An Introduction to the Science of Cosmology. D. J. Raine and E. G. Thomas. Institute of Physics Publishing, Bristol. 220 pp. Price: $ 50.

Last few decades have seen the spectacular emergence of cosmology as one of the most active topics of research in astrophysics and physics in general. Its beginning at the turn of the last century was looked upon as being too speculative and starved of real data. The march of cosmology to become one of the central arenas of research has been steady after the discovery of the cosmic microwave background radiation in 1965. It is now the era of sophisticated telescopes detecting faint glows of galaxies from far back in the past, that would have been considered impossible even a decade ago, of vast surveys of galaxies with a giddying amount of data and of very high resolution measurement of the cosmic microwave background radiation. All these data are being used to determine the underlying physics of the cosmos.

This rise of cosmology has ensured that graduate students of astrophysics do not view it as an optional course to study any longer. It has become one of the core courses and in the last few years, many textbooks have appeared to cater to this growth of interest. There have been, however, a dearth of textbooks that could explain the basics to the undergraduate students, without depriving them of the excitement of the results coming from the forefront of research. It has been so mostly for the reason that it is impossible to appreciate the subtleties of cosmology without learning the general theory of relativity, and it is difficult to do justice to all this in a small volume.

The new book written by Raine and Thomas wonderfully fills up this gap. In their lucid presentation of the details of the cosmological models of the universe, they laudably avoided the temptation of taking shortcuts and yet managed to convey the excitement of research on cosmology at the present epoch.

Let me take an example to explain the difficulty involved. The evidence of the expansion of the universe came from Hubble's discovery of redshifted spectra of galaxies. Although the redshift is usually interpreted in such textbooks as a Doppler shift, the correct interpretation is provided by the general theory of relativity through cosmological redshift. The redshift is not due to large velocities of galaxies relative to space, but is an artifact of the expansion of the space itself (although any 'peculiar velocity' that the galaxy may have would add to the redshift). Many authors usually avoid making this distinction to keep the exposition easy and in the process sow the seeds of serious confusion in the minds of students. For example, one wonders what would happen to the velocity of galaxies at large redshifts. Some authors even go to the ridiculous extent of applying special relativistic corrections to their 'Doppler' formula for cosmological redshifts. Raine and Thomas have done well to heed the advice of Edward Harrison (whose book *Cosmology* has been a classic and a notable exception to this cacophony of misinterpretations), whose papers they cite while drawing the distinctions between velocities and cosmological redshifts.

Another refreshing difference in the book by Raine and Thomas is that they begin not by describing theoretical ideas (and prejudices) behind modern cosmology but by describing astrophysical observations relevant for cosmology. It must be noted that the study of cosmology has become what it is mainly through the extraordinary developments in observational techniques in the last few decades. Most of the efforts of modern cosmologists have gone into interpreting the potpourri of data obtained by astrophysicists based on existing theoretical ideas. Students studying this book will have a clear perspective of what is known and what must be understood in the framework provided by cosmological models.

The chapters I enjoyed most were chapters 5, 6 and 7, which form the core of the book, and describe the motivations behind the cosmological models, the models themselves and the implications of the models as far as the past history of the universe is concerned. The arrangement of the material is splendid, and the presentation is lucid. The authors have attempted to bring out as many interesting features of the cosmological models as they could in the short space available to them. One example is their discussion (section 5.17) on the past light cone, bringing out the subtleties of the space–time metric of cosmological models that is rarely found in textbooks targetted for such an audience (Harrison's book is again an exception that comes to mind).

The last two chapters on inflation and formation of structure are comparatively less clear, but a more detailed exposition of these topics admittedly belongs to a more advanced level textbook. Students will nevertheless find the discussions here useful before plunging into more advanced books.

The authors have put a lot of effort in providing relevant figures, at times from recent technical papers, to make their discussions more attractive. The problems offered at the end of the chapters are also thoughtful; they are designed to bring out different aspects of the topics discussed, and at the same time are not tedious.

There are a few typos but thankfully they are of a sort that can be easily spotted. The expression for the phase space volume for particles on p. 133 has a unnecessary equality sign. The expressions for the entropy densities of electron–positron pairs on p. 158 have a wrong temperature dependence.

In brief, Raine and Thomas have written a marvellous book for undergraduate students interested in cosmology. Although it is mainly written for undergraduate students, in my opinion even graduate students would gain a lot from studying this book.

BIMAN NATH

Raman Research Institute,
Bangalore 560 080, India
e-mail: biman@rri.res.in