
Book Review

The Isotropic Universe. *D. J. Raine.* Bristol: Adam Hilger. 1981.

This is a textbook on cosmology written from an astrophysical viewpoint, giving a good discussion of the basic observational data and physical questions. It is written in a compact style that presents the bones of the argument swiftly and efficiently, and will serve as a good introduction to the subject for any audience with a reasonably mature understanding of physical principles.

The first four chapters present a broad overview of relevant observations, covering the classification, distribution, and clustering of galaxies: the concepts of an expanding universe, red shift, and the age of the universe: the spectrum and nature of cosmic background radiation: and ways of measuring the density of matter in the universe.

The next four chapters cover the standard (Friedmann-Robertson-Walker, or FRW) relativistic universe models. The concepts of the general theory of relativity are introduced in a businesslike way, as logical extensions of suitably formulated Newtonian theory: the geometry and nature of the FRW universes is presented: the standard cosmological tests are discussed; and properties of matter and radiation in an expanding universe are discussed, including their interactions with each other. This chapter includes sections on nucleosynthesis, the plasma period and the recombination era, and an introduction to the concepts of horizons and causality.

The final four chapters put the previous sections in a broader setting. More general models (Kasner, rotating and Swiss-cheese universes) are introduced and the observational limits on anisotropy are presented: possible reasons why the universe should be isotropic (Machian, chaotic cosmology, and anthropic arguments) are considered: and the definition, existence, and nature of singularities are discussed, with a brief presentation of the idea of a "whimper" singularity. The problem of the origin of structure in the universe is the subject of the final chapter.

The subject matter, then, is straightforward, perhaps including a few slightly more advanced topics than various competing volumes. The presentation is carefully thought out, and gives a precise summary of our current understanding of the universe; at each stage there is considerable evidence that the author has thought afresh about his subject matter, making the text generally interesting

reading. While the presentation is brief, it does not shirk physical or mathematical details where they are necessary to the argument.

The overall success of the presentation is marred by a few aspects that should have been done better. Three specific such points came to my attention: firstly, the Einstein equations are never properly introduced. They are well motivated in the specific case of a FRW universe, but the general form is never written down; in the case of other universes, the relevant particular form of the equations is simply quoted. This is partly related to the fact that the curvature tensor is introduced in a somewhat offhand manner, and never really treated as an object worthy of attention in its own right; again properties of matter are discussed without specifically introducing the concept of the matter stress tensor. Secondly, the concept of a symmetry is also covered adequately in the case of a FRW universe, but inadequately in the more general cases. Specifically, when “symmetry transformations” are discussed, Killing’s equations are not written down, nor is any equivalent condition stated; so in fact we are never given conditions that turn the transformations considered into isometries. Thirdly, it is implied (page 213) that only the $k = +1$ FRW universes can be spatially closed; whereas it is well known that there are $k = 0$ and $k = -1$ universes that (owing to “unnatural” topologies) are also spatially closed.

These features will not affect the reader aiming to understand the standard (FRW) universe models in a reasonably broad context. The book can be recommended as a good, solid introduction to the subject of cosmology that gets down to the essentials in an efficient way. The main problem in using it as a textbook is that (being English rather than American in style) no examples are included for the student to do. It would probably prove a little tough for a student to read by himself; and he would also need guidance concerning the points mentioned above. However it should prove useful as a text to accompany a course on cosmology, particularly in view of its concise yet readable presentation of its subject matter.

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