

IOWA STATE UNIVERSITY

Center for Multiphase Flow Research and Education

Phase-field Modeling of Phase-transforming Multicomponent Flows

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Abstract

Despite the importance of phase-transforming, multicomponent fluids in medical diagnostics, atmospheric flows, or supercavitating vehicles our understanding of their flow and mixing dynamics is very limited. This seminar will discuss the possibilities of the phase-field method to model such flows. I will present our recent work with two-component flows, where one of the components is an incondensable gas and the other one is a fluid that undergoes liquid-vapor phase transformations accompanied by changes in its miscibility with the gas. We derived a continuum model from a Gibbs free energy that includes gradients of the fluid density and gas concentration, leading to a generalization of the classical equations of multiphase flow hydrodynamics. High-fidelity numerical simulations of the model show a very complex interplay between flow, mixing and phase transformations. The model predicts quantitatively the saturation vapor pressure of water for a given mixture of air and water vapor at different temperatures. When applied to the problem of collapse of cavitation bubbles, the model allows us to study the role of gas dissolved in the liquid phase on the dynamics of the collapsing bubble. Our findings on the collapse of multicomponent bubbles have a strong bearing on the multiple applications of cavitation bubbles. The proposed model opens new possibilities to study phase-transforming multicomponent fluids.

Biography

Dr. Hector Gomez is currently an Associate 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 (SEMNI), the *MIT Innovators Under 35* (Spain section), 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* (the award is presented by the King of Spain to the best young researcher in all fields of science, engineering and humanities). Prof. Gomez has published over 75 journal papers and made over 120 contributions to conferences.



Refreshments will be provided.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.

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