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INTERNATIONAL CENTRE FOR MECHANICAL SCIENCES

KINETIC AND CONTINUUM THEORIES OF GRANULAR AND POROUS MEDIA

EDITED BY

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Kinetic And Continuum Theories Of Granular And Porous Media

Kolumban Hutter, Krzysztof Wilmanski



Kinetic And Continuum Theories Of Granular And Porous Media:

Kinetic and Continuum Theories of Granular and Porous Media Kolumban Hutter, Krzysztof Wilmanski, 2014-05-04 This book is an account on the thermomechanical behaviour of granular and porous materials and deals with experiments theoretical deduction of macroscale equations by means of averaging from microscale properties embedding the macroscopic description into a continuum thermodynamical and statistical context and analysis of solutions of macroscopic models by numerical techniques It addresses itself to engineers chemical civil mechanical applied mathematicians and physicists at the advanced student or Ph D level at universities research centres and in industry Dynamic Response of Granular and Porous Materials under Large and Catastrophic Deformations Kolumban Hutter, Nina Kirchner, 2013-02-26 A Sonderforschungsbereich SFB is a programme of the Deutsche Forschungsgemeinschaft to financially support a concentrated research effort of a number of scientists located principally at one University Research Laboratory or a number of these situated in close proximity to one another so that active interaction among individual scientists is easily possible Such SFB are devoted to a topic in our case Deformation and Failure in Metallic and Granular Material and financing is based on a peer reviewed proposal for three now four years with the intention of several prolongations after evaluation of intermediate progress and continuation reports An SFB is terminated in general by a formal workshop in which the state of the art of the achieved results is presented in oral or I and poster communications to which also guests are invited with whom the individual project investigators may have collaborated Moreover a research report in book form is produced in which a number of articles from these lectures are selected and collected which present those research results that withstood a rigorous reviewing process with generally two or three referees The theme deformation and failure of materials is presented here in two volumes of the Lecture Notes in Applied and Computational Mechanics by Springer Verlag and the present volume is devoted to granular and porous continua The complementary volume Lecture Notes in Applied and Computational Mechanics vol 10 Eds K HUTTER H **Continuum Thermodynamics - Part I** Krzysztof Wilmanski, 2008 This book is a unique presentation of thermodynamic methods of construction of continuous models It is based on a uniform approach following from the entropy inequality and using Lagrange multipliers as auxiliary quantities in its evaluation It covers a wide range of models OCo ideal gases thermoviscoelastic fluids thermoelastic and thermoviscoelastic solids plastic polycrystals miscible and immiscible mixtures and many others The structure of phenomenological thermodynamics is justified by a systematic derivation from the Liouville equation through the BBGKY hierarchy derived Boltzmann equation to an extended thermodynamics In order to simplify the reading an extensive introduction to classical continuum mechanics and thermostatics is included As a complementary volume to Part II which will contain applications and examples and to Part III which will cover numerical methods only a few simple examples are presented in this first Part One exception is an extensive example of a linear poroelastic material because it will not appear in future Parts The book is the first presentation of

continuum thermodynamics in which foundations of continuum mechanics microscopic foundations and transition to extended thermodynamics applications of extended thermodynamics beyond ideal gases and thermodynamic foundations of various material theories are exposed in a uniform and rational way The book may serve both as a support for advanced courses as well as a desk reference **Continuum Thermodynamics - Part I: Foundations** Krzysztof

Wilmanski,2008-11-25 This book is a unique presentation of thermodynamic methods of construction of continuous models It is based on a uniform approach following from the entropy inequality and using Lagrange multipliers as auxiliary quantities in its evaluation It covers a wide range of models ideal gases thermoviscoelastic fluids thermoelastic and thermoviscoelastic solids plastic polycrystals miscible and immiscible mixtures and many others The structure of phenomenological thermodynamics is justified by a systematic derivation from the Liouville equation through the BBGKY hierarchy derived Boltzmann equation to an extended thermodynamics In order to simplify the reading an extensive introduction to classical continuum mechanics and thermostatics is included As a complementary volume to Part II which will contain applications and examples and to Part III which will cover numerical methods only a few simple examples are presented in this first Part One exception is an extensive example of a linear poroelastic material because it will not appear in future Parts The book is the first presentation of continuum thermodynamics in which foundations of continuum mechanics microscopic foundations and transition to extended thermodynamics applications of extended thermodynamics beyond ideal gases and thermodynamic foundations of various material theories are exposed in a uniform and rational way The book may serve both as a support for advanced courses as well as a desk reference *Continuum Thermodynamics* Wilmanski,2008 This book is a unique presentation of thermodynamic methods of construction of continuous models It is based on a uniform approach following from the entropy inequality and using Lagrange multipliers as auxiliary quantities in its evaluation It covers a wide range of models ideal gases thermoviscoelastic fluids thermoelastic and thermoviscoelastic solids plastic polycrystals miscible and immiscible mixtures and many others The structure of phenomenological thermodynamics is justified by a systematic derivation from the Liouville equation through the BBGKY hierarchy derived Boltzmann equation to an extended thermodynamics In order to simplify the reading an extensive introduction to classical continuum mechanics and thermostatics is included As a complementary volume to Part II which will contain applications and examples and to Part III which will cover numerical methods only a few simple examples are presented in this first Part One exception is an extensive example of a linear poroelastic material because it will not appear in future Parts The book is the first presentation of continuum thermodynamics in which foundations of continuum mechanics microscopic foundations and transition to extended thermodynamics applications of extended thermodynamics beyond ideal gases and thermodynamic foundations of various material theories are exposed in a uniform and rational way The book may serve both as a support for advanced courses as well as a desk reference **Continuum Thermodynamics** Bettina Albers,Krzysztof Wilmański,2014-11-12 This

