Einstein refined — just in time

W.B. Bonnor

Exact Solutions of Einstein's Field Equations. By D. Kramer *et al.* Pp. 425. ISBN 0-521-23041-1. (Cambridge University Press: 1981.) £30, $72.

PROGRESS in theoretical physics consists largely of formulating equations and solving them. For instance, the equations put forward by Newton, and by Maxwell, are still being solved for application to special problems; and theorists have been seeking solutions of Einstein's equations since general relativity was discovered in 1915.

Solutions, yes — but why *exact* solutions? Aren't approximate solutions good enough? E. Schrödinger wrote (about Einstein's unified field theory) that "the exact solutions, involving strong fields, have disclosed the ingenuity of the mathematicians who discovered them, but nothing more". Approximate solutions are certainly good enough when a theory is well understood, like Newton's mechanics, and there is no danger of series failing to converge. But in a mathematically complicated theory like general relativity one does not always trust approximations. For example, after half a century of approximate work on motion, there is still no agreement on whether freely falling bodies radiate gravitational waves. A suitable exact solution could settle this once and for all.

A vast number of exact solutions of Einstein's equations have been discovered since 1915. With the half-dozen or so exceptions to be found in nearly all textbooks, these have lain buried in the literature. A warm welcome will therefore be given to this book. The magnitude of the authors' task is indicated by the bibliography which contains about 1,000 references; and these have been sifted from a list of twice as many. Most of the solutions given have been checked, which must have been a monumental task. Indeed, perhaps the work has been done only just in time: had it been left any longer it might not have been possible at all, because papers on exact solutions are appearing at the rate of over 100 per year.

It is possible to use the book simply as a catalogue in which to search for an exact solution, knowing to begin with some of its properties. However it is much more than this. It was essential to impress some order on the plethora of exact solutions obtained by a variety of methods. The authors choose as their principal methods of classification, first, symmetry groups and, second, Petrov types. They give an excellent introduction to both these topics, including much not easily found in other books. Part I, General Methods, also includes chapters on differential and Riemannian geometry, and on the Newman–Penrose formalism.

The authors have done such a fine job that it is important to realize what the book does *not* include. First, as stated in the Introduction, the exact solutions given are those arising from the following energy–momentum tensors: vacuum, electromagnetic fields, pure radiation, dust and perfect fluids. Although all the really important exact solutions fall under these headings, it should be noticed that some areas of physical interest are excluded, for example, charged matter and viscous fluids. It must also be remembered that nearly all solutions in the book are purely local, and no consideration is given to their global existence. Nor are boundary value problems within the authors' terms of reference, so the matching of different solutions is not considered; this leads to the somewhat bizarre omission of a famous solution, that of Einstein and Strauss for a star embedded in the expanding Universe. Another possible source of misunderstanding for the unwary reader lies in the quite forgiveable practice of giving the general form of a solution wherever possible, and omitting reference to special cases, even where these may be of physical importance.

All seriously interested in general relativity should get this book. They should also take advantage of the authors' invitation to inform them of omissions and of new solutions. In this way we may hope that the catalogue will be kept up to date and re-published from time to time. □

W.B. Bonnor is Professor of Mathematics at Queen Elizabeth College, University of London.

Les sciences bien vulgarisées

Alan Isaacs

Concise Encyclopedia of the Sciences. Edited by J.-D. Yule. Pp.590. ISBN 0-87196-491-0. (Facts on File: 1981.) $29.95.

BEING able to praise one's competitors is an indulgence not frequently available to those of us who earn a living by what the French call the *vulgarisation* of science. However, this is an excellent book, well written, expertly edited and lavishly illustrated mostly in full colour — or rather color, for this is the American edition of a book one version of which has already been published in the UK (Phaidon, 1978; £9.95). At $29.95 the American edition is undoubtedly good value — for the youngster with an interest in almost any branch of science it will certainly be a most acceptable gift. Uncles (and aunts) please note. It will also be a valuable asset for any library and for readers with no specialized knowledge of science.

Broadly speaking it does exactly what it says it will do — supplies both a dictionary of the most commonly encountered words of science as well as the encyclopaedic background material necessary for understanding their use in a wider context. The 400,000-word text is competent, accurate and jargon-free; for a book of this size it is difficult to see how it could be improved. One third of the text area is devoted to illustrations, almost all of which are a pleasure to look at, both because they communicate the information they are intended to communicate and because they are either well-chosen photographs or well-drawn diagrams. Particularly effective are the historical panels that summarize the history of some subjects and the "context panels" that illustrate the interrelationships between branches of other subjects.

If one has to criticize, one could say that it is perhaps unwise to have claimed (as the jacket does) to have covered philosophy and medicine. In both these fields the coverage is rather less than adequate. In philosophy, for example, the extent of the lacunae can be judged from the fact that there are no entries for ethics or existentialism, nor are Duns Scotus or Aquinas to be found. As Lady Bracknell might have said — to lose one scholastic doctor may be regarded as a misfortune; to lose two looks like carelessness!

In medicine the coverage is more thorough but it is perhaps surprising to find an entry for lymphoma but not one for the more common but less ominous papilloma. Some of the more recent techniques, such as tomography and thermography, are also omitted, as is the now ubiquitous Emiscanner.

If no attempt had been made to cover either philosophy or medicine there would perhaps have been room to deepen the treatment of the growing points of physical science. Quarks, for example, get only a one-sentence mention under subatomic particles, the state of play in nuclear fusion and fast-breeders is not explained, and the alternative energy field is not very well covered (nothing on wave or wind power or biomass energy).

It is, however, uncharitable to dwell on these gaps; so much is included and treated so well. This is undoubtedly an excellent reference book. □

Alan Isaacs is editor of the Macmillan Encyclopedia, *the* Penguin Dictionary of Science, Longman's New Dictionary of Physics, *and science editor of* Collins English Dictionary. *He has contributed to many other dictionaries and encyclopaedias.*