rather than allowing a broader research program defined by the observers themselves. According to Giacconi, "the slow pace of discovery" associated with investigations of galactic clusters "came about because theorists . . . had struck again and convinced themselves . . . that there were no clusters to be found. . . . Once again the theorists were wrong."

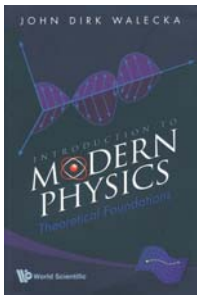
As those concerns will, if anything, play more prominent roles in the building of large 21st-century astronomy instruments, Giacconi's account is an important one.

Introduction to Modern Physics

Theoretical Foundations

John Dirk Walecka
World Scientific, Hackensack, NJ, 2008. $88.00, $65.00 paper (477 pp.). ISBN 978-981-281-224-7, ISBN 978-981-281-225-4 paper

Introduction to Modern Physics: Theoretical Foundations, by John D. Walecka, introduces a wide range of subjects commonly taught in advanced undergraduate or beginning graduate courses. The book begins with a straightforward review of classical mechanics, followed by a chapter that discusses the standard deficiencies of classical physics. The next chapter, the basis for the rest of the book, offers a succinct introduction to quantum mechanics. The remaining chapters provide elementary introductions to relativistic quantum mechanics; special and general relativity; atomic, nuclear, and particle physics; quantum fluids; and quantum field theory.



The author is obviously well versed in both teaching and writing about the topics covered, and the presentation is mostly clear and concise. Perhaps because of its ambitious breadth, the book does not provide much depth in any of its subjects. It does, however, cover the basic features, and the text is complemented and expanded by numerous well-chosen exercises. In some cases the exercises are essential for a proper understanding of the material, but the text seldom refers to them; the reader must review all the exercises in each chapter to determine whether there is one essential to the material being studied.

The no-frills approach is punctuated with nice derivations and arguments concerning, for example, the absence of Lorentz contraction perpendicular to the direction of motion, the formation of Cooper pairs, Landau's derivation of the condition for superfluidity, and the Dirac equation. Unfortunately, other parts of the text suffer from ill-chosen notation, careless editing, and poor wording. The list of such deficiencies is not unacceptably long, but it is too lengthy to be itemized here, and so I provide but three examples: quantization of angular momentum in equation 4.135 is associated with periodic boundary conditions instead of with the requirement that the wavefunction be single valued; equation 6.3 suggests that protons are not stable and might also be confusing to students because the reaction is kinematically forbidden in vacuum; and in equation 7.32 Walecka writes that lepton-family number is conserved but then negates the remark in the very next equation.

Though the author writes that with few exceptions the text is self contained, I found that the "few exceptions" sometimes include formulas or concepts that are repeatedly used throughout the text, or are central to a proper understanding of the subject matter. Examples include the Fermi–Dirac and Bose–Einstein distributions, the addition of angular momentum, the evaluation of Feynman graphs, and the idea of a virtual particle. In other sections, formulas are presented without their symbols being properly defined; such is the case for the Einstein equations of general relativity. In my opinion many students will be frustrated and confused by the sudden appearance of such concepts and formulas.

The text suffers from other deficiencies; here I mention just a few. The chapter on quantum mechanics does cover the basic material, but several omissions make the presentation less than compelling. For example, the author does not mention the probabilistic interpretation of the wavefunction, nor does he provide motivation for the quantization procedure of replacing the classical momentum with a derivative, though the substitution is mentioned several times. The chapter on special relativity presents a derivation of the standard results, but the author opts for anachronistic complex coordinates, something he has to change in the chapter on the general theory. The choice of complex coordinates also prevents the author from discussing the light cone, which, as far as I could see, is not mentioned in the text.

In his preface Walecka mentions that his book is intended as the text for a one-semester advanced undergraduate course, but I believe such a course would most likely consist of a selection of topics from the book. The presentation of the material is amenable to such treatment, as the chapters following the introduction to quantum mechanics are largely independent from one another.

Overall, *Introduction to Modern Physics* left a mixed impression. It includes sections of brilliance and insight but is marred by poor notation and lack of coherence in other places. Careful preparation of lectures, inclusion of ancillary material, and thorough discussion of the incompletely treated concepts would patch up most of those deficiencies. But an unguided reader, or one who has a less than very conscientious instructor, would face difficulties learning modern physics with only this text.

