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Continuum modeling of crystal defect dynamics

Abstract

In this talk, I will discuss recent progress to use continuum models to describe the evolution of crystal defects such as dislocations and grain boundaries, which strongly impact the physical behavior of materials. I will discuss the phase-field-crystal model inspired from older models of non equilibrium patterns (e.g. the Swift-Hohenberg equation) and "amplitude equations" that govern the evolution of complex order parameters representing the amplitudes of crystal density waves. Those equations naturally incorporate elastic interaction and defects. They can be derived as a long-wavelength limit of the phase-field-crystal model or in the framework of Ginzburg-Landau theory. I will illustrate the application of those models with a few selected examples including grain-boundary motion coupled to a coherent solids. I will conclude outlining challenges for physicists and mathematicians to improve current models and relate them to experiments.