PIV of convective complex flows driven by thermoelectric heat fluxes

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Abstract

Experimental results on mixing occurring at a convective driven or a overturning density gradient due to gravitational acceleration are analyzed considering the velocity field of the process. We present a thermoelectric driven heating and cooling experimental device in order to investigate the different motions between two dimensional convection in an enclosure and the 3 D complex flows. The size of the enclosure is of 0.2 x 0.2 x 0.1 m and the heat sources or sinks (two in facing walls) can be regulated both in power and sign (Redondo 1992). The thermal convective driven flows are generated by Seebeck and Peltier effects [1] in 4 wall extended positions of 0.05 x 0.05 cm each. The parameter range of convective cell array varies strongly with the Topology of the Boundary conditions. At present side heat fluxes are considered and estimated as a function of Rayleigh, Peclet and Nusselt numbers, but the tilting possibilities of the BEROTZA built experimental device also allow to heat/cool at top and bottom at different angles. (Redondo and Garriga 1995, Redondo et al.1992)) Visualizations are performed by PIV, Particle tracking and shadowgraph.

The experimental configuration can also be modified with a stratified solute or heat initial conditions consisting on stable or a marginally unstable two layer system held by a (heat-solute) [2] density interface which may be used to quantify the entrainment, the mixing efficiency, different types of dominant instability and the topological aspects of the turbulent cascades detected both horizontally and vertically [3,4].

Convective turbulence in a rotating stratified system is also measured with tracers (Kalliroscope), using PIV as well as with sonic

velocimetry determining the dominant spectra as i Redondo and Garriga(1995)[5]. Observations of the horizontal and vertical velocity energy spectra as well as the structure functions are used to estimate local mixedness, entrainment and intermittency [6-9]

Keywords: convection, thermoelecticity, heat flux, PIV, patterns.

References

[1] L.I. Anatychuk, *Physics of Thermoelectricity*, Institute of Thermoelectricity Kyiv, Chernivtsi, 1998.

[2] J. M. Redondo, *Vertical microstructure and mixing in stratified flows* . Advances in Turbulence VI. Eds. S. Gavrilakis et al. 605-608. 1996.

[3] J.M. Redondo, J. Garriga, F.G. Noriega, *Convective Transfer in Space Thermoelectric Driven Flows*, XI International Conference in Thermoelectrics, 147-154. Ed. K. Rao. Arlington. Tx. 1992.

[4] J.M. Redondo and I.R. Cantalapiedra, *Mixing in Horizontally Heterogeneous Flows*, Applied Scientific Research 51, 217-222, 1993.

[5] J.M. Redondo J.M. and J. Garriga. *Convection driven by thermoelectric heat fluxes*,Mixing in Geophysical Flows (Eds. Redondo JM and Metais O. 343-352. CIMNE, Barcelona , 1995.

[6] J.M. Redondo, *Termodinamica de los procesos irreversibles, efectos termoelectricos* , Rev. Termoelectricidad 2, 16-29 .AIT .Pamplona. 1996.

[7] J.M. Redondo, *The structure of density interfaces* . Ph.D. Thesis. University of Cambridge. DAMTP. Cambridge. 1990.

[8] J.M. Redondo, *Mixing efficiencies of different kinds of turbulent processes and instabilities, Applications to the environment*, Turbulent mixing in geophysical flows. Eds. Linden P.F. and Redondo J.M. 131-157. 2002.

[9] J.M. Redondo, *Turbulent mixing in the Atmosphere and Ocean* ,Fluid Physics. 584-597.World Scientific. New York. 1994.