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Drag of Spherical Particles in a Periodic Lattice: Heat Transfer, Buoyancy and Non-Boussinesq Effects[1] SWETAVA GANGULI, SANJIVA LELE, Stanford University — What are the forces that act on a particle as it moves in a fluid? How do they change in the presence of significant heat transfer from the particle, a variable density fluid or gravity? Last year, we demonstrated and quantified these effects on a single particle. We further our study by adding interactions between particles placed in a periodic lattice whose parameters we control. Our particle resolved simulations use a fully unstructured, node-based, low-Mach variable density solver to study the low-Mach response. Let the Boussinesq parameter λ as the ratio of the difference of the particle temperature and the far-field fluid temperature to the far-field fluid temperature. The heating of the fluid near the particle affects the drag significantly which can be characterized in a parameter space where the variation in Reynolds number, λ and Froude number can be collapsed to a single parameter. Despite the large drag changes, the pressure and viscous fractional contributions do not vary with λ. In the low Re limit, a semi-analytical low Mach perturbation expansion has significant explanatory power. For a single particle, these variations can be captured with 95% accuracy by developing correlations based on physical insights from the semi-analytical model. When particles are placed within a lattice, depending on the lattice parameter, the individual wakes of the particles interact and the drag increases or decreases based on the lattice position.

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