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A kinetic-based hyperbolic two-fluid model for fully compressible particle-laden flows[1] RODNEY O. FOX, Center for Multiphase Flow Research and Education, Iowa State University; and Ames Laboratory, US DOE — Starting from coupled Boltzmann–Enskog kinetic equations for a two-particle system consisting of elastic rigid spheres, a hyperbolic two-fluid model for fully compressible particle-laden flows is derived. The kinetic equations account for particle–particle collisions, the Archimedes force due to pressure gradients in each phase, the added-mass force and a dispersion force. For simplicity, the particles in a given phase are assumed to have identical mass and volume, and no internal degrees of freedom. The compressible gas phase is obtained in the limit where the particle volume in one phase tends to zero with fixed phase density. The moment systems resulting from the two kinetic equations are closed at second order by invoking the anisotropic Gaussian closure. The resulting two-fluid model consists of transport equations for the mass, mean momentum and a symmetric, second-order, kinetic energy tensor for each phase. By explicitly computing the eigenvalues of the flux matrix, it is demonstrated that the model is hyperbolic when any combination of drag, buoyancy, added mass and/or dispersion.

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