Book Reviews

Annual Review of Nuclear Science, Vol. 27. Annual Reviews, Inc., Palo Alto, California (1977). $20.00. 568 pp.

R. Vandenbosch's article, "Spontaneously Fissioning Isomers" (35 pp.), presents a review of the development of understanding of spontaneous fission isomers since their first recognition in 1962 until mid-1977. The emphasis throughout is placed on the experimental aspects (energies, spins, moments, and decay properties). The results of theoretical developments are presented only where they impinge directly on the data. The presentation convincingly establishes the progress of workers in this field beyond the stage of investigation of systematics to the current stage of detailed spectroscopy, involving difficult technique, which has much potential for developing deeper understanding of the phenomenon. This review is of particular value to nonspecialists.

"Element Production in the Early Universe" by David N. Schramm and Robert V. Wagoner explores the foundations of, and the evidence favoring, the big-bang model for nucleosynthesis. Generally speaking, it is a concise yet broadly based review of current thinking, with only brief lapses into explicit detail. The authors explain the basic assumptions of the model, having first shown that crucial experimental observations lead inevitably to the conclusion that the universe must have expanded from a state of extreme temperature and density. Starting from the "simplest" assumptions, they show that there is remarkable agreement between observation and theory for the abundance of ^{4}He; furthermore, the predicted abundance is quite insensitive to the present baryon density, the only free parameter in the standard big-bang model. On the other hand, they show that the abundance does strongly depend on the assumptions of the model itself and, by examining alternative assumptions, offer persuasive evidence that none provides as nice an explanation of our universal origins.

J. Ballam and R. D. Watt report in "Hybrid Bubble Chamber Systems" that new systems for operation with high-performance bubble chambers are still being planned and developed, with many objectives of improving the speed of gathering information and the certainty of identification of the outgoing particle tracks. A very thorough discussion is presented by Ballam and Watt of systems both established and in prospect in continental Europe, the United Kingdom, as well as in the U.S. The 40 references to the literature contain some 220 different names.

The engineering quality has reached a high standard. The well-established 1-m bubble chamber at the Stanford Linear Accelerator has survived 280 million pulses on its present bellows. Such performance demands very careful design and construction. Although it is suggested that the thermodynamic properties of liquid hydrogen would allow cycle rates up to 90 cycle/s, it is practicable to think of a 2-m chamber operating up to 30/s by good design and higher rates in smaller chambers of special design.

The discovery of sharp resonances of major interest has emphasized the need for high performance in detector and trigger devices associated with bubble chambers to form the so-called hybrid systems.

In "Chemistry of the Transactinide Elements" by O. L. Keller and G. T. Seaborg, the actinide elements are named and considered established up to lawrencium atomic number 103. Beyond that, the transactinides follow. Two elements, 104 rutherfordium and 105 hahnium, are known and named, and it appears that element 106 is also known but not yet named. Beyond that, the electronic configurations of neutral atoms in ground states are quoted from a 1975 reference for 62 more elements, that is, up to atomic number 168. These configurations do not uniquely establish the chemical properties for reasons that are discussed in particular for element 115, eka-Bi, where very large relativistic effects (detectable though small in bismuth) are expected to be profound. Interpolations as used by Mendeleev in 1871 and extrapolations within a group related to the periodic table remain the method of choice for predicting the chemistry supported by the modern atomic calculations. Tables of predicted properties from rutherfordium to element 120 are given with some discussion and also the methods being used in the search for such super-heavy elements. With the increasing availability of beams of very heavy ions and with chemical techniques capable of accumulating results from one atom at a time by gas chromatography, gas flow reactions, and reactions with surfaces and migration of ions and atoms, the search continues to be a challenging and exciting field of investigation. Some 58 references, mostly since 1970, will be useful for those looking deeper.

In their article "The Weak Neutral Current and Stellar Collapse," Daniel Z. Freedman, David N. Schramm, and David L. Tubbs illustrate how current discoveries in the physics of weak interactions may have profound effects on the astrophysicist's understanding of stellar evolution. Particularly during the supernova-gravitational collapse phase of a star's life, neutrinos play an important role in carrying away binding energy, since their mean-free-path is so long compared with stellar dimensions. However, until recently this could not explain why the relatively heavy elements (carbon to iron) from the outer regions of the star are ejected. The authors explain that through a coherence effect, the weak neutral current can lead to a cross section for neutrino scattering from nuclei that is proportional to A^2. This may well be the energy transfer mechanism that leads to ejection in a supernova explosion.

