Intermittency and Multi-Fractal Velocimetry (IMFV) in Rayleigh-Taylor and Convective Flows

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HIGHLIGHTS

• Joint analysis of PIV and Multi-Fractal analysis of mixing descriptors in Reactive Rayleigh-Taylor flows.
• Demonstration that Velocity, Volume Fraction and Vorticity fields exhibit different Fractal aspects.
• Observations of different spectra and intermittency for 2D / 3D spanwise and streamwise flows.

• Need for Multidimensional Parameter Spaces to compare different mixing experiments.

ABSTRACT

We present turbulence analysis and applications of Fractal analysis in Shock induced compressible flows as well as in convection in order to compare different measures of non-homogeneous use of fast reactive indicators such as Phenolblue, provides visual indication of the complexity of shock and buoyancy driven flows. Surface Flow image velocimetry (SFIV) allows to measure complex surface velocity fields in engineering involving 3D flow-boundary conditions and complex divergence and wave prone non uniform flows and boundary layer interactions, this may be particularly important when a single camera for PIV provides a 2D image of the real complex flows. The use of multi-fractal analysis and improvements on Structure function calculations on standard PIV, and on several methods used in experimental fluids mechanics, calibrated towards the understanding of molecular mixing and the role of vorticity and helicity in the analysis of velocity vectors. The spectral behavior has an important role in mixing processes. A practical application is related to the Rayleigh–Taylor instability. The physical mechanism producing the instability is most easily done (Castilla and Redondo 1994) with a sudden acceleration stop of a tank in a falling frame of reference such as vertical railing. Fractal spectra of the velocity and vorticity fields show the important role of intermittency in Mixing.

![Fig. 1 (left) Reactive LIF of RT front, (centre, right) Velocity and Vorticity maps of a convective buoyant flow.](image-url)