

*“Antonio Castellanos:
his outstanding contribution to
Electrohydrodynamics*

P. Atten

1978 – 1982 Universidad Autonoma Madrid

with Prof. M. Velarde (*Fisica de Fluidos*)

M. Velarde interested by EHD studies in Grenoble
first contact 1976 (in Sevilla)

1980 : beginning of collaboration

- Conference on PhysicoChemicalHydrodynamics
(*organised by M. Velarde in Madrid*)
- one month stay in Grenoble for Antonio Castellanos

1981 : - second stay in Grenoble
- short stay in Madrid for me (*P.A.*)

The Rayleigh-Bénard problem

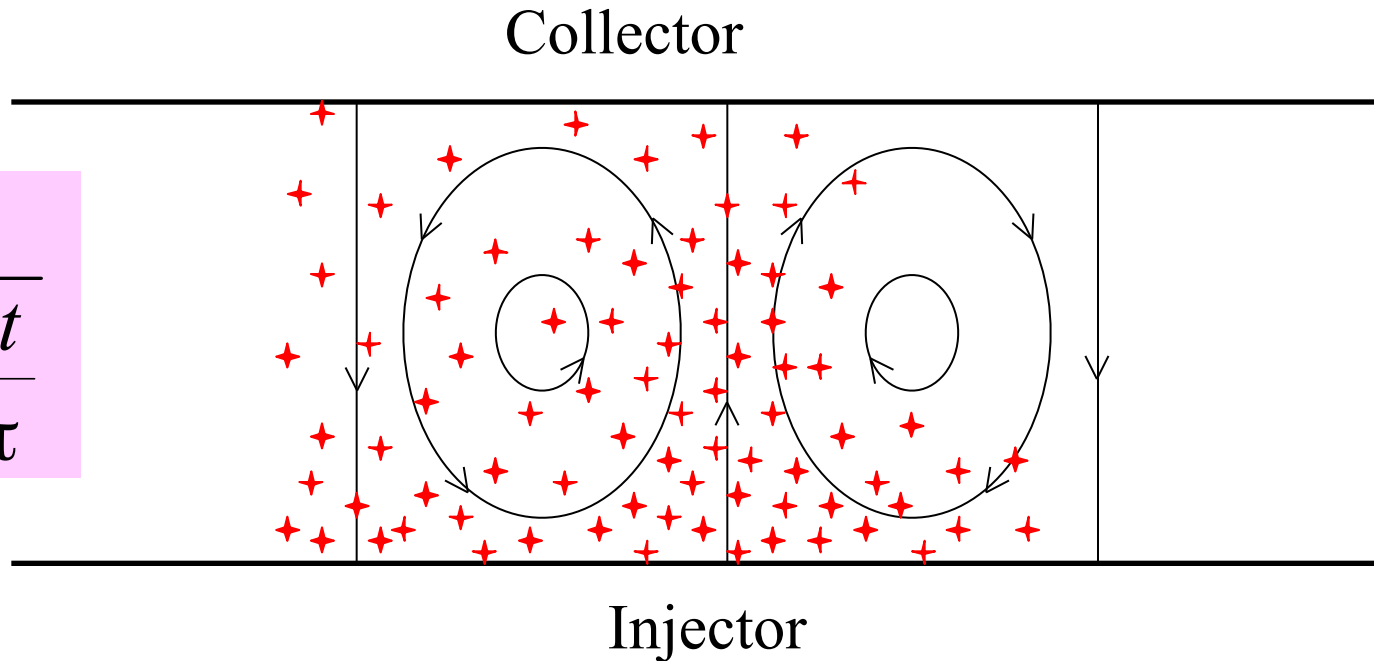
horizontal layer of fluid heated from below : potentially *unstable*

