SEMINAIRE

CentraleSupélec – Bâtiment Eiffel – 8-10 rue Joliot Curie – 91190 Gif-sur-Yvette

Amphi du centre de langues

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Kinetic-Based Hyperbolic Two-Fluid Models

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Résumé:

A longstanding shortcoming of two-fluid models for disperse multiphase flows is the lack of hyperbolicity when the Archimedes force is included. This is especially true when the material density of the disperse phase is much smaller than that of the continuous phase (e.g., bubbly flows). Mathematically, a nonhyperbolic model yields unphysical solutions and thus hyperbolicity is a necessary condition for any well-posed two-fluid model. In the literature, various *ad hoc* fixes have been proposed to achieve hyperbolicity, the most popular being the turbulent-dispersion force. While fixing the hyperbolicity problem, the physical origin of such terms is not obvious and thus they represent a mathematical fix that otherwise has only minor effects on solutions. To provide a rational approach for physics-based hyperbolicity, starting from the Boltzmann-Enskog equation we have developed a kinetic-based derivation of the two-fluid model for gas-solid flows that includes the Archimedes force. Similar approaches starting from the Boltzmann kinetic equation were pioneered in the 1960's for hard-sphere fluids with disparate masses (e.g. plasmas), but do not include the Archimedes force. A generalization of the hyperbolic kinetic-based two-fluid model to arbitrary material-density ratios will also be described.

Short Bio:

Professor Fox joined Iowa State University as the Glenn Murphy Professor of Engineering in 1999 and was the Herbert L. Stiles Professor of Chemical Engineering from 2003-2012. Since 2001, he has been Associate Scientist at the US-DOE Ames Laboratory. He was promoted to Distinguished Professor in Engineering in 2010. Prior to joining ISU, Fox was an Associate Professor of Engineering at Kansas State University, and has held visiting professorships in Belgium, Denmark, France, Italy, Switzerland and The Netherlands. From 1987-88, he was a NATO Postdoctoral Fellow at LSGC in Nancy, France working in the area of chemical reaction engineering under the guidance of Prof. Jacques Villermaux. His numerous professional awards include an NSF Presidential Young Investigator Award in 1992 and the ISU Outstanding Achievement in Research Award in 2007. Professor Fox was elected Fellow of the American Physical Society in 2007. From 2012-14, he was a Marie-Curie Senior Fellow at the Ecole Centrale in Paris, France. In 2015 he was selected as an International Francqui Professor by the Francqui Foundation in Belgium and awarded a Chaire d'Attractivité at the Université Fédérale Toulouse Midi-Pyrénées, France. In 2016 he was selected for the North American Mixing Forum Award for Excellence and Sustained Contributions to Mixing Science and Practice, and the Shell Particle Technology Forum Thomas Baron Award.

Professor Fox has made numerous ground-breaking contributions to the field of multiphase and reactive flow modeling. The Fox group spearheaded many fundamental advances in the development of novel computational fluid dynamics (CFD) models to overcome specific scientific challenges faced in the chemical and petroleum industries. He pioneered the use of in situ tabulation (ISAT) for efficiently handling complex chemistry in detailed multiphase reactor models, and developed powerful quadrature-based moment methods (DQMOM, CQMOM, EQMOM, CHyQMOM) for treating distribution functions (particle size, bubble size, etc.) required for CFD models of single and multiphase reactors. The impact of Fox's work extends far beyond chemical engineering and touches every technological area dealing with turbulent flow and chemical reactions (e.g., combustion, atmospheric science, nuclear fuel processing, etc.). His first book, Computational Models for Turbulent Reacting Flows, published by Cambridge University Press (CUP) in 2003, offers an authoritative treatment of the field. His second CUP book in 2013, Computational Models for Polydisperse Particulate and Multiphase Systems, provides a comprehensive treatment of CFD model for disperse multiphase flows.