SCHOOL OF ARCHITECTURE, CIVIL AND ENVIRONMENTAL ENGINEERING (ENAC)

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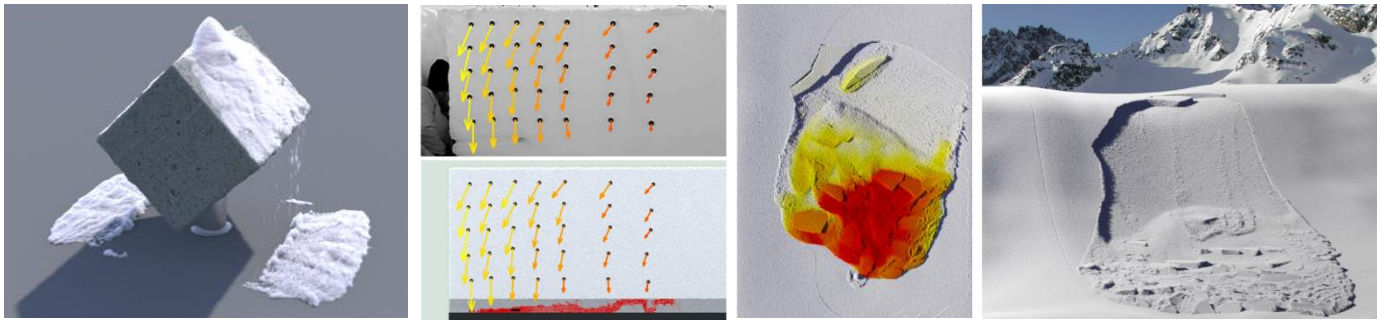
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Positions (2 PhD and 1 PostDoc) in Computational Snow and Avalanche Mechanics (Prof. J. Gaume)



The new group of Prof. J. Gaume at the Swiss Federal Institute of Technology of Lausanne (EPFL, Switzerland) invites applications by highly motivated, committed, and talented students/researchers for 2 PhD and 1 PostDoc positions in the field of computational mechanics for snow and avalanche modeling.

This group was created in the framework of the SNSF Eccellenza project "Unified modeling of snow and avalanche mechanics using the Material Point Method". The group focuses on the development of new mechanical models to simulate and improve our understanding of snow and avalanche mechanics using a multi-scale framework. Simulations of snow microstructure deformation and failure will allow to define homogenized elastoplastic constitutive models which will be used to study crack nucleation and propagation, avalanche release and flow dynamics at the slope scale. Our simulations are based on the Material Point Method (MPM), a hybrid Eulerian-Lagrangian method particularly well suited to simulate large deformations, fractures, collisions and solid-fluid transitions. It was successfully used to model snow in the Disney movie "Frozen" (Stomakhin et al. 2015, SIGGRAPH) and complex processes involved in avalanche mechanics (Gaume et al. 2018, Nature Communications).

The group collaborates closely with different teams of the WSL Institute for Snow and Avalanche Research SLF (Davos) for experimental validations and model comparisons, with the Department of Mathematics of UCLA and the Computer Science Department of UPenn for MPM simulations as well as with other EPFL laboratories (CRYOS, LSMS).

The following PhD and PostDoc positions are opened (details in the next pages):

1. **PhD Position** in "Computational and constitutive modeling of snow mechanics" (4 years)
2. **PhD Position** in "Computational mechanics for crack propagation and snow avalanche release" (4 years)
3. **PostDoc position in** "Computational mechanics for snow avalanche dynamics" (funded for 2.5 or 3 years)

For more information, please contact Prof. Gaume: johan.gaume@epfl.ch.

To apply, please send your application, including CV, motivation statement, a 1 to 2 pages summary of MSc thesis (for PhD positions) or of your PhD thesis (for the PostDoc position), names and contact information of two (for PhD positions) or three (for the PostDoc position) references as well as the transcript of your MSc grades as **one single pdf file** to johan.gaume@epfl.ch before January 14st 2019.

