Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Are surface shear stress fluctuations a true source of sound?

KARIM SHARIFF, NASA Ames, MENG WANG, Stanford University — The sound due to a localized flow over a large (compared to the acoustic wavelength) plane no-slip wall is considered. It is known that the sum of the pressure and normal viscous stress at the wall, while appearing to be a source of dipole sound in the formal solution to Lighthill's equation, is *not* a true source but rather represents the surface reflection of volume quadrupoles. Whether a similar surface shear stress term constitutes a true source of dipole sound, has been controversial. Some have assumed it to be so and used it to calculate the noise in boundary-layer flows. Others have argued that, just like the surface pressure, surface shear stress is not a true source. Here, a numerical experiment is undertaken to investigate the issue. An acoustically compact portion of an otherwise static wall is oscillated tangentially to create shear stress fluctuations. The resulting sound field, computed directly from the compressible Navier-Stokes equations, is *almost* everywhere dipolar and its amplitude agrees with an acoustic analogy prediction that regards the surface shear as acoustically compact and as a true source of sound. However, for observers near wall-grazing angles, there is a correction that increases as the computational domain size is increased. A consistency argument, validated by the simulations, shows that as the domain size $\to \infty$, *and* for observers at angles sufficiently close to grazing, shear stress fluctuations cannot be regarded as a source independent of the sound field.

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Date submitted: 04 Aug 2005 Electronic form version 1.4