we seem to ignore these matters. I would certainly welcome such additions to this text.

In the Preface, the author argues for the need for a separate text on calculus of several variables. Personally, I am not convinced, for economic as well as other reasons, by this argument. However, for those who feel the need for a text on Single-Variable Calculus I can certainly recommend this book.

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"TOPOLOGY AND GEOMETRY FOR PHYSICISTS"

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MATHEMATICAL PHYSICS YOUR MOTHER NEVER TAUGHT YOU

Mathematical Physics as a discipline has been defined and dominated by a single book in a way that no other field of science has been. This book is, of course, Methods of Mathematical Physics by Richard Courant and David Hilbert. Courant and Hilbert first appeared in Germany in 1924, and has been continuously available in a sequence of different forms ever since. It is still in print, the two volumes costing well over £100.

The mathematics in Courant and Hilbert, despite some modern touches, has a curiously nineteenth century flavour to it. The book is focused on differential equations and so naturally deals with continuous functions. The way it links up with the discontinuous nature of much of modern physics, especially quantum mechanics is via the eigenfunction/eigenvalue approach where each individual eigenfunction is a solution to a differential equation and so inherits its differentiability properties from it, but the eigenvalues themselves tend to be discrete.

The only significant branch of Mathematical Physics which stood apart from the Courant-Hilbert approach was group theory, which used the discreteness of the group elements to model nature. Thus, ten years ago, if one had a good grounding in both Courant/Hilbert and some group theory, all one needed was a smattering of physics and one could hold one's head up as a mathematical physicist in the fanciest of company.

This golden age has completely vanished. In the last decade there has been a flood of new ideas flowing into physics from mathematics especially in geometry and topology. For example, a unit cell in a crystal is a three-manifold without boundary. This means that it is trivial to show that the total charge in each cell must be zero. Of course, this is not a new result, but it is a very simple example of how even elementary topology can and should be used.

The book under review is an attempt to codify and make available to the ordinary physicist the key ideas of modern geometry and topology. It assumes no previous knowledge, and so starts off with two introductory chapters, one on general topology and one on differential geometry. Then come four chapters on homotopy, homology and cohomology. The last of the mathematical chapters is a long (80 page) chapter called "fibre bundles and further differential geometry". The last three chapters apply the previously developed tools to a range of physical problems. Two of these are fairly short and deal respectively with Morse theory, which is applied to phase transitions in crystals, and the theory of defects.

Pride of place, naturally, is given in the final chapter to Yang-Mills theory. Yang-Mill's theory was invented thirty years ago but was virtually ignored for twenty years. However, in the last ten years there has been an enormous investment in time and effort by the physics community to understand Yang-Mills theory and much of the recent advances in elementary particle physics have come from this work. Yang-Mills theory is what physicists call a gauge theory, which means that it has a natural geometrical structure. It is the attempt to unravel this geometrical structure that has forced physicists to learn geometry and it is the prime motivation for this book.

In their preface, the authors claim that they have attempted to strike a balance between rigor and clarity. I do feel that they have done this admirably. At no point during my reading of the book did I feel that the authors were sliding past me, or trying to persuade me of something, rather than proving it. At the same time, they had no hesitation in proving only part of a theorem rather than slogging through the whole thing. This means that at every stage in the book, the reader should have a very good idea of the difficulties encountered and of the techniques used to overcome these, without having to absorb a mass of material. This, I feel, is a great strength because it generates a feeling of confidence in the reader, which enables him or her actually to apply the ideas, without feeling permanently ill-at-ease.

On the other hand, this is not a book for bedtime reading. In the 300 pages is an enormous range of new ideas; not only new ideas but a new vision, a new way of seeing things. This sort of shift is not something that comes easily. When I first got the book, I was interested in learning something about Morse theory and so immediately turned to Chapter 8. I gave up very quickly. The whole structure of the book is pyramidal. Each chapter depends on the ones before, with none of the little refreshers which help reinforce the new ideas. It might be worthwhile for the novice, before plunging in, to read something easier, for example Geometrical Methods of Mathematical Physics by Bernard Schutz (Cambridge University Press, 1980).

The authors were not well-served by their lay-out man. In many places throughout the book relevant illustrations are misplaced. The printing, on the other hand, is very good, with very few mistakes in spelling or grammar or, even more importantly, in the equations.

In conclusion, I would love to teach a course with this book as a text. Both I, and the students, would learn a great deal. I can recommend it unhesitatingly. I am sure that my copy will be read and re-read in years to come.

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