

that reason, it is important that the theories be presented in a modern context. That's what Matthew Schwartz's *Quantum Field Theory and the Standard Model* attempts to do. The voluminous text provides an inspiring tour of theoretical particle physics, from the very basics, to the detailed formulation of the standard model, to advanced concepts of present-day research. The book is at a level appropriate for students who have had a solid undergraduate course in quantum mechanics. The overall format of relatively short sections, underlined headings with large fonts, and highlighted boxes helps to make the book user friendly. A bit annoying, though, is the lax handling of upper and lower Lorentz indices, which sometimes leads to confusion.

Schwartz, an associate professor at Harvard University, is an experienced researcher and an expert in applying QFT to experiments for testing the standard model. His book covers the grand ideas that feed into the standard model: relativistic QFTs, including gauge theories; symmetries; and symmetry breaking. But consistent with the spirit of Schwartz's research, it is a pragmatic text that primarily focuses on the theory's perturbative aspects, teaching ideas and methods of relativistic QFTs so that the reader can perform practical calculations.

Quantum Field Theory and the Standard Model moves from the fundamental Lorentz symmetry to the various kinds of fields and particles and their interactions in the Lagrangian and Hamiltonian approaches. It discusses perturbation theory, Feynman diagrams, the path-integral formulation, loop calculations and renormalization, broken and unbroken gauge theories, and tests of quantum chromodynamics and the electroweak theory—the sectors of the standard model that describe the strong force and electromagnetic-plus-weak forces respectively. The last part of the book is concerned with more advanced topics, such as heavy-quark effective theory and soft-collinear effective theory, which are important in current standard-model tests in flavor physics and at high-energy colliders. Schwartz's introduction to them will be useful for more sophisticated readers. Throughout, the author maintains the connection between theory and experiment; he also includes interesting historical references.

The book is full of explicit derivations and concrete calculations that will allow readers to dig into the subjects, provided they are willing to invest suf-

ficient time. Its derivation of Feynman graphs through the Hamiltonian formulation, for example, shows the pedagogically helpful relationship between the Feynman graphs and the conventional perturbation theory of nonrelativistic quantum mechanics. The more formal Lagrangian and path-integral approaches, on the other hand, are more elegant and efficient pathways to that central tool of particle physics.

Quantum Field Theory and the Standard Model may be considered a successor to Michael Peskin and Daniel Schroeder's *An Introduction to Quantum Field Theory* (Westview Press, 1995), which for almost 20 years has been a standard reference. Schwartz's book is similar in its selection of themes and presentation, yet with more details, different viewpoints, and broader introductory material. Unlike Peskin and Schroeder's, it covers new developments and modern topics, including spinor-helicity methods, heavy-quark effective theory, and soft-collinear effective theory, and it offers a modern point of view on the use and relevance of nonrenormalizable theories. Schwartz's section about tests of the standard model includes the recently measured Higgs boson properties in electroweak precision tests. That discussion, however, does not go beyond the one-loop level and gives the misleading impression that one-loop calculations are sufficient to get agreement between theory and experiment. In fact, important higher-order calculations not discussed by Schwartz have been done in the past two decades.

Overall, *Quantum Field Theory and the Standard Model* is a balanced and comprehensive text. I recommend it for beginners in particle physics and its theoretical foundations. Containing a rich collection of information in a single volume, it will also be a useful reference for lecturers and researchers.

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Astronomical Measurement A Concise Guide

Andy Lawrence
Springer, 2014. \$89.99 (192 pp.).
ISBN 978-3-642-39834-6

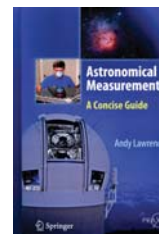
In *Astronomical Measurement: A Concise Guide*, Andy Lawrence, the Regius Professor of Astronomy at the University of Edinburgh, provides a delightfully

comprehensive summary of the essential information the budding observational astronomer needs to know. This elegantly succinct textbook—just 143 pages long, plus two appendices—is an inclusive overview of the issues a serious astronomy student should understand to plan science observations. It is aimed at the advanced undergraduate and the beginning graduate student, but it can also serve as an engaging refresher for the working astronomer who wants to venture into a new wavelength regime. For a practical handbook on observational strategies, challenges, and tactics, look no further.

We astronomers live at a time in which all sorts of ground- and space-based astronomical facilities are available to us. Lawrence makes it clear, though, that the problems of signal-to-noise ratio, atmospheric distortion, imaging resolution, detector efficiency, and spectroscopy are analogous across wavelength regimes and that basic observation strategies can be duplicated or adapted to various instruments. What's required is for astronomers to know what celestial phenomena we want to study and what physical properties will help us understand them.

