Minisymposium 9 - Nichtlineare Evolutionsgleichungen und Probleme mit freiem Rand

A non-local degenerate parabolic system arising from strain-gradient plasticity

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Size effects which metals display at micron length-scales are typically described by strain-gradient dependent theories, one of which has been recently proposed by Gurtin (J. Mech. Phys. Solids, 2004): it is characterized by a free energy which depends on the density of dislocations through the Burgers tensor (the curl of the plastic displacement gradient) and which is dissipated through the plastic spin (the time derivative of the skew part of the plastic displacement gradient). Under suitable symmetry assumptions, this model leads to a non-local and degenerate parabolic system complemented with mixed boundary conditions. I will describe the gradient flow structure of the problem and how it leads to the existence and uniqueness of solutions, as follows from a joint work with Michiel Bertsch (IAC-CNR and U. Rome "Tor Vergata"), Roberta Dal Passo and Giuseppe Tomassetti (U. Rome "Tor Vergata"). I will also discuss heuristics and open questions related both to the presence of interfaces — the boundaries of dislocation-free regions — and to two singular limits: the first one, as the ratio between the microscopic length-scale associated with the Burgers tensor and the macroscopic size of the sample vanishes, is expected to produce boundary layer effects; the second one, as the model approaches a rate-independent formulation, brings out a prototype for (possibly non-local) "infinity-curl^2" operators and their evolution.