11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

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

Hector Gomez[1]

[1] Department of Applied Mathematics, University of A Coruña, Spain

Key Words: *Isogeometric analysis, phase-field models, tumor growth modeling, complex fluids.*

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 C^0 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 segregration 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

[1] R.I. Saye, J.A. Sethian, Multiscale modeling of membrane rearrangement, drainage, and rupture in evolving foams, *Science,* Vol. **340**, pp. 720-724, 2013.

[2] T.J.R. Hughes, J.A. Cottrell, Y. Bazilevs, Isogeometric analysis: CAD, finite elements, NURBS, exact geometry and mesh refinement, *Comput. Methods Appl. Mech. Engrg.*, Vol. **194**, pp. 4135–4195, 2005.

[3] H. Gomez, V.M. Calo, Y. Bazilevs, T.J.R. Hughes, Isogeometric analysis of the Cahn-Hilliard phase-field model, *Comput. Methods Appl. Mech. Engrg.*, Vol. **197**, pp. 4333–4352, 2008.

[4] M.S. Steinberg, Reconstruction of tissues by dissociated cells, *Science*, Vol. **141**, pp. 401-408, 1963.