Contribution ID: **22** Type: **not specified**

Convergence results for critical points of the one-dimensional Ambrosio-Tortorelli functional with an obstacle condition

Thursday, June 27, 2024 10:00 AM (30 minutes)

According to the variational approach to fracture introduced by Francfort and Marigo, the Mumford-Shah energy is commonly used to modelize brittle cracks in an elastic material. Ambrosio and Tortorelli proposed a variational phase field regularization of this functional which, through a Gamma-convergence result, leads to the convergence of global minimizers. This result gives however no information about the limiting behavior of general critical points.
This problem has been solved in dimension 1 by Francfort, Le and Serfaty, and partially extended to any dimension by Babadjian, Millot and Rodiac.

In this talk, we consider a 1-dimensional critical point of the Ambrosio-Tortorelli energy under an obstacle condition on the phase field variable. This problem can be interpreted a time discretization of a quasistatic evolution problem where one puts as the obstacle the
solution obtained in the previous time step. The obstacle condition now reads as an irreversibility condition (the crack can just increase in time). First, elliptic estimates for the obstacle problem yield the $C^{1,1}$ regularity of the critical points. The limits of such critical points turn out to be critical points of the Mumford-Shah energy that inherit the possible discontinuities generated by the obstacle sequence. Finally, the phase field term converges toward a Dirac mass, the mass of which can be computed using the so-called "equipartition of the energy" principle.

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