

Research Topic for the ParisTech/CSC PhD Program

Field: Physics, Optics; Materials Science, Mechanics

Subfield: Applied Physics, Acoustics

ParisTech School: ESPCI Paris – PSL University

Title: Acoustic imaging and pumping in granular sediments

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Short description of possible research topics for a PhD:

Imaging and understanding the motion of an intruder or buried object inside opaque dense suspensions such as quicksand or ocean sediments are of practical and fundamental importance. In this PhD project, we use the ultrasonic echography with one or multiple elements to monitor the sinking dynamics of a steel ball in vibrated dense glass bead packings (3D) saturated by water [1,2]. Unlike a falling ball reaching a terminal velocity in Newtonian liquids (viscometer), the ball in gravitational granular suspensions may stop sinking at a given depth due to the yield stress, which depends on the packing density and confining pressure. We will investigate the ball motion fluidized by horizontal vibration (Fig. a) or by acoustic pumping within the framework of granular rheological models [3]. In particular, we will focus on the transition of granular sediments from solid state to liquid state resulted from a mechanism of acoustic lubrication that reduces the inter-particle friction and shear contact stiffness due to the micro-slip [4], without visible macroscopic rearrangement of grains as in usual liquefaction phenomena. This work also help a better understanding of landslides and avalanches caused by vibrations, related to human activities or to natural events such as volcanoes [5].

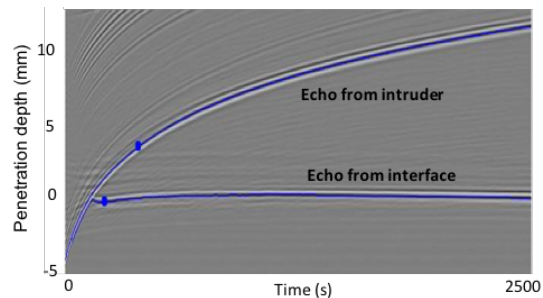
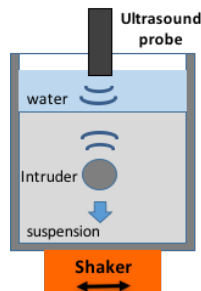


Figure : (a) Diagram of experimental setup

(b) Intruder sinking tracked by ultrasound

Required background of the student: a good background in physics in general and particularly acoustics and mechanics

A list of 5 (max.) representative publications of the group: author(s) of the group in bold

- [1] S. van den Wildenberg, **X. Jia**, J. Léopoldès, and A. Tourin, *Sci. Rep.* 9, 5460 (2019)
- [2] J. Brum, J.L. Genisson, M. Fink, A. Tourin & **X. Jia**, *Phys. Rev. E* 84, 020301 (2019)
- [3] B. Andreotti, Y. Forterre & O. Pouliquen, *Granular Media* (Cambridge University Press, 2013)
- [4] **X. Jia**, T. Brunet, J. Laurent, *Phys. Rev. E* 84, 020301(R) (2011); P. Johnson and **X. Jia**, *Nature* 437, 871 (2005)
- [5] J. Léopoldès, **X. Jia**, A. Tourin, A. Mangeney, *Phys. Rev. E* 102, 042901 (2020)