

# Preface

The Mechanics of Generalized Continua is an established research topic since the end of the 1950s–early 1960s of the last century. The starting point of this development was the monograph of the Cosserat brothers, published in 1909<sup>1</sup>, and some previous works of such famous scientists like Lord Kelvin, Duhem, Helmholtz among others. All these contributions were focussed on the fact that in a continuum one has to define translations and rotations independently (or in other words, one has to establish force and moment actions independently as it was done by Jakob Bernoulli and Euler). At the same time the continuum was not modeled as an infinite number of continuously distributed points with properties like the mass, but as an infinite number of continuously distributed infinitesimal small bodies with properties like the mass.

The reason for the revival in the mid of 1950s of the last century was that some effects of the mechanical behavior of solids and fluids could not be explained by the available classical continuum models. Examples of this are the turbulence of a fluid or the behavior of solids with a significant and very complex microstructure. Since the suggested new models fulfill all requirements from *Continuum Thermomechanics* (the balance laws were formulated and the general representation of the constitutive equations were given) the scientific community was satisfied for a while. At the same time real applicative developments were missed.

Indeed, for practical applications the developed models were not useful. The reason for this was the gap between the formulated constitutive equations and the possibilities to identify the material parameters. As is often the case one had much more parameters compared to classical models, but no facilities to measure all properties. In addition, computational progress and available machines in these times were limited.

During the last ten years the situation has drastically changed. More and more researches emerged, being kindled by the partly forgotten models. Now one has available much more computational possibilities and very complex problems can be simulated numerically. In addition, with the increased attention paid to a large

---

<sup>1</sup> E. et F. Cosserat: Cosserat, F.: *Théorie des Corps Déformables*, Hermann Editeurs, Paris, 1909 (Reprint, Gabay, Paris, 2008).

number of materials with complex microstructure and a deeper understanding of the meaning of the material parameters (scale effects) the identification becomes much more well founded. Thus we have contributions describing the micro- and macro-behavior, new existence and uniqueness theorems, the formulation of multi-scale problems, etc., and now it is time to ponder again<sup>2</sup> the state of matter and to discuss new trends and applications.

The main focus in this book will be directed on the following items:

- Modeling and simulation of materials with significant microstructure;
- Generalized continua as a result of multi-scale models;
- Multi-field actions on materials resulting in generalized material models; and
- Comparison with discrete modeling approaches.

This book contains selected papers submitted to the Second Trilateral Seminar *Generalized Continua as Models for Materials With Multi-scale Effects or Under Multifield Actions*, which held at the *Leucorea* (Lutherstadt Wittenberg, Germany) from September 26 upto 30, 2012.<sup>3</sup> Special thanks to Andreas Kutschke who took all duties connected with realization of the Seminar. In addition, we kindly acknowledge Dr. Christoph Baumann and Benjamin Feuchter (Springer Publisher) for the support of the book project. Last but not least it should be mentioned that the Seminar was sponsored by grants of the French National Center for Scientific Research (CNRS), the German Research Foundation (DFG) AL341/41-1, and the Russian Foundation for Basic Research 12-01-91260RFG.

Magdeburg, December 2012  
Paris  
St. Petersburg

Holm Altenbach  
Samuel Forest  
Anton Krivtsov

---

<sup>2</sup> There were two proceedings within the last years which should be mentioned here: Gérard A. Maugin, Andrei V. Metrikine (Eds) *Mechanics of Generalized Continua - One Hundred Years After the Cosserats*, Springer, 2010 (Advances in Mechanics and Mathematics, Vol. 21) and Holm Altenbach, Gérard Maugin, Vladimir Erofeev (Eds) *Mechanics of Generalized Continua*, Springer, 2011 (Advanced Structured Materials, Vol. 7).

<sup>3</sup> The First Trilateral French–German–Russian Seminar held also in Lutherstadt Wittenberg (Germany) August 9–11, 2010.

Generalized Continua as Models for Materials  
with Multi-scale Effects or Under Multi-field Actions

Altenbach, H.; Forest, S.; Krivtsov, A.M. (Eds.)

2013, XII, 331 p., Hardcover

ISBN: 978-3-642-36393-1