Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

Crackle noise from high-speed free-shear-flow turbulence DAVID BUCHTA, JONATHAN FREUND, University of Illinois at Urbana-Champaign — High-thrust jet engines radiate a particularly intense and distinct sound that has become known as 'crackle'. Its root mechanisms are not fully understood, though they are thought to involve nonlinear acoustics because the sound waves appear steepened. They also have a positive skewness, pressure maxima are stronger than minima, for unknown reasons. We use 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 turbulence interactions. Results indicate that crackle is insensitive to Reynolds number for the range considered, though DNS is restricted to modest Reynolds numbers. The very near field is teeming with weak, nonlinearly interacting Mach-like waves. Locally, these waves generate intense pressure fluctuations, especially as they merge. We observe that skewness changes are small over the propagation distances simulated, though more significant changes are to be expected over larger propagation distances. The source of the peculiar skewness is thus near or within the turbulence. Simulations modulating the underlying unstable linear modes reveal a sensitivity to crackle and are used to assess the role of large-scale structures in its source.

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Date submitted: 30 Jul 2015 Electronic form version 1.4