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PREFACE: RATE-INDEPENDENT EVOLUTIONS

The term *rate-independent* is usually referred to time-dependent processes which are invariant under time rescaling. In other words, the output of the process is *independent of the rate* at which the input assumes its values. This feature is common to many physical and engineering systems which do not possess, or possess a very small, internal relaxation time and hence react immediately to the change of external conditions.

Rate-independent systems are ubiquitous in applications. For instance, they arise in elasto-plasticity, phase transformation in shape-memory alloys, fracture propagation, delamination and damage phenomena, ferromagnetism and ferroelectricity, just to mention a few hot topics. The applicative relevance of rate-independence has triggered an intense mathematical research, from the original mathematical theory of *hysteresis* and *sweeping processes* to the more recent *energetic* variational approach.

This issue contains a selection of articles devoted to the mathematical treatment of rate-independent evolution systems. Being necessarily far from giving a complete representation of the current research in this very active field, to our view this issue brings a clear picture of what is the standpoint and which will be the future research lines for the rate-independent community. In particular, the interplay between a more theoretical, variational point of view with the exciting challenges coming from the applications in plasticity, shape-memory alloys, and fracture emerges as a clear trend.

Papers collected here span a relevant variety of different aspects by advancing a number of new results, techniques and perspectives. A new variational characterization of rate-independent flows is advanced by Visintin within the frame of the so-called Fitzpatrick representation theory. In particular, stability of flows with respect to perturbations is specifically addressed. A second characterization analysis is provided in the paper by Rossi & Savaré where the notion of *BV-solutions* is compared with more classical *energetic solutions* in a one-dimensional setting. We gather in this first group also the paper by Krejčí where some material on the structure and the inversion of the classical Preisach operator is provided.

A second group of papers in this collection deals with applications to plasticity. Conti, Dolzmann, & Kreisbeck analyze a three-dimensional model of finite crystal plasticity with one slip system and identify it as the Γ-limit of a family of elastic models with large elastic constants. Homogenization in strain-gradient plasticity is addressed in the paper by Francfort, Giacomini, & Musesti by means of H-convergence arguments. The delicate coupling of thermal effects and perfect plasticity is considered by Roubíček in the frame of linear viscoelastic solids. Moreover, the paper by Sullivan, Koslowski, Theil & Ortiz addresses the effective behavior of a rate-independent process in contact with a heat bath.

Two papers are devoted to a similar variational model for irreversible incomplete damage. The nonconvexity of the model calls for some delicate mathematical treatment. In the paper by THOMAS this is achieved by means of a regularization of the problem in BV spaces. The limiting case of brittle materials is then described by means of a Modica-Mortola type Γ-convergence argument. On the other hand, FIASCHI proceeds without regularization but is forced to frame the problem in the setting of Young measures. In particular, the existence of a measure-valued solution to the problem is achieved.

A final group of contributions deals with crack propagation. The principle of *Local Symmetry* as a governing mechanism for planar mixed mode fracture is considered in the paper by NEGRI where an existence proof a suitably regularized dynamics is proposed. The issue of local minimality in the specific context of crack propagation is addressed by LARSEN who presents some material in the direction of the notion of ε-stability. A locally minimal quasistatic evolution of cracks is proved to exist by LAZZARONI & TOADER by means of a vanishing-viscosity approach in the case of varying applied forces. Finally, a thorough analysis of discrete schemes for the quasistatic propagation of a single crack in elastic materials by Griffith criterion is recorded by KNEES & SCHRÖDER. Convergence of fully-discrete solutions is proved, the relation between the different discretization and material parameters is investigated, and numerical evidence is provided.

We believe this collection to be witnessing the current development of this field by specifically focusing on some of the major open research directions. As such, we are happy to express once again our gratitude to all Authors and Referees for their truly valuable contribution to this issue.

Guest Editors:
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