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Unsteady effects in normal shock wave/turbulent boundary layer interaction MATTEO BERNARDINI, SERGIO PIROZZOLI, FRANCESCO GRASSO, Department of Mechanics and Aeronautics, University of Rome 'La Sapienza' — The interaction of a spatially developing supersonic turbulent boundary layer with a normal shock wave is analyzed by means of direct numerical simulation of the compressible Navier-Stokes equations. At the selected flow conditions, corresponding to a mild shock, no mean flow separation is observed. However, the flow is strongly unsteady, and intermittent regions of flow reversal are found near the wall, while large vortical structures are observed away from it. Such structures are mainly responsible for the amplification of noise and turbulence across the interaction zone. In particular, the sound field attains very large values (up to 162dB) near the nominal impingement point. The intense acoustic loads occurring in the interaction zone are found to be strictly related to the Reynolds shear stress distribution. The analysis of the pressure energy spectra shows a behavior consistent with that observed in incompressible boundary layers in adverse pressure gradient. In particular, a power-law scaling is recovered: at low frequencies the spectra scale as $St^{0.4}$, while at high frequencies they decay as St^{-5}. The results show that the interacting shock primarily acts as a low-pass filter for the turbulence spectra. The main effect is to enhance the low-frequency components while inhibiting the higher ones. We acknowledge the CASPUR computing consortium (University of Rome 'La Sapienza') for providing the computational resources to perform the numerical simulation.

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