Book Reviews

Galactic Supernova Remnants

The Crab Nebula and Related Supernova Remnants. MINAS C. KAFATOS and RICHARD B. C. HENRY, Eds. Cambridge University Press, New York, 1985. xvi, 285 pp., illus. $39.50. From a workshop, Fairfax, VA, Oct. 1984.

It was certainly time (when the workshop that led to this volume was held) for another major conference on the Crab Nebula, that most famous and still easily the most important of all galactic supernova remnants. Since the previous symposium on the subject in 1970 the object had aged by a substantial 1.5 percent; this long baseline alone facilitated a direct measurement of the rate of decline of the radio luminosity—an important evolutionary parameter (which turns out to be within theoretical predictions, though just barely). Of considerably greater importance, of course, are the wealth of observational data that has been accumulated and the attendant theoretical advances that have occurred on the subject during the last decade and a half. These include some spectacular new images of the Crab jet (discovered in 1970) in a variety of wavelength bands, observational studies of the composition of the nebula, theoretical studies of the progenitor star, the emergence of a broad class of supernova remnants that (largely on the basis of radio and x-ray morphology) appear "Crab-like," and finally the discovery (only several months before the conference) of the remarkable remnant 0540-69 in the Large Magellanic Cloud, which bears such a close relationship to the prototype that one of the conferees can refer to it, with some justification, as being "more Crab-like than the Crab."

Overall this collection of papers is quite successful and (owing in part to its favorable timing) will be greatly appreciated as a reference by workers in the field and other interested astrophysicists. The most valuable contributions are the reviews, two good examples being "The composition of the Crab" by K. Davidson and "Evolution of the Crab Nebula" by R. Chevalier. (The latter review is related to a significant nonresult of the conference: the purported "shell" around the nebula—which would have fit well with our expectations for a type II supernova explosion—has apparently disappeared.) A nice discussion by F. Coroniti and C. Kennel of their magnetohydrodynamic model should prove helpful to anyone trying to understand their rather daunting formal papers on the subject. A few observational papers that merely duplicate material available in journals are less important but still have some convenience value. There is a useful appendix (by K. Weiler) cataloging the related objects of the title.

A minor annoyance is that the volume has the full complement of typographical and related errors that one has come to expect in photo-offset conference proceedings. (In the most embarrassing of these, at the end of one paper someone has apparently transcribed instructions for typing the references—which were then not followed.) The choice of the Vela pulsar field—not labeled as such—for the cover design seems curious (even if it is somewhat Crab-like), particularly in view of the striking photographs of the Crab jet reproduced within the volume, and will likely confuse a lot of people.

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Astrophysics

Relativistic Astrophysics. MAREK DEMIAŃSKI. Pergamon, New York, and PWN–Polish Scientific Publishers, Warsaw, 1985. xii, 341 pp., illus. $45. International Series in Natural Philosophy, vol. 110. Translated from the Polish edition by Antoni Fol.

Major astronomical discoveries in the 1960's—the cosmic background radiation, the quasars, the pulsars, and the cosmic x-ray sources—heralded the application of general relativity theory to astrophysics, and there has been vigorous development of relativistic astrophysics ever since. General relativistic effects are significant only in certain problems in astrophysics, but these tend to be ones of great fundamental interest: the end states of stellar evolution and the structure of the universe. When a theoretical astrophysicist does need general relativity, he or she is likely to find it in this book.

The main theme is the application of gravitational physics, particularly general relativity theory, to astrophysics. There are short side trips into other areas of physics in order to develop necessary topics, such as properties of matter in neutron stars or in the early universe, but gravity is the main subject. The principal applications are to stellar equilibrium and collapse, neutron stars, black holes, gravitational waves, and cosmology.