second part of Continuum Thermodynamics is designed to match almost one to one the chapters of Part I This is done so that the reader studying thermodynamics will have a deepened understanding of the subjects covered in Part I The aims of the book are in particular the illustration of basic features of some simple thermodynamical models such as ideal and viscous fluids non Newtonian fluids nonlinear solids interactions with electromagnetic fields and diffusive porous materials A further aim is the illustration of the above subjects by examples and simple solutions of initial and boundary problems as well as simple exercises to develop skills in the construction of interdisciplinary macroscopic models

Continuous Media with Microstructure 2 Bettina Albers, Mieczysław Kuczma, 2016-02-09 This book presents research advances in the field of Continuous Media with Microstructure and considers the three complementary pillars of mechanical sciences theory research and computational simulation It focuses on the following problems thermodynamic and mathematical modeling of materials with extensions of classical constitutive laws single and multicomponent media including modern multifunctional materials wave propagation multiscale and multiphysics processes phase transformations and porous granular and composite materials The book presents the proceedings of the 2nd Conference on Continuous Media with Microstructure which was held in 2015 in Łódź, Poland in memory of Prof Krzysztof Wilmański

Continuum Thermodynamics - Part II:

Applications And Examples Krzysztof Wilmanski, Bettina Albers, 2014-11-12 This second part of Continuum Thermodynamics is designed to match almost one to one the chapters of Part I This is done so that the reader studying thermodynamics will have a deepened understanding of the subjects covered in Part I The aims of the book are in particular the illustration of basic features of some simple thermodynamical models such as ideal and viscous fluids non Newtonian fluids nonlinear solids interactions with electromagnetic fields and diffusive porous materials A further aim is the illustration of the above subjects by examples and simple solutions of initial and boundary problems as well as simple exercises to develop skills in the construction of interdisciplinary macroscopic models

Earthquake Thermodynamics and Phase Transformation in the Earth's Interior Roman Teisseyre, Eugeniusz Majewski, 2000-10-19 A group of distinguished scientists contributes to the foundations of a new discipline in Earth sciences earthquake thermodynamics and thermodynamics of formation of the Earth's interior structures The predictive powers of thermodynamics are so great that those aspiring to model earthquake and the Earth's interior will certainly wish to be able to use the theory Thermodynamics is our only method of understanding and predicting the behavior of many environmental atmospheric and geological processes The need for Earth scientists to develop a functional knowledge of thermodynamic concepts and methodology is therefore urgent Sources of an entropy increase the dissipative and self organizing systems driving the evolution and dynamics of the Universe and Earth through irreversible processes The non linear interactions lead to the formation of fractal structures From the structural phase transformations the important interior boundaries emerge Non linear interactions between the defects in solids lead the authors to develop the physics of continua with a dense distribution of

defects Disclinations and dislocations interact during a slow evolution as well as during rapid dynamic events like earthquakes Splitting the dynamic processes into the 2D fault zone and 3D surrounding space brings a new tool for describing the slip nucleation and propagation along the earthquake faults Seismic efficiency rupture velocity and complexity of seismic source zone are considered from different points of view fracture band earthquake model is developed on the basis of thermodynamics of line defects like dislocations Earthquake thermodynamics offers us a microscopic model of earthquake sources Physics of defects helps the authors describe and explain a number of precursory phenomena caused by the buildup of stresses Anomalies in electric polarization and electromagnetic radiation prior to earthquakes are considered from this point of view Through the thermodynamic approach the authors arrive at the fascinating question of possibility of earthquake prediction In general the Earth is considered here as a multicomponent system Transport phenomena as well as wave propagation and shock waves are considered in this system subjected also to chemical and phase transformations

