Book Reviews

Double Stars

Structure and Evolution of Close Binary Systems. Proceedings of a symposium, Cambridge, England, July 1975. PETER EGGLETON, SIMON MITTON, and JOHN WHELAN, Eds. Published for the International Astronomical Union by Reidel, Boston, 1976. International Astronomical Union Symposium No. 73.

It is difficult to remember now what a central role the study of close double stars played in the astronomy of 40 years ago. Inspired by the seminal ideas of Otto Struve, astronomers armed only with limited photographic equipment and mostly modest telescopes recorded the curious properties of pairs of stars so close together that heat transport and mass exchange are important and puzzled over the components' violation of the mass-luminosity relation. As radio astronomy, larger optical telescopes, and more sophisticated electronic detectors appeared on the scene in the 1950's and, '60's, most astronomers turned from the study of close double stars to the contemplation of remote regions of space and time, though there remained a few traditionalists who continued to cultivate the arcane pleasures of double star astronomy.

Happily, research in this field has been revitalized by the discovery that most galactic x-ray sources are associated with close binary stars. High energy photons are emitted as matter flows from the less evolved component in these systems and accreted material falls into the deep potential well of the more evolved companion. Given the indications that the latter may be a neutron star or a black hole and that in some cases the flow of ionized gas takes place in the presence of a magnetic field, one can readily understand why the subject attracts workers in hydrodynamics, gravitational theory, and solid state physics as well as in x-ray, optical, and radio astronomy. The fundamental issues, however, have to do with stellar evolution and remain much the same as those of Struve's time: What is the origin of close binaries? How do "old" stars of low mass come to be paired with "young" ones of high mass? What is the ultimate fate of such systems? Why do some classes develop into cataclysmic binaries (CB's) such as novas and U Geminorum stars and others develop into x-ray sources?

This symposium volume succeeds admirably in stressing the unity of the subject by putting it in the context of the theory of stellar evolution. The book has four parts. The first deals with massive close binaries and binary x-ray sources. Critical reviews of the observational data are presented by Hutchings, Gursky, and Wilson. Loore and DeGrève describe the evolution of massive systems with total mass and angular momentum conserved for the case in which the primary swells up to fill its Roche lobe during shell hydrogen burning. The most interesting paper in this group is by van den Heuvel, who presents plausible arguments not only that the ultimate state of evolution of a massive close binary is a strong function of its initial mass ratio, but that systems with initial mass ratios close to unity have a long-lived (10^6 to 10^7 years) "quiet" period in subsequent evolution that is not to be associated with Wolf-Rayet stars or x-ray sources. Van den Heuvel's calculations further undermine the assumption that, during evolution, binaries conserve total mass and angular momentum; indeed, several authors argue in the second part of the book that the nonconservation of these quantities is an essential point in the understanding of CB's.

The essential point arising from Warner's comprehensive review of the observations of CB's is that the collapsed components, presumably white dwarfs, have masses near 1 solar mass although, according to evolutionary theory, such objects cannot descend from binaries having primaries in the range of 1 to 2 solar masses. If, as is stressed in the important paper by Ritter, collapsed components must descend from fairly massive stars, then the observed low orbital angular momentum and the total mass of the present CB's imply a significant loss in these quantities as evolution proceeds. Mechanisms are discussed in stimulating papers by Eggleton and Paczynski. The detached binary V471 Tauri has been discovered by Young and Nelson to contain a white dwarf and to be a member of a young galactic star cluster, Hyades, and its importance as a typical precursive metamorph of a CB is stressed.

In the second part of the book we are treated to an exchange of views over the cause of a nova outburst. Does the mass-losing star undergo a quasi-periodic instability (Bath), or are the outbursts triggered by nuclear burning of fresh hydrogen fuel accreted onto the surface of the white dwarf (Starrfield, Sparks, and Truran)? And what is the mechanism that drives the mass flow in CB's? Years ago we supposed that nuclear core exhaustion, with the consequent expansion of the radius of the primary through the Roche lobe, was ubiquitous in such systems, yet we now know that many of these stars have masses too small and periods too short for nuclear exhaustion to have played a significant role. In his paper, Faulkner stresses the novel idea that gravitational wave emission is a sink for angular momentum and energy and is thus a driving mechanism for mass loss, particularly in hydrogen-poor systems having ultrashort periods, as, for example, HZ 29.

In the third part of the book, Rees discusses the properties of the accretion disks surrounding the degenerate components and the emission mechanisms for radiation. The mass flow itself is discussed by Lin and Pringle, Shu, Flannery, and Kondo and McCluskey. It is good to see that, in the ecumenical spirit of the proceedings, Rees's brief discussion treats accretion onto white dwarfs (as in CB's) as well as magnetized neutron stars or black holes (as in x-ray sources). The discussions of mass flow led to a lively exchange between the participants over the adequacy of one another's calculation of the hydrodynamics of the process.

