Research description

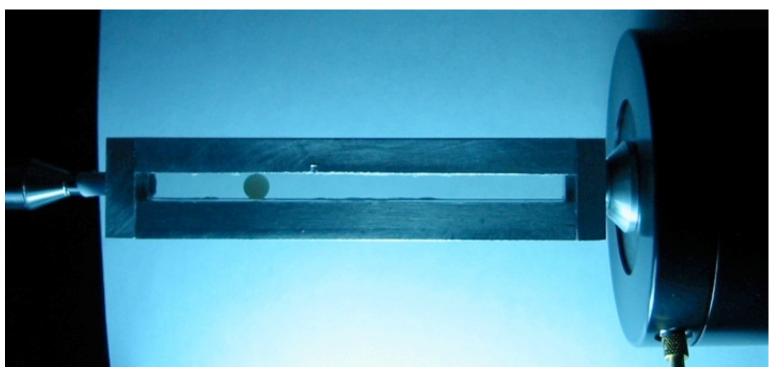
When I arrived in the laboratory in December 2006, we decided with Pr. Felipe Barra and Pr. Nicolás Mujica that I will begin a subject related with nonlinear acoustics. Then, after some discussions with Pr. Marcel Clerc it seemed very interesting to begin a cooperation with him on a Nonlinear Hydrodynamic problem.

So I will describe the two research projects with, what it has already done before my arrival and what I have done during this year.

Experimental study of acoustic interactions in two-phase media

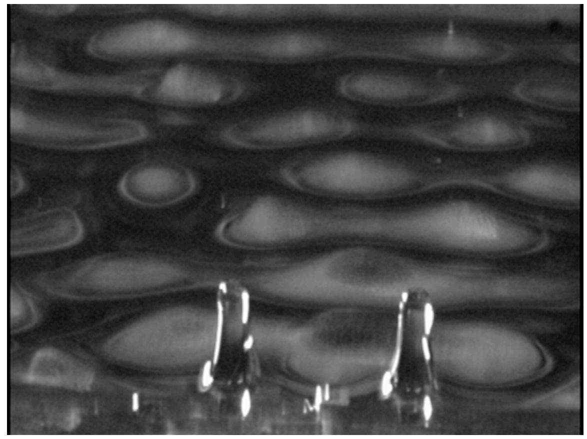
This work concerns the experimental study of acoustic interactions in two-phase media. We studied the behavior of solid particle o gas bubble immersed in liquid, which was forced by acoustic waves. We studied systems with relatively simple interactions, but intense enough such that the radiation pressure is not negligible. More specifically, the effects studied are nonlinear in pressure amplitude. The interactions result from the scattering of sound by the objects (particles or bubbles).

So we studied the self-adaptation of a single object in a near-to-resonance acoustic cavity (see Fig.); and we began to studied the collective behavior of many particles. Before my arrival, first very hopeful experiments were realized by Pr. Nicolás Mujica and his student María Luisa Cordero. But they had experimental problems with the friction between the ball and the acoustic cavity and other problems that they didn't understand. So the first thing we did was to try to minimize this friction factor, this objective was more complicate to reach that we thought. Then, we tried to realize clean experiments but we showed that problems of mechanical resonance could hided the acoustical resonance. So we progressed in the study of the self -adaptation of a single object in a near-to-resonance acoustic cavity but we couldn't do enough clean experiments to publish our results yet.



Some experiments concerning acoustic interactions have already been realized before. When two or more particles are introduced in the cavity more complex dynamical behaviors are observed, like particle aggregation, dipole formation, non-steady dynamics, and metastability between different geometrical configurations. These observations confirm that particles interact through acoustic waves; the radiation pressure force on a given particle is no longer the result of the cavity's standing wave plus its scattered wave, but now the scattered wave from other particles has to be considered. However, more systematic and better experiments was necessary. We first tackled this part with solid particles confined in a cavity with smoother walls. We also designed a second setup were spherical air bubbles was introduced in a water filled cavity.

Faraday instability



I also did a collaboration with Pr. Marcel Clerc and his postdoc on the Faraday instability. Parametric forcing of a variety of systems like fluids, granular matter, and mechanical systems have shown a rich variety of collective behavior, ranging from standing waves, hexagons and squares, spatio-temporal chaotic behavior to localized objects (see Fig.). In a Newtonian fluid when non-linear surface waves are parametrically excited with two resonant frequencies, we observe stationary highly localized (oscillon) structures. In a region of the phase space we observe experimentally a localized state with a background of patterns with a variety of different spatial symmetries. So, we proceed with an experimental study of this system, the numerical part was doing in parallel by a post doc of Pr. Marcel Clerc.

Experimentally, a similar experiment exists in 2D in the laboratory, so first we used it in order to realize a complete characterization of the phase diagram. We also studied a 1D configuration, in which the interactions between the different patterns are simplified.

We also participated to develop the adequate numerical tools to study this system. In particular, we developed realistic numerical description of this parametric forced system. For the classical problem of the Faraday instability, there is a reliable continuum description at the onset bifurcation by means of the amplitude equation. However, when the system is excited by two frequencies, its description is still an open problem and our work is likely going to be important. We are going to publish an article soon.

Benefits of the SCAT Project for me and my future

The central objective of theses projects, and of course of the laboratory, is research on the macroscopic behaviour of matter out of equilibrium from an experimental, numerical and theoretical point of view. This Laboratory with all the researchers that I met, and more generally the Universidad de Chile, appeared to me as a particularly favourable environment for such a research. I am sure that this post doctoral year financed by SCAT allowed me to expand my research experience in the field of Nonlinear Macroscopic Physic. But not only! This year also allowed me to learn Spanish, to improve my English, and to meet a whole community of excellent researchers with which, I am sure, I will stay in contact all my life.

And each point that I have detailed here are very important for me, because I really want to do my career in the academic research! And so this year allowed me to build a serious experience, essential to join academia.

Finally, there are already many collaborations between both French and Chilean researchers in the field of macroscopic physic, and I’m already gladden to be able to pursue these very rewarding collaborations.