Waves And Stability In Continuous Media - Proceedings Of The 10th Conference On Wascom 99 Vincenzo Ciancio, Andrea Donato, Francesco Oliveri, Salvatore Rionero, 2001-04-30 Mathematical problems concerning time evolution of solutions related to nonlinear systems modelling dynamics of continuous media are of great interest both in wave propagation and in stability problems During the last few decades many striking developments have taken place especially in connection with the effects of nonlinearity of the equations describing physical situations The articles in this book have been written by reputable specialists in the field and represent a valuable contribution to its advancement The topics are discontinuity and shock waves linear and nonlinear stability in fluid dynamics kinetic theories and comparison with continuum models propagation and non equilibrium thermodynamics exact solutions via group methods numerical applications **Variational Models and Methods in Solid and Fluid Mechanics** Francesco dell'Isola, Sergey Gavrilyuk, 2012-01-15 F dell Isola L Placidi Variational principles are a powerful tool also for formulating field theories F dell Isola P Seppecher A Madeo Beyond Euler Cauchy Continua The structure of contact actions in N th gradient generalized continua a generalization of the Cauchy tetrahedron argument B Bourdin G A Francfort Fracture S Gavrilyuk Multiphase flow modeling via Hamilton's principle V L Berdichevsky Introduction to stochastic variational problems A Carcaterra New concepts in damping generation and control theoretical formulation and industrial applications F dell Isola P Seppecher A Madeo Fluid shock wave generation at solid material discontinuity surfaces in porous media Variational methods give an efficient and elegant way to formulate and solve mathematical problems that are of interest to scientists and engineers In this book three fundamental aspects of the variational formulation of mechanics will be presented physical mathematical and applicative ones The first aspect concerns the investigation of the nature of real physical problems with the aim of finding the best variational formulation suitable to those problems The second aspect is the study of the well posedness of those mathematical problems which need to be solved in order to draw previsions from the formulated models And the third aspect is related to the direct application of

variational analysis to solve real engineering problems

Poromechanics III - Biot Centennial (1905-2005) Younane N. Aousleiman, Alexander H.-D. Cheung, Franz-Josef Ulm, 2005-05-01 These proceedings represent the latest advances in the mechanics of porous materials known as poromechanics The porous materials considered are solids containing voids that are impregnated with fluid The focus is on the mechanical interactions of the inhomogeneous solid with the single or multi phase fluid under the loading of mechanical force fluid pressure thermal chemical and magnetic fields The response time can be in static diffusional and dynamic ranges The length scale can start from nano to micro macro and up to field scales Its application covers many branches of science and engineering including geophysics geomechanics composite materials biomechanics acoustics seismicity civil mechanical environmental and petroleum engineering The approaches taken include analytical computational and experimental To honor the pioneering contributions of Maurice A Biot 1905 1985 to poromechanics the Biot Conference on Poromechanics was convened for the first time in Louvain la Neuve Belgium in 1998 The success of the first conference led to the 2nd Biot Conference held in Grenoble France in 2002 To celebrate the centennial birthday of Biot May 25 2005 the 3rd Biot Conference on Poromechanics was held at the University of Oklahoma Norman Oklahoma U S A on May 24 27 2005

Surface Waves in Geomechanics: Direct and Inverse Modelling for Soils and Rocks Carlo G. Lai, Krzysztof Wilmanski, 2007-03-23 Theories of surface waves develop since the end of XIX century and many fundamental problems like existence phase and group velocities attenuation quality factor mode conversion etc have been in part successfully solved within the framework of such simple models as ideal fluids or linear elasticity However a sufficiently complete presentation of this subject particularly for solids is still missing in the literature The sole exception is the book of I A Viktorov which contains an extensive discussion of fundamental properties of surface waves in homogeneous and stratified linear elastic solids with particular emphasis on contributions of Russian scientists Unfortunately the book has never been translated to English and its Russian version is also hardly available Practical applications of surface waves develop intensively since a much shorter period of time than theories even though the motivation of discoverers of surface waves such as Lord Rayleigh stems from their appearance in geophysics and seismology Nowadays the growing interest in practical applications of surface waves stem from the following two main factors surface waves are ideal for developing relatively cheap and convenient methods of nondestructive testing of various systems spanning from nanomaterials e g