While reading *Astronomical Measurement*, one thought kept coming back to me: Where were books like this when I was an astronomy student? As a professional who has worked across the electromagnetic spectrum but trained with a bias toward optical astronomy, I am thrilled to see this text. No longer will the student need to struggle through separate introductory textbooks to learn about observing with optical, radio, and high-energy telescopes. *Astronomical Measurement* covers them all. I would even recommend it as background for proposal writing, provided the writer is already familiar with the physics of radiative processes, which is not covered in detail.

Lawrence's book is clear about what it is not: a lengthy tome of technical details. For every concept introduced in a chapter, the "Further Reading" and "References" sections at the chapter's end direct the reader to more thorough discussions in relevant technical books, articles, and manuals. Consequently, *Astronomical Measurement* will also serve as an excellent reference. Lawrence places his discussion of statistics and orbital mechanics into the appendices, thus making them crucial



overview reading. Nonetheless, the student will need to go elsewhere for greater detail on those topics.

I particularly enjoyed reading through the end-of-chapter exercises, which presented real-world examples, not abstract physics puzzles. I was also pleased to see the out-of-the-box question asking students to estimate the total lifetime cost of building and launching a space satellite. Most, if not all, contemporary professional astronomers need to tackle such questions of cost analysis.

Two other good recent multiwavelength treatments are George Rieke's *Measuring the Universe: A Multiwavelength Perspective* (Cambridge University Press, 2012) and Edmund Sutton's *Observational Astronomy: Techniques and Instrumentation* (Cambridge University Press, 2012). Like Lawrence's book, Rieke's covers all the basics, but it is more geared to graduate-level work. And it features the traditional separation of wavelength regimes. In *Measuring the Universe*, there is much more physics, leading to a large number of equations that interrupt the flow of the text. *Observational Astronomy* is an intense read adapted from a graduate course aimed at both the theorist and the observer. It also separates the wavelength regimes and is more mathematically oriented; in particular, it provides a greater coverage of statistics. Nice sections on cosmic-ray, neutrino, and gravitational-wave detectors also make it suitable for the experimental physicist.

The theorist may do better with Sutton or even Rieke. But the student will find that Lawrence hits all the vital points, and the observer will find that everything he mentions is of practical value.

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Five Billion Years of Solitude

The Search for Life Among the Stars

Lee Billings

Current, 2013. \$27.95 (304 pp.).

ISBN 978-1-61723-006-6

Back in rosy 2001, the search for extraterrestrial life was taking off. The SETI Institute was developing the huge Allen telescope array. NASA was studying a \$10-billion mission concept called the

Terrestrial Planet Finder to discover habitable worlds orbiting other suns. (I designed instrumentation for that project.) In *Five Billion Years of Solitude: The Search for Life Among the Stars*, journalist Lee Billings paints a desolate picture of how economic and ecological calamities have dampened those and other grand dreams. At the same time, the book celebrates the ongoing work and the tenacious spirit of the scientists involved.

Seeking life on extrasolar planets has become a subfield of its own. Billings



highlights some of the discipline's core concepts, including the Drake equation, the carbon cycle, and various methods for finding extrasolar planets. Balancing lofty visions with down-to-earth economics, he also discusses such controversial topics in space politics as the cancellation of the US space shuttle program and the dollar value of a habitable planet.

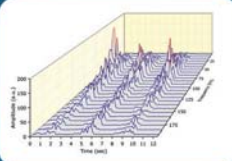
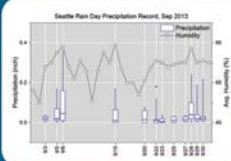
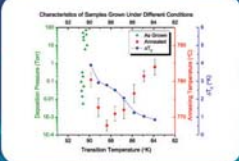
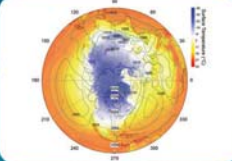
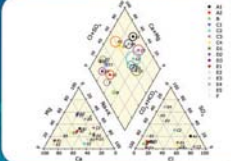
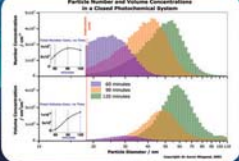
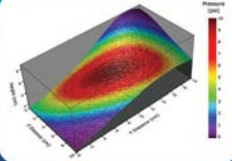
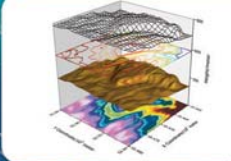
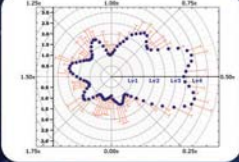
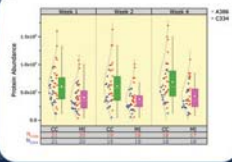
But education is not all the reader will receive from *Five Billion Years of Solitude*. The book also portrays—like

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