

approximate a perfect conductor or to produce a successful Rayleigh fountain is not its high dielectric constant; the dielectric constant of ice is questionable when compared to that of liquid water. As another example, the extremely low frequency range given in table T.1 does not properly include the region of Schumann resonances. These errors could rather easily be eliminated in a corrected edition.

An examination of the authors' sub-

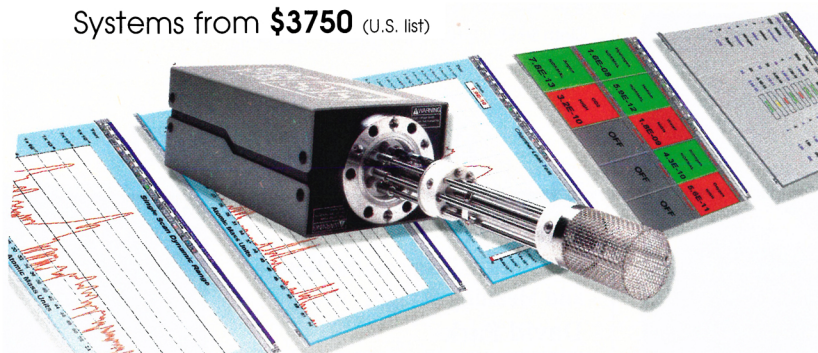
stantial reference list indicates that, in the book's main area of emphasis, the number of published papers has approximately doubled every ten years for more than four decades. This exponential growth in interest underscores the need for a thoughtful new organization and integration of information, which this book successfully delivers.

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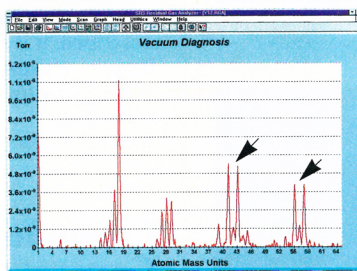


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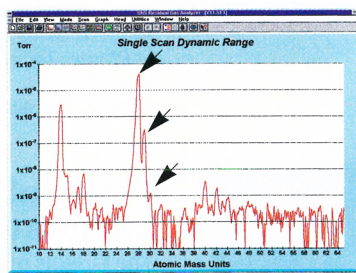
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Foundations of Modern Cosmology

John F. Hawley
and Katherine A. Holcomb
Oxford U. P., New York, 1998.
506 pp. \$50.00 hc
ISBN 0-19-510497-8

Foundations of Modern Cosmology by John F. Hawley and Katherine A. Holcomb is a welcome addition to the list of college-level astronomy textbooks for nonscience majors. Cosmology and relativistic astrophysics are active and exciting fields that regularly capture the headlines and the imagination of millions. Hawley and Holcomb bring to their writing valuable firsthand knowledge and accomplishment in relativistic astrophysics research. Their book reflects the careful development that occurs only when a textbook is written after years of teaching the material—in this case, at the University of Virginia. It neatly fills a particular gap, too, as follows:

Introductory astronomy textbooks for nonscientists abound, but no other recent textbook has the focus on cosmology and relativity that this one does. *Foundations of Modern Cosmology*, intended for advanced undergraduate liberal-arts students, would be an excellent choice for a followup to the standard one-semester astronomy survey course. While the book assumes no previous background in astronomy or physics, a previous introductory astronomy course would permit a teaching pace fast enough to complete the book in one semester. Alternatively, since the book provides a self-contained review of basic astronomy and physics, it could be used for a general survey course in astronomy in which cosmology and relativity are the theme.

The text is divided into five parts. The first provides historical background: from the ancient Greeks to the Renaissance, the Copernican Revolution, Brahe, Kepler and his laws of planetary orbits, Galileo's and Newton's laws of motion and the universal law of gravity, and on to Darwinian evolution and the early attempts to measure the age of Earth and the Sun. Part II extends the historical development and overview of basic physical principles to include the quantum properties of matter, the fundamental forces of physics, properties of light and its interaction with matter, a brief review of stars and stellar evolution, and a tiny sketch of Earth as a planet around a star in a galaxy in a universe of galaxies.

The heart of the book begins with Part III, a much better and more in-depth treatment of relativity—including

ing a chapter on black holes—than one typically finds in introductory astronomy texts. Modern cosmology is described in Parts IV and V. The historical development follows the continuous push of the scale of the known universe outward and of Earth away from the center, leading to the discovery of external galaxies, the Hubble law of galactic redshifts, and universal expansion. The application of relativity to explain the geometry, kinematics, and

dynamics of a homogeneous and isotropic expanding universe is discussed, followed by the triumphs of the Big Bang model, including its explanation of the origin of hydrogen and helium and the cosmic microwave background. The history of the universe according to the Big Bang model is traced from the Planck era through baryogenesis, to the epochs of quarks, hadrons, leptons and the nucleosynthesis of the light elements, to the transition from

radiation- to matter-dominance, to the era of hydrogen and helium recombination, and finally to the age of galaxies and the present. The existence and origin of galaxies and large-scale structure are discussed, including the evidence that some as-yet-unidentified nonluminous form of matter—that is, dark matter—dominates the total density of matter in the universe and determines the outcome of cosmic structure formation.

The final chapters are devoted to the critical unsolved problems of the standard Big Bang model. These include the horizon and flatness problems and the quantum origin of the primordial density fluctuations responsible for structure formation and the anisotropy observed in the microwave background, problems for which the theory of inflationary cosmology is discussed as a possible explanation, including a summary of its observational tests, and the cosmological constant problem, which inflation alone does not yet solve. The book concludes by mentioning such even murkier matters of quantum cosmology as the fundamental interpretation of quantum mechanics, the Wheeler–DeWitt equation, the concept of the “wavefunction of the universe,” and the nature of time.

One of the book’s great virtues is that it is structured like a classroom-ready textbook, not like a popularized narrative. Each of its 16 chapters is followed by homework questions and a list of key terms to focus the student’s review. A glossary is provided at the end, as well as a comprehensive index and a bibliography of books and articles. While there may be other excellent popular-level accounts of the history and recent developments in cosmology, Hawley and Holcomb’s book is designed for classroom use rather than mass consumption, and its technical level is correspondingly higher.

I have only a few minor reservations about this book. First, although it meets the high production standards of textbooks for upper-level science undergraduates, the overall aesthetic of the book is somewhat below that of the lavish, full-color, introductory astronomy textbooks on the market. More significant, however, is the inevitable omission of some of the latest research developments in this explosively growing field. For example, the recent measurement of distances to Type Ia supernovae, which indicates that cosmic expansion is accelerating and suggests a positive cosmological constant, is not included. I hope the authors will remedy this by periodically updating their book or, perhaps, by offering a companion addendum. This would ensure that their valuable book retains its value in

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years to come, as the rate of cosmological discovery accelerates at least as fast as the universe itself appears to be doing.

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