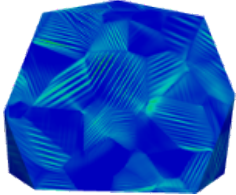




IUTAM Symposium on



Generalized continua
emerging from microstructures



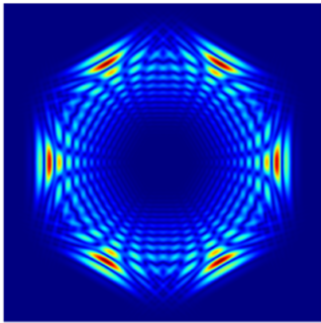
19–23 July 2021
Paris, France

Sponsors



International Union of Theoretical and Applied Mechanics

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<https://iutam-2021-gc.sciencesconf.org>

Scope of the Symposium

The mechanics of generalized continua has become a well-established field of continuum mechanics of materials and structures, with many applications in computational mechanics. It includes gradient approaches (strain gradient media or gradient of mechanical variables like plastic strain or damage parameters) and higher order continua that rely on the introduction of additional kinematic degrees of freedom (Cosserat or micromorphic theories for instance). It is now well-accepted that such approaches are necessary in particular for the analysis of strain localization phenomena, up to fracture. They are also very effective for the description of size effects in the linear and nonlinear mechanical behavior of materials and structures. However, the formulation of such models very often remains purely phenomenological even though the origin of the generalized contributions is attributed to the underlying microstructure.

The objective of this symposium is to bring together experts in the field of generalized continua and homogenization methods in order to elaborate strategies for the construction of higher order theories starting from the detailed knowledge of the properties of the microstructure. The main features of the microstructure are very often of discrete nature: defects in crystalline solids or granular media, beam networks or unit cells in architected materials or composites. How to predict size effects and the associated effective characteristic lengths from the collective behavior of defects under load or from the unit cell deformation fields in periodic media?

Fruitful discussions are expected between experts in the development of thermodynamically consistent phenomenological strain gradient theories and specialists of homogenization and coarse graining methods. The targeted material and structural properties are the static elastic-plastic and damage responses but also the dynamic behavior of architected materials. The dispersion of waves in heterogeneous materials like metamaterials can be described successfully by generalized continuum models. We expect that the meeting of experts from different communities will result in common or alternative strategies to address scale bridging from microstructures to generalized continua. Generalized continuum models can be only validated by comparison and identification with field measurements which are now striving in experimental mechanics: crystal lattice orientation and dislocation density field by diffraction, strain field measurements by digital image correlation. This experimental information will be presented in the Symposium.

Conference topics

Theory of generalized continua
Instabilities and localization
Strain gradient plasticity
Crystal plasticity
Homogenization and generalized continua
Discrete defects in solids
Computational mechanics of generalized continua
Metamaterials
Geomaterials
Gradient damage and fracture
Phase field approaches

Scientific Committee

- P. Gumbsch (KIT, Karlsruhe, Germany)
- G. Hu (Beijing Institute of Technology, China)
- V. Kouznetsova (TU Eindhoven, The Netherlands)
- J. Kysar (Columbia, New York, USA)
- D. McDowell (GeorgiaTech, Atlanta, USA)
- G. Milton (University of Utah, Salt Lake City, USA)
- C. Niordson (DTU, Lyngby, Denmark)

IUTAM representative: N. Fleck (Cambridge, UK)

Conference chair

Samuel Forest (CNRS Research Director, Centre des Matériaux, Mines ParisTech)
and Francesco dell'Isola (Director of MEMOCS, Sapienza Università di Roma)

Local organizing committee

Samuel Forest, Sandrine Laurent-Fontaine, Aldo Marano (Mines ParisTech), Jean-Michel Scherer (LMS Ecole Polytechnique)

Symposium website

<https://iutam-2021-gc.sciencesconf.org>

Detailed program

Monday 19 July 2021

12:00 *Registration and welcome (mini) lunch at Mines ParisTech*

Theory of generalized continua Chair of the afternoon: Samuel Forest

13:45 *Introduction of the Symposium and presentation of the IUTAM*

Samuel Forest and Henryk Petryk

14:00 *Explicit harmonic structure of bidimensional linear strain-gradient elasticity*

Nicolas Auffray

14:30 *Multiphase continua for fiber-reinforced materials*

Jérémy Bleyer

15:00 *Local micromorphic non-affine anisotropy*

Sebastian Skatulla

15:30 *Microtwist elasticity: Zero modes and polarization in kagome lattices*

Hussein Nassar

16:00–16:30 Coffee break

16:30 *Gradient materials: The different behavior of free boundaries of a body and the fictitious cut around some subbody*

