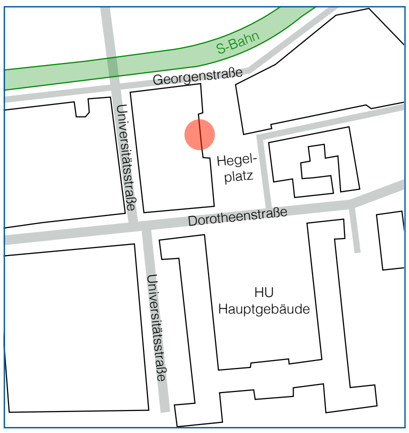

# Colloquium in Honor of the 60th Birthday of ***Alexander Mielke***

## *September 26, 2018*

| | |
|---|---|
| ***2.15 pm*** | **Welcoming address by**<br>Helge Holden (NTNU and IMU)<br>Manuela Urban (Forschungsverbund Berlin)<br>Christof Schütte (ZIB and MATHEON)<br>Michael Hintermüller (WIAS and HU Berlin) |
| ***2.45 pm*** | **Mixed Lagrangian-Eulerian formulations**<br>Ulisse Stefanelli (U Vienna) |
| ***3.30 pm*** | Coffee break |
| ***4.15 pm*** | **Rate-independent systems in the context of damage and fracture**<br>Dorothee Knees (U Kassel) |
| ***5.00 pm*** | **Onsager reciprocity, gradient flows, and large deviations**<br>Mark A. Peletier (TU Eindhoven) |

Humboldt-Universität zu Berlin
Universitätsgebäude am Hegelplatz
Dorotheenstraße 24
Lecture room 1.101




Contact: alex2018@wias-berlin.de

Weierstraß-Institut für Angewandte Analysis und Stochastik

ECMath Einstein Center for Mathematics Berlin

SFB 910

CRC 1114

Universität Stuttgart

DFG Deutsche Forschungsgemeinschaft

### Dorothee Knees (U Kassel)

Rate-independent systems in the context of damage and fracture

Models describing the damage evolution and failure of brittle materials typically belong to the class of rate-independent systems. Such systems have the property that after rescaling (w.r.t. time) the data and solutions in the same way the rescaled solutions solve the rescaled system.

In the first part of the lecture we give a short introduction to rate-independent systems. Of particular interest are systems, where certain underlying energies are not convex. In this case solutions might be discontinuous in time even if the given data is smooth in time. There is an active debate about possible (weak) solution concepts that allow for dis continuities. Suitable jump criteria have to be developed that select trajectories with a physically reasonable jump behavior. We will provide an overview of the most popular solution concepts and illustrate them with some examples.

In the second part of the lecture we transfer these concepts to damage models and discuss the additional analytic challenges that arise for this particular class of models. If time permits we will also address the question of suitable discretization schemes.

### Mark Peletier (TU Eindhoven)

Onsager reciprocity, gradient flows, and large deviations

The second law states that in a thermodynamically consistent system the 'entropy' is a Lyapunov function, a function which is monotonic along solutions of the corresponding differential equations. When the system can be written as a gradient flow of the entropy, then this statement is strengthened: not only is this functional monotonic, but it drives the dissipative part of the evolution in a precise way, mediated by a 'friction operator'.

In this talk I will go one step further. Onsager already pointed out how symmetry properties of linear friction operators arise through an upscaling procedure from a microscopic-reversibility property of the underlying system. Fluctuations figure centrally in his argument, but at that time their theory was not well developed, and more could not be said.

However, recently we have found that the connection between microscopic reversibility and macroscopic 'symmetry' properties is not at all limited to the close-to-equilibrium, linear-friction- operator context of Onsager's. I will describe how the large-deviation theory of fluctuations allows one to make a much more general statement, where microscopic reversibility is one-to-one coupled to „symmetry" at the macroscopic level - provided one generalizes the concept of symmetry in an appropriate way.
This is joint work with Michiel Renger and Alexander Mielke (both WIAS, Berlin).

### Ulisse Stefanelli (U Wien)

Mixed Lagrangian-Eulerian formulations

In presence of finite strains, reference and actual configurations need to be distinguished. This is particularly relevant when mechanics is combined with other effects, requiring to simultaneously deal with both Lagrangian and Eulerian variables. Magneto-elastic materials are a first example in this direction, for the energy is defined in terms of deformation (Lagrangian) and magnetization (Eulerian). Other examples are nematic polymers, where the Eulerian variable is the nematic orientation, and piezoelectrics, which involve the Eulerian polarization instead. In fact, an interplay of Lagrangian and Eulerian effects occurs already in case of space-dependent forcings, as well as in some specific models of finite plasticity, where plastic deformations compose with the elastic ones. Mixed Lagrangian-Eulerian formulations arise in fluid-structure interaction, where the deformed body defines the (complement of the) fluid domain, and in solid-solid phase change, in case actual phase interphases are considered. I will present some classical and recent results on the topic.