Preface

Tensors are needed in Physics to describe anisotropies and orientational behavior. While every physics student knows what a vector is, there is often an uneasiness about the notion *tensor*. In lectures, I used to tell students: “you can be a good physicist without knowing much about tensors, but when you learn how to handle tensors and what they are good for, you will have a considerable advantage. And here is your chance to learn about tensors as a mathematical tool and to get familiar with their applications to physics.”

This book is, up to Chap. 14, largely based on the two books:

Siegfried Hess, Vektor- und Tensor-Rechnung, which, in turn, was based on lectures for first-year physics students, and

Siegfried Hess and Walter Köhler, Formeln zur Tensor-Rechnung, a collection of computational rules and formulas needed in more advanced theory.

Both books were published by *Palm and Enke*, Erlangen, Germany in 1980, reprinted in 1982, but are out of print since many years.

Here, the emphasis is on Cartesian tensors in 3D. The applications of tensors to be presented are strongly influenced by my presentations of the standard four courses in Theoretical Physics: Mechanics, Quantum Mechanics, Electrodynamics and Optics, Thermodynamics and Statistical Physics, and by my research experience in the kinetic theory of gases of particles with spin and of rotating molecules, in transport, orientational and optical phenomena of molecular fluids, liquid crystals and colloidal dispersions, in hydrodynamics and rheology, as well as in the elastic and plastic properties of solids. The original publications cited, in particular in the second part of the book, show a wide range of applications of tensors. An outlook to 4D is provided in Chap. 18, where the Maxwell equations of electrodynamics are formulated in the appropriate four-dimensional form.

While learning the mathematics, first- and second-year students may skip the applications involving physics they are not yet familiar with, however, brief introductions to basic physics are given at many places in the book. Exercises are found throughout the book, answers and solutions are given at the end.

Here, I wish to express my gratitude to Prof. Ludwig Waldmann (1913–1980), who introduced me to Cartesian Tensors, quite some time ago, when I was a student. I thank my master- and PhD-students, postdocs, co-workers, and colleagues for fruitful cooperation on research projects, where tensors played a key role. I am grateful to Springer for publishing this Tensor book in the series *Undergraduate Lecture Notes in Physics*, and I thank Adelheid Duhm, Project Coordinator at Production Physics Books of Springer in Heidelberg for her diligent editorial work.

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Springer

http://www.springer.com/978-3-319-12786-6

Tensors for Physics
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2015, XVII, 440 p. 55 illus., Softcover
ISBN: 978-3-319-12786-6