final one is devoted to a substantial review of the field of total cross sections and elastic scattering at very high energies.

From these contents, it is clear that the author has leaned towards the topics with which he has been most directly involved, particularly the physics of hadronic interactions.

The omission of the considerable work done in the last decade to study the hadronic interactions of photons, underlines the dilemma in which any author tackling this subject is placed, since it is impossible to cover all aspects and be up to date at the same time. But the author has taken on, quite successfully, a prodidgous task and can be congratulated on seeing this through to its end. The shorter chapters come over well as concise, yet essentially comprehensive, statements of the facts, while in the main parts of the book, one is left in no doubt as to the author's comprehensive and detailed knowledge of his topics, and of the considerable experimental and theoretical activity in the field over the past twenty years. The reference lists are extensive, and the well-known "Tables of Particle Properties", originating from the "Particle Data Group", round off the volume.

The production standards of the book are of the highest quality, and typographical errors, though present, are rare. Appropriate libraries should be encouraged to purchase the book.

W. Galbraith

Serious black holes

Black Holes: Les Houches 1972. Edited by C. DeWitt and B. S. DeWitt. Pp. xii + 552. (Lectures delivered at Summer School of Theoretical Physics of the University of Grenoble.) (Gordon and Breach: New York, London and Paris, 1973.) £13.50.

This book has already established itself as an essential work for those interested in black holes. The publication is timely because after some years of theoretical studies evidence is now mounting that black holes may have been observed indirectly in some X-ray sources. Both theoretical and observational aspects are treated in these lectures.

The book begins with Hawking's lectures on the "Event Horizon"—the "one way membrane" which separates the exterior of a black hole from the hidden interior. In them he establishes the general properties of the event horizon using the topological methods which were developed by Penrose, Geroch and himself to prove the singularity theorems which show that according to general relativity the outcome of catastrophic gravitational collapse will be a space time singularity. By assuming that these singularities will lie hidden inside an event horizon ("Cosmic Censorship Hypothesis") he shows that the event horizon must be a null surface any connected component of which may not bifircate and whose area must not decrease with time. He goes on to establish that a stationary black hole must be static or axisymmetric and have spherical topology. Then he applies these ideas to the flow of energy and angular momentum into black holes and to time symmetric black holes.

The flow of energy and angular momentum down a hole is taken up by Carter, who restricts most of his lectures to asymmetric, stationary black holes and gives an account of the thermodynamics of a system of matter and a black hole. Quite apart from its relevance to black holes this is an excellent account of general relativistic thermodynamics. After discussing some important properties of the Kerr solution he goes on to show that the most likely final state of an isolated black hole is that of a Kerr black hole.

Both Carter and Bardeen give a great deal of space to the Kerr metric which must now rank with the Friedman expanding universe metric as the most important exact solutions of Einstein's equations we have. Bardeen provides much detailed material on the geodesics in this geometry and then proceeds to a study of rapidly rotating bodies in general relativity culminating in a fascinating study of self gravitating disks which is of especial importance because they are the only ones so far showing how a rapidly rotating black hole may form.

After reading so much theory the reader is then encouraged to proceed further by considering the data assembled by Gursky on the X-ray observations. In this chapter Gursky indicates some of the observational techniques and their pitfalls and argues that only accretion into compact objects can explain the data. He discusses particular sources in detail—notably Cygnus X1 which may contain a black hole and Hercules X1 which probably contains a neutron star.

From Gursky's lectures it emerges that the most interesting X-ray sources from the point of view of black holes are those in which a bright young star is orbiting an unseen companion in a close binary system. The energy of the X rays is held to arise from the accretion of matter coming from the bright primary star which is spilling over its Roche lobe. Because this matter possesses angular momentum it cannot fall directly in but forms a disc around the companion and angular momentum and energy are transferred outwards by some viscous mechanism. In their lectures Novikov and Thorne treat this transfer of angular momentum with characteristic clarity avoiding the errors of some earlier workers. Because the precise mechanism of viscosity is as yet not understood—turbulence and magnetic fields playing a major role—they provide a rather general analysis of accreting discs leaving plenty of room for viscosity parameters to be plugged in later. They also build some detailed models however, and give a useful summary of the astrophysical principles behind the calculation of the various emission processes.

In the final set of lectures Ruffini discusses a variety of important topics amongst which stand out an attempt to determine the maximum possible mass of a neutron star on rather general physical grounds and an account of why such a maximum exists at all. This is obviously of especial importance when discussing actual binary systems. He also gives a number of calculations of the gravitational waves emitted by particles falling down a hole, though some of the calculations on charged black holes should be treated with care because the coupling between electromagnetic and gravitational perturbations seems to have been ignored. This section contains much of interest but the format (short introductions followed by photo-reproductions of reprints and preprints) does not make for easy reading or compact presentations.

To finish: this is an important book which everyone seriously interested in black holes should read; I hope for the sake of their pockets that a paperback edition will be produced soon.

G. W. Gibbons

Methods for metals

Physical Metallurgy: Techniques and Applications. By K. W. Andrews. Vol. 1 pp. 349; vol. 2 pp. 347. (Allen and Unwin: Hemel Hempstead, August 1973.) Vol. 1 £7.95; vol. 2 £8.20.

Books of this type are usually compilations by various specialists whose contributions are under the control, to a greater or lesser degree, of an editor. The present book has the great advantage of having been written by one author of wide experience who has brought to the task an impressive expertise and has imposed on the book a most desirable uniformity of treatment. It could be argued that several of the topics, such as electron microscopy and crystallography, have been adequately dealt with