ME 600 Seminar
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A novel diffuse-interface method for the simulation of compressible turbulent multiphase flows

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Abstract:
Multiphase flows have a wide range of applications in natural and engineering processes. In this talk, I'll present a novel diffuse-interface model for the simulation of compressible multiphase turbulent flows. Starting from a baseline five-equation model that consists of transport equations for the volume fraction, the mass of each phase, momentum, and total energy, I'll present modifications to the model in such a way that the system of equations can be discretized using a non-dissipative central scheme that is suitable for the simulation of turbulent flows. The resulting model is conservative, accurate, scalable, and maintains a constant interface thickness throughout the simulation.

For stable and accurate numerical simulations of compressible flows, particularly at higher Reynolds numbers (Re), it is known that a discrete entropy condition needs to be satisfied in addition to the discrete conservation of kinetic energy. I'll present a numerical flux formulation for the five-equation model that satisfies this condition (a KEEP scheme) and show that this formulation results in stable numerical simulations of compressible turbulent multiphase flows at high Re.

Finally, I'll briefly highlight some of the related research efforts on shock-capturing methods, unstructured grids, fluid-solid simulations, and data-driven methods for particle-laden flows; and conclude by presenting the vision and plans for future research, teaching, and inclusion and diversity.

Biography:
Suhas S. Jain is a postdoctoral fellow at the Center for Turbulence Research, Stanford University, working primarily with Prof. Parviz Moin. Suhas graduated with an M.S. and Ph.D. in Mechanical Engineering from Stanford University in December 2021. Prior to his graduate studies, he was a guest researcher at the Institute of Fluid Dynamics at Helmholtz-Zentrum Dresden-Rossendorf, Germany 2014-15, and a project assistant at the Multiphase Flow Simulations Lab at the Indian Institute of Science 2015-16. During his graduate studies, Suhas was a Franklin P. and Caroline M. Johnson Fellow, and a recipient of the American Physical Society (APS) Gallery of Fluid Motion award in 2018 and the National Overseas Scholarship in 2019. He also received the APS Forum for Early Career Scientists mini award in 2022. His research interests include multiphase flows and particle-laden flows; numerical modeling of compressible flows, turbulent flows, and fluid-structure interaction; and high-performance computing.

***This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.**
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