An Introduction to Fluid Mechanics Chung Fang, 2018-12-31 This textbook provides a concise introduction to the mathematical theory of fluid motion with the underlying physics Different branches of fluid mechanics are developed from general to specific topics At the end of each chapter carefully designed problems are assigned as homework for which selected fully worked out solutions are provided This book can be used for self study as well as in conjunction with a course in fluid mechanics

Porous Media Transport Phenomena Faruk Civan, 2011-07-18 The book that makes transport in porous media accessible to students and researchers alike Porous Media Transport Phenomena covers the general theories behind

flow and transport in porous media a solid permeated by a network of pores filled with fluid which encompasses rocks biological tissues ceramics and much more Designed for use in graduate courses in various disciplines involving fluids in porous materials and as a reference for practitioners in the field the text includes exercises and practical applications while avoiding the complex math found in other books allowing the reader to focus on the central elements of the topic Covering general porous media applications including the effects of temperature and particle migration and placing an emphasis on energy resource development the book provides an overview of mass momentum and energy conservation equations and their applications in engineered and natural porous media for general applications Offering a multidisciplinary approach to transport in porous media material is presented in a uniform format with consistent SI units An indispensable resource on an extremely wide and varied topic drawn from numerous engineering fields Porous Media Transport Phenomena includes a solutions manual for all exercises found in the book additional questions for study purposes and PowerPoint slides that follow the order of the text

Rational Continua, Classical and New P. Podio-Guidugli, M. Brocato, 2012-12-06 This book is a tribute to Gianfranco Capriz on the occasion of his seventy fifth birthday This book collects about twenty research papers written by world leading scientists in the field of continuum thermomechanics The authors discuss a number of different theories classical and new Moreover general underlying themes are both the exploration of the limits of the continuum approach as it was consolidated between the late 50s and the early 70s and the study of those amendments and extensions that would hopefully allow to treat mathematically a host of real life problems that have been proposed but not yet adequately modelled within materials science structural optimisation biosciences medical engineering superconductivity etc The reader will find displayed the recent progresses in modelling non standard material structures

Continuum Methods of Physical Modeling Kolumban Hutter, Klaus Jöhnk, 2013-11-11 This book is a considerable outgrowth of lecture notes on Mechanics of environmentally related systems I which I hold since more than ten years in the Department of Mechanics at the Darmstadt University of Technology for upper level students majoring in mechanics mathematics physics and the classical engineering sciences These lectures form a canon of courses over three semesters in which I present the foundations of continuum physics first semester those of physical oceanography and limnology second semester and those of soil snow and ice physics in the geophysical context third semester The intention is to build an understanding of the mathematical foundations of the mentioned geophysical research fields combined with a corresponding understanding of the regional but equally also the global processes that govern the climate dynamics of our globe The present book contains the material and extensions of it of the first semester it gives an introduction into continuum thermomechanics the methods of dimensional analysis and turbulence modeling All these themes belong today to the every day working methods of not only environmental physicists but equally also those engineers who are confronted with continuous systems of solid and fluid mechanics soil mechanics and generally the mechanics and thermodynamics of heterogeneous systems The book addresses a broad spectrum of

researchers both at Universities and Research Laboratories who wish to familiarize themselves with the methods of rational continuum physics and students from engineering and classical continuum physics

IUTAM Symposium on Mechanics of Granular and Porous Materials N.A. Fleck, A.C.F. Cocks, 2012-12-06 This volume constitutes the Proceedings of the IUTAM Symposium on Mechanics of Granular and Porous Materials held in Cambridge from 15th to 17th July 1996 The objectives were 1 To review existing experimental results and practical phenomena on the flow and compaction of particulate media 2 To review the current state of constitutive models and their implementation for predicting the macroscopic response 3 Identification of the shortcomings of existing models and procedures in understanding practical phenomena The Symposium brought together the research communities of solid mechanics materials science geomechanics chemical engineering and mathematics to review current knowledge of the flow and compaction of granular and porous media The meeting emphasised the development and use of constitutive laws to model practical processes such as mixing drainage and drying compaction of metal and ceramic powders and soils and instabilities associated with these processes A common theme was to develop constitutive models from an understanding of the underlying physical mechanisms of deformation and fracture It was particularly rewarding to find that the separate research communities came together during the meeting and came to a consensus as to the main mechanisms of deformation and failure of particulate and porous solids

Coupled Site and Soil-Structure Interaction Effects with Application to Seismic Risk Mitigation Tom Schanz, Roumen Iankov, 2009-06-18 Proceedings of the NATO Advanced Research Workshop on Coupled Site and Soil Structure Interaction Effects with Application to Seismic Risk Mitigation Borovets Bulgaria 30 August 3 September 2008 [Archives of Mechanics](#), 2006

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