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Complex Convective Thermal Fluxes and Vorticity Structure

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Local Diffusion and the topological structure of vorticity and velocity fields is measured in the transition from a homogeneous linearly stratified fluid to a cellular or layered structure by means of convective cooling and/or heating[1,2]. Patterns arise by setting up a convective flow generated by an array of Thermoelectric devices (Peltier/Seebeck cells) these are controlled by thermal PID generating a buoyant heat flux [2].
The experiments described here investigate high Prandtl number mixing using brine and fresh water in order to form density interfaces and low Prandtl number mixing with temperature gradients. The set of dimensionless parameters define conditions of numeric and small scale laboratory modeling of environmental flows. Fields of velocity, density and their gradients were computed and visualized [3,4]. When convective heating and cooling takes place the combination of internal waves and buoyant turbulence is much more complicated if the Rayleigh and Reynolds numbers are high in order to study entrainment and mixing.

Using ESS and selfsimilarity structures in the velocity and vorticity fieds and intermittency [3,5] that forms in the non-homogeneous flow is related to mixing and stiring. The evolution of the mixing fronts are compared and the topological characteristics of the merging of plumes and jets in different configurations presenting detailed comparison of the evolution of RM and RT, Jets and Plumes in overall mixing. The relation between structure functions, fractal analysis and spectral analysis can be very useful to determine the evolution of scales.
Experimental and numerical results on the advance of a mixing or nonmixing front occurring at a density interface due to body forces [6]and gravitational acceleration are analyzed considering the fractal and spectral structure of the fronts like in removable plate experiments for Rayleigh-Taylor flows.

The evolution of the turbulent mixing layer and its complex configuration is studied taking into account the dependence on the initial modes at the early stages and its spectral, self-similar information [3,7-9]. Spectral and Fractal analysis on the images has been used in order to estimate dominant mixing structures as well as the dispersion relations of basic instabilities [4,8.

Comparison of the range of entrainment values from laboratory experiments with those ocurring in nature, both in the atmosphere and ocean or in Astrophysics shows the importance of modeling correctly the integral lengthscales of the turbulence. The Entrainment may actually be related to the ratio of the flux to gradient Richardson numbers as well as the Turbulent Schmidt or Prandtl number [6,8] and their structure functions [5].
Turbulent mixing diagnostics are based on schlieren and shadowgraph visualization, planar laser sheet, laser Doppler velocimetry (LDV) and particle image velocimetry (PIV). We are interested by the influence of initial conditions [9](flux gradients of various sizes) on the transition to turbulent mixing, the influence of subsequent vortices and waves, initially in a one dimensional or plane configuration and furthermore in a two-three dimensional configuration with the interface oblique with respect to the horizontal.

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