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Response of Hypervelocity Boundary Layers to Global and Local Distortion WILLIAM FLAHERTY, JOANNA AUSTIN, University of Illinois —
Concave surface curvature can impose significant distortion to compressible boundary layer flows due to multiple, potentially coupled, effects including an adverse pressure gradient, bulk flow compression, and possible centrifugal instabilities. Approximate methods provide insight into dominant mechanisms, however few strategies are capable of treating heat transfer effects and predictions diverge significantly from the available experimental data at larger pressure gradient. In this work, we examine the response of boundary layers to global and local distortions in hypervelocity flows where thermochemical energy exchange has significant impact on boundary layer structure and stability. Experiments are carried out in a novel expansion tube facility built at Illinois. We demonstrate that reasonable estimates of the laminar heat flux augmentation may be obtained as a function of the local turning angle, even at the conditions of greatest distortion. As a model problem to study the evolution of large-scale structures under strained conditions, streamwise vortices are imposed into the boundary layer. The impact of the additional local distortion is investigated. The heat transfer scaling is found to be robust even in the presence of the imposed structures.

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