Unipolar injection into an insulating medium

Homogeneous injection of ions in a planar layer : potentially *unstable*

$$\mathbf{F}_e = q \mathbf{E}$$

$$q = \frac{q_0}{1 + \frac{t}{\tau}}$$



ETHD (ElectroThermoHydroDynamics) : 1st phase

stability analyses for : Unipolar Injection + thermal gradient (U.I. + ∇T)

$\nabla T \Rightarrow \nabla \varepsilon$ and ∇K (ε : permittivity, K : mobility)

$$\mathbf{F}_e = q\mathbf{E} - \frac{E^2}{2} \nabla \varepsilon + \nabla \left[\rho \left(\frac{\partial \varepsilon}{\partial \rho} \right)_T \frac{E^2}{2} \right]$$

1981 : - second stay in Grenoble
- short stay in Madrid for me (P.A.)

also application for a position in Sevilla : successful

1982 Agregado Numerario Universidad de Sevilla

1983 - third stay in Grenoble
- catedrático Universidad de Sevilla

ETHD (ElectroThermoHydroDynamics) : 2nd phase

basic points
for research
activity of
A. Castellanos

theory (analytical and/or numerical)
heuristic models
experiments (if possible)
collaboration and exchanges with
colleagues in other laboratories

from 1984 collaboration with A.T. Richardson (Bristol)
LEMD (Grenoble)

topic : heat transfer augmentation by electroconvection

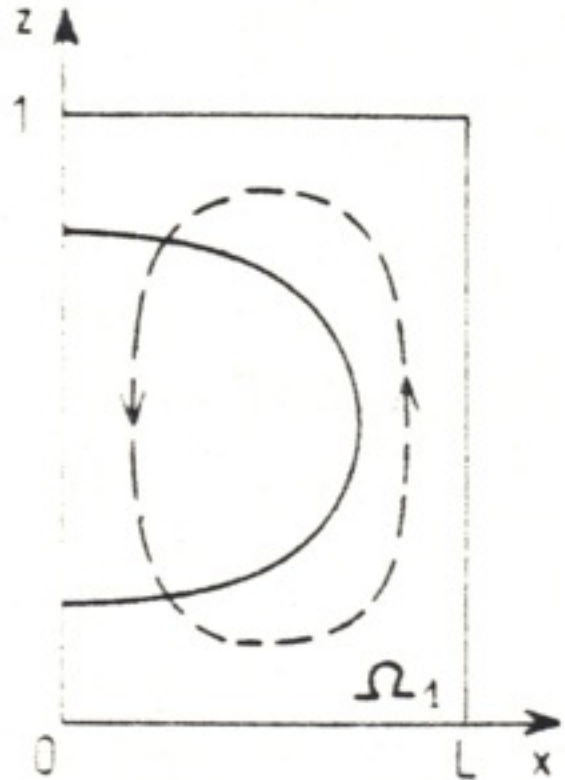
Supports	1985-87	NATO
	1986	French CNRS
	1987-89	EEC (Stimulation Program)

