Granular Media: Complex Systems of Physics

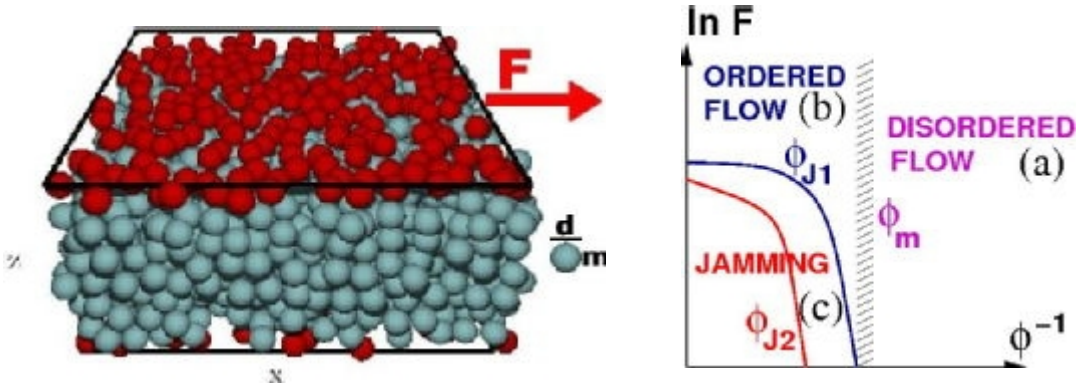
Miniprojects with Mario Nicodemi

Granular media, such as powders or sands, fall in the class of *complex systems*. They are the second most dealt with material in human activities (after water) with substantial industrial applications. Yet, a theory of their equilibrium and off-equilibrium properties remains still elusive and raises important issues of basic science.

Two mini-projects are available, suited to become a full PhD research project. They consist in developing *theoretical methods* and/or *computer simulations* on the topics summarized below. Details to be discussed with supervisor. A good background in math/phys and/or computation is required.

Rheology of Granular Media

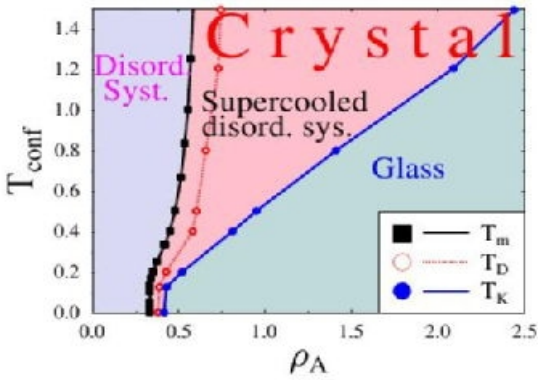
The rheology of granular suspensions is currently focus of intense research. We envisaged that it is characterized by three sharply separated regimes: (a) disordered grain flow, (b) ordered grain flow and (c) grain jamming. The project consists in exploring the properties of these regimes.



Selected references:
D.S. Grebenkov, M. Pica Ciamarra, M. Nicodemi, A. Coniglio, *"Flow, ordering, and jamming of sheared granular suspensions"*, **Phys. Rev. Lett. 100**, 078001 (2008)

Statistical Mechanics of Granular Media.

Granular media are non-thermal systems and standard thermodynamics cannot be used for their description. It has been proposed that granular systems could be described via a generalized Statistical Mechanics approach where time averages are replaced by suitable ensemble averages. The project concerns the investigation of such a theory.



Selected references:
P. Richard, M. Nicodemi, R. Delannay, P. Ribiere, D. Bideau, *"Slow relaxation and compaction of granular systems''*, **Nature Materials 4**, 121 (2005)
M. Pica Ciamarra, A. Coniglio, and M. Nicodemi, *"Thermodynamics and Statistical Mechanics of Dense Granular Media''*, **Phys. Rev. Lett. 97**, 158001 (2006)
M. Nicodemi, *"Dynamical response functions in models of vibrated granular media''*, **Phys. Rev. Lett. 82**, 3734 (1999)