

MATHEMATISCHES FORSCHUNGSINSTITUT OBERWOLFACH

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## Material Theories

Organised by  
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Stephan Luckhaus, Leipzig  
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**ABSTRACT.** This biennial workshop brings together mathematicians, mechanicians and theoretical physicists interested in developing new mathematical models of complex materials, medias and systems. The workshop covers a wide range of topics from nonequilibrium statistical mechanics and dynamical systems to calculus of variations and nonlinear functional analysis. A particular focus of this meeting was on continuum description of biological systems, pattern formation, granular media, plasticity and turbulence.

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### Introduction by the Organisers

The biennial workshop Material Theories organized by Antonio DeSimone, (Trieste), Stephan Luckhaus (Leipzig) and Lev Truskinovsky (Palaiseau) brings together mathematicians, mechanicians and theoretical physicists interested in developing new mathematical models of complex materials, medias and systems. The workshop covers a wide range of topics from nonequilibrium statistical mechanics and dynamical systems to calculus of variations and nonlinear functional analysis.

A particular focus of the 2009 meeting was on continuum description of biological systems, pattern formation, granular media, molecular dynamics, plasticity and turbulence. In addition to 25 general lectures the conference program included an evening talk on thermodynamic modeling of evolutionary genetics and an exceptional concert of classical music.

Among the highlights of the conference we would like to mention the talk of Florian Theil (Coventry), who presented a significant advance in 3D crystal problem,

the talk of Hans Herrmann (Zürich) devoted to the modeling of optimal fractal organization in moving granular systems and the talk of Yann Brenier (Nice) on multidimensional rearrangement theory and its relation to Navier-Stokes Boussinesq equations.

The exciting lectures of Jean-Francois Joanny (Paris), Frank Jülicher (Dresden), Karsten Kruse (Saarbrücken), Sebastien Neukirch (Paris), Paolo Cermelli (Torino) and Marta Lewicka (Minneapolis) reviewed new developments in the continuum representation of active biological systems (at both cellular and tissue level) which targeted such diverse applications as viruses, DNA, tumors and trees. Another novel and still poorly understood subject is pinning-depinning transition and the related self organized criticality. Mathematical progress in the related problems leading to power law spectrum of fluctuations was reviewed in the lectures of Luis Bonilla (Leganes) Nicolas Dirr (Bath), Francisco-Jose Perez-Reche (Cambridge) and Oguz Umut Salman (Palaiseau).

Borrowing most their tools from probability theory, Stefano Olla (Paris) and Sergei Kuksin (Palaiseau) discussed the averaged behavior of stochastically regularized nonlinear dynamical systems originating in the theory of heat conduction and fluid mechanics (nonequilibrium steady states). Recent progress in the classical problems of nonlinear solid mechanics, such as fracture, plasticity and strain localization was addressed in the lectures of Antonin Chambolle (Palaiseau), Davide Bigoni (Trento) and Luca Mugnai (Leipzig). More general issues of rate independent hysteresis, structural self-similarity, pattern formation and band gaps in continuum mechanical systems and the new mathematical tools developed for the adequate representation became the subject of the lectures of Giovanni Alberti (Pisa), Alexander Mielke (Berlin), Victor Berdichevsky (Detroit), Mark Peletier (Eindhoven) and Guy Bouchitte (La Garde). Recent advances in the rigorous study of coarse graining and the transition from discrete to continuum in both statics and dynamics were reviewed by Bernd Schmidt (München) and Antonio DiCarlo (Roma).

Overall, the workshop created an unprecedented opportunity for the researchers working in different disciplines to be exposed to new and fruitful ideas and to build otherwise impossible exchanges and collaborations.