Plasticity as the Γ–Limit of Models for Straight, Parallel Dislocations

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Crystal plasticity is the effect of a crystal undergoing a permanent change of shape in response to applied forces. At the atomic scale, dislocations – local defects of the crystalline lattice concentrated on lines – are considered to play a main role in this effect.

In this talk, we will derive a macroscopic strain-gradient plasticity theory from two different semi-discrete models for straight, parallel edge dislocations. Firstly, we complement the existing literature by considering a rotationally invariant energy with mixed growth. The main advantage of this formulation is that it does not need the ad-hoc definition of a core-radius. In addition to the Γ-convergence result we present a rigidity result for fields with non-vanishing curl in this setting. Secondly, we will address the fact that most results in the literature are derived under the assumption that the present dislocations are separated on a mesoscopic scale. We will show how to overcome this assumption by an adaption of the ball construction technique which was developed in the context of the Ginzburg-Landau model for superconductivity.