Postdoc position 2017-2019

Turbulence imprints on a viscous fluid

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Project page (movies and papers): www.fast.u-psud.fr/~moisy/windwaves
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When wind blows over a liquid surface, waves can be generated and propagate downstream. Even though this simple phenomenon has inspired over a century of research, understanding the physics of wind wave generation is still a challenge. Remarkably, even for a wind speed lower than the critical threshold for wave generation, it is known that the surface of a liquid subjected to a tangent air flow is never strictly plane: the surface is populated by small disorganized deformations of amplitude of the order of 1 - 10 μm, questioning the relevance of the wave generation problem in terms of instability. These microscopic deformations, called 'wrinkles', can be understood as the imprint on the surface of the fluctuating stresses (streaks) in the turbulent boundary layer in the air. We have characterized for the first time this wrinkle regime for a large range of liquid viscosity (Paquier et al., 2015, 2016) thanks to wind tunnel experiments using the Free-Surface Synthetic Schlieren (FS-SS) optical method. The FS-SS method, originally developed at laboratory FAST, is based on the image correlation of a refracted pattern, and allows to reconstruct the instantaneous shape of an interface with an unmatched resolution of the order of a micrometer (Moisy et al., 2009).

The objective of this post-doc is to develop analytical, numerical and experimental tools to understand and model these microscopic deformations. A first step is to model the effect of a localized stress perturbation on the surface of a viscous liquid. This requires an extension to the case of tangential stress of the classical work of Miles (1968) for a step pressure fluctuation. In a second step, these theoretical predictions can be tested in a simplified numerical configuration: assuming that the surface deformations remain of very small amplitude, the feedback on the boundary layer in the air can be neglected, and a linearized surface response can be computed. Finally, we want to address a fundamental question regarding the general problem of the formation of waves by the wind: is the threshold of wave generation triggered by the wrinkles, or are they two disjoint phenomena which simply coexist in a certain range of the experimental parameters? New experiments will be carried out to address this issue: we propose to modify the wind entry conditions, thus modifying the amplitude and the spatial structures of the boundary layer in the air, and investigate their impact on the wrinkles dynamics and on the onset velocity of waves.

Applicants should have a strong expertise in fluid mechanics, in particular in mathematical aspects. An expertise in numerical and/or experimental methods is also appreciated.

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M. Benzaquen, A. Darmon and E. Raphaël, Wake pattern and wave resistance for anisotropic moving disturbances, Physics of Fluids **26**, 092106 (2014).
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