

# reviews

COSMOLOGY is a subject with long traditions, and general relativistic cosmology in particular has been developed in detail, both mathematical and physical, in many textbooks. In recent years there has been a distinct resurgence of interest in the subject, partly resulting from the stimulus of impressive observational discoveries (the microwave background, quasars, and so on) and partly from the elegant new mathematical techniques which have been constructed. Not least among these are the theorems of Hawking, Penrose and Geroch, which predict in very general circumstances that space-time can develop singularities or 'edges'.

The demand for well written books covering cosmology from this new perspective is growing. Ryan and Shepley have made a useful contribution in this latest volume in the Princeton Series in Physics. An earlier volume by Peebles, called *Physical Cosmology*, deals with observational aspects, whereas this book concentrates on the mathematical side. The authors restrict themselves to models of the Universe which are homogeneous in space. These models, being a good approximation to the large scale structure of the real Universe, are simple enough to allow a tractable mathematical description, but rich enough to confront some of the more challenging and bizarre physical problems.

The early part of the book builds up the terminology and formalism of modern tensor analysis, moving straight into the Robertson-Walker isotropic

## Heavenly views

P. C. W. Davies

*Homogeneous Relativistic Cosmologies.* By Michael P. Ryan Jr and Lawrence C. Shepley. Princeton Series in Physics. Pp. xv+320. (Princeton University Press, Princeton, New Jersey, 1975.) \$15.00.

models and the big-bang Friedmann solutions. One of the major themes of the book is then taken up with a fairly detailed description of singularities. Much of this discussion is rather sophisticated, and the new student may feel a certain frustration that very recent developments are not explained in greater detail.

Following the singularities, more traditional work is outlined on the subject of Killing vectors and isometry groups, enabling discussion of the full range of homogeneous cosmological models. Well known examples are described in some detail, though the authors have a tendency to concentrate rather too much on the more bizarre aspects. Godel's model, which apparently allows observers to visit their own past, and the mysterious and baffling Taub-NUT and T-NUT-M spaces, each command a whole section. Some further work on singularities in homogeneous models then follows, leading naturally to the thorny subject of quantum cosmology. In Chapter 10 the authors state that "All explicitly known models which can serve as cosmological models are mathematically

singular", and point out that classical physics runs into a barrier here. The hope that quantum theory will open that barrier is long standing, but current results are still very superficial.

Some of these results are dealt with by Ryan and Shepley. They first build up the idea of 'Hamiltonian cosmology'—treating the Universe as a physical entity moving in a highly simplified fashion with a small number of degrees of freedom only. Quantisation of this simple system is then briefly alluded to. An entire chapter is devoted to the simplest of the anisotropic models, the Bianchi types I and IX, and the so-called mixmaster Universe, in which an initially chaotic motion smooths itself out into the more uniform, isotropic form observed in the real Universe today. A final chapter treats some problems in perturbation theory.

As a teaching textbook, this volume will prove useful. It is inclined to read a little breathlessly, and the level of discussion is somewhat variable, but graduate students and researchers will find it valuable for both reference and instruction. An extensive bibliography is provided, together with some exercises for the more ambitious reader. A little homespun philosophy creeps in here and there, to add a needed touch of perspective on this rather esoteric of subjects.

In summary, this book manages to get to grips with very recent results in cosmology at a time when the subject is undergoing rapid development. It is to be recommended to all serious students of modern cosmology. □

HIGH energy astrophysics is a rapidly growing field in which there have been many important discoveries, although graduate students or research workers may find it difficult to obtain a general introduction to the subject, with the possible exception of some lecture notes from summer schools. Now, however, several authors, associated with Nasa's Goddard Space Flight Center, have produced a book which may overcome this problem as far as cosmic X and  $\gamma$ -ray astronomy are concerned. The authors are all well known researchers, each writing about his own specialty.

About one half of the book deals with cosmic rays. Experimental techniques, results concerning nuclear and electron components, and propaga-

tion effects in space are carefully reviewed. Not much is said about sources or about acceleration mechanisms.

The other half of the book deals with X-ray and  $\gamma$ -ray astronomy,

*High Energy Particles and Quanta in Astrophysics.* Edited by Frank B. McDonald and Carl E. Fichtel. Pp. xii+476. (MIT Press: Cambridge, Massachusetts and London, 1974.) \$18.50; £9.25.

with an introductory chapter on radioastronomy. Little that is basically new has happened in X-ray astronomy over the last couple of years and these chapters can therefore be considered as a good reference. On the other hand, however,

$\gamma$ -ray astronomy has recently led to the discoveries of bursts and of the SAS 2 results. Since the Goddard Center has been heavily involved in these developments, it is a pity that they were not included.

In a book of this kind a certain amount of bias is unavoidable in the choice and presentation of results. Readers curious about the more general aspects of high energy astrophysics will not find here a discussion of radiogalaxies, quasars and so on. Indeed, the authors never intended to provide an introduction to the whole field but only to those aspects indicated by the title. They have, however, certainly produced a useful collection of review articles which, largely, can be read independently.

F. Pacini