

Phase-field modeling of multiphase flows: Theory, computations and applications

Hector Gomez

Professor, School of Mechanical Engineering, Purdue University

Abstract:

Phase-field modeling has been widely utilized in material sciences for several decades, but its emergence as a pivotal tool in fluid mechanics and biomechanics is more recent. This seminar will show how a unique combination of advanced modeling techniques based on the phase field theory and innovative computational methods based on isogeometric analysis can fundamentally advance our understanding of interface dynamics problems. First, I will first present recent research on cavitating flows, which are ubiquitous in science and engineering. Despite their significance, a number of fundamental problems remain open; and our ability to make quantitative predictions is very limited. I will present a phase-field model and a computational method which open opportunities for predictive computations of liquid-vapor flows, including cavitation inception —one of the most elusive aspects of cavitation. Second, I will present our models and computational methods of elastocapillarity —the process whereby capillary forces at a fluid-fluid interface deform a solid. Our elastocapillarity research is motivated by intriguing experiments which showed spontaneous droplet motion on soft surfaces with space-varying stiffness (droplet durotaxis). Through an innovative fluid-structure algorithm, we showed that durotactic droplet motion can be inverted by changing the system's wettability, which is important in microfluidics, microfabrication and thermal control. I will finalize my talk showing how our quantitative approach to phase-field modeling has permitted us to break new ground in the study of interfacial biomechanics.

Bio:

Dr. Hector Gomez is a Professor in the School of Mechanical Engineering at Purdue University. Prof. Gomez specializes in computational mechanics with particular emphasis in isogeometric modeling and analysis, interfacial mechanics of multiphysics systems and simulation at the interface of engineering and medicine. Prof. Gomez's research has been recognized with multiple awards including the Juan C. Simo Award from the Spanish Society of Computational Mechanics, the MIT Innovators Under 35, the Young Investigator Award from the Royal Academy of Engineering of Spain, the Gallagher Young Investigator Award from the US Association for Computational Mechanics and the Princess of Girona Scientific Research Award (presented by the King of Spain to the best young researcher in all fields of science, engineering and humanities). Prof. Gomez has published over 90 journal papers and made over 140 contributions to conferences, including multiple plenary and keynote presentations.



Monday, March 21st, 2022 4:00 – 5:20 p.m.

1310 Yeh Student Center