The article is an attempt to marry aspects of two disciplines, particle physics and astrophysics, and is admittedly intended for the adherents of one or the other.

Although it is unlikely to entirely suit those readers with a different specialization, the style is congenial and, on occasion, pleasantly irreverent. Even the general reader could expect to gain from the introductory and concluding sections.

"Neutrino Scattering and New-Particle Production" by D. Cline and W. F. Fry is a review of recent high-energy neutrino interaction experiments. Topics include charged-current interaction cross-section systematics and a summary of deduced neutral-current characteristics. Evidence suggesting onset of a $V + A$ interaction form at high neutrino energies is presented. A large portion of the article is devoted to a description of the characteristics of dimuon and trimuon events and their interpretation in terms of new hadron and lepton production. A reader not familiar with the subject would need to use the references to fully comprehend the significance of many of the results or critically evaluate the interpretation provided. The clarity of presentation is clouded by the inadequacy of documentation of terminology and obscurity of figure content.

"K-Shell Ionization in Heavy Ion Collisions" by W. E. Meyerhof and Knud Taulbjerg describes both theoretical and experimental work on the enhanced x-ray production from heavy ion collisions with emphasis on the case when the target and projectile energy levels are matched. This is interpreted in terms of the transient formation of diatomic molecular orbitals during the collision.

The review is divided into two parts. The first deals with vacancy formation in the atomic K-shells of the collision partners, leading to emission of characteristic line radiation. The second deals with continuum radiation due to electronic transitions during the collision. In each case, a basic theory is developed, followed by experimental results and interpretation using the theory.

Comparisons are described both for integral and differential cross-section measurements, with the latter being a more stringent test of both the theory and experiment. The experimental techniques illustrated are the inelastic energy loss method and the coincidence technique, where the emitted K x rays are detected in coincidence with the scattered particle. For low energies of collision, an impact parameter semiclassical description of the scattering works well. A perturbation theory description is used for higher energies of collision, with both Born approximations and distorted-wave Born approximation results discussed.

If the atomic numbers of the collision partners are comparable and if $v_1 \ll v_e$, where v_1 is the projectile velocity and v_e is the Bohr velocity of the ejected electron, the molecular description is relevant and works well in explaining the experimental results. In this case, the radiative decay process involves the transition of an electron to or from an inner shell, usually requiring the existence of an inner shell vacancy in one of the collision partners. The theoretical models of Macek, Briggs, Fano, and others are compared with experiment. The comparison is given between theory and experiment for such processes as 30-MeV bromine on bromine, nickel on nickel at various energies, and 326-MeV xenon on tin. Comparison is made with photon energy distributions, with some discussion of angular distributions.

A small section on positron creation in super heavy molecules is given at the end. The literature is well reviewed, with ~300 references up to 1977.

Next we have Joseph Cerny and J. C. Hardy's "Delayed Proton Radioactivities." The subject of delayed proton radioactivities was reviewed by Goldanskii in 1966 only three or four years after the first papers appeared. Since then, the number of known precursors has grown from 10 to 42, and the phenomenon has ceased to be a curiosity and has become a "rich and diverse source of nuclear information." The discussion is divided into two sections, separating the light precursors for which $Z > N$ from the heavier ones with $Z < N$. Among the light nuclei, the intensity of each peak in the proton energy spectrum can be directly related to the intensity of the preceding β^+ transition. On the other hand, for $Z < N$ precursors, the use of the statistical model approach is necessitated by the spectral complexity. The recent Chalk River Nuclear Laboratory results for ^{69}Se are used to demonstrate the success of this approach. The initial β^+ emitters have been produced by many reactions from both high-energy protons, ^{3}He nuclei, and several heavy particles such as ^{16}O, ^{32}S, and ^{40}Ca. All these reactions involve neutron emission.

In contrast to the wealth of spectral evidence for the β^+ delayed emissions, the direct emission of protons also predicted in Goldanskii's review has made little advance. Only one case of single proton radioactivity has been positively identified in the decay of 247-ms ^{53m}Co. No case of two proton radioactivity has been observed.

