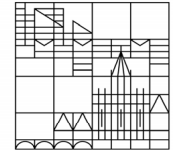# Physikalisches Kolloquium

Universität Konstanz

Prof. Dr.Jörg Rottler
University of British Columbia,
Vancouver, Canada

Di 30.05.23
15:15 Uhr
P 603
im Anschluss Getränke und Snacks

The nonequilibrium physics of driven amorphous materials

This talk will describe the yielding transition in disordered solids, a nonequilibrium phase transition between arrested and flowing states of matter. In the limit of slow driving and in the absence of thermal excitations, this transition exhibits spectacular collective effects: the material responds highly intermittently and dissipative events organize in the form of avalanches with scale free correlations that can be described using the language of critical phenomena. Such behavior is encountered in many condensed matter systems with disorder, such as magnetic domain walls, contact lines, vortices in superconductors, and earthquakes. Using particle scale simulations, we will first explain the elementary processes and nature of mechanical excitations that underpin this behavior in amorphous matter. We then develop mesoscale lattice (cellular automaton) models that highlight the universal nature of this critical point, and that allow one to test scaling arguments. Our current theoretical understanding culminates in a set of critical exponents and scaling relations that link the statistics of avalanches to the distribution of local stability in the material.

The second part of the talk will explore how temperature and finite shear rate introduce new time scales into the system that reduce criticality, and instead lead to new dynamical phases. We develop a nonequilibrium phase diagram that captures how temperature and strain rate effects compete, when avalanches overlap, and whether finite-size effects dominate over temperature effects. This allows for an interpretation of the macroscopic flow curve, i.e. the relation between the steady state shear stress and shear rate. We conclude by showing that much of this behavior can be captured with a mean-field description that further coarse grains the lattice model into a dynamical equation for the probability density of the local load.
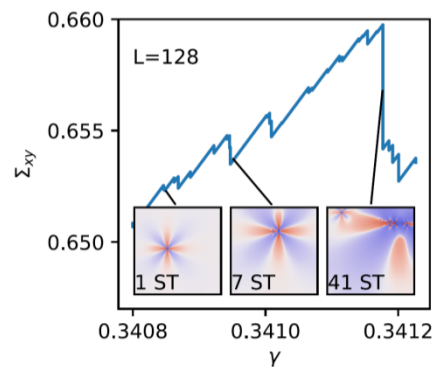

FIG. 1. Segment of a stress-strain curve obtained from the elasto-plastic model with $L = 128$. Stress drops correspond to plastic rearrangements comprised of shear transformations. Insets: Plastic activity in the model for different sizes of stress-drop. Larger avalanches tend to form linelike events.

Host: Prof. Fuchs

Organisation: Prof. Bechinger