1. PhD Position in "Computational and constitutive modeling of snow mechanics" (4 years)

You will perform mechanical simulations of snow microstructure based on finite strain elastoplasticity (for the ice matrix) and the Material Point Method. Data of snow microstructures obtained through X-ray computer tomography at the SLF will be used as input geometry. You will analyze the influence of snow type, density, anisotropy on i) the stiffness tensor; ii) the yield surface and iii) the post-peak behavior of the samples for loading rates involved in natural and artificial snow avalanches. This will lead to the development of a fully homogenized elastoplastic constitutive model accounting for the ductile-to-brittle transition in snow able to reproduce classical snow behaviors such as compaction hardening but also more complex processes such as the propagation and reflection of compaction bands (Barraclough et al. 2017, Nature Physics). Results will be validated by comparing MPM simulations to laboratory experiments. You will publish your results will in renowned scientific journals, present them at international conferences and promote their transfer into practice.

Candidates should hold a Master's degree in (computational) mechanics, (computational) physics or computer science (or equivalent). Background/experience in solid mechanics, numerical modeling and c++ is mandatory. Additional experience with continuum numerical methods for solving partial differential equations such as the Finite Element Method and/or the Material Point Method is an advantage. The candidate should have very good English skills and excellent communication capabilities as most tasks will be done in collaboration with the other students and researchers of the group as well as with several external collaborations through exchange visits (SLF, UCLA, UPenn).

The position is funded for 4 years for a salary of approx. 50 kCHF annual.

2. PhD Position in "Computational mechanics for crack propagation and snow avalanche release" (4 years)

You will investigate crack propagation in snow in view of predicting snow slab avalanche release size. The work will mainly consist in performing numerical simulations based on finite strain elastoplasticity and the Material Point Method. Simulations of 2D and 3D ideal slopes will be performed to study the effect of snowpack stratigraphy, mechanics (constitutive model parameters), topography (angle, curvature) and triggering mode (skier or bombing) on dynamic crack propagation and on the size and shape of the avalanche release zone, information which is currently missing in engineering approaches for avalanche hazard assessment. The final goal will be to relate the avalanche release size to field measurable quantities by relating output from the numerical simulations with results from small scale fracture mechanical experiments (critical crack length, propagation speed and distance), avalanche observations and terrain parameters. Simplified physically-based parametrizations will be developed to reproduce simulation results in view of introducing an avalanche release size index in the snow cover model SNOWPACK to improve avalanche forecasting. You will publish your results in renowned scientific journals, present them at international conferences and promote their transfer into practice.

Candidates should hold a Master's degree in (computational) mechanics, (computational) physics or computer science (or equivalent). Background/experience in solid mechanics, numerical modeling and c++ is mandatory. Additional experience with continuum numerical methods for solving partial differential equations such as the Finite Element Method and/or the Material Point Method is an advantage. The candidate should have very good English skills and excellent communication capabilities as most tasks will be done in collaboration with the other students and researchers of the group as well as with several external collaborations through exchange visits (SLF, UCLA, UPenn).

The position is funded for 4 years for a salary of approx. 50 kCHF annual.

3. PostDoc position in "Computational mechanics for snow avalanche dynamics" (2.5 or 3 years)

You will investigate the effect of snow mechanical properties on avalanche dynamics using MPM simulations and finite strain elastoplasticity. Different snow types will be used as input of large-scale ideal 2D and 3D avalanche simulations to study how snow mechanical properties affects the avalanche flow rheology, snow entrainment and their complex interplay. This will allow to improve simplified rheological and entrainment models used in avalanche dynamics engineering approaches in order to refine run-out distance and impact pressure estimates required for avalanche risk management. Furthermore, real-scale avalanches will be simulated based on remote sensing data of terrain and snow depth at a fully instrumented test site (Vallée de la Sionne in Valais) and existing simulations of a distributed snow cover (Alpine3D). The avalanche release sizes, run-out distances and pressures obtained in the simulations will be compared to the experimentally measured ones. Finally, you will explore the explicit coupling between snow and air with MPM to simulate the turbulent aerosol in powder-snow avalanches. You will publish your results in renowned scientific journals, present them at international conferences and promote their transfer into practice.

Candidates should hold a PhD in (computational) mechanics, (computational) physics or computer science (or equivalent). Background/experience in solid and/or fluid mechanics, numerical modeling and c++ is mandatory. Additional experience with avalanche dynamics and with continuum numerical methods for solving partial differential equations such as the Finite Element Method and/or the Material Point Method is an advantage. The candidate should have very good English skills and excellent communication capabilities as he will contribute to the supervision of 2 PhD students and MSc students of the group and will be involved in several external collaborations through exchange visits (SLF, UCLA, UPenn).

The position is funded for 2.5 years for a starting salary of approx. 80 kCHF annual. It is also possible to apply for 80% working time for 3 years funding.