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Fast linear solvers for variable density turbulent flows HADI POURANSARI, ALI MANI, ERIC DARVE, Stanford University — Variable density flows are ubiquitous in variety of natural and industrial systems. Two-phase and multi-phase flows in natural and industrial processes, astrophysical flows, and flows involved in combustion processes are such examples. For an ideal gas subject to low-Mach approximation, variations in temperature can lead to a non-uniform density field. In this work, we consider radiatively heated particle-laden turbulent flows as an example application in which density variability is resulted from inhomogeneities in the heat absorption by an inhomogeneous particle field. Under such conditions, the divergence constraint of the fluid is enforced through a variable coefficient Poisson equation. Inversion of the discretized variable coefficient Poisson operator is difficult using the conventional linear solvers as the size of the problem grows. We apply a novel hierarchical linear solve algorithm based on low-rank approximations. The proposed linear solver could be applied to variety of linear systems arising from discretized partial differential equations. It can be used as a standalone direct-solver with tunable accuracy and linear complexity, or as a high-accuracy pre-conditioner in conjunction with other iterative methods.

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