Understanding the Aeroacoustic Radiation Sources and Mechanism in High-Speed Jets

Dissertation

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By

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Abstract

Who reads a dissertation abstract?

This work is dedicated to Science . . .

Acknowledgments

I should probably acknowledge someone here . . .

Vita

September 10, 1986	Born - Plano, Texas
2009	B.S. Mechanical Engineering, University of Texas, Austin.
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Publications

Research Publications

M. Crawley, C.-W. Kuo, and M. Samimy, "Identification of the Acoustic Response in the Irrotational Near-field of an Excited Subsonic Jet." submitted to *International Journal of Aeroacoustics.*

M. Crawley, R. Speth, D. V. Gaitonde, and M. Samimy, "A Study of the Noise Source Mechanisms in an Excited Mach 0.9 Jet - Complementary Experimental and Computational Analysis." AIAA Paper 2015-0736, *53rd AIAA Aerospace Sciences Meeting.*

M. Crawley, A. Sinha, and M. Samimy, "Near-field and Acoustic Far-field Response of a High-Speed Jet Forced with Plasma Actuators." *AIAA Journal*, expected 2015.

M. Crawley and M. Samimy, "Decomposition of the Near-Field Pressure in an Excited Subsonic Jet." AIAA Paper 2014-2342, *20th AIAA/CEAS Aeroacoustics Conference.*

M. Crawley, A. Sinha, and M. Samimy, "Near-field Pressure and Far-field Acoustic Response of Forced High-Speed Jets." AIAA Paper 2014-0527, *52nd AIAA Aerospace Sciences Meeting.*

M. Crawley, H. Alkandry, A. Sinha, and M. Samimy, "Correlation of Irrotational Near-Field Pressure and Far-Field Acoustic in Forced High-Speed Jets." AIAA Paper 2013-2188, *19th AIAA/CEAS Aeroacoustics Conference.*

H. Alkandry, **M. Crawley**, A. Sinha, M. Kearney-Fischer, and M. Samimy, "An Investigation of the Irrotational Near Field of an Excited High-Speed Jet." AIAA Paper 2013-0325, *51st AIAA Aerospace Sciences Meeting.*

M. Crawley, M. Kearney-Fischer, and M. Samimy, "Control of a Supersonic Rectangular Jet Using Plasma Actuators." AIAA Paper 2012-2211, *18th AIAA/CEAS Aeroacoustics Conference.*

Fields of Study

Major Field: Mechanical and Aerospace Engineering

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Chapter 1: Introduction

The advent of the turbojet engine led to a transformation in both commercial and military aviation, allowing for much faster flight than previously possible with propellor-driven aircraft. However, the increased thrust of turbojets has come at great cost. Significant acoustic radiation is generated by the rotating components (compressor, turbine, fan), by the combustion process, and ultimately by the free jet itself. On the commercial side, the escalating number of flights, encroachment of urban and residential areas near airports, and tightening of environmental regulations have combined to force airports to institute curfews, surcharges and flight path restrictions to combat noise pollution. For the military, hearing damage inflicted on nearby personnel (particularly on aircraft carriers) has necessitated the implementation of noise reduction concepts on tactical aircraft. During takeoff and landing, when acoustic radiation is most problematic to ground crew and surrounding urban and residential areas, the dominant noise source of the jet engine is the aeroacoustic radiation generated by the high velocity engine exhaust. This has spurred extensive research, spanning over six decades, into the aeroacoustic source mechanism in high speed, high Reynolds number jets.

By rearranging the Navier-Stokes equations, Lighthill [3] was able to transform the governing equations for fluid dynamics into an inhomogeneous convected wave equation. In this acoustic analogy, the source term comprises Reynolds stress, shear stress, and density fluctuation terms (commonly referred to as *Lighthill's stress tensor*). As this formulation is exact (aside from the assumption of a constant sound speed), complete knowledge of the source field will yield an exact solution for the acoustic far field. In practical applications (e.g. high-speed, turbulent jets) however, the full source field cannot be measured using current experimental capabilities nor simulated with sufficient fidelity, thereby requiring certain simplifications. While great progress has been made in the field of aeroacoustics, both experimentally [4, 6, 5] as well as theoretically [1], understanding of jet noise sources and their radiation mechanisms remains incomplete [2].

Where to go from here? ...

Chapter 2: Background

2.1 Components of Jet Noise

2.2 Acoustic Analogy

2.3 Source Models

2.4 Flow Control

Chapter 3: Experimental Methodology

3.1 Anechoic Chamber

3.2 Data Acquisition

3.3 LAFPAs as Diagnostic Tools

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