

tioners in the field for many years to come.

RUTH A. DALY
*Pennsylvania State University
Reading*

Introduction to General Relativity

▶ Gerard 't Hooft
*Rinton Press, Princeton, N.J.,
2001. \$38.00 (86 pp.).
ISBN 1-58949-000-2*

What precisely are the goals of an introductory textbook on general relativity? In conversations with my colleagues over the years, I received many and varied answers. Some physicists feel that material should first be introduced at a deep but intuitive and unsophisticated level. Others prefer an axiomatic approach with all tangents and distractions saved for later. A third group wants the maximal list of topics surveyed, with each receiving the minimum necessary treatment.

The best way to understand the particular goals of Gerard 't Hooft's *Introduction to General Relativity* is to read the prologue (and to ignore the publisher's comments on the cover). In the prologue, 't Hooft states plainly that this book consists of his notes from a set of lectures on the subject, and that he wishes to address fairly sophisticated students who will be able both to deal with changes in notation between chapters and to pursue the literature on their own in search of further details. Such students should already have had some exposure to the ideas of general relativity or should be able to bring questions to a more advanced student or professor. Students of that caliber will indeed enjoy and benefit from 't Hooft's treatment.

With many books, one obtains a sufficient impression of the text by simply picking up the book and flipping through the pages. I was pleasantly surprised to learn that this is not the case here. At first glance, the book appears to be quite brief and densely packed with equations. However, reading through the text, I found that it displayed significant physical insight and contained many useful analogies to other branches of physics. In particular, 't Hooft makes elegant use of Rindler space and the equivalence principle in a manner that is typically found only in much longer introductions to the subject. As a result, I found this text to be far superior to P. A. M. Dirac's *General Theory of Relativity* (Wiley, 1975). Fans of Dirac's nondiscursive style should

also appreciate 't Hooft's book, and the additional physical insight will be useful in solidifying their grasp of the subject.

While 't Hooft makes very efficient use of his 86 pages, the reader will no doubt recognize that such a brief treatment cannot provide complete coverage of the subject. The book is not intended to compete with either Robert Wald's *General Relativity* (U. of Chicago Press, 1984) or Charles Misner, Kip Thorne, and John Wheeler's *Gravitation* (W. H. Freeman, 1970). A number of choices have been made as to what material is included, and many of 't Hooft's chapters contain only a sketch of the ideas, with the reader being referred elsewhere for details and proofs.

Introduction to General Relativity lacks some of the standard amenities that one may expect from a textbook. It contains only a few homework exercises and has no index at all. As a result, one might best use the book together with another text. The equations also contain some rather annoying typographic problems, which is surprising for such a short book.

I would be tempted to use this book in combination with, for example, *A First Course In General Relativity* (Cambridge U. Press, 1985) by Bernard F. Schutz. While more sophisticated than Schutz's book, 't Hooft's *Introduction* might serve as a useful guide for students who become lost in Schutz's more physical treatment and more discursive style. While 't Hooft provides greater physical insight than one would expect after a brief look at his book, the extent of that insight is nevertheless limited by the length of the book and the very direct style. Simultaneous study of Schutz's book would offset this limitation. The two books cover a similar range of topics (the basics, the Newtonian limit, Schwarzschild black holes, and gravitational radiation) and would complement each other well.

The style used by Schutz is more geometric, while that of 't Hooft is distinctly algebraic, somewhat in the vein of Steven Weinberg's *Gravitation and Cosmology* (Wiley, 1972). The texts of 't Hooft and Schutz are similar in that both pass only briefly over the full introduction to differential geometry that sometimes constitutes the first semester material for a two-semester graduate general relativity course at US institutions. Schutz's more lengthy introduction and discussion of relativistic fluids would also assist those not already intimately familiar with stress-energy tensors in special relativity to better

appreciate 't Hooft's comments.

While it is not particularly elementary, particularly advanced, or particularly complete, I am sure that 't Hooft's direct and rather elegant style will find many supporters. The role currently played by Dirac's *General Theory of Relativity* may well come to be filled by 't Hooft's new *Introduction*.

DONALD MAROLF
*Syracuse University
Syracuse, New York*

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