feld paper. But only two of his papers are quoted, and his book, *From c-Numbers to q-Numbers* (U. of California Press, 1992) is not referred to. Chevalley, who has written extensively and insightfully on the philosophical traditions that contributed to Bohr's and Heisenberg's interpretation of quantum mechanics, receives similar treatment. Tian Yu Cao published an important book, *The Conceptual Developments of 20th Century Field Theories* (Cambridge U. Press, 1997), which was extensively and very favorably reviewed by leading physicists, historians, and philosophers. There is no reference to it in Volume 6.

My criticisms notwithstanding, Mehra and Rechenberg's *The Historical Development of Quantum Theory* is indeed a most impressive accomplishment. The volumes will undoubtedly become the point of departure of all future investigations into the history of quantum mechanics.

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Exploring Black Holes: Introduction to General Relativity

Edwin F. Taylor
and John Archibald Wheeler
Addison Wesley Longman, New York, 2000. $37.33 (286 pp.). ISBN 0-201-38423-X

It has been 85 years since Einstein's formulation of general relativity. In that time, the theory has been extensively tested in its weak-field limit in the Solar System. The prediction of gravitational waves has also been dramatically confirmed by the orbital decay of the binary pulsar 1913+16. General relativity is crucial to understanding the astrophysics of black holes, neutron stars, gravitational lenses, and the expansion of the universe. It has even found practical applications: The global positioning system would fail very quickly if it did not take into account general relativistic corrections.

General relativity also occupies a central place in modern physics. It is our best theory of the gravitational interaction, and provides a radical new view of what it means to be in an inertial frame of reference in the presence of gravity, which couples to all matter and energy. General relativity is also central to the effort to unify all the fundamental interactions of physics within a consistent and experimentally testable quantum theory of gravity. Finally, classical general relativity is on the brink of an experimental revolution, with the expected detection of gravitational waves by new generations of such ground-based observatories as LIGO (Laser Interferometer Gravitational Wave Observatory).

Nonetheless, there is no sign of general relativity in the core undergraduate physics curricula of most colleges and universities, apart from the trivial (and highly misleading) derivation of the Schwarzschild radius from Newtonian escape velocity arguments. What a shame, especially when students are generally filled with a tremendous desire to learn about such exotic objects as black holes! The likely reason for this gap in the curriculum is that the mathematics is considered to be too daunting. However, books are coming on the market, that succeed in explaining relativistic gravity correctly and with a minimum of math.

Exploring Black Holes, by Taylor and Wheeler, is a superb example. No tensors or differential forms here; not even any calculus of variations to derive geodesics! Instead, the book uses very basic differential and integral calculus to get at all the essential physics of black holes. Every physicist should be exposed to the ideas presented here at some time in his or her career.

As would be expected from these authors, the book is extremely well written, and the presentation is physical and intuitive. Common student questions and misconceptions are anticipated and addressed head-on in a series of dialogue formats sprinkled throughout the text. Technical jargon is almost entirely avoided. The importance of different classes of observers is emphasized, as are the ideas of extremal aging for geodesic motion and the fact that energy is a unified whole in general relativity. Taylor and Wheeler masterfully explain exactly what those coordinates in the metrics mean and how they are related to measurements by local observers.

This book should be accessible to physics majors in their sophomore year or later; by then they should have had some exposure to basic Newtonian mechanics and special relativity. Its organization provides considerable flexibility, making it suitable for use in courses of many kinds. The central material is presented in just five short chapters entitled "Speeding," "Curving," "Plunging," "Orbiting," and "Seeing." Interspersed among these chapters are seven "Project" chapters, which lead the student through various interesting applications, including gravitational lensing, rotating black holes, and an introduction to cosmological spacetimes.

This book is not intended to be a broad overview of general relativity. The Einstein equations are not presented or explained, nor is there any discussion of gravitational waves. The cosmology project chapter just scratches the surface of that important field. Such limited treatment is perhaps just as well, given the authors' stated philosophical objections to the recent observational evidence of accelerating expansion. To their credit, however, this is treated fairly in the text. The book also concentrates on the physics of black holes, not their astrophysics, so readers should not expect to find much on accretion disks, iron K-alpha lines, jets, or black hole mass/stellar velocity dispersion correlations.

As a textbook that really teaches the basic physics of black holes and focuses on that physics rather than on difficult mathematics, this book is right on the mark. I can only hope that *Exploring Black Holes* and similar books will equip us to modernize undergraduate physics curricula to include a discussion of general relativity, one of the truly revolutionary advances in 20th-century physics, an advance that is central to modern fundamental physics.

