Volumetric Density Field Measurements in Turbulent Flows

Callum Atkinson
Laboratory for Turbulence Research in Aerospace and Combustion, Department of Mechanical and Aerospace Engineering, Monash University, VIC 3800, AUSTRALIA
callum.atkinson@monash.edu

ABSTRACT

Engineers are confronted by a wide array of flows which exhibit and in many cases are either solely or partially driven by density gradients. The past 20 years have seen significant advancement in our ability to experimentally measure instantaneous velocity fields to the extent that time-resolved volumetric velocity fields measurements are now possible. However, quantifying instantaneous density fields remains a challenge. The impact of density gradients on the refraction of light has been exploited to enable qualitative visualisations of density gradients via the use of schlieren systems in a path integrated sense. As an extension to this, the present talk will detail how we can compute an instantaneous fluctuating density field from a distributed array of simultaneous background oriented schlieren measurements of a flow utilising tomographic reconstruction. Examples with be taken from analytical models, direct numerical simulations and experimental measurements of a heated axisymmetric subsonic turbulent jet with an inlet Mach number on the order of 0.5 with a nozzle exit temperature approximately 100 K above ambient. This case will be used to demonstrate the factors that influence the resolution and accuracy of such measurements, the practical experimental requirements and the sort of performance we can expect in turbulent flows.