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Study of the Invariants of the Velocity-Gradient Tensor in Homogeneous Isotropic Turbulence by means of 3C-3D Tomographic PIV
NICOLAS BUCHMANN, SYLVAIN ROUVIER, JULIO SORIA, Monash University, Victoria 3800, Australia, NO TEAM — The study of coherent structures (CS) in turbulent flows is essential for understanding turbulence mechanisms in technological and theoretical relevant flows. The recent advent of instantaneous three-component and three-dimensional (3C-3D) measurement techniques now permits detailed experimental investigation into the dynamics and topology of CSs by for example analysis of the invariants of the velocity gradient tensor. For this purpose, the present work presents instantaneous, high-resolution 3C-3D Tomographic Particle Image Velocimetry (TPIV) measurements in a grid-generated, homogeneous isotropic turbulent flow ($Re_\lambda \approx 140$). The experiments are conducted in a larger water tunnel facility using a passive grid, four high-resolution digital cameras and a pulsed Nd:YAG laser for volume illumination. The invariants of the velocity gradient, rate of strain and rate of rotation tensor are used to characterize the dynamics and topology of the turbulent flow field and in particular its dissipation and vortex structure. Preliminary results are in agreement with previous literature and DNS simulations. The objective of this work is to measure these quantities experimentally and directly without additional assumptions pertaining to the structure and dynamics of the turbulent flow field.

Nicolas Buchmann
Monash University, Victoria 3800, Australia

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