

of the evolutionary link between rotation- and accretion-powered pulsars is a milestone of modern astrophysics.” That description appears to be an overstatement: In my opinion, there is no milestone, and I seriously doubt that such a claim is solid justification for acquiring Ghosh’s book. It is further advertised that the book starts with simple, basic physical concepts and builds up to the point where the latest and most exciting developments become accessible to readers. That is simply incorrect. In addition, important recent developments concerning, for example, cooling neutron stars, gamma-ray pulsars, XDINs, CCOs, and RRATs have been omitted.

Despite its flaws, *Rotation and Accretion Powered Pulsars* may be useful as an introductory text, but mostly in the sense that it provides a starting point for interested readers. Thus Ghosh’s text should be in every university library.

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Functional Integration

Action and Symmetries

**Pierre Cartier and
Cécile DeWitt-Morette**
Cambridge U. Press, New York,
2007. \$160.00 (456 pp.).
ISBN 978-0-521-86696-5

Since its inception in Richard Feynman’s 1942 doctoral thesis, the path integral has been a physicist’s dream and a mathematician’s nightmare. To a physicist, the path integral provides a powerful and intuitive way to understand quantum mechanics, building on the simple idea that quantum physics is fundamentally a theory of superposi-

tion and interference of probability amplitudes. The “sum over histories” offers a framework for tackling problems ranging from Feynman diagrams to lattice chromodynamics, from quantum cosmology to superfluid vortices to stock-option pricing. To a mathematician, the path integral is at best an ill-defined formal expression. It is some sort of vaguely integral-like object involving a “sum” over a badly specified collection of functions, having an undefined measure, and whose value is apparently determined by a group of unclear and perhaps incompatible limits that may or may not yield finite answers.

Pierre Cartier and Cécile DeWitt-Morette’s *Functional Integration: Action and Symmetries* is both a survey of selected path-integral methods and a valiant effort to put those methods on a sound mathematical footing. DeWitt-Morette, a mathematical physicist and professor emerita at the University of Texas at Austin, has spent much of her career thinking about how to make sense of the path integral. Her first paper on the subject dates back to 1951. Cartier, a member of the Bourbaki group—Nicolas Bourbaki was the pseudonym for the famous group of French mathematicians—is a researcher at the Institute of Advanced Scientific Studies in France. He adds broad expertise and a further degree of mathematical rigor to the text.

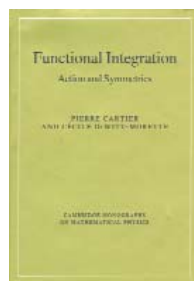
The first 10 chapters focus on Gaussian path integrals, for which the action is either quadratic in the fundamental variables or contains higher-order terms that can be treated perturbatively. Most of the material is not new, although the authors are careful to define their domain of integration far more precisely than other authors, and they

show that their constructions are valid without requiring a Wick rotation to imaginary time. The chapters contain interesting discussions of curved spaces, noncommuting variables, and approximation methods.

Chapter 11 describes an elegant extension of differential geometry to infinite-dimensional function spaces, and it is worth reading in its own right. For readers interested in the mathematical foundations, chapters 12–14 are the real meat of the book, where the authors construct mathematically rigorous path integrals for the Klein–Gordon, Dirac, and time-independent Schrödinger equations. Although the final results are those that a physicist would expect, the derivations are now at a level a mathematician might accept. Again, no Wick rotation is needed; path integrals are defined in terms of real time and a Lorentzian metric, a task many thought impossible to pull off.

The next four chapters, 15–18, discuss various topics in quantum field theory, including a Lorentzian approach to the renormalization group and a Lie algebraic approach to Feynman diagram combinatorics. The book’s concluding chapter, 19, contains a list of “projects,” many of which could form the bases of good PhD dissertations, and is followed by extensive appendixes.

Scattered throughout the book are many little gems of insight. Cartier and DeWitt-Morette refute the folk theorem that the propagator for the anharmonic oscillator (the harmonic oscillator with an additional λx^4 term) is singular at $\lambda = 0$. They give a beautiful summary of the many inequivalent perturbative expansions available in different regimes. They discuss the role of the topology of the space of paths, showing how the distinction between bosons and fermions



can arise from the topology of the configuration space of identical particles.

Unfortunately, it is not clear what audience the book intends to reach. The authors assume a rather peculiar mathematical background. In chapter 1, for instance, they carefully define metric spaces, completeness, and open sets while assuming that readers understand Banach spaces and tempered distributions and can make sense of the comment that “the familiar convergence theorems are valid.” They later refer in passing to Hadamard’s inequality of determinants, uniqueness of Fourier transforms on separable Banach spaces, and the like. Potentially illuminating examples are scattered throughout the text, but their descriptions are telegraphic: Too often the reader is offered a tantalizing glimpse, only to be referred to the literature before the picture is clear enough to help. It is certainly possible for a physicist without a strong background in analysis, or a mathematician without a strong background in quantum mechanics, to glean a good deal from this book—but only by skipping details.

The book’s inside flap describes functional integration as a “user-friendly

tool.” I agree, but I cannot call the book itself user friendly. For a student who is interested in learning path integration or a physicist who wants a survey of applications, there are better texts. One example is R. J. Rivers’s *Path Integral Methods in Quantum Field Theory* (Cambridge University Press, 1987). However, for someone who is interested in the mathematical foundations or merely curious to see some of the deep insight of two true experts, Cartier and DeWitt-Morette’s book is well worth reading.

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new books

instrumentation and techniques

Vacuum Technology: Practice for Scientific Instruments. N. Yoshimura. Springer, Berlin, Germany, 2008. \$139.00 (353 pp.). ISBN 978-3-540-74432-0

materials science

Carbon Nanotubes: Advanced Topics in the Synthesis, Structure, Properties and Applications. A. Jorio, G. Dresselhaus, M. S. Dresselhaus, eds. *Topics in Applied Physics 111*. Springer, New York, 2008. \$249.00 (720 pp.). ISBN 978-3-540-72864-1

Microcavities. A. V. Kavokin, J. J. Baumberg, G. Malpuech, F. P. Laussy. *Series on Semiconductor Science and Technology 16*. Oxford U. Press, New York, 2007. \$130.00 (430 pp.). ISBN 978-0-19-922894-2

Multiscale and Functionally Graded Materials. G. H. Paulino et al., eds. *AIP Conference Proceedings 973*. Proc. conf., Oahu, HI, Oct. 2006. AIP, Melville, NY, 2008. \$375.00 (1001 pp.). ISBN 978-0-7354-0492-2

Nano- and Micromaterials. K. Ohno, M. Tanaka, J. Takeda, Y. Kawazoe, eds. *Advances in Materials Research 9*. Springer, New York, 2008. \$159.00 (337 pp.). ISBN 978-3-540-74556-3

The Physics and Chemistry of Nanosolids. F. J. Owens, C. P. Poole Jr. Wiley, Hoboken, NJ, 2008. \$85.00 (539 pp.). ISBN 978-0-470-06740-6

Transparent Conductive Zinc Oxide: Basics and Applications in Thin Film Solar Cells. K. Ellmer, A. Klein, B. Rech, eds. *Springer Series in Materials Science 104*. Springer, New York, 2008. \$199.00 (443 pp.). ISBN 978-3-540-73611-0

miscellaneous

A Century of Ideas: Perspectives from Leading Scientists of the 20th Century. B. G. Sidharth, ed. *Fundamental Theories of Physics 149*. Springer, New York, 2008. \$129.00 (207 pp.). ISBN 978-1-4020-4359-8

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