The pedagogical style is that of the famous course on theoretical physics by L. D. Landau and E. M. Lifshitz. The author moves quickly and does not pause for long derivations or explanations; he depends on a certain sophistication on the part of the reader. There are a lot of equations (but, alas, no exercises). Many physicists and astrophysicists will like this style, but it can be hard on the student or the specialist from another field. There is a quick introduction to general relativity, but most readers will find it necessary to learn relativity elsewhere before tackling this book. As for the main applications, this or that subject is covered in greater detail in other books, monographs, and review articles, to which the author frequently refers. However, no one book has the same coverage as this one, and the book serves a useful purpose in bringing together a coherent set of topics.

The book is up to date as of its original publication date of 1978, but inevitably it is now out of date in significant respects. Theoretical cosmology—and the overlap between cosmology and theoretical elementary particle physics—have seen enormous developments over the last decade. However, most of the author's material is of permanent significance and needs only to be added to, not supplanted, in light of recent developments in the field.

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Mathematical Physics

Gravitational Physics of Stellar and Galactic Systems. WILLIAM C. SASLAW. Cambridge University Press, New York, 1985. xviii, 491 pp., illus. $90. Cambridge Monographs on Mathematical Physics.

In the last 20 years there has been a revival in the application of the Newtonian theory of gravitation to a variety of astronomical phenomena. This was motivated on the one hand by observations of globular clusters, of spiral density waves in galaxies, of the violent events that take place in galactic nuclei, and of the large-scale structure of the universe as it is delineated by the clustering of galaxies and on the other hand by the ability to simulate these systems efficiently on computers, by integration of the equations of motion for many thousands of particles.

Saslaw's book addresses the whole of Newtonian gravitational physics. It is the first treatise on the subject to appear in a long time. Although astronomical applications and computer simulations of N-body systems are discussed, the main emphasis is on the physics of gravitation and not on the modeling of particular astronomical objects. The book is written in a pleasant and informal style and contains many apt quotations. Most derivations are preceded by an introduction to the underlying physical ideas, and the derivations are usually transparent.

The author has organized the book on the principle of decreasing symmetry and—consequently—of increasing importance for application to astronomical problems. The book is divided into four parts: homogeneous systems, infinite inhomogeneous systems, finite spherical systems, and flattened systems. The first part treats fundamental gravitational processes such as collisional relaxation, dynamical friction, collective scattering, and Landau damping as well as formalisms such as the Boltzmann, Liouville, and Fokker-Planck equations and the BBGKY hierarchy and various techniques for their solution. The second part describes gravitational instabilities in an expanding universe, the use of correlation functions, an analysis of voids, and an attempt to explain the observed clustering of galaxies by means of thermodynamics. The third part discusses violent relaxation to equilibrium and the construction of quasi-equilibrium models as well as the evolution of finite spherical systems as a result of collisionless relaxation and binary formation. The discussion covers evaporation, mass and orbit segregation, and the role of a central singularity. The results are applied to globular clusters, galactic nuclei, and clusters of galaxies. The final part briefly describes some of the complications that arise when the assumption of spherical symmetry is relaxed. The discussion covers bar and spiral instabilities, the importance of integrals of motion, the occurrence of ergodic orbits, and gravitational shocks. Each part concludes with a short section of problems that are intended as a connection to the literature and to current research.

Unfortunately, the discussion of the different topics in the book is rather uneven and seems more correlated with the author's own research interests than with their astronomical importance. The first part contains some lengthy and detailed derivations, in particular for Landau damping and collective scattering, that are of minor interest. By contrast, the second half of the book sometimes deals in a rather cursory manner with important subjects of active research. Among these are equilibrium models and their stability, both for spherical and for flattened systems, the theory of orbits, adiabatic invariants, and mergers of galaxies.

This state of affairs is probably nearly unavoidable in a book with such a wide scope, but it makes it difficult to ascertain to which audience the book is addressed. It would not be an easy task to give a graduate-level course on the basis of it.

