GDRI: *ECO-Math*

Project 2017

Stochastique et interférences avec EDP et théorie du Potential

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Activites:

- 2 visites scientifiques de deux semaines a l'Universite Paris 13
- 2 visites scientifiques d'une semaine a l'IMAR
- l'organisation d'un atelier de travail à Bucarest, en aout-septembre 2017.

Articles:

[1] L. Beznea and O. Lupascu, Measure-valued discrete branching Markov processes, *Trans. Amer. Math. Soc.* **368** (2016), 5153-5176.

[2] I. R. Ionescu and O. Lupascu, Modeling shallow avalanche onset over complex basal topography, *Advances in Computational Math. 42* (2016), *5-26.*

[3] L. Beznea, M. Deaconu, and O. Lupascu, Stochastic equation of fragmentation and branching processes related to avalanches, *Journal of Statistical Physics* **162** (2016), 824-841.

[4] I. R. Ionescu and O. Lupascu, Onset of a dense avalanche on a plane slope, *Proc. Romanian Academy* **16** (2015), 405-412.

[5] L. Beznea, M. Deaconu, and O. Lupascu, Branching processes for the fragmentation equation, *Stochastic Processes and their Applications* **125** (2015), 1861-1885.

Projet de recherche

Processus de branchement-fragmentation et leur EDP

Branching-fragmentation processes and their PDEs. Fragmentation is a real life phenomenon which is present in various sciences, the soil fracture in geophysics being one example. In last few years, a lot of efforts in geophysics and engineering have been devoted to the understanding of the physics of avalanche formation and to the shallow flow of soils, snow or other geomaterials over an inclined surface. Reduced 2-D models, called also Saint-Venant models, are generally considered. Such models are able to capture the principal features of the flow: onset, dynamic propagation and arrest. The associated shallow yield criterion was used in [2] and [4] to define a "safety factor" (or a limit load) which characterizes whenever the fluid/solid flows form a rest configuration. The onset of the avalanches is viewed as a fragmentation process modeled by a nonlinear PDE. We intend to consider a new meshless numerical method for solving the generalized Cheeger problem (the safety factor and the collapse domain) modeling landslides, snow avalanches and other geophysical flows.

Basic tools for the models and the time evolution are specific differential equations and more recently stochastic differential equations. In [3] it was given a stochastic model for the fragmentation phase of an avalanche. We constructed a fragmentation-branching process related to the avalanches, on the set of all fragmentation sizes of Bertoin, fragmentation process constructed in [5], by approximation with branching Markov processes studied in [1]. A fractal property was emphasized. However, it was considered only the fragmentation process and not the dynamic evolution of the positions of the fragments.

In the present collaboration project, we intend to study fragmentation processes depending on several fragmentation kernels and on the position of the fragments in a given space, where a spatial movement given by a Markov process is fixed. The original element of considering multi-fragmentation processes has a strong motivation in the above relation we intend to show. Namely, the real-life model of a material rupture indicates that at each space position not only the fragmentation of the material occurs but also the energy is “fragmented”. Space position dependence have been previously considered rather for coagulation processes than for fragmentation. The final goal is to complete the above probabilistic approach with a numerical simulation