Abstract Submitted
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Low-frequency dynamics in supersonic shock turbulent boundary layer interactions[1] JOHAN LARSSON, JOSEPH W. NICHOLS, Center for Turbulence Research, Stanford University, MATTEO BERNARDINI, SERGIO PIROZZOLI, Dept. of Mech. and Aerosp. Eng., University La Sapienza, Rome, BRANDON E. MORGAN, SANJIVA K. LELE, Dept. of Aero. and Astro., Stanford University — Supersonic shock/turbulent boundary layer interactions are studied using a large LES database. Consistent with previous experimental and numerical findings, the simulations indicate the occurrence of low-frequency dynamics, mainly related to the oscillation of the reflected shock foot. In the proximity of the latter, the wall pressure spectra exhibit substantial spectral content at frequencies at least two orders of magnitude smaller that those typical of the incoming boundary layer. Such trend becomes more pronounced for the strong interactions, with significant flow separation. The analysis of the low- and high-pass filtered flow fields allows to isolate two basic 'modes': i) a low-frequency 'breathing' mode of the separation bubble/reflected shock system, which is weakly coupled with the upstream flow; and ii) a high-frequency mode, which is dominated by the system response to the incoming boundary layer turbulence. The analysis of the Koopman modes (eigenmodes of the Koopman operator associated with snapshots of the flow field) confirms such scenario, and shows that the wall pressure signature in the low-frequency range is primarily affected by the breathing mode.

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