Most popular Western science books tend to include anecdotes about the individual researchers. This book mentions very few living scientists (which is a bit demoralizing for those of us who love to see our names in print), but instead livens things up with ancient Chinese stories. For example, "Gong-Gong the Destroyer" is invoked to describe how *CP* violation can explain the origin of the net excess of matter over antimatter in the universe.

The book also has some nice catch phrases such as this comment on stellar nucleosynthesis: "Never would the ancient alchemists have thought that all stars were the furnaces they were looking for." There are also some cute miswordings such as "sky telescope" for "space telescope." The text contains some minor errors and an excessively awkward explanation of Olber's paradox (why is the night sky dark?). Perhaps the book's biggest problem lies in mixing well-established material with very speculative material and not differentiating between the two to any great degree. For example, Fang and Li's discussion of periodicity in quasar redshifts would not find resonance with many other cosmologists.

The book's final speculations on Planck time and quantum gravity and making universes from nothing are up-to-date and more complete than those in most other popular cosmology books. The discussions of the creation of space-time and the wave function of the universe are particularly nice.

As the book wanders into "philosophical" areas, the "anthropic principle" is unfortunately brought forth. The anthropic principle argues that our existence as thinking beings selected the initial conditions and laws of the universe. I personally have difficulty in viewing the anthropic principle as a scientific argument, because in my view scientific progress occurs when we search for "natural" ways to enable a wide range of initial conditions to yield the observed universe, not when we throw our hands up and invoke the anthropic priciple as an explanation. However, others without my prejudice might not be as irritated by the anthropic approach.

I have mentioned several points where I question the presentation in *Creation of the Universe*; however, I would no doubt find comparable quibbles with any of the multitude of popular and semipopular cosmology books on the market. All in all, I think this book is a worthwhile addition to the field. It presents Big-Bang cosmology from a different orientation and shows us Fang's and Li's scientific perspectives and biases.

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Optical Waves in Layered Media

Pochi Yeh
Wiley Series in Pure and Applied Optics.
Wiley, New York 1988.
406 pp. $44.95 hc
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The science of thin films for optical applications is certainly not new, and there are several fine books on the subject. The question then is, Do we need another one? The answer is yes; *Optical Waves in Layered Media* by Pochi Yeh does successfully fill a void in the current literature.

In the past, the major application of optical thin films has been to make filters, such as antireflection coatings and dielectric mirrors. Since the advent of optical communications and integrated optics, a significant use of thin films has been the fabrication of waveguides and integrated optical components. This book develops the theory of thin-film optics in a general manner, making it applicable to the diverse modern field.

The first 100 pages of the book are devoted to a review of electromagnetic theory, along the lines of that in *Principles of Optics* (Pergamon, New York, 1959) by Max Born and Emil Wolf. Next Yeh develops the matrix theory of thin-film optics. In earlier books the usual approach treats the characteristic matrix of each film. Yeh, on the other hand, generates a matrix for each dielectric interface and propagation distance; this matrix is then more easily applied to different structures. Yeh applies the matrix to analyze the transmission properties of filters and interferometers and gives examples.

Other subjects not found in most books on thin-film optics are also covered. Inhomogeneous films are discussed, and approximate (WKB) and exact solutions are presented. The text also treats anisotropic films and their applications. The final topics are single- and multilayer waveguiding, which are important in optical communications, and semiconductor quantum wells, which are used in integrated laser fabrication.

Optical Waves in Layered Media brings the field of thin films up to date. The book covers its subject in a more general way than is usually done and includes more advanced

topics and modern applications. Each chapter has challenging problems at the end, and short illustrative examples of actual devices are interspersed throughout. The book's one fault is its dearth of references: Most chapters contain only 2–5 references to basic texts. More references to original theoretical material and recent experimental work would provide not only additional background on theory when needed, but access to current research in the fields of interest as well. (Some of the desired references include the author's own work.)

In conclusion, this book is a useful text and reference for those working in the field. Those working exclusively with thin-film filters will still be satisfied with the classic texts *Thin Film Optical Filters* by H. Angus Macleod (Macmillan, New York, 1985) and *Optical Properties of Thin Solid Films* by O. S. Heavens (Dover, New York, 1965). These books discuss the production and testing of thin films, which are beyond the scope of Yeh's book. However, for anyone interested in a more complete study of optical thin films, *Optical Waves in Layered Media* will make a fine addition to his or her collection.

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Neutrino Astrophysics

J. N. Bahcall
Cambridge U. P., New York, 1989. 567 pp. $75.00 hc ISBN 0-521-35113-8; $24.95 pb ISBN 0-521-37975-X

Most of our information about stars comes from electromagnetic radiation emitted from the stellar photosphere. However, some of the energy emitted (about 2% in the case of the Sun and over 99% in the case of stellar collapse) arrives in the form of neutrinos coming directly from the deep stellar interior. Since neutrinos interact very weakly they are extremely hard to detect, and only recently have experimenters made definite observations of solar and supernova neutrinos. The subject of neutrino astrophysics is just beginning to develop, and the present volume, *Neutrino Astrophysics*, provides a timely introduction to the field.

Raymond Davis carried out the first observations of solar neutrinos using radiochemical techniques in an experiment that started in 1968 and is still going on. John Bahcall has been carrying out the most complete theoretical calculations of the expected rate for over 25 years. An appendix in the present volume reviews the history of the collaboration between Bahcall and Davis. Very recently the Kamiokande group in Japan has confirmed the Davis results using an electronic detector that identifies the direction of the neutrinos as coming from the Sun.

Bahcall's book provides both an introduction to the subject of solar neutrinos for students and a reference source for researchers in the field. Each chapter of the book is designed to be self-contained even to the extent that identical figures appear in two different chapters. The book provides the basic theory of stellar models, nuclear fusion reactions and neutrino oscillations with an emphasis on the physical principles involved. It also contains the detailed results of the calculations of solar models and detector responses given by Bahcall and Roger Ulrich in the April 1988 issue of the *Reviews of Modern Physics*. In addition to a complete set of references, each chapter contains a carefully selected annotated bibliography.

An interesting and unique feature of the book is a set of questions and answers in the first chapter in which Bahcall gives a somewhat personal viewpoint on a number of issues frequently raised. Chapter 5 provides a comprehensive compendium of nonstandard solar models with a brief critique of each.

In spite of its general title, more than 90% of the book is devoted to solar neutrinos. Possible astrophysical sources of high-energy neutrinos, much discussed in connection with the DUMAND (Deep Underwater Muon and Neutrino Detector) and other experimental projects, are not included. One chapter is devoted to neutrinos from stellar collapse, but this is much less detailed than the discussion of solar neutrinos. The main emphasis is on the analysis of the observations of neutrinos from the supernova 1987a made by the Kamiokande and IMB groups. Many issues of importance for plans for observing the next supernova, such as the dependence of time and energy distributions on different supernova models, are not discussed.

Bahcall emphasizes the "solar neutrino problem," which refers to the discrepancy between the Davis observations and the calculated results of Bahcall and his collaborators. Bahcall states that the Kamiokande results confirm this discrepancy; in fact, most people would consider that the Kamiokande results by themselves, while consistent with those of Davis, do not demonstrate a significant dis-