Arnold Krawietz

17:00 *Modelling contact interactions of generalized continua:*

microblock contact model for a Cosserat body

Stanislaw Stupkiewicz

17:30 *Three-dimensional solids and structures within strain gradient elasticity: numerical methods and model comparisons*

Jarkko Niiranen

18:00–19:30 *Get together cocktail and buffet*

Tuesday 20 July 2021

Crystal plasticity Chairman: Emilio Martinez-Pañeda

- 8:30 *A FFT-based approach for Mesoscale Field Dislocation Mechanics: applications to internal length scale effects in polycrystals and steel matrix composites*
Stephane Berbenni
- 9:00 *A mesoscale continuum approach of dislocation dynamics and the approximation by discontinuous Galerkin methods*
Christian Wieners
- 9:30 *Modeling plastic slip localization within polycrystals*
Aldo Marano
- 10:00 *On the control of elastic gaps in Gurtin-type strain gradient crystal plasticity theories using uncoupled dissipation assumption*
Mohamed Jebahi
- 10:30–11:00 *Coffee break*
- 11:00 *Microstructural aspects of gradient-enhanced crystal plasticity*
Henryk Petryk
- 11:30 *Plastic flow and dislocation strengthening in a continuum formulation of dislocation dynamics*
Katrin Schulz
- 12:00 *Analytic solutions for strengthening of a strain gradient plasticity material reinforced by small elastic particles*
Jonas Faleskog
- 12:30–14:00 *Lunch buffet at Mines ParisTech*

Strain gradient plasticity Chair of the afternoon: Julien Réthoré

- 14:00 *Distortion gradient plasticity modelling of the small-scale behaviour of metals under non-proportional loading*
Lorenzo Bardella
- 14:30 *A phase field fracture and strain gradient plasticity-based model for predicting hydrogen embrittlement*
Emilio Martinez-Pañeda
- 15:00 *Modeling micron-scale compression molding*
Christian Niordson
- 15:30 *Enhanced Strength of Cu-Gr-Cu nanolaminate*
Jeff Kysar
- 16:00–16:30 *Coffee break*
- 16:30 *The evolution of Hooke's law under finite plastic deformations for fiber reinforced materials*
Albrecht Bertram
- 17:00 *A stochastic solver based on the residence time algorithm for crystal plasticity models*
Jaime Marian
- 17:30 *Gradient models for softening thermo-plasticity at large strain*
Jerzy Pamin

Wednesday 21 July 2021

Homogenization and generalized continua Chair: Nicolas Auffray

- 8:30 *Green functions and integral representation of anisotropic second gradient continua
The case of pantographic lattices*
Claude Boutin
- 9:00 *Predictive strain-gradient homogenization of a pantographic material
with compliant junctions and experimental evidence*
Arthur Lebé
- 9:30 *Nonlinear gradient models in hyper-elasticity:
from slender structures to architected materials*
Claire Lestringant
- 10:00 *Direct FE2 for concurrent multiscale modelling of heterogeneous thin plate structures*
Leong Hien Poh
- 10:30–11:00 *Coffee break*
- 11:00 *Interpretation of the moduli of isotropic micromorphic elasticity
by harmonic decomposition and analytical homogenisation*
Gerald Hütter
- 11:30 *Hashin–Shtrikman bounds on the effective properties of stress-gradient materials*
Karam Sab
- 12:00 *Enhanced flexoelectricity in heterogeneous piezoelectric composites
using topology optimization*
Julien Yvonnet
- 12:30 *Analysis of the failure of heterogeneous materials: a bottom-up approach*
Julien Réthoré
- 13:00 *Direct and energy based homogenization approaches within the second gradient
elasticity theory: examples and general relations*
Yuri Solyaev
- 13:30–14:30 *Lunch buffet at Mines ParisTech*
- 17:00–18:00 *Visit of the Mineralogy Museum at Mines ParisTech*
- 18:00–19:30 *Wine and cheese session at Mines ParisTech*

