any degree of felicity.

Campbell, a researcher with a long and distinguished record of research in ionospheric currents and geomagnetic storms, has succeeded in covering the last two topics of the three mentioned above, and he has made what amounts to an honorable stab at the first. This is not a damning criticism, because it is rare to find an introductory text on magnetic storms and quiet-day variations free of the daunting derivations of equations that Campbell calls "mathematical gymnastics." These two research fields cover 110 of the total of 247 pages in the five chapters of the book. Each chapter has a wealth of figures and a helpful summary at the end. The references to work published after 1990 tend to be few and far between.

Chapters 2 and 3 present a very readable and simplified description of the behavior of quiet-field (Sq) ionospheric current systems, their spherical harmonic analyses and the plethora of solar–terrestrial effects of an active Sun: sunspots, flares, mass ejections, storms and substorms. For a main-field enthusiast such as myself, these two chapters were a very helpful primer for more advanced research papers on these topics, and I know that my students in main-field geomagnetism will also benefit from my broadened horizon.

I wish I could be as enthusiastic about chapter 1, on the main field. The 61 pages in this chapter provide a good description of the components of the dipole field, Carl Friederich Gauss's spherical harmonic analysis of the global field and the International Geomagnetic Reference Field descriptions up to the year 1995 and gauss coefficients up to degree and order 6. But the origin of the field (dynamo theory) and its geological time variations (paleomagnetism) are barely touched upon. Even when the reader is referred to other textbooks for further details, the summary information given is fairly old. For example, Campbell not only fails to mention the path-breaking three-dimensional numerical modeling of the geodynamo by Gary A. Glatzmaier and Paul H. Roberts in 1995, but also ignores the kinematic dynamo models of the 1950s by Edward C. Bullard and by Walter M. Elsasser. I was surprised to find that these two stalwarts of geomagnetism were not even listed in the references of a book published last year. (Nor did I expect to see "quadrupole" and "octupole" spelled as "quadr*a*pole" and "oct*a*pole!")

Let me end the review by citing some of the book's strengths that will make it attractive to beginning graduate students, geomagnetic observatory technicians and others new to geomagnetism and especially to the non-main field that is generated outside Earth's fluid core. Such "goodies" include a large list of computer programs for data handling and manipulation and addresses of the sources for such utility programs and an appendix that briefly introduces the student reader to the mysteries of logarithm, trigonometry, complex numbers and vector calculus. Also noteworthy is the list of Campbell's technical reports on his research, cited in the acknowledgements.

Overall, the personal style of Campbell's writing, his concern for the reader being "on the same page" as he is and his obvious enthusiasm for the subject make the book a good introduction for the nonspecialist. For the student with a stronger background in physics and mathematics, Wilfred Dudley Parkinson's *Introduction to Geomagnetism* (Scottish Academic Press, 1983) is still a better bet.

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The Geometry of Physics: An Introduction

Theodore Frankel
Cambridge U. P., New York, 1997. 654 pp. $95.00 hc
ISBN 0-521-38334-X

From the earliest days of science, there has been a love affair between geometry and physics. In fact, there were times when the two disciplines were so intertwined that it was hard to tell them apart. Newtonian mechanics went hand in hand with Descartes's analytic geometry, and many of the founders of modern differential geometry, such as Carl Friedrich Gauss, Bernhard Riemann, Felix Klein, Sophus Lie and Henri Poincaré, would qualify as mathematical physicists in their own right.

With the birth of the two theories of relativity (in 1905 and 1915, respectively), thanks to such people as Albert Einstein (with some help from Marcel Grossmann and Hermann Minkowski), Hermann Weyl, David Hilbert and many others, tensors slowly became a household word among theoretical physicists. Theoretical physicists became masters of "index gymnastics," while neglecting another important line of development: the use of exterior differential forms, developed mainly by Elie Cartan and his school and carried forth by the younger generation of French, Swiss, Chinese and American mathematicians.

