Abstract. The workshop brought together researchers from geometry, non-linear functional analysis, calculus of variations, partial differential equations, and stochastics around a common topic: systems whose evolution is driven by variational principles such as gradient or Hamiltonian systems. The talks covered a wide range of topics, including variational tools such as incremental minimization approximations, Gamma convergence, and optimal transport, reaction-diffusion systems, singular perturbation and homogenization, rate-independent models for visco-plasticity and fracture, Hamiltonian and hyperbolic systems, stochastic models and new gradient structures for Markov processes or variational large-deviation principles.

Mathematics Subject Classification (2010): 35A15, 35Qxx, 49xx, 74xx, 60F10, 60H15, 26Dxx, 82xx.

Introduction by the Organisers

The variational approach to evolutionary systems provides one of the most interesting areas of mathematical research, as it combines geometric information, such as metric or more general dissipation structures, with energy landscapes and functional analysis in infinite-dimensional spaces. Thus it opens up new approaches and mathematical fields for studying evolutionary systems, which already generated a lot of original contributions from various points of view in the pure and applied fields.

In the last decades many problems concerning evolutionary PDEs, modeling of mechanical and biological phenomena, fluid and transport dynamics, stochastic behaviour of many-particle systems, geometric evolution, Hamiltonian, dissipative
and rate-independent flows, have been studied by new and various variational techniques, with a clever combination of well established tools and new ideas.

These investigations have stimulated a fruitful interaction between the classical approaches of PDE’s, calculus of variations (such as direct methods, Gamma-convergence and relaxation, iterated minimization schemes, and variational principles), geometric measure theory and nonsmooth analysis (BV functions, motion of interfaces, and analysis in metric-measure spaces), functional analysis (Dirichlet forms, semigroup theory, Gamma-calculus, convex integration, and infinite-dimensional spaces), optimal transport, and calculus of probability (stochastic processes, large-deviation principles, and stochastic perturbations). New beautiful results have arisen and contributed to the advance of each field in a promising interdisciplinary way with interesting and deep connections.

Among the themes presented during the workshop, we mention here:

- gradient flows and large deviations,
- regularity structures and rough paths;
- stochastic homogenization;
- optimal transport techniques and transportation distances, functional inequalities, entropic interpolation;
- discrete interaction systems, evolution on graphs, and their metric-variational interpretation;
- rate-independent problems, quasi-static crack growth, elasto-plasticity;
- singular limit of gradient flows and conservative systems and their asymptotic dynamics, hysteretic phase transitions;
- entropy-entropy dissipation methods, reaction-diffusion systems and their geometric interpretation, discrete approach and structure-preserving numerical methods;
- front propagation and models derived from Allen-Cahn equations;
- variational time discretizations for compressible Euler equations;
- general variational principles and models for evolution;
- evolution in metric spaces and Hamilton-Jacobi equations.

The workshop, organized by Luigi Ambrosio (Scuola Normale Superiore, Pisa), Alexander Mielke (WIAS, Berlin), Mark Peletier (TU Eindhoven), and Giuseppe Savaré (University of Pavia), aimed to present many new, striking and promising achievements in this wide area, thanks to the contribution of 48 participants (16 young researchers) with broad geographic representation from Austria, Czech Republic, France, Germany, Italy, Netherlands, UK and USA, and a variety of research fields, each revealing different methodology, interests, and level of abstraction. Twenty-eight invited talks, mostly of 45 minutes, have been delivered, leaving plenty of time for discussions, which have been greatly stimulated by the diversity of the topics and of the contributions. The friendly atmosphere and the perfect environment of Oberwolfach have also contributed to the success of the meeting.
Acknowledgement: The MFO and the workshop organizers would like to thank the National Science Foundation for supporting the participation of junior researchers in the workshop by the grant DMS-1049268, “US Junior Oberwolfach Fellows”.
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