Thursday 22 July 2021

Instabilities and generalized continua Chair: J  r  my Bleyer

- 8:30 *Generalized continuum models confronted to cell-commensurate instabilities in structured media*
Christelle Combescure
- 9:00 *Capturing microscopic and macroscopic instabilities in mechanical metamaterials by micromorphic computational homogenization*
Ron Peerlings
- 9:30 *Determination of homogenized continua behaviors from actual printed microstructures*
Maxence Wangermez
- 10:00 *A gradient-extended large-strain anisotropic damage model with crack orientation director*
Stephan Wulfinghoff
- 10:30–11:00 *Coffee break*

Fracture of materials

- 11:00 *A strain-gradient plasticity model of ductile failure in porous single crystals*
J.M. Scherer
- 11:30 *Thermal pressurization of earthquake faults under large co-seismic slip using Cosserat continuum*
Ioannis Stefanou
- 12:00 *A granular-based elasto-plastic–damage energy formulation for strain gradient solids*
Luca Placidi
- 12:30–14:00 *Lunch buffet at Mines ParisTech*

Fracture of materials Chair: Giuseppe Rosi

- 14:00 *Development, implementation and application of a second-gradient model for porous ductile solids*
Jean-Baptiste Leblond
- 14:30 *An FFT framework for simulating non-local ductile failure in heterogeneous materials*
Javier Segurado
- 15:00 *Energetic versus dissipative gradient damage models: A comparative analysis*
Djimedo Kondo
- 15:30 *Damage in periodic composite materials resulting from a micromechanics-based phase field approach*
Marco Paggi
- 16:00–16:30 *Coffee break*

Diffusion and phase field methods

- 16:30 *Mass transport and shape changes in nonhomogeneous sintering*
Sinisa Mesarovic
- 17:00 *Phase field modeling of deformation twinning in β -metastable titanium alloys*
Beno  t Appolaire
- 17:30–18:00 *A phase-field enhanced Cosserat model for prediction of microstructure evolution*
Anna Ask

Friday 23 July 2021

Metamaterials Chair: Arthur Lebé

- 8:30 *Some perspectives on the Willis equations*
Graeme Milton
- 9:00 *Interfacial wave between two acoustic bianisotropic materials*
Gengkai Hu
- 9:30 *An examination of primitive causality in linear generalized continuum theories*
Venkata Mutnuri
- 10:00 *Elastic wave propagation in non-centrosymmetric and chiral architected materials: insights from strain gradient elasticity*
Giuseppe Rosi
- 10:30–11:00 *Coffee break*
- 11:00 *An enriched continuum framework for metamaterial panels obtained through computational homogenization and model order reduction*
Varvara Kouznetsova
- 11:30 *Wave propagation control in active metamaterial with shunted piezoelectric microstructure*
Maria Laura De Bellis
- 12:00 *Local material symmetry group for first- and second-order strain gradient materials with application to fluids and subfluids*
Victor Eremeyev
- 12:30 *Piola transformation of stress and double stress in second gradient continua*
Francesco dell'Isola
- 13:00–14:00 *Lunch buffet at Mines ParisTech*

End of the IUTAM Symposium

List of participants

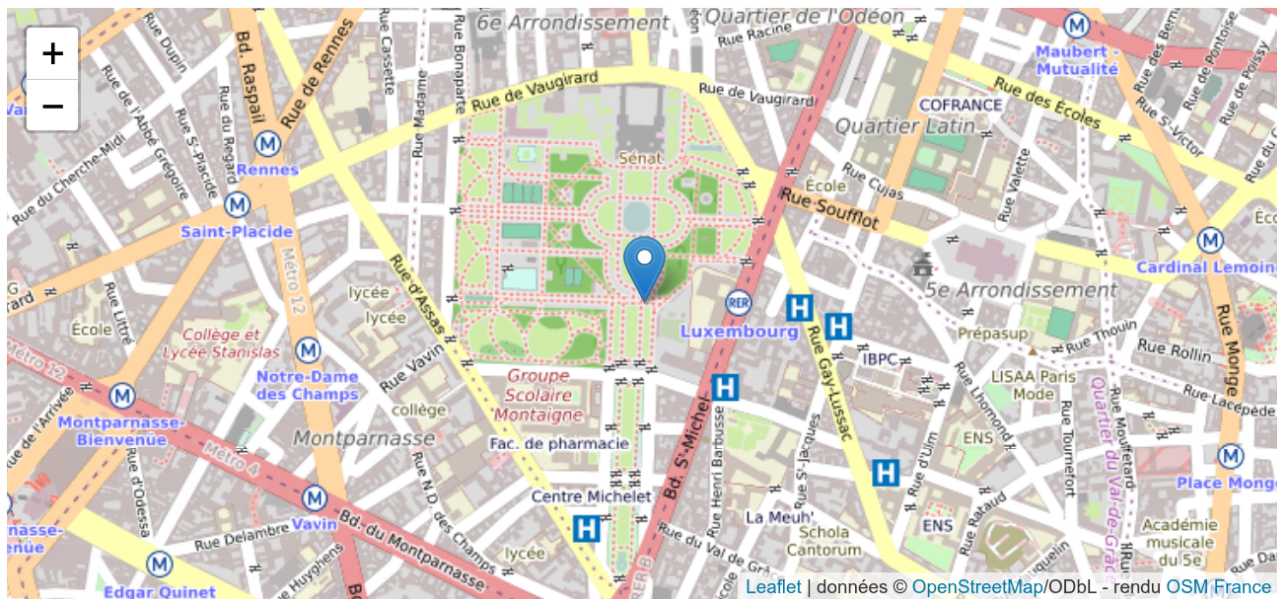
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Representation by countries:

