Cosmology

Steven Weinberg
Oxford U. Press, New York, 2008. $90.00 (593 pp.). ISBN 978-0-19-852682-7

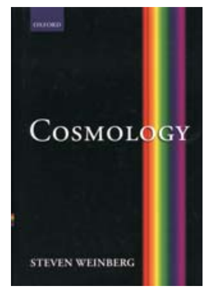
For many years I knew Steven Weinberg was synthesizing and reformulating cosmology for a major new book that would inhabit a vastly different cosmic landscape from that of his masterful *Gravitation and Cosmology* (Wiley, 1972). I would receive e-mails from him on the finest details of cosmic microwave background (CMB) theory; eventually respond, sometimes at 2:00am; and get immediate replies. I am sure my heady experience was far from unique. Weinberg has cast his gaze over the vast terrain that cosmology has become since 1972, and his new work ranges from early-universe field and string theory, through inflation and phase transitions, Big Bang nucleosynthesis, and the decoupling of the microwave background radiation, and forward to the nonlinear era of the dissipative formation of galaxies and their large-scale clustering into an interconnected cosmic web.

For me, a tragic aspect of the wondrous growth of cosmology is its fragmentation into many subfields, each requiring special expertise and methods. It is therefore a pleasure to see Weinberg's finished product and the role it can play in broadening and deepening the cosmic comprehension of graduate students, postdoctoral fellows, and indeed professors.

For decades, *Gravitation and Cosmology* and the equally famous *Gravitation* (Freeman, 1973), the Charles Misner, Kip Thorne, and John Wheeler tome, dominated how gravity was taught. Weinberg's was the simpler and more direct approach of a particle physicist. When I taught advanced gravity I oscillated between the two. *Cosmology* arrives amidst texts of varying difficulty, several of which have successfully been used in graduate courses. Two noteworthy examples that cover much the same ground as Weinberg's new text are the nicely accessible *Modern Cosmology* (Academic Press, 2003) by Scott Dodelson (reviewed in PHYSICS TODAY, July 2004, page 60) and *Physical Foundations of Cosmology* (Cambridge University Press, 2005) by Viatcheslav Mukhanov. How does *Cosmology* do relative to those two? Very well for serious students of the subject; they should probably own all three books.

Cosmology quickly gets into in-depth arguments, relying on extensive and useful appendices and on *Gravitation and Cosmology* to bring the uninitiated up to speed. The first chapter includes a fast-paced introduction to basic tests showing the universe is homogeneous and isotropic. It elegantly sets up the Friedmann-Robertson-Walker metrics, providing nice historical notes along the way, and discusses the observational support for an accelerating universe. I found it interesting that the word "anthropic" does not appear in the book, despite Weinberg's influential anthropic explanation for the problematically small value of the cosmological constant.

The next few chapters focus on the basic homogeneous hot Big Bang model and its thermal history. Then the hard work associated with inhomogeneities begins. Weinberg's emphasis is on linear perturbation theory, a well-founded subject that has given us the exquisite CMB inferences about cosmic densities and fluctuation spectra. He offers coverage of fluctuation development, an extensive and technical treatment of the CMB, a less extensive treatment of strong and weak gravitational lensing, and a relatively complete theory of inflation. He does not, however, indulge in the more speculative aspects of inflationary theory, in particular the string-inspired models so popular now. I think Weinberg was quite right in that omission, given that his book is destined to stand the test of time. Still, it would be nice to have gotten his take on such leading-edge and fun ideas. *Cosmology* treats the nonlinear development of the cosmic web with simple models to illustrate the physical aspects, but one comes away without insight into why the interconnected web has the texture it has. The great advances in simulation and the methods used to achieve them are not covered.



Weinberg, who is better known as a particle theorist than as a cosmologist, has made an admirable attempt at historical accuracy and credit; nonetheless he does miss a number of works of relevance. Another curious feature of *Cosmology*—particularly given its visually stunning subject—is the relative lack of figures: There are no *WMAP* (*Wilkinson Microwave Anisotropy Probe*) all-sky CMB maps to be seen. Tables are often Weinberg's preferred method of information delivery. I find that in this age of computer dominance, young people learn visually much more than did prior generations, for whom the equation is the thing. Yet everyone who plans to be a serious cosmologist must endure the strength exercise of equation working to develop physical intuition. *Cosmology* is one book with which they can develop their chops. Moreover, Weinberg's reputation as a powerful and insightful deriver is without peer, so the reader can rest assured all equations are well vetted.

Cosmology is a worthy follow-on to *Gravitation and Cosmology* and continues the earlier work's effective, straightforward derivational approach. A technical tour de force for the intrepid graduate student, Weinberg's new book will greatly appeal to particle physicists tooling up in cosmology and be an indispensable source for the practitioner.

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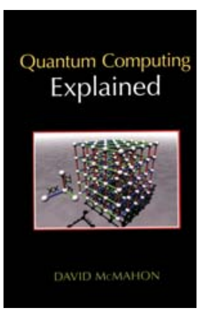
Quantum Computing Explained

David McMahon
Wiley Interscience, Hoboken, NJ, 2008. $84.95 (332 pp.).
ISBN 978-0-470-09699-4

The field of quantum information has emerged from the intersection of quantum physics and information science as a rapidly growing area with both fundamental and technical significance.



Even as it advances our understanding of the unique properties of the quantum world, quantum information is addressing some of today's most challenging scientific and technological questions. For example, quantum information processing leads to a revolutionary new paradigm for computation that has been shown to provide efficient solutions for such complex calculations as integer factorization, the basis for widely used cryptographic systems.

Quantum information processing has seen explosive growth since the mid-1990s, when experimental investigations to implement quantum computation began in earnest. Those investigations followed a decade of theoretical work that culminated in demonstrations of algorithms for quantum computation and error correction. An increasingly broad community of experimental and theoretical scientists, including chemists, mathematicians, computer scientists, engineers, and physicists, is now seeking to realize and expand the promise of quantum information. As a result, the challenge for writers of textbooks on quantum computation is only becoming more complex.

As the field of quantum information continues to mature, an increasing number of textbooks on it and its related subfields are appearing; since 2001 at least five of them have been reviewed in PHYSICS TODAY. Most of those texts, written for graduate students and researchers, assume a familiarity with quantum mechanics. However, it is one thing to write a textbook about a new field for a specific community, and quite another to write a text that satisfies multiple communities. That challenge is particularly acute if the audience includes undergraduates or scientists and engineers who have not had any real exposure to quantum mechanical concepts.

In his book *Quantum Computing Explained*, David McMahon has picked up the challenge. He sets out to introduce the key concepts, features, and developments in quantum computation to undergraduates and professionals who do not necessarily have backgrounds in