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On the effect of velocity slip and temperature jump on flat plate boundary layer stability at Mach 4.5[1] ANGELOS KLOTHAKIS, Technical University of Crete, HELIO QUINTANILHA JR, University of Liverpool, SAURABH S. SAWANT, University of Illinois at Urbana-Champaign, EFTYCHIOS PROTOPAPADAKIS, University of West Attica, VASSILIS THEOFILIS, University of Liverpool, DEBORAH A. LEVIN, University of Illinois at Urbana-Champaign
— The laminar flat plate boundary layer is revisited using the Direct Simulation Monte Carlo (DSMC) method at Mach 4.5 and rather low pressure of 45Pa. Steady mean flow profiles are extracted from the DSMC results using a novel stack autoencoder neural network algorithm, the latter trained using ensemble averaged DSMC simulation results at a number of stations on the plate. The laminar profiles obtained from the neural network are of sufficient quality to accurately compute wall-normal derivatives appropriate for the subsequent linear modal instability analysis. The profiles also compare favorably with those obtained from compressible laminar boundary layer theory subject to the standard Maxwell-von Smoluchowski wall-slip and temperature-jump wall boundary conditions. Linear stability characteristics of the DSMC-obtained boundary layer flow, in which velocity slip and temperature jump are naturally included in the base flow are compared with results delivered by classic laminar boundary layer instability analysis based on the Linearised Navier-Stokes Equations. First and second (Mack) modes are identified in the DSMC eigenspectrum and the influence of slip on instability characteristics at these parameters is documented. Work to include the leading-edge shock in the analysis is underway.

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