France	27
Germany	7
Italy	7
USA	6
Poland	4
The Netherlands	2
Spain	2
Sweden	2
United Kingdom	2
China	1
Czech Republic	1
Denmark	1
Finland	1
India	1
Russia	1
Singapore	1
South Africa	1

Venue



The IUTAM Symposium will take place at Mines ParisTech, in the center of Paris, close to the Luxembourg Garden.

Address: Mines ParisTech, 60 Boulevard Saint-Michel, 75006, Paris, France

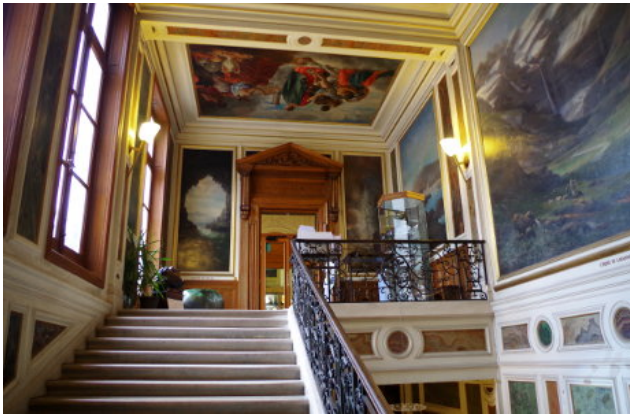
www.mines-paristech.fr

Room: V107 Amphi Schlumberger

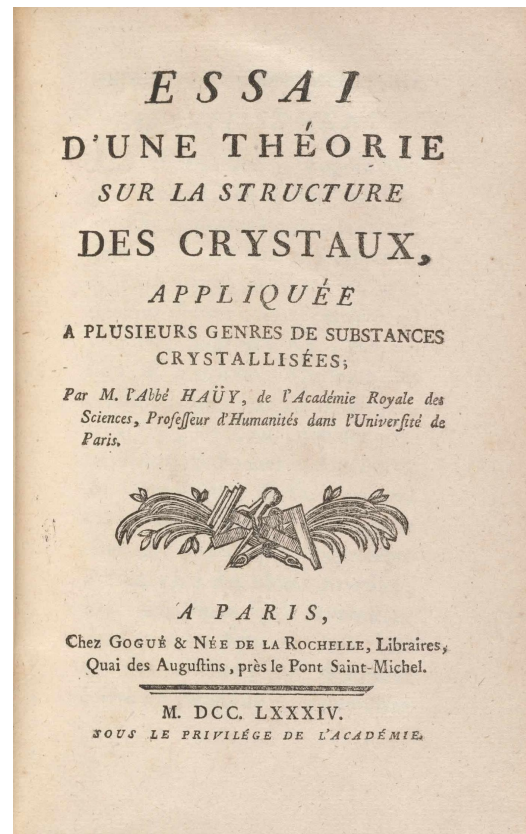
- How to get to Mines ParisTech from Public transportations:
Mines ParisTech can be accessed by regional train line (RER B), by metro or by bus. The closest train/bus stations are listed on the Symposium webpage. Unfortunately the RER B station Luxembourg is closed during July 2021 because of works. You can use instead Saint-Michel or Port-Royal but you will have to walk 20 minutes. The other possibility is the metro station Odeon and then 15 minutes walk.
- How to get to Mines ParisTech from Paris Airports: Both Paris airports are connected to the RER line B, which is directly connected to Mines ParisTech. To reach it, take the RER B and get off at the Luxembourg station (see above).
 - ★ To reach Paris from Orly airports, you will find indications on the webpage of the symposium
 - ★ To reach Paris from Charles de Gaulle airport, you will find indications on the webpage of the symposium

