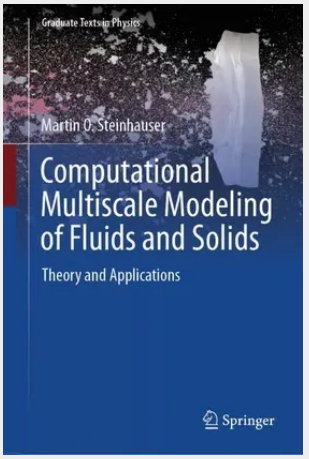
Steinhauser

Computational Multiscale Modeling of Fluids and Solids

Theory and Applications in Computational Science



This book covers the principles and applications of computational multiscale modeling of fluids and solids. It explores the physics across various length and timescales, introducing fundamental concepts in fluid and solid mechanics, and the objectives of experimental and theoretical physics. With detailed discussions on numerical methods, statistical physics, thermodynamics, and the theory of elasticity, this book integrates theoretical background with practical computational examples. Designed for advanced students and professionals, the book includes computational exercises and projects, supported by source code available within the text and for download.

This edition contains several significant updates and expansions. It now features standalone chapters on molecular dynamics simulations and on the Monte Carlo method, both enriched with new applications and examples. The treatment of hypervelocity impact and shock-related applications has also been expanded and is integrated into the broader multiscale discussion of the book, including particle-based space-debris impact scenarios. In addition, a thorough introduction to quantum mechanics is presented, including exercises and source code examples such as the numerical solution of the Schrödinger equation. The computer science material has been expanded into a full chapter, offering a comprehensive introduction to theoretical computer science. Furthermore, the mathematical background has been revised and enlarged to include differential forms, enhancing the understanding of space in physics. Updated references, new exercises, case studies, and repository-supported C/C++ code examples make this book even more valuable for academic use.

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