Heavy nuclei

Heavy Nuclei, Superheavy Nuclei, and Neutron Stars. (Oxford Studies in Nuclear Physics.) By J. M. Irvine. Pp. 158. (Clarendon: Oxford; Oxford University: London, July 1975.) £8.

THE prospective reader who is attracted to this book by the words "superheavy nuclei" or "neutron stars" is likely to be disappointed. Of its 158 pages of text only one chapter of 8 pages is concerned directly with superheavy nuclei, and a further 9-page chapter is devoted to neutron stars. What it does contain is an excellent review of the current theories of the properties and structure of heavy nuclei.

The book concentrates on the region of heavy nuclei beyond ^{208}Pb and as is pointed out in the introductory chapter this contains only ten naturally occuring elements, although a further 14 have been artificially produced in the laboratory. It is perhaps disappointing that the book contains no hint of the excitement and controversy which have surrounded the discovery of these heaviest elements.

The second chapter contains a brief but thorough review of the observed systematics of heavy nuclei such as binding energies, half lives, decay modes and fission properties. The third chapter then goes on to give a very detailed discussion of the nuclear models, such as the liquid-drop and individual particle models, which have been used to explain these systematic features. Nuclear correlations are introduced here and used to bridge the gap between these two very simple models. The following chapter deals with the particular topic of collective rotations and the specific modifications which need to be considered to bring theoretical predictions into quantitative agreement with experiment.

Nuclear stability and shell effects are next considered and this leads very naturally, through a discussion of fission and alpha decay, to the prediction of the possible existence of superheavy nuclei and the final chapter on neutron stars. A short list of references to relevant review papers and books is included.

The book is written at an introductory level suitable for research students in nuclear structure physics. It is also likely to be of interest to more experienced workers in this field as providing an extensive and thorough review of current theories of the properties of heavy nuclei with a hint and hope of discoveries yet to come.

C. J. Batty

Come back Aristotle

Confrontation of Cosmological Theories with Observational Data. Edited by M. S. Longair. (International Astronomical Union Symposium No. 63, Cracow, Poland, 1973.) Pp. xi+382. (Reidel: Dordrecht and Boston, Massachusetts, 1974.) Dfl.115; $38.50.

THIS symposium, held in 1973 to commemorate the 500th anniversary of the birth of Copernicus, provides an excellent picture of cosmology today—of a science caught, as Zeldovich says in his introduction, at a turning point. The programme of Sandage and Tammann to extend the redshift–distance relation for galaxies, the close agreement between the expansion time of the Universe and the age of our Galaxy and other galaxies, and the 2.7 K blackbody spectrum and high degree of isotropy of the microwave background radiation (reviewed here by Blair, Partridge and Boynton) have together convinced all but the most sceptical cosmologists that we live in a hot, big bang Universe.

In paper after paper the most simple, conservative view seems to be supported. Petrosian argues that the cosmological term, introduced and later repudiated by Einstein, is zero. Tammann demonstrates that the velocity flow field of nearby galaxies is isotropic and linear. Wagoner shows how the cosmic abundances of those elements and isotopes formed primarily in the fireball (deuterium, helium, lithium) favour the simplest type of model, deuterium, in particular, pointing to the existence of the low-density Universe also indicated by the density of matter in galaxies. Steigmann sets severe limits on the amount of antimatter in the Universe.

In his amusing introduction Zeldovich sets out what seems to be a very open minded philosophy of cosmology. That we cannot simply solve backwards in time the equations describing the evolution of the Universe, but have to take arbitrary chosen variants of the initial state and follow the theory of its evolution to the present and thus to a confrontation with observations. The snag of this procedure being that it is dependent on the prejudices, likes and dislikes of authors and "perhaps even their subconscious Freudian attitude to such things as order, chaos, antimatter". Hence the importance of the confrontation with observation, in which "false theory fades".

But is it really cosmological theories that are being confronted with observations? Apart from a few dissenting, sceptical and dissatisfied voices (for example, those of Arp, Kellermann, Omnes and Elvius), only one theory is discussed in this book. Kuhn's gestalt switch has occurred and the isotropic big bang has become the paradigm. Within that framework the theoreticians set to work on the details: the problem of galaxy formation (Silk, Doroshkevich, Sunyaev, Zeldovich and Ozernoy), the structure of the initial singularity (Penrose, Novikov, Lifschitz and Khalatnikov), and the exciting work on pair creation by anisotropic expansion (Zeldovich and Misner). This is a situation in which the mathematically brilliant but philosophically conservative Russian school of cosmology flourishes. But is it likely that we shall again have to wait the 2,000 years between Aristotle and Copernicus to see this picture overthrown?

Yet even in the ranks of the believers there are some novel perspectives. Hawking analyses homogeneous, anisotropic perturbations of the standard models and concludes that we must be in a unique model (with zero curvature), arguing that the reason for this must be, in a sense, because we are here. If the Universe was not as it is, galaxies and stars could not have formed and we would not be here to observe it—the 'anthropic principle' developed elegantly in a paper by Brandon Carter.

Come back Aristotle, all is forgiven.

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