Fecko, Marián

Differential geometry and Lie groups for physicists. (English) Zbl 1121.53001
Cambridge: Cambridge University Press (ISBN 0-521-84507-6/hbk). xv, 697 p. (2006).

The book under review is a gigantic compendium of aspects of differential geometry relevant for modern physics. The reader should not think, however, that physics is an ever-present part of the book. Only in the last several chapters does physics make an essential appearance, for instance when gauge theory is discussed. The author is correct when he says in the preface, "The orientation on physics makes itself felt in the choice of material, in the way it is presented (e.g. with no use of a definition-theorem-proof scheme), as well as in the content of exercises (often they are closely related to physics)." Indeed, the presentation is almost colloquial and this makes reading rather pleasant.

The author has made a concerted effort to give intuitive interpretations of complicated ideas such as: the Lie derivative, tensors, the Hodge star operator, Lie group representations, Hamiltonian and Lagrangian mechanics, parallel transport, connections, curvature, gauge theories, spinors and Dirac operators. This will be much appreciated by students (and even researchers, I think). But in a single book, even one of 697 pages, it is difficult to cover all these topics in enough detail to make them understandable. In the preface the author also states, "The book is intentionally written in a form which makes it possible to be fully grasped also by a self-taught person ..." and it is certainly the case that much of the book's exposition takes place within exercises (which, to be fair, contain many hints and elucidations), but it seems to the reviewer that the time-frame for a "self-taught" person to complete the book's material is well into decades! So what is the bottom line here?

Clearly, the book is an excellent reference for geometers. I think it might also be successful as a class text as long as students can expect really superb lectures and then use the book for its fine set of exercises. But almost no student will be able to get through the book by himself or herself; and it would be the truly extraordinary student who could appreciate the bits of physics strewn throughout the book (in exercises remember!) without the guidance of an expert. Conversely, it would be an extraordinary physicist who has the time to go through all the differential geometry contained in the exercises. So my feelings are mixed. I enjoyed the author's writing and explanations, but I could not make myself work all the problems. Will others?

Reviewer: John F. Oprea (Cleveland)

MSC:

53-01	Introductory exposition (textbooks, tutorial papers, etc.) pertaining to differential geometry
81-01	Introductory exposition (textbooks, tutorial papers, etc.) pertaining to quantum theory
53C80	Applications of global differential geometry to the sciences
53C20	Global Riemannian geometry, including pinching
53B20	Local Riemannian geometry

Keywords:

differential geometry; Lie group; field; gauge theory