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Mechanisms of "crackle" acoustic radiation from high speed turbulence AARON ANDERSON, JONATHAN FREUND, University of Illinois at Urbana-Champaign — "Crackle" describes the perception of a particular type of jet noise produced by high specific thrust engines, which is both annoying and potentially damaging to hearing. Direct numerical simulations of free shear flows at Mach numbers ranging from $M = 1.5$ to 3.5 are used to investigate its source mechanisms. Shear layers with $M > 2$ are seen to produced radiation with the accepted character of crackling jets: weak shocks, asymmetric and apparently steepened pressure waves, sound pressure levels exceeding 160 dB, and a distinctive Mach angle in the near acoustic field. Space–time correlations suggest that eddy advection is indeed responsible for the Mach-wave radiation. However, the length and time scales of the space–time statistics are significantly smaller than would be expected based upon the observed Mach waves, which suggests that near-field agglomeration of the waves is an essential feature. The pressure skewness, a metric that correlates with perception of crackle, is near zero for $M = 1.5$ and increases above 0.6 for $M = 3.5$ in the near acoustic field. Within the simulation domain, skewness is shown to increase with increasing distance from the turbulent shear layer indicative of multi-dimensional wave interaction effects.

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