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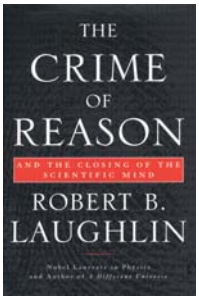
The Crime of Reason

and the Closing of the Scientific Mind

Robert B. Laughlin
Basic Books, New York, 2008. $25.95 (186 pp.). ISBN 978-0-465-00507-9

Robert Laughlin, author of *The Crime of Reason, and the Closing of the Scientific Mind*, has won many physics prizes and awards, including a share of the 1998 Nobel Prize in Physics for his work on the fractional quantum Hall effect. His first book, *A Different Universe: Reinventing Physics from the Bottom Down* (Basic Books, 2005), is a popularization aimed at a broad readership that lacks specialized scientific or technical training (see the review by Anthony Leggett in PHYSICS TODAY, October 2005, page 77). His second book, *Looking for a Hero* (privately published in 2006), describes his experiences as the first foreign president of the Korea Advanced Institute of Science and Technology. With this, his third effort—a mere 30 000 words, and not graced by a single equation—Laughlin again addresses a general audience, but he now treats a topic that



bears little relation to his field of expertise.

The Crime of Reason manifests Laughlin's evidently sincere concerns about increasing restrictions on the dissemination of knowledge. He gives as examples the practice of attaching a "classified" label to any information that might conceivably be employed to endanger a nation's security and the growing willingness of governments to grant patents that limit the accessibility of new research discoveries.

Those concerns have led Laughlin to the primary—essentially, the sole—thesis of the present volume. I can do no better than quote from the book's dust jacket:

> Many of us believe that in our modern, Internet-enabled world, information is more freely available than ever before. But according to . . . Laughlin, this is a dangerous delusion. We are surrounded by mounting volumes of advertising and spam, but a great deal of truly valuable information is increasingly classified or designated as private property. More and more, a flash of insight can become a patent infringement or threat to national security. More and more, the act of reasoning for oneself is becoming a crime. . . . In this dangerous new era, free intellectual inquiry—something once valued and honored—has become an antisocial and often illegal activity.

To support his contentions, Laughlin uses categorical and declarative sentences throughout the 10 chapters. He includes no supporting tables or figures but makes many a detour into such peripheral topics as cryptography (chapter 2) and cloning (chapter 8); on the latter, the author does not hesitate to divulge his strong opinions. Laughlin is an excellent writer and obviously very smart. In fact, he appears to be a polymath. For example, *A Different Universe* is replete with cartoons he drew himself, and his Stanford University website lists a number of his piano compositions.

Though I, like Laughlin, deplore restrictions on the dissemination of knowledge, I must say that on the whole I find Laughlin's thesis too apocalyptic and therefore unconvincing, as, I judge, would most of his thoughtful readers. For instance, US patent law is undoubtedly restrictive, as Laughlin claims. But even in recent years it has permitted the creation, often by small computer firms, of many highly inventive and startlingly useful computer programs. Moreover, intellectual creativity is not and never has been confined, as suggested in the dust jacket quote, to matters that may infringe on patents or threaten national security. That quote hardly pertains to the work of artists, historians, archaeologists, or marriage counselors. Of course, Laughlin is aware of that, but in his book he seems to imply that even those professionals and their insights are rapidly obsolescing because of modern economic activity.

As Laughlin puts it in chapter 2, "Dangerous Knowledge,"

> If you want, you can fill your head with knowledge that couldn't possibly be dangerous, such as telephone numbers or grains of sand, but you'll soon be unemployed if you do. Everyone knows this. If you want to survive, you had better acquire knowledge that empowers you and is therefore potentially dangerous. That's what other people want to buy.

My problems with Laughlin's thesis also are illustrated by the following quote from chapter 10, "The Troubled Utopia":

> The criminalization of knowledge threatens our creative cultural traditions. Demoting geeks from Internet heroes to thieves, guerrilla warriors, and spies . . . will have consequences. . . . The point is only that it's foolish to think of the creative technical traditions as a bottomless well that will never run dry—a kind of genetic birthright to which European civilization will always be entitled. These traditions sprang into being quite by accident during the Renaissance and have no more imperative to exist forever than an auk or a dodo.

Once again I, like Laughlin, fear the possibility that future generations will be significantly less creative than our own. But I cannot believe that such a diminution of human creativity, if it does occur, is more likely to be a consequence of modern economic activity, patent law, and security restrictions than of war, pestilence, and energy shortages. Actually, I foresee that the recent remarkable loosening of social restrictions in the US, exemplified inter alia by the election of Barack Obama and the growing willingness to legalize same-sex marriages, will stimulate an enduring flood of creativity in a wide variety of disciplines, including the sciences. In so writing, I am quite aware that this is a review of Laughlin's book, wherein what I foresee should be irrelevant. However, I could find nothing in the book that would make my prediction unreasonable.

