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Multiscale Modeling of Particles Embedded in High Speed Flows[1]

SEAN DAVIS, Aerospace Engineering, San Diego State University, OISHIK SEN, Mechanical Engineering, The University of Iowa, GUSTAAF JACOBS, Aerospace Engineering, San Diego State University, H.S. UDAYKUMAR, Mechanical Engineering, The University of Iowa — Problems involving propagation of shock waves through a cloud of particles are inherently multiscale. The system scale is governed by macro-scale conservation equations, which average over solid and fluid phases. The averaging process results in source terms that represent the unresolved momentum exchange between the solid phase and the fluid phase. Typically, such source terms are modeled using empirical correlations derived from physical experiments conducted in a limited parameter space. The focus of the current research is to advance the multiscale modeling of shocked particle-laden gas flows; particle- (i.e. meso-)scale computations are performed to resolve the dynamics of ensembles of particles and closure laws are obtained from the meso-scale for use in the macro-scale equations. Closure models are constructed from meso-scale simulations using the Dynamic Kriging method. The presentation will demonstrate the multiscale approach by connecting meso-scale simulations to an Eulerian-Lagrangian macro-scale model of particle laden flows. The technique is applied to study shock interactions with particle curtains in shock tubes and the results are compared with experimental data in such systems.

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