Surface du Verre et Interfaces
CNRS/Saint-Gobain

PMMH
ESPCI/PSL/CNRS/Sorbonne Univ./Univ. de Paris

Institut Jean Le Rond ∂'Alembert
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Ph.D. Thesis (funded): Mixing in granular systems (COPERMIX ITN project)

Granular materials are ubiquitous as industrial raw materials. Often industrial processes require a homogeneous material. It is obtained by blending different powders or grains, however, less effort has been made to propose a hydrodynamic description of the mixing than with the classical fluids.

The Ph.D. project will focus on the dispersion of grains experimentally in a 2D system. How is the system homogenized by the chaotic flow produced by a rod and what is the coupling with the shear-induced diffusion?

The objectives are to understand the role of the trajectory of the blade and to model the evolution of the local concentration of one type of the grains. The expected results are the ability to link the velocity field and the Lagrangian trajectories to the homogenization. We will follow the fluid mechanics approach which models the stirring and mixing of Newtonian fluids, but not yet applied to granular materials.

We will study the dispersion of grains with the same properties. The student will measure and follow the grain trajectories at short timescale to estimate the diffusion and at longer time scale for the homogenization. We will use a 2D set-up developed in a previous PhD, made of small cylinders on a horizontal glass plate. In the first steps, the student will characterize the mean displacements, then the diffusion around those trajectories. For example, we have identified that the packing fraction drastically modifies the displacement field and consequently changes the homogenization rate. Finally, analysis tools from the chaotic mixing (combining stretching and diffusion) will be used to model the evolution of the granular system.

This subject is related both to the fluid mechanics and to the mechanics of granular materials. While it will extend the hydrodynamic approach of the mixing of Newtonian fluids, we must take into account the specific properties of the shear induced diffusion.

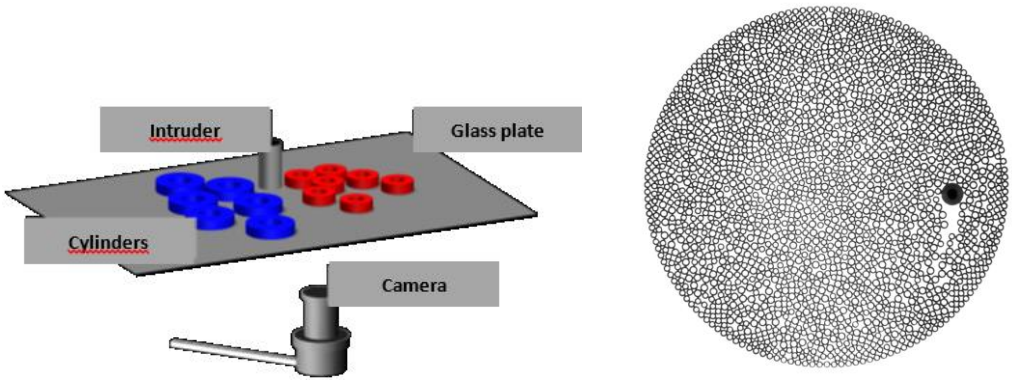

Figure 1: (left) Schematic of the experiment. (right) Horizontal 2D granular mixture.

These academic works will be discussed with Saint-Gobain researchers facing mixing issues, for example in glass batch or in building materials. The results could provide recommendations for industrial processes or be implemented in numerical scheme of continuous media codes. As part of a European Union's Project, COPERMIX, strong interactions with the other PhD are expected inside the network https://www.copermix-itn.eu/ , details for application (mail + euraxess) https://euraxess.ec.europa.eu/jobs/801689

We look for a good master student in fundamental sciences, keen on experiments, with a good communication. The student will be hired as a PhD by Saint-Gobain Recherche. The student must not have spent more than 12 months in France over the last 36 months.

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