makes it very difficult to implement a coherent reform.

The U.S.S.R. is undoubtedly going through an intense acute phase of this long-standing debate again today, but without all the arguments out in the open. In interpreting what clues we do get, I find the kind of retrospective Parrott has provided is extremely helpful.

ROBERT CAMPBELL
Department of Economics, Indiana University, Bloomington 47405

Differences of Scale

Powers of Ten. A Book about the Relative Size of Things in the Universe and the Effect of Adding Another Zero. PHILIP AND PHYLIS MORRISON and the OFFICE OF CHARLES AND RAY EAMES. Scientific American Library (Freeman), New York, 1983. xii, 150 pp., illus., + index. $29.95.

This book is a celebration of the creative friendship of two couples, Charles and Ray Eames and Philip and Phylis Morrison. It is also a memorial to the one member of this extraordinary quartet who is no longer among us, the architect Charles Eames. It is written in a tone of reverence—for Eames, for his vision, and above all for the sense of wonder that drives us to transcend the limits imposed by our senses.

It is a rendering in book form of a ten-minute film produced in 1977 by the Eames team with Philip Morrison providing the narration. The film presented 42 still photographs descending in scale by a factor of 10 at each step from the cosmic range of 10^{25} meters to a subnuclear 10^{-16}. At the center of each image, the next image in the sequence was highlighted by a thin border and defined in slightly greater detail, inviting the eye to make the next leap.

In order to take full advantage of the superior resolution of high-quality color printing, the images have been rephotographed from their original sources. On the page facing each are smaller illustrations and text, offering far more information than could be conveyed in the ten seconds alloted to each order of magnitude in the original sound track. A film designed to whet the appetite has become a book to satisfy it. The reader's attention is drawn to details that might otherwise be overlooked, and to ideas and facts that illuminate what is seen.

For the benefit of those not yet satiated, 50 additional pages of text explain the technologies behind the images, the history of the discoveries and inventions that made them possible, and the scientific and aesthetic visions that governed this enterprise. Devotees of Philip Morrison's book reviews in *Scientific American* will recognize his lucid and lyrical style in these passages.

For the insatiably curious the text is extensively referenced, and there is a bibliography. The book is also provided with a fairly comprehensive index. A short section introduces the uninitiated to the wonders of exponential notation.

The authors are careful to remind the reader that only 15 of the 42 images, those spanning the range from 10^{8} meters to 10^{-6}, are based on anything that can be rightfully called a photograph. Images of larger orders of magnitude depict the cosmos from vantage points that cameras have never reached. Those of smaller ones depict a world in which the very notion of vision, on which so much of our consciousness is based, breaks down. Any rendering of a DNA molecule, of the electron "cloud" in an atom, or of the dance of quarks and gluons at the final step is necessarily symbolic. Passive observation of objects that are unaffected by our presence, and that change slowly enough for the eye to follow, has no place in the study of the microworld.

Where true images are possible, however, they have been selected with great care. The splendid blue-and-white orb of our planet as seen from the moon grows closer until we view North America centered on the Chicago lakefront. There we spy on a couple sunning themselves on a blanket. We enter the surface of the skin, meeting a leukocyte and finally its nucleus as seen in a scanning electron micrograph. Then follows the symbolic plunge through molecules to the heart of a nucleon. The photographs have been enhanced to improve contrast and definition without making them seem artificial.

This book may be read for pleasure and profit by anyone from a teenager to a working research scientist. The former will gain a sense of the vast scope of present-day science and of some questions it can answer and others that remain tantalizingly unanswered. The latter may find a vivid depiction of how his or her work fits into this grander vista. The book is sufficiently handsome to serve as the kind of coffee-table ornament that seems to be required to keep the book business alive in an age of more clamorous visual media.

ROBERT H. MARCH
Department of Physics, University of Wisconsin, Madison 53706

Cosmology

Astrophysical Cosmology. Proceedings of a study week, The Vatican, Sept. 1981. H. A. BRÜCK, G. V. COYNE, and M. S. LONGAIR, Eds. Pontifical Academy of Sciences, Vatican City, 1982 (distributor, Specola Vaticana, Vatican City). xxxviii, 600 pp., illus. Paper. $43; to libraries and institutions, $58. Pontificiae Academiae Scientiarvm Scripta Varia, 48.

During the past few years there has been an enormous growth in the interaction between cosmology and fundamental physics, and elementary particle physics is now addressing such important cosmological issues as nucleosynthesis, the origin of galaxies, the excess of particles over antiparticles in the universe, the extreme isotropy of the universe, and the closeness of the universe to being gravitationally bound. Conversely, new theories of particle physics are being constrained by astrophysical and cosmological considerations.

This proceedings volume consists of papers on the large-scale structure of the universe, the origin and evolution of galaxies and active galactic nuclei, primordial nucleosynthesis, and particle physics in the very early universe. Roughly half the papers are reviews. The remainder present the results of original research, usually with broad introductory surveys of the field. A useful transcript of the questions and answers following each paper is also included.

An introductory paper by Rees and a summary paper by Longair are helpful in putting the other papers into a unifying context. In all, there is remarkable agreement among the authors about a variety of issues. A paper by Oort on the large-scale structure of the universe demonstrates the clumpiness of the universe, with filamentary superclusters of galaxies separated by large voids. Additional evidence concerning the large-scale structure and its dynamical implications is presented in a paper by Davis. Besides discussing the evolution of galaxies, papers by Faber and by Gunn discuss the evidence that only 10 percent of the mass in galaxies and clusters of galaxies is visible and that the ratio of visible to total mass may be constant on galactic scales and larger. Papers by Silk and by Peebles discuss constraints on models of galaxy formation and the possibility that the dark matter that dominates the mass of galaxies may consist of neutrinos having nonzero mass. The contribution of active galaxies to the x-ray background and the evidence that quasars were either formed or first began