Physics of Continuous Matter: exotic and everyday phenomena in the macroscopic world

Subject area
Solid Mechanics, Fluid Mechanics

Description
This text covers classical continua for physics students.

Authors
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Level
Undergraduate, research

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Summary Review

range: * poor to ***** good	
Academic content	*****
Usefulness to student	*****
Usefulness to teacher	*****
Meets objectives	*****
Accuracy	*****

Nobody would deny the necessity to keep physics courses up to date, the inclusion of more modern topics has meant that classical continuum phenomena receive quite cursory treatments in today's curriculum. There may even be a feeling that continuous systems are the province of engineers or earth scientists rather than physicists. Ironically, perhaps, the drive to smaller and smaller devices is forcing physicists to go back and learn again about fluid flow in confined geometries, and about the deformations of structures that are not just simple beams. It is also true that processes that can be described by a continuum treatment of matter play a larger part in everyday life than do many atomic and quantum processes. Furthermore, fluid flows provide us with a useful reminder that processes can be nonlinear.

There is, then, a need for a book that can revive interest in classical continua in physics students - a need that this book satisfies with great style. Although it starts from the very beginning of the subject, it also reaches advanced topics, but without discontinuities along the way. Starting from the basics of Newtonian mechanics and vector and tensor algebra, the first half of the book covers solids and fluids at rest and in motion, gravitation, buoyancy, and hydrostatics with and without surface tension. A good introductory course could be based on this material.

The second half of the book, labelled 'special topics', builds on what has gone before to cover a range of largely hydrodynamic problems. These include fluid surface waves, shock waves, vortices and turbulence, lubrication and boundary layers, flight, and heat transfer. This is not the place to give a detailed list: go and look at the book, but be prepared not to be able to put it down. In every case the approximations made are carefully justified, and the mathematical analysis is clearly presented. Even in this half, the materials treated are homogeneous and isotropic. It would have been nice to see the methods applied to a few modern composite materials, and this would also have made greater use of the tensor notation that was explained early in the book.

Amongst the mathematics, the author never takes his eyes off the practical issues. For example, in the midst of the treatment of linear elasticity there is an excellent explanation of the physical constraints on the elastic constants. Examples from everyday life abound: I had to break off from reading to experiment with hydraulic jumps in the kitchen sink. Other examples, one hopes, are less common, such as the instability of ferries with water on the vehicle deck. The emphasis is on understanding the problems and obtaining analytical solutions, but there are two chapters on computational methods, for static elasticity and for fluid dynamics.

The layout is attractive: it follows the pattern set by many very successful (often American) introductory physics texts, albeit in monochrome rather than colour. Wide margins are used for small explanatory diagrams, tables of physical constants, and one-paragraph biographical summaries of the major historical figures. Important points are illustrated with well chosen photographs which range from a spider walking on water to condensation round an aircraft breaking the sound barrier. There are references to original papers as well as a comprehensive general bibliography.

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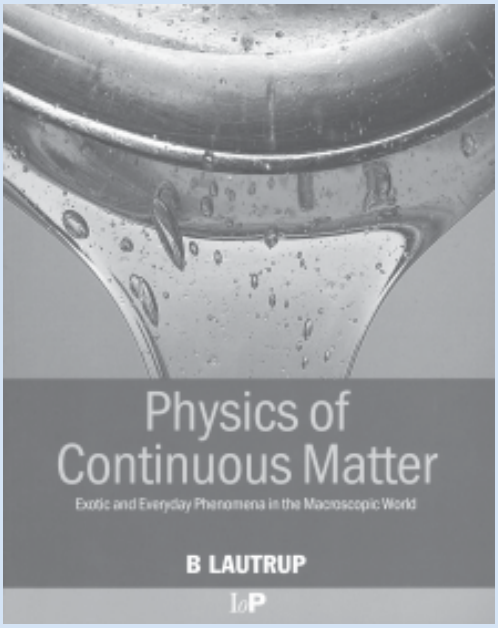

From the publisher...

Physics of Continuous Matter: Exotic and Everyday Phenomena in the Macroscopic World

By B Lautrup The Niels Bohr Institute, Copenhagen, Denmark

Provides a description of the macroscopic world of apparently continuous matter accessible to students of all branches of physics.
Develops the necessary mathematical tools along with the physics as needed.
Demonstrates how to reason about physics both qualitatively and quantitatively.
Includes two whole chapters on numeric simulation in elastostatics and fluid mechanics.
Contains historical comments and microbiologies of major players in the field.

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Every chapter is followed by a good selection of problems. Some of these fill in steps from the argument in the text, whilst some of the others will remind older readers of the Cavendish Problems in Physics: clear solutions are given at the back of the book. Although it is not mentioned in the text, a web site (www.nbi.dk/~lautrup/continuum) contains additional material, including *Mathematica* notebooks.

This is an excellent text, which ought to inspire students and teachers alike with the richness of behaviour that is contained within a few continuum equations - equations that are easy to derive but often far from easy to solve. The subject may have its roots in the nineteenth century, but this book shows that it is still alive, relevant and challenging in the twenty-first.