Soutenance de thèse de Pablo Gutiérrez

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Effects on the free surface of a turbulent flow

Préparée au sein du Laboratoire SPHYNX, Service de Physique de l'État Condensé, CEA Saclay, et présentée le **12 septembre 2013 à 10h au CEA, amphithéâtre Claude Bloch** (Bât. 774, Orme des Merisiers), devant le jury composé de:

M.	Sébastien	Aumaître	CEA-Saclay	(Co-directeur de thèse)
M.	Mickaël	Bourgoin	LEGI, Grenoble	(Rapporteur)
M.	Olivier	Cadot	ENSTA	(Rapporteur)
M.	Christophe	Clanet	École Polytechnique	(Examinateur)
M.	François	Daviaud	CEA-Saclay	(Directeur de thèse)
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Le pot qui suivra aura lieu en salle de reunion SPHYNX.

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We study surface manifestations of a turbulent flow from an experimental point of view. Specifically we study a turbulent flow in a thin layer of fluid (a liquid metal) with free surface. The flow is generated with an electromagnetic force. It exhibits interacting vortices, shear bands and waves, depending on the forcing conditions. We explored two consequences of the horizontal turbulent motion as observed on the surface: Surface deformation itself; and the effects on floating particles.

Concerning the surface deformation: when the forcing strength is increased, we observe a linear increase of the surface level r.m.s. fluctuations up to 10% of the liquid layer thickness. Largest deformations, however, can reach a half of the layer thickness. At low forcing, surface deformation is mainly produced by vortices, thus it is asymmetric. This contrast to observations in random sea waves and wave turbulence, were an asymmetry appears as well, consequence of sharp crests in steep gravity waves. This difference is reflected in the skewness of probability distribution functions: negative in our case, and positive in wave turbulence. However, when increasing the forcing strength, the skewness tends to a positive value, very likely because of wave generation by the turbulent flow.

We considered another aspect of the wave-turbulence relation: we mechanically induced a monochromatic wave over the turbulent flow and we observed the enhancement of wave attenuation due to turbulence.

Concerning dynamics of floating particles: We observe that particles have the tendency to form clusters, and we confirm this observation by developing a statistical method based on the areas defined by the position of three nearest neighbors. This tool allows us to clearly identify particles belonging to a cluster. Indeed, clustered particles exhibit much stronger velocity and angular correlations than the unconditioned case. Several mechanisms are susceptible to induce clustering of floating particles. We identify i) particles' inertia, ii) upwelling/downwelling flows and iii) surface tension. For each mechanism we construct suitable quantities, which we correlate with the cumulated concentration of particles. These correlations suggest upwelling and downwelling motions as responsible for particles clustering.