Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Importance of Variable Density and Non-Boussinesq Effects on the Drag of Spherical Particles[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, using particle-resolved simulations we quantified these effects on a single spherical particle and on particles in periodic lattices when $O(10^{-3}) < Re < O(10)$. Let λ be the normalized particle-fluid temperature difference. Large deviations (>50%) in the absolute drag are observed as λ approaches unity. Oppenheimer, et al (2016) [1] have proposed a theoretical formula for the drag of a heated sphere at extremely low Re. We show that when $Re > O(10)$, inertial effects completely dominate the drag while when $Re < O(10^{-3})$, viscous effects completely dominate the drag and our simulations agree well with [1]. In the middle, there is honest competition between inertial and viscous effects and the drag modification strongly depends on the thermally induced near-particle density variation causing a non-zero volumetric dilation rate. In the limit of λ approaching 0 (Stokes' limit), the drag modification can also be captured as a correction to Stokes' drag using a suitable scaling based on the dilation rate.

[1]Stanford University - Predictive Science Academic Alliance Program (PSSAP II)

Swetava Ganguli
Stanford University

Date submitted: 30 Jul 2017 Electronic form version 1.4