59th MSS-Seminar
Wednesday, March 19th, 15:30, Nägelsbachstr. 49b

MSS

Solid Mechanics of Snow and Avalanches

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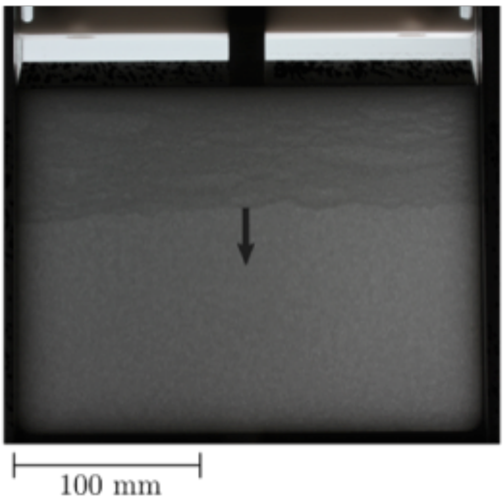

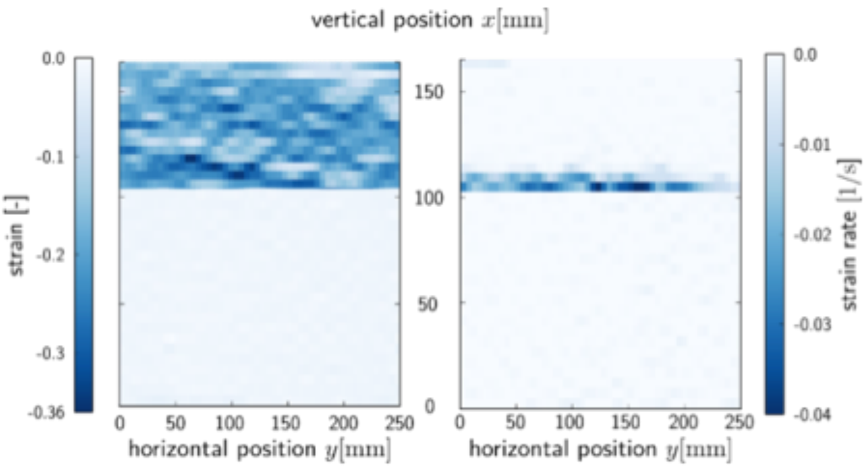

The mechanical behavior of snow is unusual because (i) snow is "in between" granular materials and open-cell solid foams, and (ii) snow as a material is typically operated at extremely high homologous temperatures. Because of (i), snow may under load undergo a transition from a stronger, less dense "solid foam-like" microstructure to a weaker, more dense "granular liquid-like" microstructure. Because of (ii), the granular liquid may solidify due to rapid sintering processes which occur on the time scale of seconds to minutes.

We first discuss uniaxial compression experiments which exhibit complex spatio-temporal strain localization phenomena. Deformation is characterized by repeated nucleation and propagation of compaction bands which repeatedly nucleate and propagate across the sample. Band nucleation and/or reflection of bands at the sample boundaries are accompanied by stress drops which punctuate the stress strain curve. A constitutive model is formulated which quantitatively reproduces all features of this oscillatory deformation mode. To this end, a well-established compressive plasticity framework for solid foams is generalized to account for shear softening behavior, time dependence of microstructure (`rapid sintering') and non-locality of damage processes in snow.

We then apply the same framework to the rapid deformation of a weak layer in stratified snow under gravitational load and demonstrate a transition between a stable stationary and a propagating deformation pattern with indefinite shear deformation. The saddle-point configuration can be interpreted as a critical crack with negative crack opening displacement in mixed shear-compression loading ("anticrack"), and the transition corresponds to the release of a snow slab avalanche.