Ph. D proposal 2017

Interplay between damage and friction weakening during earthquake initiation:

from laboratory experiment to numerical modeling

Earthquake sliding occurs naturally in response to long-term deformation produced by plate tectonics; they may also be triggered by human activities related to natural resource extraction that affect the stress field and damage the rocks. However, the way the damage of the medium and the cohesiveness of the damaged rocks control the slip behavior and the seismic patterns is not well understood.

This thesis is part of an interdisciplinary effort involving seismology, geodesy, mechanics and applied mathematics in the framework of the F-IMAGE project supported by ERC (PI: Michel Campillo, Université Grenoble-Alpes). In this context, this thesis will address the challenge of a unified model able to describe the earthquake initiation (nucleation) from both fault friction and bulk damage. The main objective of the thesis is to study the interplay between these two aspects, through the joint analysis of data obtained in controlled laboratory experiments and the quantitative implications of new theoretical and numerical models of slip evolution.

A series of laboratory shear experiments will be performed to study the slip behaviour for different media with mechanical state ranging from cohesive to granular. The acoustic emission during fracture process (seismic activity) will be also detected and processed in the same way as actual seismological data are processed. The experiment results will be analyzed in the theoretical perspective of the behaviour of a frictional interface in a damaged medium. A discontinuous Galerkin strategy for the numerical modelling of damage and wave propagation will be also developed. The numerical and theoretical description of the instabilities, related to the weakening of both the friction and the damaged host rocks will be related to earthquake initiation (nucleation) dynamics and duration.

This work will develop in parallel to the other aspects of the same project, namely seismic characterization of damage, monitoring of apparent elastic properties and micro-earthquake detection in the vicinity of actual active fault systems.

We seek a motivated candidate with a strong background in at least one of these fields: seismology, mechanics, wave physics, and numerical analysis. The candidate will register with Université Grenoble-Alpes. The experimental work will be done at Institut Langevin (ESPCI Paris) where the candidate will be based for at least the two first years. He will visit Grenoble on a regular basis.

Contact and supervision: M. Campillo (Institut des Sciences de la Terre, Université Grenoble-Alpes, CNRS, *michel.campillo@univ-grenoble-alpes.fr*), I.R. Ionescu (Laboratoire des Sciences des Procédés et des Matériaux, Université Paris 13, CNRS, *ioan.r.ionescu@gmail.com*), X. Jia (Institut Langevin, ESPCI Paris, CNRS, *xiaoping.jia@espci.fr*)

Funding: European Research Council (ERC)