The final part of the book deals with the more conventional (traditional) contact binaries, the Algol-type, RS Canum Venaticorum-type and W Ursae Majoris (W UMa) systems. The work of Naftilan on U Sagittae (U Sge), reviewed by Plavec and Polidan, was of special interest to the reviewer. In U Sge, the more evolved, and presumably once more massive, component appears to be deficient in metal, relative to the sun, by a factor of about five. Does this mean that the original outer envelope, now stripped away by mass transfer, had a higher metal abundance than the interior material left behind, or did the star simply have a reduced metal abundance ini-

tially? At the moment, evidence can be marshaled to support various explanations. Although the results are inconclusive, they are nevertheless intriguing. Several papers in this section deal with the evolution of main sequence contact systems (W UMa stars), the most numerous sort of close binary system to be found in the galaxy. The vigorous, if inconclusive, discussion of the subject by the various contributors (Hazlehurst, Webbink, Flannery, Whelan, Vilhu and Rahunen, and van't Veer) is best summarized by the remark of the editors to the effect that the participants were unable to agree on an estimate of the lifetimes of W UMa systems to within a factor of 100!

The book belongs in the library of every serious student of stellar evolution.

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Immunity

The Generation of Antibody Diversity. A New Look. A. J. CUNNINGHAM, Ed. Academic Press, New York, 1976. x, 212 pp., illus. $19.75.

This compilation of a dozen essays on the subject of antibody diversity represents a genuine attempt to provide a fresh perspective on a subject of long-standing controversy. The dispute has to do mainly with whether the diverse information coding for multitudinous antibody structures exists completely in the genome of every individual ("germ line theory") or whether a small number of genes gives rise to the diversity by a series of mutational events during development ("somatic theory"). The editor himself clearly favors the latter theory and indeed extends it even further with his notion that diversification reaches its fullest extent as a result of antigen stimulation. Thus, there are three possible explanations for antibody diversity. First, there may be a large number of genes coding for the variable regions of light and heavy chains whose combinations can account for the large number of antibody structures known to exist. Estimates based on known amino acid sequences indicate that the number of such variable genes would have to exceed 10,000. In the second case, there may be a small number of genes ("pauci-gene" as opposed to "multi-gene") giving rise to a large number of antibody structures as a result of exaggerated mutational events occurring during the course of development. Finally, Cunningham's extension of the latter theory postulates that the increased diversity is prompted by antigen stimulation. In this case, combination with low-affinity antibodies on the parental lymphocyte surfaces would cause those cell lines to proliferate, which would in turn lead to a hypermutation-induced expansion of the antibody repertoire, with some of the antibodies having higher affinities. The theory has other attractive features, including plausible explanations of tolerance and self-nonself recognition in general.

Cunningham has chosen a set of authors who, in the main, provide circumstantial support for many of his own viewpoints. This is not to say that they all favor the notion of the necessity of antigen stimulation or even the idea that generation of diversity is primarily somatic. In fact, if my reading is accurate, two chapters definitely favor the germ line theory, five lean strongly to somatic schemes, and the remainder either sit on the fence or incorporate elements of both.

For example, D. G. Braun and his coworkers at Basel discuss the variability patterns of homogeneous antipolysaccharide antibodies ("clonotypes") and conclude that the different phenotypes observed in rabbits must be the expression of different genes in the germ line. At the other extreme, S. Tonegawa and C. Steinberg, in a chapter on RNA–DNA hybridization studies, present convincing evidence and arguments that there aren't nearly enough gene copies in the genome to account for antibody diversity.

There is a tantalizing chapter by David Baltimore and his colleagues on the unique occurrence of the enzyme terminal deoxynucleotidyl transferase in thymocytes, although the authors stop short of actually proposing that this enzyme is involved in the generation of antibody diversity. Other chapters providing apparent support for somatic models include a discussion of the somatic instability of mouse immunoglobulin genes by M. D. Scharff and his colleagues and a good chapter on lymphocyte population dynamics by G. Adam and E. Weiler. Peter Bretscher reviews some standard somatic arguments, especially as developed in his earlier collaborations with Melvin Cohn.

This a well-conceived book, one that anyone interested in the biology of the immune response can read with profit. On the other hand, the issue is clearly not settled, and the genuinely convincing experiments have yet to be executed. If anything, the distinction between "multi-gene" and "pauci-gene" seems to be growing fuzzier (how few is pauci?). And although Cunningham as editor and author has indeed tried to provide a new look at the problem, the large number of ad hoc arguments and models presented leads to an unavoidable and lingering sense of déjà vu.

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Biological Anthropology

The Measures of Man. Methodologies in Biological Anthropology. EUGENE GILES and JONATHAN S. FRIEDLAENDER, Eds. Peabody Museum Press, Harvard University, Cambridge, Mass., 1976. xl, 654 pp., illus. Cloth, $30; paper, $15.

Perhaps no one alive today has had such a profound effect upon biological anthropology as has William White Howells. It is with especial pleasure that one sees a tribute like this book, honoring Howells on his retirement from active teaching at Harvard, published while the principal continues to work away with no diminution, indeed with continuing growth, in his investigative powers. A bibliography included in this book reminds us of those many publications of Howells's that start with a 60-page report on the Mimbres Valley expeditions in the Peabody Museum Papers in 1932 and continue with six items, of which two are books, in the last two years. My reprint collection turns up yet five more contributions that have appeared since this volume was set in type.

The book also tells us of many other facets of Howells's contributions; the senior authors of the papers it contains were all students of Howells's, and many of the other authors have been heavily affected by his teaching. The range of institutions the authors now represent demonstrates that there has been no deleterious inbreeding here; and the spread of disciplines, methodologies, and citations in the various papers indicates enormous hybrid vigor. To those of us who have not been closely tied to the American scene, the nature of the interconnections of institutions and workers through Howells is most impressive.

The aim of the editors is, however, not only to provide a tribute to Howells but also to display the vitality of biological