

A ghost-cell immersed boundary method for complex and dynamic shock-particle interactions

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We present an inverse distance weighting based ghost-cell immersed boundary method for complex and dynamic shock-particle interactions. This method is developed under a generalized framework of ghost cell based immersed boundary treatments and possesses desirable properties such as simplicity, accuracy, efficiency, memory friendly, etc. A Cartesian grid based three-dimensional Navier-Stokes solver incorporating the proposed method is developed, and extensive case studies of shock diffraction over a circular cylinder with comparison among present numerical results, published experimental and numerical data are studied to demonstrate the validity and accuracy of the proposed method. In addition, two- and three-dimensional challenging shock-particle interaction problems involving stationary and moving geometries, especially problems involving zero-gap configured particles, are investigated to demonstrate the high capability and robustness of the method. The current proposed method represents a systematic development of numerical schemes for ghost cell based immersed boundary treatments, which is independent from specific flow conditions such as compressible and incompressible flows, and whether the geometry is stationary or moving.