditions. For this reason, many recently proposed models have given up the elegance and the theoretical and practical advantages of the variational setting to achieve greater flexibility in reproducing experimental observations.

In this presentation, we explore recent strategies developed in the group of the speaker to endow variational phase-field models with sufficient flexibility to overcome current limitations, potentially paving the way for a second generation of variational phase-field fracture models. For fracture under multiaxial stress states, we first illustrate the pros and cons of models based on the notion of energy decomposition and propose a new model of this type that controls the competition between nucleation under compressive and tensile stresses. Then, we illustrate a novel phase-field model of cohesive fracture that allows for an arbitrarily shaped convex strength surface, thereby reconciling fracture nucleation and propagation within a unified framework. Finally, if time allows, we illustrate further recent results on phase-field modeling of cohesive fracture in anisotropic materials and under dynamic conditions.

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