and mentions the powerful theorems proved recently by Stephen Hawking and Roger Penrose, which indicates that they occur in a wide range of conditions. If the Universe was exactly uniform in density, then such a singularity at the beginning of the big bang would indeed represent a boundary of the physical world and a place of infinite compression. The author points out, however, that the theorems do not require this situation when departures from exact symmetry occur, as they do in the real Universe. Nor do we expect general relativity to apply unchanged all the way down to the singularity, because quantum gravity effects will presumably dominate at sufficiently early moments. Thus, he leaves open the question of whether the Universe existed before the big bang.

The remainder of the book deals with black holes. First, a description is given of how a star is constituted and burns, and the mechanism whereby it eventually fails to support itself internally against the crushing weight of its own material. After a brief account of supernovae and neutron stars, the reader is introduced to black holes, with all their exotic and enigmatic properties. Dr Wald pays more attention than most authors to the intriguing question of cosmic censorship—can gravitational collapse cause the occurrence of space-time singularities that are not hidden inside black holes, that is, are naked? Drawing on some theoretical studies, he concludes that in all probability a 'cosmic censor' is at work to prevent us from viewing naked singularities.

A whole chapter is devoted to energy extraction from black holes that rotate, and a discussion of the efficiency limits on these processes. A further chapter deals with the astrophysics of black holes, for in spite of the wide attention they have received there is no clear observational evidence for them. Dr Wald explains how difficult it is to actually spot one, but draws the personal conclusion that the X-ray source known as Cygnus X-1 does contain a black hole.

The final chapter brings the subject right up to date with an account of the quantum process of black hole evaporation discovered by Stephen Hawking in 1974. No attempt is made to describe the mechanism of the process in detail, but some of its consequences are explored, particularly its significance in providing a basis in thermodynamics for black hole processes.

In summary, I found this a well written, entertaining and authoritative book. It is extremely concise, so the reader should not expect anything other than a brief and eccasionally patchy introduction. I see the book as excellent spare time reading for non-specialist scientists, good stimulation for school children with a scientific curiosity, and a helpful introduction for laymen and students to a subject of continuing scientific interest.

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Digital image processing

Digital Image Processing. By Rafael C. Gonzalez and Paul Wintz. Pp. 431. (Addison-Wesley: Reading, Massachusetts, 1977.) Hardback $29.50; paperback $19.50.

In collaboration with different co-authors, Professor Gonzalez is writing a series of three introductory textbooks on pattern recognition and image processing. The volume under review is the second of these and is a direct rival of two volumes that have recently appeared with similar titles (reviewed in *Nature* **264**, 142, 1976; and **268**, 275, 1977). The contents of Gonzalez and Wintz's book are very similar to those of Rosenfeld and Kak's volume, but whereas Rosenfeld has made major contributions to both image processing and pattern recognition, the present authors have published comparatively little on most of the topics covered in this volume. Although they discuss all the material one would expect, their book is less useful than the rival texts in that it is difficult to grasp the role of any particular procedure, to place it in the context of contemporary attempts to process images in sophisticated ways. It will be even more difficult for the student to absorb some of the material, for the authors seem deliberately to have avoided analogies with other subjects that could have been helpful. The Hotelling transform (the discrete analogue of that of Karhunen and Loève) is a case in point: we are told, as though it were surprising, that pre- and post-multiplying a matrix by the matrix of its eigenvectors produces a diagonal matrix. Yet a large part of image processing theory is applied matrix algebra, the elements of which are indispensable for any would-be reader of this book (or indeed any image processing book). Moreover, the student is likely to have met similar reasoning in quantum mechanics courses. In short, it is hard to imagine that anyone unaware of such an elementary result would embark on this text.

After introductory chapters on fundamentals—system requirements, sampling and film properties, in particular—separate chapters are devoted to transforms, image enhancement, restoration, coding, and image segmentation. The best of these is the chapter on image encoding, in which the authors successfully convey the reasons why the many different types of coding are necessary.

Digital Image Processing is a well illustrated, rather pedestrian text, containing plenty of examples and much rather wordy explanation. It will probably be welcomed by students with an examination to pass, but graduate students planning to continue in this field would be better off with the book by Rosenfeld and Kak. Incidentally, the hardback is probably worth the extra $10, as the paperback is very flimsily bound.

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Water and climate

Climate and Water Supply. (US National Research Council: Washington, DC, 1977.) Paperback $7.75.

The US National Research Council is producing a series of "Studies in Geophysics" on topics such as geophysical prediction, the upper atmosphere, energy and climate, and the present volume on water and climate. The studies vary in size and scope, with in this case a rather sharp focus on the water supply problems of the contiguous states of North America, which must inevitably reduce the usefulness of the volume compared with, say, the recent publication on energy and climate.

Nevertheless, some attempt is made to set these water supply problems within the broad framework of the developing understanding of climatic change, with contributions from Stephen Schneider and Richard Temkin on "Water Supply and the Future Climate" and from Charles Stockton on "Interpretation of Past Climate Variability from Paleoenvironmental Indicators". For readers outside the US, the result is best seen as a conveniently packaged and neat example of the application of studies of the changing climate to the specific problems of water supply in one part of the world; as such, the volume could be particularly useful in a teaching context for courses in geography or the Earth sciences. The volume is also a restrained and timely antidote to some of the more hysterical writings on climatic change that are now proliferating.

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