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Physical origins of the dependence of drag force on density ratio through fully-resolved direct numerical simulation of particle-laden to bubbly flow[1] VAHID TAVANASHAD, SHANKAR SUBRAMANIAM, Iowa State University — The objective of this study is to understand the dynamics of freely evolving particle suspensions over a wide range of particle to fluid density ratios, from solid particles in a gas (high density ratio) to bubbles in a liquid (low density ratio). The dynamics of particle suspensions are characterized by the average momentum equation, where the dominant contribution to average interphase momentum transfer is the mean drag force. The mean drag is characterized using fully-resolved simulation over a wide range of density ratios in a canonical problem: a statistically homogeneous suspension where a steady mean slip velocity between the phases is established by an imposed mean pressure gradient. We explain the change of mean drag of freely evolving particle suspensions with reference to a fixed bed by considering the emergence of spatial structure in the particle configuration, effect of particle velocity fluctuations, and the mobility of particles. These considerations could be used to develop a physics-based drag law for dispersed multiphase flows. The study of the fluctuations of the drag force on individual particles about the mean drag shows that the force distribution follows a normal distribution with a variance from the mean drag that decreases with decreasing density ratio.

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