Eulerian two-fluid models for high-speed polydisperse gas–particle flow

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High-speed gas–particle flows arise in many applications, and almost always involve polydisperse particles (size, composition, etc.) over a wide range for the solids volume fractions. In this seminar, I will describe how to combine quadrature-based moment methods (QBMM) [1] with a well-posed compressible Eulerian two-fluid model derived from the kinetic theory of granular flows to model such flows. Our approach relies on first formulating a particle-phase kinetic model valid for close-packed to dilute particulate suspensions, coupled to a modified Euler equation for the compressible gas phase. A critical component of our computational approach for treating polydispersity is the formulation of the numerical fluxes for the size-velocity moments found from the kinetic model. Using the hyperbolic quadrature method of moments (HyQMOM) [2] and size-conditioned velocity moments (CQMOM) [3] for the particle phase, we compute the flux eigenvalues needed for hyperbolic flow solvers, which are real-valued for all physically relevant conditions. Finally, through numerical examples, we demonstrate that by including added mass and fluid-phase pseudoturbulence [4], our modeling approach extends to fluid–particle flows with arbitrary material-density ratios (e.g., bubbly flows).

References

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