

incarnation is due mainly to the work of Brandon Carter and Robert Dicke, and this book, written by two well-known cosmologists, is an attempt to summarize both their history and the evidence in support of them. The erudition displayed here is simply awesome, and it is difficult indeed to imagine a topic that touches, however tangentially, on these principles that has been omitted. That said, I found that too many of the discussions lacked sufficient detail to allow the general reader, or even the specialist, to follow the argument—too much has to be taken on faith. While, for example, the chapter on cosmology abounds with formulas, very few are actually derived and many of the order-of-magnitude arguments left me unconvinced. One longs for the deductive approach one finds for example in Steven Weinberg's *Gravitation and Cosmology*. In fairness to the authors I should say that they do cite references in support of each of their assertions. But without access to a large scientific library the reader will have difficulty tracking them down (some have not been published in standard journals). And I fear that most of the references will be beyond comprehension except to specialists. Finally, I found the presentation relentless. There was no space, no doubts. The reader is simply overwhelmed in the end, but not necessarily convinced.

One of the main objections to the necessary version of the anthropic principle is that it does not satisfy Karl Popper's requirement of falsifiability. To refute this claim the authors offer the Carter inequality, which connects the number of improbable steps in the evolution of the species *Homo sapiens* and the length of time the Earth will remain a habitable planet. I could not follow the derivation given in the book. But worse, the estimates of the number of improbable steps range from about 10^4 , which gives an upper limit of 4.5×10^8 years for the length of time the biosphere can continue into the future, to more than 110 000, giving an upper limit of 4.1×10^4 years for this time. Strangely, this latter estimate is based on a probabilistic calculation of the odds of assembling a single gene that does not take into account the enormous reduction in these odds when one includes the solar energy input into the system where this assemblage presumably took place. In any case it is not a prediction that most of us will be able to check. Furthermore, no mechanism for the demise of the biosphere is suggested by the derivation, so the lengthy discussion of such mechanisms that follows it seems irrelevant.

Finally I must say a few words about

the sufficient version of the anthropic principle. One of the major goals of this book apparently is to impress the reader with the improbable fine tuning of the laws of nature that is necessary for our existence. We are told, for example, that "if the relative strengths of the nuclear and electromagnetic forces were to be slightly different then carbon atoms could not exist in nature and human physicists could not have evolved." And indeed, one cannot help but be impressed with the large number of such fine tunings that seem to be required for our existence. But does this mean that they are sufficient for this existence? One cannot help but conclude that the main purpose of this book is to argue for such a teleological interpretation as the only way to understand this fine tuning. This is a fascinating question but in my opinion not—despite the authors' claims to the contrary—part of the discourse of contemporary science.

JAMES L. ANDERSON
Stevens Institute of Technology

Physics of Dense Matter

Y. C. Leung

268 pp. World Scientific, Singapore
(Teaneck, N. J.), 1985.
ISBN 9971-978-10-5. \$47.00

Supernova 1987a is a timely reminder of the rich and fascinating physics of dense matter and its role in supernovae and neutron stars. Few problems have such fundamental appeal and involve such a rich blend of nuclear physics, particle physics, astrophysics and condensed matter physics.

One essential ingredient for understanding supernovae and neutron stars is the equation of state of equilibrated matter. Y. C. Leung has written a clear, pedagogical introduction to our present understanding of the equation of state of condensed matter from terrestrial densities to beyond the densities found within nuclei. Leung assumes no prior or specialized background and his thorough and detailed treatment is easily accessible to an advanced undergraduate student or beginning graduate student with a knowledge of quantum mechanics. Particularly valuable is his treatment of the regime up to nuclear density, for which the relevant approximations have been tested quantitatively in experiments on atomic nuclei. In no other place, to my knowledge, can a student find collected so conveniently all the relevant ingredients of many-body physics, atomic physics and nuclear physics: the Thomas-Fermi, Hartree-Fock and thermal Hartree-Fock approximations; a review of nuclear interactions; and the independent-pair

and variational treatments of nuclear matter. From these ingredients, Leung provides a quantitative description of how matter progresses from the low-density state, consisting of isolated nuclei; through the region of subnuclear densities, in which the high Fermi energy of electrons results in increasingly neutron-rich nuclei and eventually forces neutrons out of nuclei; and to the emergence of a uniform quantum liquid at nuclear density. The last section of the book treats the more controversial region above the density of nuclear matter, providing a brief survey of meson-nucleon field theory, pion condensation and quark matter. In contrast to earlier sections, the treatment of these topics is not self-contained, and serves only as an introduction. Numerical tables of the calculated equation of state are provided in an appendix, a thoughtful convenience for those who wish to use the equation of state in astrophysical calculations.

If the book has any fault, it is that treating so rich a topic in 268 pages necessarily leaves much unsaid. Conspicuously absent is discussion of superfluidity and the associated pinning of vortices to nuclei in the neutron drip regime, which are important for understanding pulsar glitches. There is no discussion of strange matter nor of the possibility that it is in fact the true ground state of matter. The few experimental facts that constrain the equation of state—such as the compression modulus obtained from giant monopole resonances, and the limits placed by the measured masses of neutron stars—are not mentioned. These omissions are consistent with the fact that the most recent references cited are from 1982. Clearly, Leung has chosen to focus his book on older aspects of dense matter physics that are reasonably well understood. For readers who seek a clear, readable presentation of this physics, and are not put off by photoreproduction of a typewritten manuscript in the era of computer-driven laser printers, this book is an excellent reference.

