Wind wave generation: Filtering role of a liquid interface

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Subject

When the wind blows over a liquid surface, it generates waves that emerge out of a sea of small amplitude perturbations called wrinkles. They are the footprint of air turbulence on the interface. In this process, the viscous liquid surface plays a crucial filtering role and sets the conditions of wave birth. What are the fundamental properties of these surface deformations and how can a perturbation emerge from this complex background? These questions are intimately linked with the current theory of wind wave generation that can be traced back to the 50?s (Phillips [3] and Miles [1]). Neither viscous effects nor the influence of a noisy initial state have been yet investigated. Only recent experiments performed at the FAST (Orsay) [2] have shown the crucial importance of both the liquid viscosity and of the wrinkles regime on the wave generation process.

Figure 1: Wind waves.

The internship will aim at understanding from a theoretical point of view how a viscous liquid filters the applied surface constraints either in time (viscous effects) or in space (gravito-capillary effects). We believe that this filtering operation plays a crucial role in the generation of wind-waves, and that significant advance can be made in that direction at the scale of a Master degree internship. The underlying theoretical framework is currently being developed at the LadHyX (Ecole Polytechnique), based on un-stationnary lubrication theory and wave equations with viscosity. The work may also involve toy-model numerical simulations that will be implemented with Gerris/Basilisk, a powerful software for numerical solving of free surface flow situations. The internship will be held in close connection with the experimental team of F. Moisy and M. Rabaud at the FAST laboratory (Orsay).

References

[1] J. W. Miles, *On the generation of surface waves by turbulent shear flows*, J. Fluid Mech., 7 (1960), pp. 469–478.

[2] A. Paquier, F. Moisy, and M. Rabaud, *Surface deformations and wave generation by wind blowing over a viscous liquid*, Phys. Fluids, 27 (2015), p. 122103.

[3] O. M. Phillips, *On the generation of waves by turbulent wind*, J. Fluid Mech., 2 (1957), pp. 417–445.