MONASH
ENGINEERING

MONASH University

Faculty of Engineering
Summer Research Program 2024-2025

Project Title: Reduced-Order simulations of coherent structures in jets

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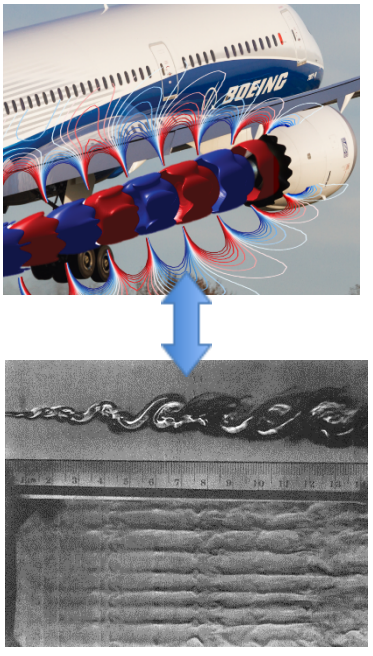
Objective



Coherent structures have been observed in turbulent flows for a long time. Recently, these structures were linked to a myriad of important phenomena, such as noise radiation and turbulence production. In this project we aim to study the possible interactions between two of these coherent structures: the Kelvin-Helmholtz (KH) instability wave and streaks. By using a reduced-order direct numerical simulation, the possible paths of evolution of these structures will be evaluated, and the mechanisms in which these two structures may interact will be brought to light. This study will help understanding the noise reductions achieved by application of serrations at the nozzle exit (chevrons) in a commercial aircraft.

Project Details

The project will use Dedalus, an open-source python-based partial differential equation solver to compute the direct Navier-Stokes solution of a periodic mixing layer. This flow case has many of the important elements present in jet turbulence, including some of its most important coherent structures. By setting up different simulations with varying initial conditions, the development of the KH instability will be studied, with special focus on the non-linear growth of disturbances. The development of streaks will also be studied, so as to understand how these two structures interact, transferring energy to each other. These two structures are exemplified in the figure above, in photographs of a compressible mixing layer. The same structures are observed in the sketch of a chevron jet, shown above.

Prerequisites

The student must have taken MAE3401 – Aerodynamics II or equivalent. They must also have experience with Python/Matlab. Experience with numerical simulations is desirable, but not required.