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Gustaaf Jacobs

San Diego State University, USA

Multi-scale modeling of particle-laden flow with shocks

Particle-laden flows have many scales ranging from the large-scale process scale up to the minute particle scale. This type of multiscale problems appears in several important engineering applications, e.g. the dynamics of particle-laden gases, deformation of heterogeneous materials such as bones, concrete, heterogeneous explosives, sediment transport in river beds and mesoscale models of blood flow. In such problems, computational approaches typically model unresolved or subgrid scales in an ad-hoc manner. Closure laws are obtained from physical experiments, canonical theoretical constructs or phenomenological arguments. In multiscale modeling, the macroscale is coupled with a mesoscale approach and closure laws are obtained from highly resolved mesoscale simulations. In this presentation, I will discuss multiscale modeling for particle-laden flows with shocks. Highly resolved mesoscale simulations of a shock interaction with a cloud of particles are discussed. Macroscale computations of the shock-fluid problem are performed where a point particle assumption is used to model the particle phase. The linkage between scales is established through metamodels that assimilate mesoscale physics into surrogate models and serve as closure models for the macro-scale simulations.

Biography

Gustaaf Jacobs received a MSc in Aerospace Engineering from the Delft University of Technology in 1998, where after graduation, he was appointed to Research Associate. He received a PhD in Mechanical Engineering from the University of Illinois at Chicago. Following graduation in August of 2003, he was appointed Visiting Assistant Professor in the Division of Applied Mathematics at Brown University. He later combined this position with a Postdoctoral Fellowship at the Department of Mechanical Engineering at the Massachusetts Institute of Technology. As of August 2006, he was appointed Assistant Professor of Aerospace Engineering at San Diego State University and was promoted to Associate Professor in August of 2010. He graduated with an Honor Propedeuse from the Delft University of Technology. In 2002 he was awarded a University Fellowship at the University of Illinois. He received an AFOSR Young Investigator Award in 2009 and became an Associate Fellow of the American Institute of Aeronautics and Astronautics in 2013. The research interests of his can broadly be defined in an area of computational multiphase and multi-scale flow physics using high-order methods. Particular emphasis is on simulation and analysis of particle-laden flows and flows separation in complex geometries and plasmas to aid flow control relating to combustion optimization and drag reduction.

gjacobs@mail.sdsu.edu

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