Preface

Why do we have analogies in physics?

This question has been the leitmotif of the author's research for about half a century. Six physical theories are considered: particle mechanics, electromagnetism, mechanics of deformable solids, fluid mechanics, gravitational field and heat conduction. The reasons for the analogies have been discovered, and the main purpose of this book is to make them known.

Usually, analogies are revealed based on the similarities of equations of various physical theories. As the present research developed, it was found that, instead of starting from the equations, the first step must be an analysis of the physical variables that compose them, more precisely, an analysis of the global variables from which the field variables follow as their density and rates. The reason for analogies has been localized in the fact that global variables have a natural association with the four so-called space elements, i.e. points, lines, surface and volumes, and with the two time elements, i.e. time instants and time intervals. In this association, a fundamental role is played by the notion of the orientation of a space and time element. It will be shown that there are two kinds of orientation, inner and outer. Since each of the four space elements can have two possible orientations, it follows that we must consider *eight* distinct space elements and *four* distinct time elements.

This discovery leads to the construction, for the first time, of a classification diagram of these eight oriented space elements and, due to the correspondence of global variables with space and time elements, the construction of a corresponding classification diagram for the global variables of the physical theories.

It follows that the mathematical structure underlying the classification diagram is of a geometric nature, specifically of a topological nature. This diagram brings to light the existence of a mathematical structure that is common to various branches of physics.

However, we emphasize that this is a book about physics, not mathematics. It begins with an analysis of the operational definition of physical variables, with

their measurement process, and not with a mathematical theory as the theory of affine spaces or that of differential forms.

The book offers an interdisciplinary approach to the various branches of classical and relativistic physics. To this end, an attempt has been made to write the book with Ph.D. students in mind.

At this point, we would like to quote Cornelius Lanczos from the preface of his book *The Variational Principles of Mechanics*: "Many of the scientific treatises of today are formulated in a half-mystical language, as though to impress the reader with the uncomfortable feeling that he is in the permanent presence of a superman. The present book is conceived in a humble spirit and is written for humble people."

To help the reader, we have made copious citations of books and articles, indicating also the page of the cited books for easy referencing and comparing of statements and formulae by the reader.

Epigraph

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Not all suggestions made by these reviewers were accepted, and the author retains sole responsibility for any flaws or faulty judgments expressed in the book.

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