JOHN W. NEGELE
Center for Theoretical Physics, MIT

Applied Classical Electrodynamics

Frederic A. Hopf and George I. A. Stegeman

Volume 1: Linear Optics
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ISBN 0-471-82788-6. \$29.95

Volume 2: Nonlinear Optics
182 pp. Wiley, New York, 1986.
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George Stegeman, fills a need in the field of modern optics. In these volumes both linear and nonlinear interaction of light with matter are treated using the versatile harmonic oscillator model of the atom. In volume 1 various problems in linear physical optics are presented with an eye toward nonlinear and other electro-optic applications. For example, chapter 6 on optical activity provides a very clear physical and mathematical picture of this somewhat tricky subject, and the treatment of scattering—including statistical, Brillouin and Raman scattering—is especially recommended. This work really comes into its own in the second volume. There one finds a nice treatment of nonlinear optics in general, beginning with second harmonic generation, and a careful treatment of the phase matching problem and of such topics as refraction and reflection at a surface. Many applications of nonlinear optics involving cubic nonlinearities, such as optical nonreciprocity, real-time holography, four-wave mixing and phase conjugate optics, are to be found in this volume.

The books contain much background material, derivations of conventional formalisms, and a wealth of references to previous works. Most topics of linear and nonlinear optics are introduced briefly; for details concerning the problems readers are referred to specialized texts and literature. This pair of volumes provides an excellent basis for a graduate level introductory course to classical nonlinear optics, in particular for the experimentally oriented student. In fact, preliminary versions of these volumes have been used for graduate level courses with outstanding success.

MARLAN O. SCULLY
University of New Mexico

Physics in Medicine and Biology Encyclopedia: Medical Physics, Bioengineering and Biophysics, Volumes 1 and 2.

Edited by T. F. McAlinsh
980 pp. Pergamon, New York, 1986.
ISBN 0-08-026497-2. \$275.00

This encyclopedia of physics in medicine and biology covers many of the same topics found in a three-volume edition (edited by Otto Glasser) that was published in 1944, 1950 and 1960—and is long out of date. A new encyclopedia was badly needed.

This encyclopedia is as much for scientists outside medical physics as for those in it. Medical physicists will find

succinct summaries of many subjects outside their specialty. Physicists, especially those who teach premedical students, will find a treasure of applications of physics in medicine and biology. The simply curious will not be disappointed.

The two volumes contain about 250 short articles on a wide variety of topics, written by about 180 contributors, each a specialist in the field. At the beginning of volume 1 the editor lists the articles under 25 general headings. These include audiology, biophysics, blood, cardiology, computers in medicine, nuclear magnetic resonance, physiological measurements and monitoring (the largest category), radiology and vision. Individual articles are arranged alphabetically, and each contains a list of related articles as well as a bibliography.

The comprehensive index has over 5000 entries that make it easy to track down almost any topic. The only significant lapse I found in the index was the lack of entries for either "magnetic" or "magnetism," despite mentions in several articles dealing with nuclear magnetic resonance imaging.

The editor admits in the preface that a good deal of editing was necessary to make the articles uniformly readable. There are numerous medical terms, all carefully explained. In addition there is a 20-page glossary, which is useful if all you want is the definition of a technical word or medical term. The encyclopedia primarily uses SI units, often without reference to units in common use in the US. It will take a

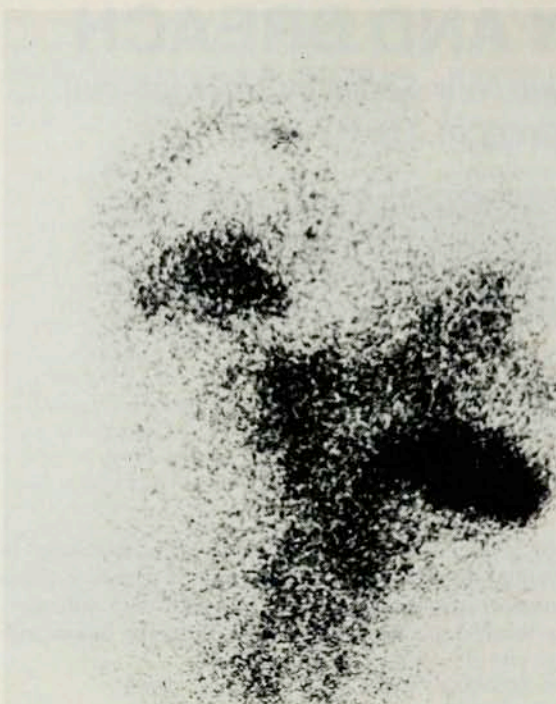
little effort to get used to blood pressure expressed in kPa instead of mm Hg.

The selection of topics for an encyclopedia is a formidable task. With advice from colleagues, the editor has done an excellent job. About one-third of the articles deal with the conventional areas of radiological physics. But there are a few topics that seem inappropriate, such as articles on cancer statistics, dental diagnosis and chemical carcinogenesis. The most significant omission, to me, was the lack of an article on biomagnetism or magneto-biology.

The great majority of authors are from the UK, with many from Scotland. This is not surprising as Tom McAlinsh, the editor, is a medical physicist at the world's largest medical physics group, in the Department of Clinical Physics and Bioengineering in Glasgow, with 90 professional physicists and engineers and 130 medical physics technicians.

The practice of medical physics is much broader in the UK, where each medical school has a department of medical physics, than in the US, where only one medical school has such a department. Members of these physics departments are often involved with applications of physics outside radiology and radiation therapy, the main departments that hire medical physicists in the US.

A serious problem is the cost of the encyclopedia. While the average physicist will not want to spend \$275, all should encourage their libraries to buy it. It will be especially useful in those



Radionuclide imaging reveals, in this scintillation photo, a tumor in the parietal region of the brain. The radioisotope is also clearly present in the submandibular glands in the jaw. The photograph (reproduced by permission of the publisher) appears in the *Physics in Medicine and Biology Encyclopedia*.