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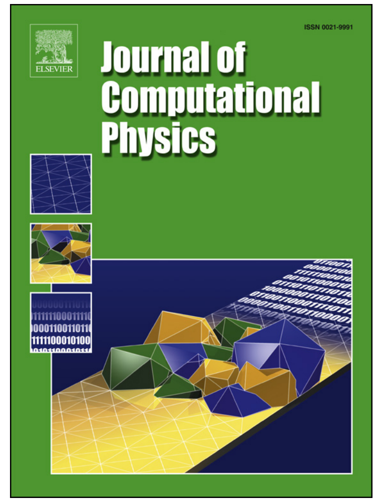

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A numerical method for shock driven multiphase flow with evaporating particles

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Abstract

A numerical method for predicting the interaction of active, phase changing particles in a shock driven flow is presented in this paper. The Particle-in-Cell (PIC) technique was used to couple particles in a Lagrangian coordinate system with a fluid in an Eulerian coordinate system. The Piecewise Parabolic Method (PPM) hydrodynamics solver was used for solving the conservation equations and was modified with mass, momentum, and energy source terms from the particle phase. The method was implemented in the open source hydrodynamics software FLASH, developed at the University of Chicago. A simple validation of the methods is accomplished by comparing velocity and temperature histories from a single particle simulation with the analytical solution. Furthermore, simple single particle parcel simulations were run at two different sizes to study the effect of particle size on vorticity deposition in a shock-driven multiphase instability. Large particles were found to have lower enstrophy production at early times and higher enstrophy dissipation at late times due to the advection of the particle vorticity source term through the carrier gas. A 2D shock-driven instability of a circular perturbation is studied in simulations and compared to previous experimental data as further validation of the numerical methods. The effect of the particle size distribution and particle evaporation is examined further for this case. The results show that larger particles reduce the vorticity deposition, while particle evaporation increases it. It is also shown that for a distribution of particles sizes the vorticity deposition is decreased compared to single particle size case at the

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