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DNS and LIA analysis of the shock turbulence interaction DANIEL LIVESCU, Los Alamos National Laboratory, JAIYOUNG RYU, UC Berkeley — The interaction between isotropic turbulence and a normal shock wave is studied using Direct Numerical Simulations (DNS), with all flow scales (including the shock width) accurately solved, and the Linear Interaction Analysis (LIA). The turbulence quantities from DNS converge to the LIA solutions as the turbulent Mach number, M_t, becomes small, even at low upstream Reynolds numbers. This reconciles a long time open question about the role of LIA and establishes it as a reliable prediction tool for turbulence-shock interaction problems when there is a significant separation between the shock width and turbulence scales and M_t is low, which is encountered in many practical applications. The final LIA formulas are extended to investigate detailed turbulence physics. The extended LIA relations are used to show consistency with the DNS results and study the interaction at high M_s, where the resolution requirements make DNS studies unfeasible. The results show that the shock wave significantly changes the topology of the turbulent structures, with a symmetrization of the third invariant of the velocity gradient tensor and (M_s mediated) of the PDF of the longitudinal velocity derivatives, and an M_s dependent increase in the correlation between strain and rotation.

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