* "attraction" of
doctoral students

A. Perez
F. Pontiga (after 1990)

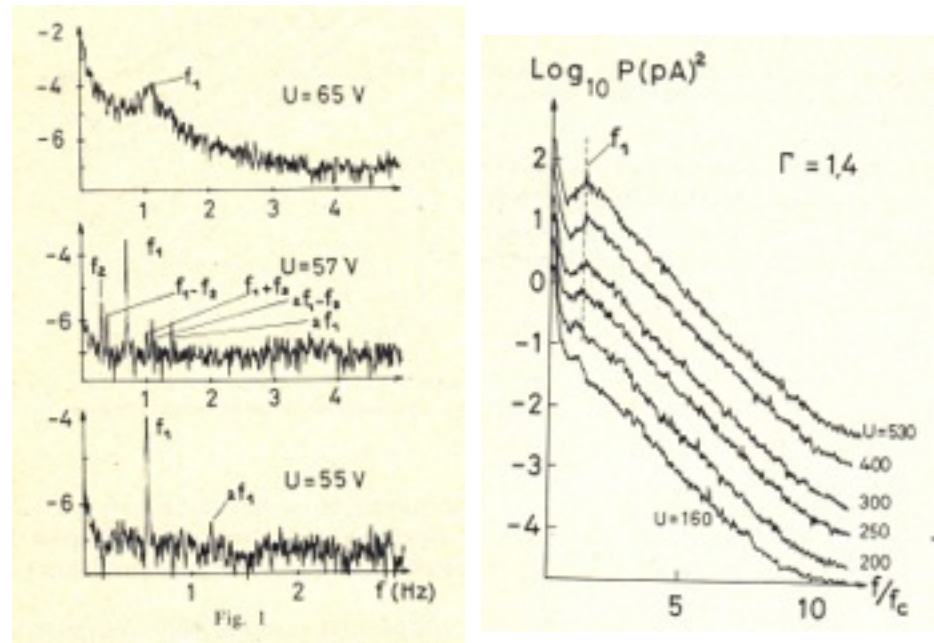
Electroconvection

- * particularly examined :
 electroconvection under U.I.
- * approaches :
 - stream function of given form
 - particles method
- * after 1990 : refined numerical techniques
 - FCT (Flux Corrected Transport)
 - PIC (Particles-in-cell)with *A. Perez, P. Vazquez*



Electroconvection and deterministic chaos

- * Experiments in Grenoble suggesting a chaotic behaviour



- * basic studies
 - chaotic nature of ions trajectories
 - characterization of chaoswith *A. Perez*

Various problems with volumic Coulomb force

- * Superimposing
Unipolar Injection and
 - rotation
 - planar Couette flow
 - planar Poiseuille flow
 - cylindrical Taylor-Couette flow

from 1986 to 1998 with *N. Agrait, F. Pontiga*

- * EHD plumes

1994 - 1998 with *A. Perez, P. Vazquez*

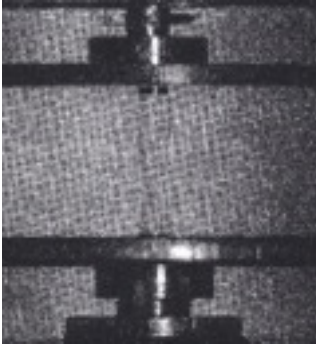
New field : interfacial EHD

- * Electric field at interfaces
 - permittivity jump
 - surface charge density

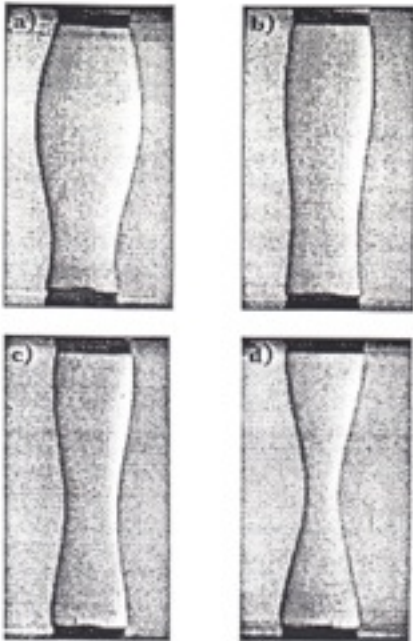
- * from about 1987
 - liquid bridges and jets
 - with *H. Gonzalez, J. Garcia*

- * 1988 - 1998
 - linear and non linear interfacial waves
 - cones, interface disruption
 - with *A. Ramos, A. Gonzalez*

Liquid bridges and jets



- * field stabilization of liquid bridges
 - experiments
 - analytical studies
 - influence of rotation, residual gravity, shape



- * liquid jets
 - 1-D modeling
 - parametric instabilities
 - influence of rotation, residual gravity, shape

