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Book Review

Modern Cosmology. By Scott Dodelson. Academic Press, London, San Diego, California, 2003. xiii + 440 pp., $70 (hardcover). ISBN 0-12-219141-2.

It has been repeatedly stated that the history of physical cosmology of the XX century is essentially the history of search for three numbers. The "big trio" is, of course, comprised of the (present-day) Hubble constant H_0, the total cosmological energy-density Ω, and the cosmological constant (recently generalized under the label of "dark energy") Λ.

Appropriately enough, the very end of the last century has apparently brought this history to a close with an observational revolution based on the SNe Ia and cosmic microwave background observations (from 1998 onward). The revolution enabled zeroing in on the values of the three classical parameters with precision approaching 1%, thus terminating seemingly endless controversies and debates between various schools and factions of cosmology. Specifically, we have strong reasons to accept a flat, $\Omega = 1$ dark-energy dominated universe, with about 30% matter content and the current expansion rate given by $H_0 \approx 65\,\mathrm{km \cdot s^{-1} \cdot Mpc^{-1}}$. Thus, the universe is 13.6 Gyr old, has both particle and event horizons and will expand forever. However, the emerging "new standard" cosmology has immediately opened a host of new questions. Fortunately, in Dodelson's *Modern Cosmology* we have recently obtained an appropriate textbook for the dawn of this new epoch. In a sense, this books is *post*modern cosmology (with an affirmative connotation!), in being the first to consider the new wave of challenges for this oldest scientific and philosophical pursuit.

Modern Cosmology splendidly proves the old adage of Bondi, Hoyle, Ryle, Zwicky, and other early pundits that the universe at the largest scales is the best laboratory for testing our local physics. It is, as the author clearly states in the Preface, a textbook intended for advanced undergraduate and beginning graduate students in physics and astronomy. However, it is much more than that—it is a pioneering endeavor, the first true XXI century cosmological reference book. Its particularly commendable

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feature is thorough insistence on using simplest possible mathematical methods to obtain heuristically important results.

Dodelson's book consists of two large parts. The first (Chapters 1 through 6) exhibits what can be called background and the "standard cosmological lore." Here we encounter a very good treatment of the standard set of related topics, like the inventory of cosmic matter, basics of the General Relativity, standard Friedmann models, difficulties of classical cosmology (flatness, horizon, etc.). However, even here the author adds a specific flavor with a detailed exposition of Boltzmann's kinetic equations (Chapters 3 and 4), which is not usually found in cosmology textbooks. The emphasis on the underlying physics is certainly very welcome in this type of project.

The real topic of the book starts with Chapter 7 and is followed to the end (Chapter 11), and is concerned with the analysis of the cosmological inhomogeneities and the structure formation problem. Topics like the cosmological power spectrum, CMB anisotropies, weak gravitational lensing, present-day power spectrum, and the like are covered in thorough detail. Dodelson effectively deconstructs the ancient "cosmological principle" of Eddington and Milne, showing how much information we can extract today from observing and modeling of minuscule anisotropies and inhomogeneities in both CMB and the matter distribution. Chapter 7 deals with inhomogeneities and Chapter 8 with anisotropies; the two present the summit of this book, in the opinion of this reviewer. Chapter 9 surveys observational methods of probing various levels of inhomogeneities; among those particular attention is paid to angular correlation of galaxies, redshift-space distortions and galaxy clusters. Chapter 10 makes an advanced and exciting excursion in treating weak gravitational lensing, polarization, and gravity waves. A minor problem is that the book lacks a concluding or summarizing chapter. Instead, it ends rather abruptly with a rather dry Chapter 11 devoted to statistical methods.

There are several instances in which Dodelson attempts to refresh the exposition with the allegorical, anecdotal, or just amusing digressions (e.g., the opening part of the section on the horizon problem, pp. 142–143). In general, the book is written with a verve which is rare to find among similar textbooks. Still, the book manages to stay both focused to its key epistemic targets and relaxed in approach, which is certainly a rarity.

The only misleading thing in the book is its title. When compared with other monographs of the last decade purporting to expose standard tenets of "modern cosmology," like *Principles of Physical Cosmology* by P. J. E. Peebles and *Cosmological Physics* by John Peacock, it is clear that *Modern Cosmology* covers much narrower ground. At places, the author admits its slant toward the theory of cosmological perturbations, but the origin and

justification of this slant is missing. Its treatment of contemporary quantum cosmology (which is "modern" almost by definition!) is only very cursory and does not give credit for enormous advances in this field which impact almost the entire range of human thinking (even outside the realm of science). We lack the wealth of historical digressions characterizing, for instance, Peebles' book; while it is not a demerit in a succinct treatment of *modern* issues in cosmology, we lose a valuable perspective on such topics like the (neo)classical cosmological tests (redshift-magnitude, angular size-redshift, etc.), which are still a very much live research subjects. Of other "hot" topics either missing or treated only in passing in Dodelson's account, one may mention observational aspects of the epochal SNe Ia results, implications of QSO and Ly-α forest counts, correlations and evolution, topological defects and their signatures, large-scale topology of the universe, philosophical implications of quantum cosmology (notably notions of chaotic inflation and the multiverse), future cosmological evolution, the "cosmic coincidence" problem, anthropic principle(s), reionization of IGM and Population III objects, and, of course, non-standard cosmologies[1] for which being non-standard does not necessarily imply being "non-modern." Even if omission of some or all of these topics is rationally justifiable, such justification should be explicitly given in a narrative of so wide target audience. Again, this is not a demerit after we understand the real scope of the book's contents; in that framework, the contents are splendid and easily surpassing any other treatment on a similarly accessible level.

"Suggested reading" sections are added at the end of each chapter, offering immensely useful points of entry into the huge pile of literature on the contemporary astrophysics and cosmology. Bibliography provided is satisfactory and more than adequate for the given scope. In addition, a host of very interesting and instructive exercises is given at the end of each chapter (with solutions to some of them provided in detail near the end of the book). Illustrations (including the beautiful insert in full color) are generally very clear and pedagogical. Diagrams are helpful, although not always printed sufficiently sharply (for instance, the quality of the photon trajectories scheme on p. 249 or the shear correlation function graph on p. 309 is rather poor). The volume is reasonably free of typographical errors. In general, the book is graphically appealing, and *exceptionally* robustly made (one is tempted to say appropriately for timescales of the subject matter!).

[1] Like, for instance, those described in a beautiful recent review of J. V. Narlikar and T. Padmanabhan (*Ann. Rev. Astron. Astrophys.* **39**, 211 (2001)).

To summarize, Dodelson's book is a very good textbook, as well as a useful general reference for any researcher. For the range of topics covered (with the limitations mentioned above) it provides an excellent introduction to some of the most dynamical areas in physics and astronomy, very likely to remain attractive for at least a couple of decades into the XXI century.

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