In the field of the science of string

C.H. Llewellyn Smith

Gauge Fields and Strings. By A.M. Polyakov. *Harwood: 1987. Pp.301. Hbk $48, £32; pbk $18, £12.*

THIS is a unique book. It can and should be read for profit and pleasure by all advanced students of field theory, and by professional mathematical and theoretical physicists.

Polyakov is an outstanding theoretician who has made many seminal contributions to particle physics and statistical physics. He describes the origin of his book in the preface:

For many years I have been keeping notes on different topics in physics — a kind of scientific diary. They contain occasional new results and mostly derivations of known things, done in a way that seemed nice to me. . . . This book has arisen from these notes, or better to say, from the part of them devoted to field theory. . . . In many cases I discuss things that have never been completely understood. I do this in the hope that the approach I suggest, although imperfect, will stimulate deeper penetration into the subject.

As this passage suggests, the book conveys the author's personal approach to subjects on which his own work, and that of other members of the 'school' of Russian physicists to which he belongs, has had a profound influence. It starts with a discussion of the analogy between statistical mechanics and quantum field theory, which is then exploited throughout the book as Polyakov moves back and forth between statistical systems, such as the Ising model, and continuum field theories in a way that illuminates both. Much of the material in Chapters 1–8 — asymptotic freedom, the strong coupling expansion, instantons (which were discovered by Polyakov and co-workers), the topology of gauge fields and the large N expansion — is now included in advanced textbooks on field theory, but Polyakov's treatment is more wide ranging and goes on in content, and also in style and approach, to the frontiers of research.

The climax of the book is the 100-page Chapter 9, "Quantum Strings and Random Surfaces", which is followed by a final chapter entitled "Attempt at Synthesis". Polyakov approaches string theory from the so far incomplete attempt to formulate quantum chromodynamics, the theory of the sub-nuclear inter-quark force, entirely in terms of Wilson's loop variables, which was developed largely by the Russian school. The treatment is centred on Polyakov's own contributions to the definition and calculation of functional integrals for strings which has

been the basis of much recent progress. It is only latterly that gravity enters and the currently fashionable idea that the underlying 'unified theory of everything' is based on strings moving in nine space dimensions, six of which have curled up to minute sizes, is not discussed until Chapter 10. This ordering of the material is an important reminder that even if string theory is not relevant for fundamental unification, it is likely to find applications in quantum chromodynamics and/or in the theory of random surfaces.

Polyakov's book is a supplement to, not a substitute for, the standard books on advanced field theory and will be inaccessible to readers who have not already acquired considerable sophistication in the subject. It is not necessary to be a mathematical field theorist to benefit

from it, however, because Polyakov does not use the language of topology and differential geometry and continually resorts to physical arguments, explanations and analogies. As a relatively pragmatic user rather than producer of field theory, I found this volume a source of enlightenment on many of the developments that have taken place during the remarkable renaissance of field theory in the past 15 years which I have only partially absorbed by osmosis from my colleagues. I have learned a great deal from a first quick reading, and I look forward to studying the book in more detail and referring to it in the future. □

C.H. Llewellyn Smith is Chairman of the Department of Physics, Clarendon Laboratory, University of Oxford, Parks Road, Oxford OX1 3PU, UK.

Simian society

Carel P. van Schaik

Primate Social Systems. By Robin I.M. Dunbar. *Croom Helm/Cornell University Press: 1988. Pp. 373. Hbk £35, $49.50. pbk £17.50, $24.95.*

WHY is there so much variation in the social systems of the 180 or so species of primate? In the early 1960s, the findings of field workers seemed to indicate clear-cut associations between the habitat, diet and activity period of a species and selected features of its society. The flurry of activity that followed, however, produced many exceptions but no prospects for a new framework.

During the 1970s most field studies concentrated either on ecology or on aspects of social behaviour, such as infanticide and mating strategies. The new concepts of sociobiology made it clear that only the social strategies of individuals are directly affected by ecological conditions. Hence, the links between ecology and the social system are indirect, and therefore complicated.

Robin Dunbar's *Primate Social Systems* is the first book to explore systematically the effects of ecological and demographic factors on the social strategies of individuals and the structure of their societies. In the opening chapters he provides a pithy introduction to the main concepts of evolution and demography that enable us to frame and answer questions about functional aspects of primate social behaviour. After treating the ecology of grouping patterns, he discusses how animals can best obtain their mates, rear their young and use their conspecifics as allies. In the final chapters, he extrapolates from the individual level to that of the society as a whole by developing quantitative models and examining their dynamics.

The great strength of the book is in the detailed analyses of individual variation in social strategies. Dunbar is at his best when he discusses the feedback between demography and social behaviour. We learn that the balance of give and take in a relationship is negotiable, and that patterns in alliance formation depend on the availability of suitable partners. Both of these change in a predictable way as demography or social context changes. Dunbar stresses that such demographic factors can explain much of the inter-specific variation in the structure of primate societies.

Where Dunbar treats ecological questions, his grasp is less firm. The tests that he proposes are not always adequately derived or executed. For instance, to test the hypothesis that communal defence of food sources is the main benefit of group living in primates, he erroneously predicts that groups suffer most from between-group food competition at low population densities. In some tests he does not eliminate possible confounding effects, or he inadvisedly fits curves by eye.

We are only just beginning to understand the intricate links between external conditions and the social behaviour of primates. Some of Dunbar's conclusions may be wrong, but his reasoning is always explicit; and as the ecologist Robert MacArthur once said, it is far more important to be interesting than it is to be right. □

Carel P. van Schaik is a Senior Research Fellow with the Royal Netherlands Academy of Arts and Sciences (KNAW), Laboratory of Comparative Physiology, University of Utrecht, 3572 LA Utrecht, the Netherlands.

More primatology

With the appearance of Vols 2B (*Behavior, Cognition, and Motivation*) and 4 (*Neurosciences*) Alan R. Liss has recently completed publication of the mammoth multi-author work *Comparative Primate Biology*. The books will be reviewed in a forthcoming issue of *Nature*.