SOUND OF THE SUBSONIC JET

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A large portion of aircraft sound is produced simply by the air jet flow from the aircraft engine's exhaust. If we can reach a better understanding of the sound produced by air jets, we can take steps to reduce it, where its presence can be annoying and even dangerous. The anechoic chamber at the VKI is equipped for taking sound measurements of a subsonic air jet, however until now this has not been done. The jet may be excited using a loudspeaker such that vortex shedding—and therefore vortex pairing—is extremely periodic. C. Schram previously made a theoretical prediction for the sound produced only by vortex pairing based on Particle Image Velocimetry using this anechoic facility.

Flow visualization of the excited jet flow (velocity U = 34.2 m/s and excitation frequency F_{ex} = 2500 Hz) was performed to confirm similar flow conditions as for Schram's theoretical prediction, as shown in Figure 1.

Microphone measurements were performed on the unexcited jet at various velocities [19 m/s – 40 m/s] and microphone angles from horizontal [20° – 65°]. The acoustic power was found to vary proportionally to $U^{6.06}$, as compared to the U^8 theory of Lighthill. Shear layer instabilities were found at a constant Strouhal number of 0.01. Suppression of broadband noise was found to occur when the jet (U = 34.2 m/s and F_{ex} = 2500 Hz) was then excited by loudspeaker. Total jet sound for both the excited and unexcited jet cases agreed well with directivity trends in literature. Finally, vortex pairing and double pairing sound have been measured experimentally for the range of measurement angles of 20° to 60°. Vortex pairing sound was determined to range from 0.0008 to 0.0061 Pascals, extracted from total excited jet sound of 0.28 to 0.32 Pascals. This agrees within 0.0017 Pa of Schram's theoretical prediction for all measured angles, as shown in Figure 2.

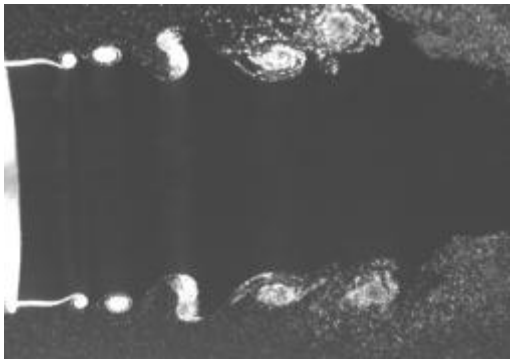

Figure 1: Visualization of the excited jet flow vortex pairing and double pairing

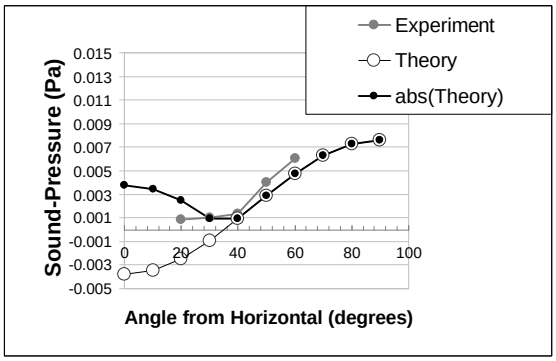

Figure 2: Experimental and theoretical showing comparison of vortex pairing sound