All in all, I found *The Crime of Reason* quite interesting and am glad to have read it. I recommend you read it too. You'll enjoy it, though I doubt you'll agree with its thesis.

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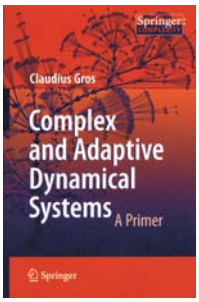
Complex and Adaptive Dynamical Systems

A Primer

Claudius Gros
Springer, Berlin, 2008. $69.95 (250 pp.). ISBN 978-3-540-71873-4

Inherently interdisciplinary, the study of complex systems draws on a range of computational and analytic methods, applies those methods to a broad and growing number of phenomena, and attracts the interest of researchers and students with various levels of mathematical preparation. Complex systems have many strongly interacting degrees of freedom and exhibit unexpected or interesting dynamic or collective behavior. However, even those who study complex systems do not agree as to what, exactly, those systems are or what models should serve as exemplars for them. Nevertheless, the field continues to grow. The subject draws students and researchers alike because of both the promise of its techniques to give insight into challenging and important scientific questions and the fun and excitement of working in a new, interdisciplinary field full of counterintuitive surprises.



Writing a textbook on complex systems is thus a difficult and important task. Claudius Gros's *Complex and Adaptive Dynamical Systems: A Primer* is a welcome addition to the literature. Although I have some criticisms, overall it is a solid text that complements other current books on the subject. Gros, who holds a chair in theoretical physics at the University of Frankfurt, has published research on complex networks, neural networks, and a range of topics in condensed-matter physics. His text is based on a graduate-level course he teaches at Frankfurt for students in the natural sciences, engineering, and neuroscience who have a basic knowledge of probability and ordinary and partial differential equations.

Gros's text is concise and focused. It does not attempt to survey the entire field of complex systems but instead zeros in on a narrow, albeit important, terrain that includes random Boolean networks, self-organized criticality, evolutionary dynamics, and synchronization phenomena. Gros has written a streamlined book that avoids the philosophizing and extrapolations that, in my view, too often accompany writing on complex systems. For the most part, he lets the mathematics and physics speak for themselves. The mathematical level, though, is fairly sophisticated; students who have had only an introductory class in differential equations or who have not studied statistical mechanics or dynamical systems will likely have difficulty with portions of the text. And at times I felt that the exposition was so lean that it may be hard for readers to discern common themes and ideas that tie together the book's topics.

The first two chapters of *Complex and Adaptive Dynamical Systems* are an overview of complex networks and dynamical systems. I found those chapters somewhat difficult to read. A lot of material is covered quickly, and several sections are unclear or contain minor misstatements. Subsequent chapters apply and extend the techniques introduced in the first two chapters, and I found them to be much more effective. A particular strength of the book is its emphasis on analytical techniques for studying complex systems. Although Gros includes some numerical results, he consistently uses analytic methods to build intuition and confirm the results of simulation. He gives a more central role to self-organized criticality than I think it deserves, and his final chapter on cognitive systems theory is more qualitative and speculative than the rest of the book. But on balance, Gros includes a good range of topics that will give readers a solid introduction to the portion of the field of complex systems most related to statistical mechanics and dynamical systems.

Each chapter includes 5–10 exercises, and an appendix gives partial solutions. Many of the problems strike me as lengthy and potentially quite challenging for students who lack a strong math or programming background. A few simpler problems would be a welcome addition. At the end of each chapter is a list of references. However, those references are not always tied to specific statements in the text. As a result, it is sometimes difficult to know where to turn to follow up particular ideas mentioned by Gros. On a related note, I wish the book did more to give readers a sense of current research questions concerning complex systems. While not a research monograph, Gros's book is for a fairly advanced and mathematically sophisticated audience that would benefit from an awareness of frontier topics in the field.

Instructors looking for a more general and slightly less demanding work may want to consider Nino Boccara's *Modeling Complex Systems* (Springer, 2004; see the review in PHYSICS TODAY, February 2005, page 65). Boccara's text gives little coverage to adaptive systems, so Gros's book complements it well. Those interested in an even less technical introduction to the subject may want to consider Gary William Flake's *The Computational Beauty of Nature* (MIT Press, 1998). An excellent, introduction to and perspective on the field of complex systems is Melanie Mitchell's *Complexity: A Guided Tour* (Oxford University Press, 2009), written