Musée de minéralogie de Mines ParisTech

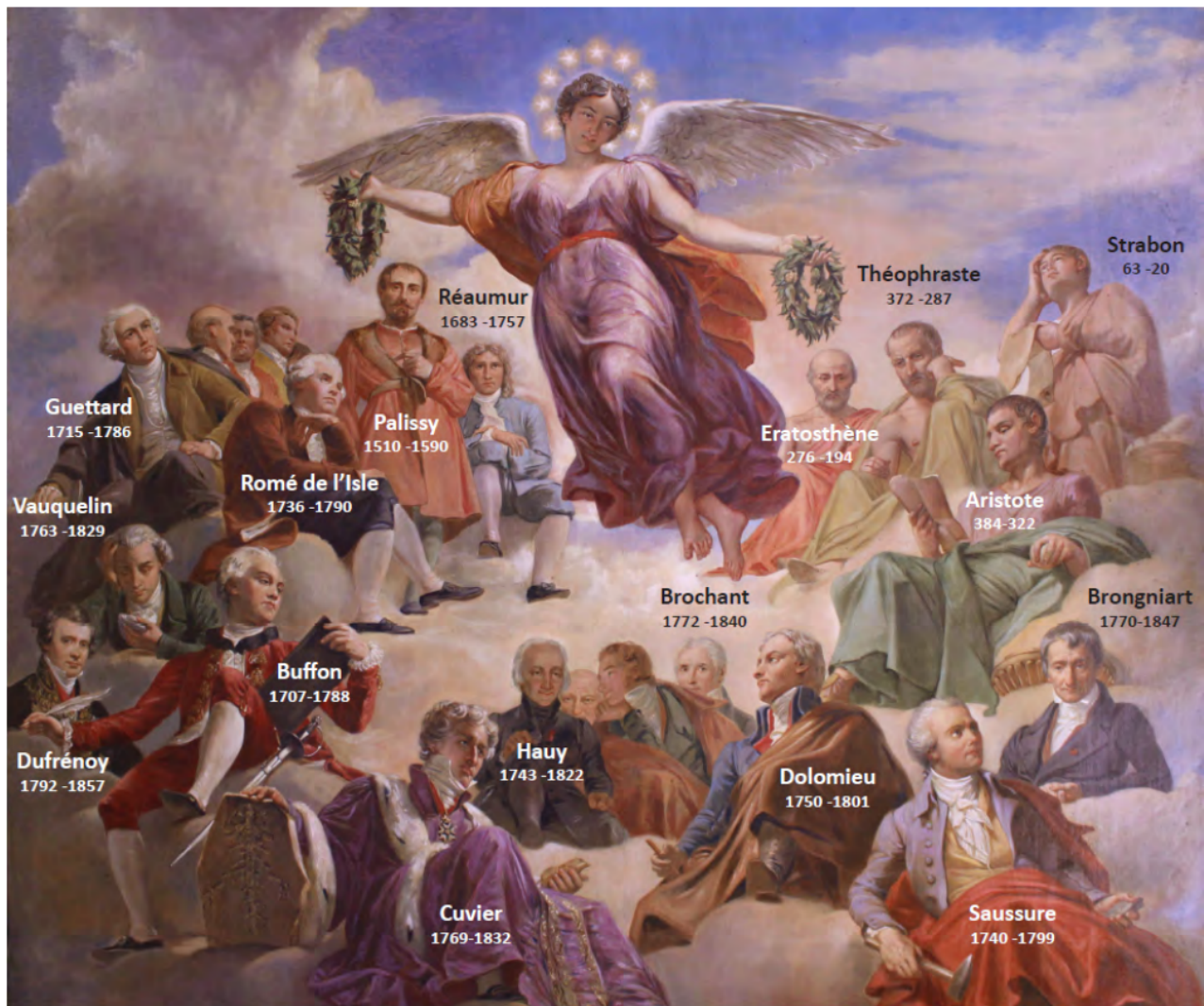
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One of the largest collections in the world: 100000 samples, 4000 exposed (cf. British museum, Freiberg museum), in connection with *Museum d'histoire naturelle*



René-Just Haüy: Founder of crystallography



the ceiling of the majestic staircase leading to the museum

