ISOGEOMETRIC ANALYSIS OF PHASE-FIELD MODELS: FROM COMPLEX FLUIDS TO TUMOR GROWTH

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Phase-field modeling refers to a particular mathematical description of a system with evolving interfaces. The key idea is that interfaces are described by a smoothly-changing phase field, defined on a fixed domain. The phase field is governed by a partial differential equation, which tracks the so-called diffuse interfaces and encodes the interfacial physics at once. The phase-field methodology is having a significant impact in the field of complex fluids [1] and holds promise to impact other areas of fluid mechanics and also solid mechanics. Typically, the phase-field equations are strongly nonlinear with higher-order spatial derivatives that account for the interfacial forces. From a numerical perspective, the higher-order partial-differential operators usually present in phase-field equations are difficult to deal with by standard finite element approaches that utilize C0 trial and weighting functions. In the first part of this presentation, I will show how our computational approach, based on Isogeometric Analysis [2], permits simple and efficient discretizations through the use of continuously differentiable splines [3]. I will illustrate the effectiveness of our algorithms, by showing several examples including, phase segregation of immiscible fluids, water/water-vapor two-phase flows and the implosion of structures due to condensation of a complex fluid. In the last part of this presentation, I will show how concepts of fluid mechanics [4] and phase-field modeling may be useful to model the growth of cancerous tumors and their associated vasculature.

REFERENCES