Direct Numerical Simulation of High-Speed Turbulent Flows

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Abstract:
The development of predictive CFD tools is critical for the design of next-generation high-speed vehicles for routine and affordable rapid global transport and space exploration. So far, we have only limited understanding of the intricate interaction between turbulence and many important flow processes typical of high-speed flows, such as shock wave-turbulence interaction, turbulence-chemistry interaction, and flow-surface interaction. The lack of physical understanding and physics-based turbulence models will in turn result in unrefined and costly engineering designs. Direct numerical simulations (DNS) provide detailed data that can be used to study critical turbulence phenomena and to develop physics-based turbulence models. In this talk, newly developed DNS methodologies for high-speed turbulent flows are first introduced. The numerical tool is capable of capturing flow features across a wide range of length and time scales, thus robust for a broad range of turbulent flow conditions, including flows containing shock waves, chemical reactions, radiation, and surface interactions. The talk will then focus on applying the DNS tool to investigate the interaction of riblet surface with the overlying supersonic turbulent flow which reduces drag and surface heating. If time permits, DNS studies of other high-speed flow phenomena will also be covered.

Speaker Bio:
Dr. Lian Duan is currently a research scientist at the National Institute of Aerospace resident at NASA Langley Research Center. He received his Ph.D. in Mechanical and Aerospace Engineering from Princeton University in 2011. His research interests include direct numerical simulation (DNS) and large eddy simulation (LES), chemically reacting flow modeling, high-speed transitional and turbulent flow simulation, and laminar and turbulent flow control.