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Oceanography

Turbulence in the Ocean. A. S. MONIN and R. V. OZMIDOV. Reidel, Dordrecht, 1985 (U.S. distributor, Kluwer, Hingham, MA). xvi, 247 pp., illus. $44.50. Environmental Fluid Mechanics. Translated from the Russian edition. H. Tennekes, Transl. Ed.

This short monograph by two distinguished Soviet oceanographers is a welcome addition to the literature. It is written with authority and translated with grace; its perspective of this extremely active field is somewhat (and interestingly) different from that of most work done by oceanographers in the United States.

The book opens with a brief description of simple ideas concerning strange attractors, but, as the authors confess, these ideas still provide only a vague image of turbulence. The conventional equations of turbulent flow are developed, and the particular mechanisms of turbulence generation in the stratified ocean are listed. Similarity methods, developed for atmospheric turbulence by Monin and Obukhov, are extended to the more intermittent and transient turbulent events in the ocean and give both scaling relations and spectra. This long opening chapter, written by Monin, gives a lucid though fairly conventional overview of things every oceanographer ought to know, but this reviewer wonders whether it is sufficient. Turbulent patches in the thermocline are intermittent; we conjecture that they arise from a local instability of some kind, and that the turbulence develops, modifies the basic state locally, transfers energy to smaller scales, loses its energy supply, collapses, and decays. Samples taken by falling probes will include representatives of all these stages of evolution, but conventionally they are lumped together, analyzed by means of Fourier analysis, and averaged. One has the feeling that much is to be learned, not only by the use of overall similarity statistics but by trying to unravel in some way the natural history of these events.

The second chapter, by Ozmidov, presents a clear and comprehensive account of sensors, instruments, measurement, and analysis techniques. It is, overall, the best of its kind that this reviewer has seen—it should be the observational physical oceanographer's bible. How one makes inferences from small samples, what reliability one can attribute to estimates, whether variations are physically significant or an artifact of sampling—these are discussed in detail with typical results from various parts of the world's oceans. The final chapter, on large-scale horizontal turbulence (with length scales of the order of the Rossby radius, about 100 kilometers), places small-scale observations in their larger context, the link between the small eddies themselves and the planetary scales of ocean circulation.

This is a very interesting book. One is drawn to compare the style of the science it describes with that of the science done in the United States. Characterized by a firmer reliance on theory and similarity techniques in the analysis of data, the former is perhaps limited in the questions it is asking, with the result that possibly new phenomena are interpreted in old terms. American oceanographers are sometimes quite naive about these theoretical approaches, when they are useful, and where their limitations lie but have displayed much greater ingenuity in the development of new sensors, new vehicles, and new kinds of measurement. Individual communications among U.S. and Soviet oceanographers have usually been easy, but each group still has something to learn from the other.

The translation and Tennekes's editing are excellent, the language is colloquial and accurate, and the book itself is cleanly produced. Physical oceanographers, whether studying or doing research on this subject, will find it a pleasure to use.

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Some Other Books of Interest

Species and Speciation. E. S. VRBA, Ed. Transvaal Museum, Pretoria, South Africa, 1985. xviii, 176 pp., illus. $30. Transvaal Museum Monograph no. 4. From a symposium, Pretoria, Sept. 1982.

The contributors to this volume are characterized by the editor as "a diverse assortment of systematists. . ., ecologists, population geneticists, developmental biologists, palaeontologists and anthropologists." All but one of the 24 are or have been affiliated with institutions in South Africa. The volume opens with a general discussion by Vrba of species and speciation. A section headed Species Concepts contains further general discussions by N. Eldredge, H. E. H. Paterson, M. J. Scoble, and D. J. Brothers. Under the heading Development and Speciation B. Fabian discusses evolutionary change from the point of view of an embryologist and E. Holm attempts to apply a "structurally integrated" approach to the evolution of generalist and specialist species. The remaining sections of the volume—Climate, Population Structure and Speciation; Faunal Case Histories; Speciation in