Book Reviews

The Early Universe

Cosmologie Physique. Physical Cosmology. Papers from a summer school, July 1979. ROGER BALIAN, JEAN AUDOUZE, and DAVID N. SCHRAMM, Eds. North-Holland, Amsterdam, 1980 (U.S. distributor, Elsevier/North-Holland, New York). xxxiv, 668 pp., illus. $109.75. Les Houches, Session 32.

This is a remarkable document; never before, to this reviewer's knowledge, has the current wisdom from so many of the outstanding researchers in this dynamic field been gathered together in one place, and certainly not in the (generally) excellent pedagogical form presented here. The book is made much more attractive by the fact that recognition of the enormous potential of the grand unification schemes had burst upon the field just prior to the summer school from which the book stems, so much of the flavor and excitement that today surround the physics of the early universe are captured here.

The book begins with a quite comprehensive review of global observational cosmology by J. Lequeux, which makes use of the semiclassical approach of this reviewer in his 1978 Saas-Fee lectures—and which he can without undue immodesty say is excellent, since he himself borrowed much of it from much earlier work by Whitrow. Lequeux follows this introduction with an overview of observed structure and the various electromagnetic backgrounds. This and the other general reviews in the book—the lectures by Véron, Wagoner, Gott, and Rees covering active galactic nuclei, the early universe, galaxy formation, and almost everything, respectively—are excellent, with much attention to detail and presentation. These lectures provide a quite serviceable introduction to the subject and address well the outstanding questions in the field.

Rather more specialized papers by Tinsley on galactic evolution, Mészaros on galaxy formation in standard and some nonstandard cosmologies, and Audouze on determining the age of the universe represent quite fairly the range of currently envisioned possibilities. The review by Audouze is, to this reviewer, especially noteworthy because of the stress it places on the uncertainty and model-dependence of cosmochemical age estimates, which is often found lacking in works on this subject. The paper by Tinsley stresses again the difficulty of performing the classical global cosmological tests with real galaxies and raises the fascinating possibility of unraveling the evolution of galaxies with the new deep galaxy counts, an endeavor that is certain to attract much of the effort in observational cosmology over the next decade.

The role of the new ideas in elementary particle physics in our understanding of the physics of the early universe is touched upon by several authors, most notably Steigman, Schramm and Turner, and Hut and Olive. A comprehensive look at the effect of (the usually ignored possibility of) lepton degeneracy is provided by David and Reeves. It is well that it is included here, since the almost universal view now is that grand unification precludes a net lepton number much in excess of (and possibly exactly equal to) the baryon number, and the annoying fact that we have no real handle on the lepton number is likely to be further forgotten.

There are observational papers, and papers that interpret observations, by Tammann, Yahil, and Sandage and by Peebles. The presentation by Peebles, especially, is lucid and disarming in its simplicity. That the conclusions reached in these papers are vastly different is distressing, but not so much so, perhaps, as the fact that the difference is not addressed in the papers. The student faced with the evidence presented here will wind up believing nothing, and though that may be appropriate it seems a bit unfair to these and other workers in the field. It is, in any case, difficult to extract what is known from what is believed on the basis of (at least one set of) extremely shaky assumptions. The problem pervades the field, unfortunately, and must account in large part for the fervor exhibited by many of the leading lights for their own particular views.

No view of contemporary cosmology would be complete without some "nonstandard" models. These are represented here modestly, from an impeccable review by Carter on the formation of primeval black holes to a paper by Omnès on the seemingly unkillable baryon-symmetric models to a review by Maeder of models with variable G (whose impetus, the notion that gravitation should be scale-invariant, has, to the reviewer's mind, been seriously undermined by the recent clarification by Beckenstein, which showed that general relativity *is* scale-invariant) to a paper by Englert on his notion that the universe *began* as a spontaneous-symmetry-breaking event in some supertheory.

The book, in short, is an excellent introduction to the field and belongs on the shelf of any serious worker in the field, or of any scientist who is interested in the progress of this most ambitious scientific endeavor. Even its shortcomings represent the state of the subject; one may bemoan them, but it would hardly be fair to expect a mere book to correct them.

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Ecological Genetics

Evolution in Age-Structured Populations. BRIAN CHARLESWORTH. Cambridge University Press, New York, 1980. xiv, 300 pp., illus. Cloth, $44.50; paper, $13.95. Cambridge Studies in Mathematical Biology, 1.

Population geneticists and population ecologists approach evolutionary problems from different perspectives. The geneticist regards gene frequencies as the common denominator of evolutionary events, whereas the ecologist is more interested in organisms, their numbers and life-history attributes. Both disciplines have a rich theoretical tradition, and in fact both had their origins in the hands of mathematicians. In ecology, one of the first accomplishments of this mathematical work was a theory of population growth and demography. The early mathematical geneticists, for the most part, ignored this basic aspect of population biology and concentrated on gene-frequency change in populations with discrete, nonoverlapping generations. An exception is found in the work of H. T. J. Norton, who in the 1920's undertook an extensive study of the outcome of selection in an age-structured population. Norton's work was largely ignored by evolutionary biologists until recently, when interest in the determinants of fitness has led geneticists to incorporate ecological variables into their models. During the past decade there has been much work in evolutionary biology dealing with the effects on gene frequencies of age structure and

population growth. Although there are unsolved problems, incorporation of these factors into the genetical models has been so extensive that a review of the subject is badly needed. This is the purpose of Charlesworth's book.