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Nearest Star: The Surprising Science of Our Sun

Leon Golub and Jay M. Pasachoff
Harvard U. Press, Cambridge, Mass., 2001. $29.95 (304 pp.). ISBN 0-674-00467-1

Nearest Star: The Surprising Science Of Our Sun tells the story of our most important star, the Sun, and its relationship to our most important planet, Earth. It is a story with many facets, and multiple links to fundamental physics that might surprise as well as engage the reader. The book is beautifully written and conveys the love that the authors have for the subject.

One of its authors, Leon Golub, is a solar astronomer and one of the leaders of the Transition Region and Coronal Explorer (TRACE) team. The other, Jay Pasachoff, is a noted astronomer who has seen more total eclipses than perhaps any other person. Pasachoff has written several astronomy textbooks, including, one of the best middle-school science books available, *Science Explorer: Astronomy* (Prentice-Hall, 2000). Together, they are uniquely qualified to write a book on the Sun, and they have produced a truly fascinating tour, complete with an outstanding set of images.

Nearest Star takes us on a multidimensional journey—in space, from the center of the sun to the atmosphere of the Earth, and in time, from the Big Bang to our current arguments about global warming. If you ever wondered what the "saros" is, or how the solar wind is generated, this is the book for you. The breadth of information the authors provide is exceptional. I don't think I will be the only reader to stop and reread sections, taking in all that these expert authors have to offer.

This book can appeal to a wide audience. Students of space science will find it provides a wonderful overview, and the wider public would enjoy it as well; *Nearest Star* is, for the most part, written at a *Scientific American* level. The chapter on current and future space missions might be less appealing to general readers, but space buffs will appreciate the birds-eye view that the authors provide. Overall, the grand scope of the book will engage folks who enjoy keeping abreast of current science.

One especially appealing feature of this book is the historical context provided by the authors. The Sun is the dominant feature in our sky and has absorbed the attentions of observers for millennia. In the scientific age, the Sun continued to be the source of such fundamental questions as How does it shine? Golub and Pasachoff treat the subject by essentially providing a biography of the Sun, weaving together current knowledge and history into a seamless tapestry.

The last chapters of the book deal with the Sun's influence on Earth. As elsewhere, Golub and Pasachoff are thorough, leading the reader through a wide-ranging discussion of climate, ice ages, and global warming. They also point out that we are, after all, living with a variable star. Solar variability is a wild card in the global climate question, despite the clear anthropogenic forcing of the industrial age. A more direct effect of solar variability is "space weather." For readers unfamiliar with the term, *Nearest Star* will provide a nice introduction. And it is gratifying to see a discussion of the aurora that gets the basics right—too many books, even today, still invoke an obsolete picture of direct entry of solar wind particles into the polar regions to explain the northern lights.

In sum, *Nearest Star* provides an excellent overview of our current understanding of the Sun and its effects on Earth. But, of course, science does not stand still. Already one of the questions left open by this book has been answered: The recent results from the Sudbury Neutrino Observatory have confirmed that neutrinos do change flavors, and that we do seem to understand the processes that power the Sun's core. That new and fundamental understandings continue to emerge from the study of our nearest star is a testament to the importance of solar physics.

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Quantum Computation and Quantum Information

Michael A. Nielsen
and Isaac L. Chuang
Cambridge U. Press, New York, 2000. $130.00, $47.95 paper (700 pp.). ISBN 0-521-63235-8, ISBN 0-521-63503-9 paper

Michael Nielsen and Isaac L. "Ike" Chuang have produced a highly readable, thorough, and timely survey of the field of theoretical quantum information science. Their *Quantum Computation and Quantum Information* is probably destined to become a standard text for researchers in this still emerging, rapidly developing field. Quantum information science is the application of the fundamental quantum physics phenomena to the storage, communication, and processing of information; it represents a complete paradigm shift for information processing technology. Phenomena such as superposition and entanglement, in theory, allow the solution of important mathematical problems thought to be intractable with standard electronic computers.

Research in quantum information science, which has seen remarkable growth in the last five years or so, is highly interdisciplinary, encompassing mathematics, computer science, physics, electrical engineering, materials science, and physical chemistry. Nielsen, an associate professor at the University of Queensland node of the Australian Special Research Center for Quantum Computing Technology, in Sydney, Australia, and Chuang, an associate professor at the MIT Media Laboratory, are two of the brightest