Though the monumental treatise *Gravitation* by Charles Misner, Kip Thorne and John Archibald Wheeler (W. H. Freeman, 1973) made extensive use of differential forms, it took a long time for other textbooks on relativity to follow suit. The situation changed somewhat in the late 1960s and early 1970s, when a number of people (such as Elihu Lubkin, Robert Hermann, Andrzej Trautman and I) noticed that the language of connections in fiber bundles was the natural setting for gauge theories (of both the abelian and nonabelian kind).

The discovery of instantons and their interpretation in terms of Chern classes, and the use of the Atiyah–Singer index theorem for "instanton counting," finally brought the importance of modern differential geometry to the attention of the wider theoretical physics community. Differential geometry methods in physics have gained a new impetus through the popularity of string theories and their "moduli spaces" and the widened interest in relativistic gravitation and cosmology. A number of new textbooks and monographs—by Ralph Abraham, Jerrold Marsden and Tudor Ratiu (*Manifolds, Tensor Analysis, and Applications*, Addison-Wesley, 1983), by Yvonne Choquet-Bruhat, Cécile de Witt-Morette and Margaret Dillard-Bleick (*Analysis, Manifolds and Physics*, North-Holland, 1982 and later editions); by Bernard Schutz (*Geometrical Methods of Mathematical Physics*, Cambridge U. P., 1980), by Walter Thirring (*A Course in Mathematical Physics Vol. I, II*, Springer-Wien, 1978, 1979 and later editions) and several others—appeared, and some have been used to teach graduate students.

The publication of *The Geometry of Physics* by Theodore Frankel fills a gap in the available literature in that it provides a highly readable and enjoyable exposition of a variety of differential geometric methods that are useful in physics. The book could be used as a text in a graduate course or as a reference for working theoretical and mathematical physicists. The author, a professor emeritus at the University of California, San Diego, is well known for his contributions to general relativity, the application of differential forms to electromagnetism and continuum mechanics and waves on manifolds. He is the author of *Gravitational Curvature* (Freeman, 1979).

Frankel's book is very well written, avoids the dry definition–theorem–proof approach and introduces nontrivial topics early, keeping the interest of the reader alive. Thus, the concept of vector bundle appears as early as page 48, and even an advanced reader will find interesting topics scattered throughout the book. Although the emphasis is on coordinate-free presentations, the book does not discourage detailed calculations and is rich in examples and exercises.

Many newer topics are presented in an amusing way. Thus, Barry Simon's treatment of Michael Berry's phase in terms of a connection is called the "Simon connection (avoiding the temptation to call it the Berry–Barry connection)."

There are a few shortcomings, mainly in the oversimplification of physical examples and sketchy historical references, which a physicist will easily be able to complete and a mathematician will, one would hope, not propagate. I have been informed by the author that a number of typos and errors will be corrected in a second printing, which the publisher has scheduled. It is well worth watching for this second printing.

Two problems that will have to wait for a second edition are somewhat related: Owing to the proliferation of symbols used by the author (such as boldface and normal "partial dees," Greek letters and asterisks), a notation index would have been extremely helpful. And the typesetting used by the publisher is confusing. Equations in the main text are set in what looks like Times Roman (rather than Donald Knuth's Computer Modern Roman, which has become second nature to many of us) and in the exercises they are set in Helvetica. Even an experienced reader will have difficulty deciding whether two symbols in these different fonts mean the same thing! The spaces among elements of the equations and the mismatched sizes give one the impression of an old Microsoft Word screen rather than a typeset book and are rather tiring to the eyes.

In spite of these problems, the book will make an excellent course text or self-study manual for this interesting subject.

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Chaos in Atomic Physics

Reinhold Blümel
and William P. Reinhardt
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ISBN 0-521-45502-2

Atomic physics is in flux. Bose–Einstein condensation, ultracold atomic collisions, quantum computing, artificial atoms and the subject of this book—chaos—make it an exciting discipline, one that straddles most of the