The author begins with the basics of demography. The presentation is too condensed to serve as a first introduction to demographic theory, but those with some previous exposure to demography will profit from the treatment, since this is one of the few places where the basics are presented in an evolutionary perspective. The middle of the book is devoted to genetical evolution in age-structured populations, and an extensive final chapter surveys the theory of life-history evolution.

Charlesworth develops age-structured analogues to many of the traditional concepts in population genetics: Hardy-Weinberg equilibrium, inbreeding, effective population size, and so on. However, most of the genetical material concerns the study of selection, to which Charlesworth has contributed much. The chapters dealing with selection (3 and 4) are basically a redevelopment of Charlesworth's earlier work and, although clearer, contain almost as much mathematical detail as the original papers. The central question addressed is to what extent a single statistic can predict gene frequencies in an age-structured model, as individual fitness does in the discrete-generation models. The problem is a difficult one and was first addressed by Norton in 1928. Norton, Charlesworth, and others have found that the genotypic intrinsic rate of increase summarizes much of what is of interest concerning selection in an age-structured population. However, there are some exceptions, which Charlesworth's work points out. Rather than wallow in these exceptions, Charlesworth goes on and utilizes the intrinsic rate of increase as a sufficient parameter to study life-history evolution. It is fashionable among certain population geneticists to dwell upon the technical restrictions involved in deriving evolutionary concepts from first principles, and this tendency is represented in Charlesworth's book. The strength of his approach, however, lies in the balance between rigorous deduction of evolutionary concepts and their use in explaining organisms and their phenotypes. Charlesworth realizes that concepts that appear fragile when cast in the rigid deductive framework of population genetics can have great heuristic utility in evolutionary ecology.

Because the shift to life-history evolution in the last chapter is well motivated genetically, the theoretical underpinnings of such standard techniques in evolutionary ecology as maximizing the intrinsic rate of increase are made explicit. Such connections between evolutionary ecology and population genetics are crucial links in a synthetic theory of evolution. This chapter is the best review of life-history theory available. There has been so much loose theorizing and speculation in this area (Charlesworth is quick to point out where) that it is important to have all the correct concepts presented in one place. Some effort is made to discuss the data, but only as they bear on the theoretical points. In this regard it is disappointing how few data there actually are that bear directly on the theory, especially the reproductive-effort model.

Charlesworth's book will be a useful reference for serious students of evolutionary biology. The subjects covered are intricate, and the logical and detailed presentation will be satisfying for readers who already possess a certain amount of fascination with theory. Others may become bogged down in the mathematical technicalities and lose sight of the general points. Nevertheless, this book exemplifies both the logical development and the creative use of theory on the interface of population genetics and evolutionary ecology.

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An Ethological Problem

Olfaction in Mammals. Proceedings of a symposium, London, Nov. 1978. D. MICHAEL STODDART, Ed. Published for the Zoological Society of London by Academic Press, New York, 1980. xvi, 364 pp., illus. $63.50. Symposia of the Zoological Society of London, No. 45.

The study of olfaction in mammals is full of challenging problems, a prime example being simply to describe the message produced and to analyze its function in any communicatory act involving the use of scent gland secretions, urine, or feces. In the study of auditory communication, the sounds of an animal can be described accurately with respect to numerous parameters with equipment that is easily available to and usable by an ethologist. Sounds can then be categorized on the basis of their major characteristics, and the classical ethological questions of function, ontogeny, motivation, and evolution can be explored. In the study of olfactory communication, however, the first step, that is, the description of the presumed "signal," requires both equipment and expertise in chemistry that are unavailable to most ethologists. Thus the presumed communicatory information is usually unstudied while the behavior patterns (for example scent marking) used in the production of the message are emphasized. This is analogous to concentrating on the singing bird rather than the bird song, an approach that would be considered bizarre in studies of auditory communication.

A further factor complicating studies of olfaction is the lack of a clear correlation between an odor as perceived by the human olfactory system and the structure of the compound responsible for it. A competent student of bird song can usually look at a sonagram and know what the song sounds like. Even a chemist cannot necessarily predict the odor from the chemical structure, a problem addressed early in this volume by MacLeod.

Despite the problems it presents to researchers, olfaction is a subject of active study, as evidenced by the number of compilations of papers dealing with it that have appeared in the last decade. Yet as this and other volumes indicate, techniques of study are only slightly more advanced than they were 20 years ago, and the major problems have yet to be tackled.

This volume exemplifies some of the recent trends in mammalian olfaction research, with some authors concentrating mainly on reviewing particular topics, including the structure and distribution of scent-producing areas (Adams), olfactory influences on reproductive physiology (Milligan), the structure and function of the olfactory system (Dodd), and the chemistry of odors (MacLeod). There are also chapters specifically devoted to particular mammalian groups or species, such as carnivores (Gorman, Macdonald), ungulates (Gosling), pigs (Booth), primates (Schilling, Keverne), and lagomorphs (Bell), although these chapters vary greatly in the proportions devoted to review and to the authors' own research findings. Most of the chapters regarding particular mammalian groups are implicitly (or explicitly) concerned with the function of the various odors produced, although there are no real theoretical advances and several of the authors persist in synonymizing causation (motivation) and function, a long-standing problem in ethological research.