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Near-field Nonlinear Interactions Leading to Jet Crackle DAVID BUCHTA, JONATHAN FREUND, University of Illinois at Urbana-Champaign — The noise from high-specific thrust jet exhausts, such as on military jets, is not just particularly intense but also exhibits a peculiar raspy crackling sound. The near acoustic field of this peculiar sound has weak shock-like waves that radiate at a distinct angle with a steepened "footprint" having higher peaks than valleys and thus a positive pressure skewness. We use large-scale direct numerical simulations of free-shear-flow turbulence with Mach numbers ranging from $M = 0.9$ to 3.5 to study the very near acoustic field and the nonlinear turbulence interactions that lead to this sound. Our simulations reveal that for $M \geq 2.5$ sharp, Mach-like waves radiate at a distribution of angles in the near acoustic field. As they propagate, these waves interact nonlinearly. Wave merging increases the length of the correlated waves and decreases the wave density with distance from the turbulence. Locally, the merging waves generate intense pressure fluctuations with elevated pressure skewness, $S_k(p') > 0.4$, which correlates with the perception of "crackle." These very-near-field nonlinear interactions may explain the peculiar positive $S_k(p')$—the "footprint" of which has been experimentally observed to propagate approximately linearly to larger distances from the shear layer.

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