BOOK REVIEWS

Excellent Astrophysicist

Relativistic Astrophysics. By Ya B. Zel'dovich and I. D. Novikov. Edited by Kip. S. Thorne and W. David Arnett. Translated by Eli Arlock. (Vol. 1.) Pp. xviii+522. (University of Chicago: Illinois, July 1971.) $24.00.

THIS eagerly awaited first English version of Zel'dovich and Novikov's Russian classic fully lives up to expectations. With the editing of the translation in the capable hands of Kip Thorne and David Arnett, this first volume, *Stars and Relativity,* deals with the fundamental concepts of general relativity, thermodynamics and non-equilibrium processes for matter at ultrahigh temperatures and densities, before applying these concepts to the development of the theory of stellar structure and evolution. The extensive revision and updating of this edition includes a comprehensive discussion of the pulsar phenomenon, but it is unfortunate that no similar treatment of X-ray sources is attempted. This is perhaps the only real flaw in the construction of the volume.

By dividing the book into two essentially independent parts, the authors have catered for a much wider audience than high energy astrophysicists. The first half of the volume is subdivided into two sections, on the theory of gravitation and the equation of state of matter in extreme conditions, which put many monographs on these subjects to shame. Equally, any physicist or mathematician already conversant with these concepts will find the second half of the book an excellent introduction to stellar structure, for, logically enough, the authors have briefly developed the theory of "normal" stars before dealing in detail with the specific aspects of the relativistic stages of stellar revolution.

It is seldom that a comprehensive volume of this kind, especially a translation, can be produced at a price which makes it accessible to individuals. This is the first time I have found such a book which is not only excellent value overall, but which is worth buying for either the first or second halves alone, if one is either already familiar with the other half or totally unconcerned with it. Perhaps other publishers will be encouraged by this when preparing other major works.

The content of the book cannot be faulted, as might be expected when four such prominent astrophysicists have collaborated so closely, the only obvious sins being those of omission, where my own judgment is very much biased. If the forthcoming second volume, *The Universe and Relativity,* provides a treatment of cosmology and the evolution of the universe which is as comprehensive as the present treatment of stars and stellar evolution, then the set will provide a formidable standard for any other author venturing into the field of high energy astrophysics to live up to. Undoubtedly this will become a fundamental reference text and source for teaching. J. RICHARD GRIBBIN

Polyelectrolytes

Polyelectrolytes. By Fumio Oosawa. Pp. vii+160. (Dekker: New York, January 1971.) £7.00.

PROFESSOR OOSAWA's purpose is to give a consistent picture of polyelectrolyte behaviour on the basis of fundamental laws of statistical thermodynamics. Most of the book is based on the original theoretical and experimental work of Kagawa, Oosawa, Imai and their colleagues at Nagoya.

The book has eleven chapters, the first being a brief introduction to the classification and structure of polyelectrolytes, together with a description of the electric potential domains of a macroion. The second chapter discusses the equilibrium distribution of counterions in polyelectrolyte solutions. The treatment is based on a two-phase model advanced by the author in 1957, and derives equations for two typical distributions (for spherical and rodlike macroions). Counterion condensation, a characteristic of cylindrical macroions, is also described. It is unfortunate that the distribution equilibrium equations in chapters two and four are made ambiguous by the omission of inclusive brackets in logarithmic fractional terms. Chapter three deals with the electric potential and electric free energy of macroions on the basis of the Poisson–Boltzmann equation. Two specific cases are treated fully. The first, for a random coil macroion occupying a spherical volume, does not use the Debye–Hückel linearization of the P–B equation, but an approximation derived from the two-phase equilibrium model of Oosawa, Imai, and Kagawa. The second, for a rod-like macroion, is based on Fuoss, Katchalsky, and Lifson's rigorous solution of the P–B equation in cylindrical coordinates, linearized by the D–H approximation. Lifson and Katchalsky's derivation of the electric energy and the electric free energy per macromolecule is also used. The equations for the electric energy contain a sign error. The chapter ends with a short analysis of the P–B equation for a rigid spherical macroion in a spherical free volume. The fourth chapter deals with the effect of the valence and size of counterions on the counterion condensation phenomenon. This is achieved by the further use of the two-phase model introduced in the second chapter. The fifth chapter, on the polarizability of polyelectrolytes, is based on Oosawa's (1970) theory of counterion fluctuation and dielectric dispersion. The sixth chapter, on the state of binding of counterions, examines ion pair and localized binding, hydrogen ion equilibrium, and the effect of counterion binding on macroion hydration. In the seventh chapter the additivity law for the osmotic properties of polyelectrolyte-salt solutions is derived from the P–B equation for a rod-like macroion. A simple derivation of the osmotic coefficient in terms of charge density is also given. The eighth chapter deals with the application of the additivity law to express the chemical potential of macroions as a function of salt concentration, and to describe hydrogen ion equilibrium in the presence of salts, considering the electric potential of the macroion. The ninth chapter considers the interaction between parallel rod-like macroions using the same method as that used in deriving the additivity law, without solution of the P–B equation. In the tenth chapter the two-phase approximation is applied to the extensive force of spherical and cylindrical macroions, in the absence and presence of salts. The contractile force and flexibility of linear macroions are evaluated by the methods of statistical thermodynamics. The eleventh chapter deals with the application of the additivity law to the relation between the thermodynamic and conformational properties of macroions in solution.

Professor Oosawa has succeeded in building a consistent framework of polyelectrolyte theory within the limits imposed by the two-phase approximation and the additivity law. Taken as a whole, the book is badly marred by numerous typographical errors in equations and references, and by an inadequate index. J. RUSSELL

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