Picasso program : 1998 – 1999

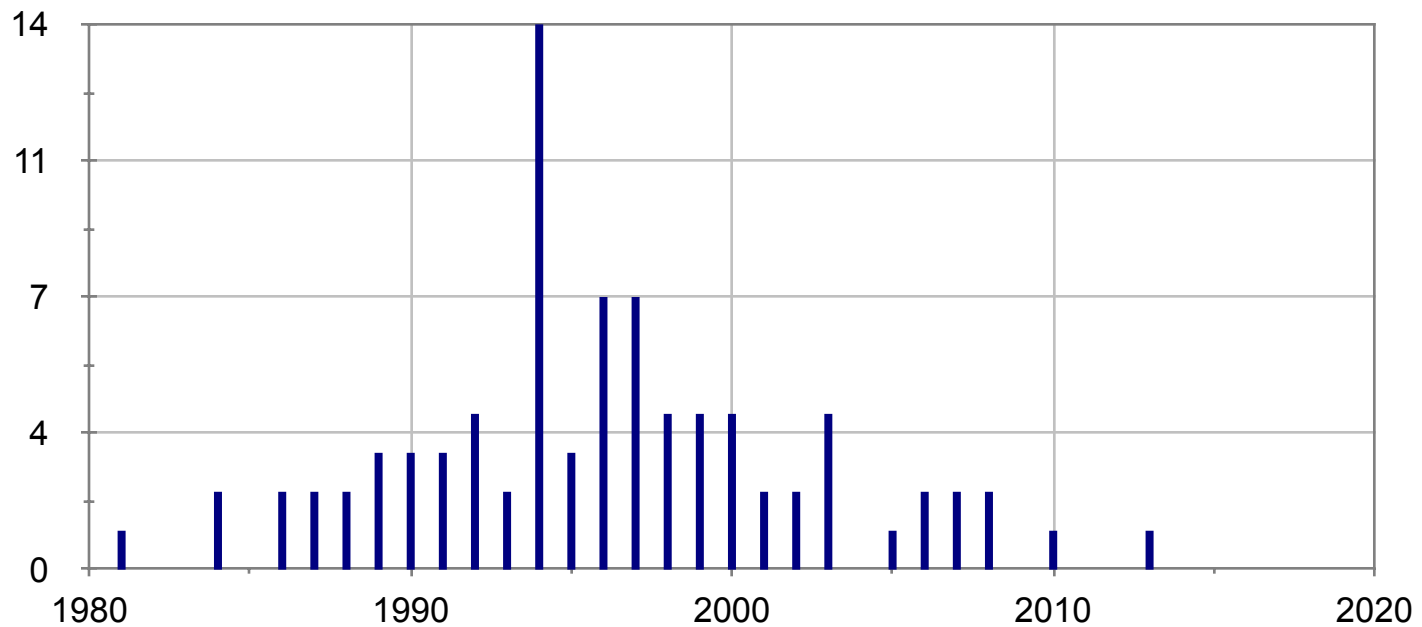
many exchanges Grenoble – Sevilla

(A. Castellanos invited Professor 2 months)

The ninety years : very fruitful decade

Publications in international journals

A. Castellanos author or co-author



The ninety years : very fruitful decade

- * 1994 4 chapters in the book
 " Fluid Physics " (series
 Nonlinear Scineces)
 - EHD : basic equations
 - chaotic electroconvection
 - liquid bridges
 - solitary wave on conducting liquid

- * 1995 a chapter in "Handbook of Electrostatic Processes"

- * 1996 - Summer School on EHD in Udine (*IUTAM*)
 - workshop on EHD (Udine)

- * 1998 - Book on EHD (*Springer Verlag*)
 - workshop in Sevilla " Conduction, convection, breakdown in fluids "

A new domain : EHD in electrolytes and μ -electrodes

Dielectrophoresis of particles and cells

* Morgan (Glasgow) : problem of disturbing convective flows

- strong conductivity
- strong fields

* Electrothermal convection ?

* AC electro-osmosis

with *A. Ramos, A. Gonzalez*

