

## Research Topic for the ParisTech/CSC PhD Program

**Subfield:** Applied Physics

**ParisTech School:** ESPCI Paris (Langevin Institute)

**Title:** Acoustic monitoring and triggering of avalanches in granular media

**Advisor(s):** Professors X. Jia ([xiaoping.jia@espci.fr](mailto:xiaoping.jia@espci.fr)) and J. Léopoldès ([julien.leopoldes@espci.fr](mailto:julien.leopoldes@espci.fr)), <https://www.institut-langevin.espci.fr>

### **Short description of possible research topics for a PhD:**

Laboratory studies of granular materials have emerged as a powerful tool for investigating dynamics of seismic faults [1] (Fig. 1a), such as local and remote dynamic triggering of earthquakes [2]. However, the physical origin of dynamic triggering still remains a challenging issue due to small strain amplitude of impinging seismic waves. Advances in granular physics and acoustics lead to the emerging view that dynamic perturbation of sheared granular materials causes a material softening (Fig. 1b) and that fault slip can be considered as unjamming transition (solid-to-liquid states) [3] induced by the acoustic fluidization [4]. Here we investigate the shearing instability along the free surface of granular media, namely avalanches (Fig. 1c) by acoustic probing of precursor events and also study their triggering by impinging elastic waves via nonlinear acoustic pumping. Prior to the shear failure, we will measure the shear wave velocity softening and use the correlation function of the multiply scattered coda waves to monitor the stick-slip like rearrangement of granular networks [5,6], together with the passive detection of acoustic emission. At the same time, we will study the onset of avalanches triggered far below the static threshold by the acoustic lubrication of the contact area between solid particles [7].

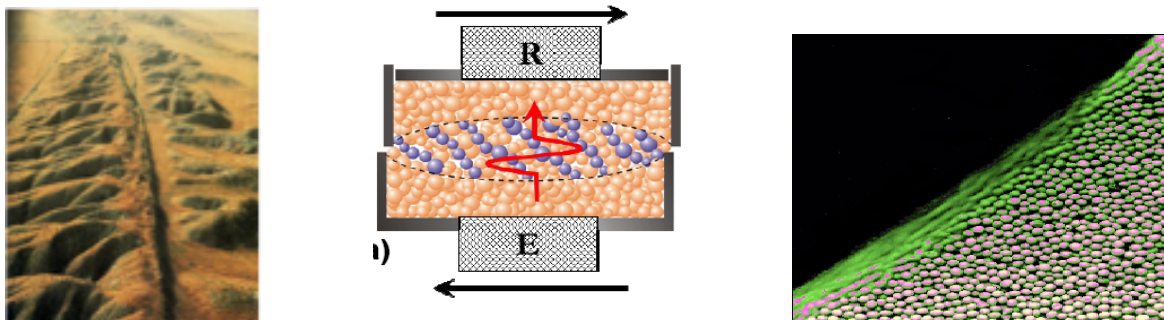


Fig. 1a) San Andreas fault      b) Acoustic probing of shear banding      c) Granular avalanche

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

- [1] C. Marone, *Ann. Rev. Earth & Plan. Sci.* 26, 643 (1998)
- [2] P. Johnson and **X. Jia**, *Nature* 437, 871 (2005)
- [3] H. Jaeger, S. Nagel, R. Behringer, *Rev. Mod. Phys.* 68, 1259 (1996)
- [4] **X. Jia**, T. Brunet, J. Laurent, *Phys. Rev. E* 84, 020301(R) (2011)
- [5] Y. Khidas and **X. Jia**, *Phys. Rev. E* 85, 051302 (2012)
- [6] **X. Jia**, C. Caroli, B. Velicky, *Phys. Rev. Lett.* 82, 1863 (1999) & *PR Focus* 3, story 12
- [7] **J. Léopoldès**, G. Conrad, **X. Jia**, *Phys. Rev. Lett.* 110, 248301 (2013)

**Required background of the student:** Physics or Acoustics or Mechanics