Defining a heavy ion as one with an atomic mass larger than four to exclude hydrogen and helium, H. A. Grunder and F. B. Selph in "Heavy Ion Accelerators" lead up to some 66 installations—existing, under construction, or proposed—in 20 countries in their summary. They comment that the many plans for extension and for new facilities indicate the keen interest in these machines as tools for nuclear physics. There is a trend to higher energies and a number use two or more accelerators in series. One, the French GANIL project, is planned for three cyclotrons in series. The list includes five superconducting cyclotrons or postaccelerator devices. "Many projects are for isochronous cyclotrons; the next largest number involve electrostatic accelerators." Mention is made of devices for other purposes, many as dedicated machines for the treatment of cancer. Another goal is to trigger fusion power generation by intense short pulses from collective accelerators or otherwise.

Interesting sketches are shown illustrating typical facilities, including the Wideroe and Alvarez linear accelerators and the performance expected from major devices, such as 25 and 30 MV on the terminal of reflecting tandem accelerators at Oak Ridge and Daresbury. Problems of emittance control, charge exchange, and the complexity of dealing with ions of different characteristics are discussed, and two pages are devoted to ion sources of four types—PIG, duoplasmatron, electron cyclotron resonance, and electron beam. Mention is made of ion sources for propulsion. Eighty-three references are given, many to reviews at conferences.

The review article by Chinowsky, "Psionic Matter," provides an excellent summary of the experimental results about J/ψ particles that have accumulated over the past three years. The discovery of J/ψ particles was one of the major breakthroughs in high-energy physics. At present, there are four ψ particles, with their intrinsic properties and decay rates quite well established. Qualitatively, these particles can be viewed as a bound state of a charmed quark and antiquark, i.e., charmonium. Quantitatively, such a description fails to provide an adequate explanation of the properties of ψ particles; this fact is brought out quite well in this article. There is evidence for particles with nonzero charm. Experimental results on these particles should help us to understand the strong interaction among quarks and the underlying symmetries. The review article provides an excellent summary of the rapid developments in our understanding of the problems of psionic matter.

W. U. Schröder and J. R. Huizenga's long review, "Damped Heavy-Ion Collisions" (82 pp.), synthesizes the recent experimental and theoretical investigation of those aspects of the heavy-ion reaction mechanism classified as "deep inelastic transfer, quasi-fission, strongly damped collisions and relaxed processes." The conceptual language of the discipline is developed early, and the measured heavy-ion reaction systematics (angular distributions, fragment mass and charge distributions, kinetic energy damping) are used to illustrate the characteristics of damped heavy-ion collisions. Although much has been accomplished in the five years since these processes began to attract attention, detailed work at higher incident energies will be required to clarify the physics of the microscopic processes of the reaction mechanism.

This thorough review will be of much value to scientists participating in this developing field.

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About the Reviewers: We welcome again Bennett Lewis and his team for this deep review of a multisubject writing. Dr. Lewis, now retired from the senior vice presidency of Atomic Energy of Canada Limited, was trained in physics at Cambridge and appropriately occupied a number of positions, including senior scientific officer of the U.K. Air Ministry during the World War II years, before coming to nuclear in Canada in 1946. He retains his University association, with continuing interests in the several nuclear fuel cycles and in radiation effects. Dr. Lewis was President of the American Nuclear Society in 1961-1962.

William R. Conkie is professor of physics at Queen's University and, for five years, was at the Chalk River Nuclear Laboratories. Dr. Conkie, a native of Scotland, was trained in Canada, taking his PhD at Saskatoon.

W. McLatchie, also of the physics staff at Queen's, was at Oxford following his scientific studies at McMaster University, lastly with a National Research Council, Canada, studentship.

B. C. Robertson completed his graduate studies at Oxford before joining Queen's. Dr. Robertson has made major contributions to the study of nuclear reactions.

J. C. Hardy, who did not participate in the entire review, has been in the Nuclear Research Branch at Chalk River since 1970, following assignments to Oxford and to the Lawrence Radiation Laboratory in Berkeley. Dr. Hardy received his academic training at McGill.

F. C. Khanna's early training was in India and was completed at Florida State University. Dr. Khanna was a National Research Council, Canada, fellow at Chalk River and has been a member of the staff there since 1967. His current interests are in few-nucleon problems.

Flow Induced Vibration. By R. D. Blevins. Van Nostrand Reinhold Company, New York (1977). 363 pp. $16.95.

The undertaking of this book constituted a daring and ambitious project. This is particularly so, since it appears to be the first such publication in this relatively new and rapidly emerging field of technology. A wide family of problems is treated, with most of the attention being devoted to those of the nuclear industry. These latter problems involve the cross-flow-induced vibration of tubular bundles used in heat exchangers and steam generators. Parallel-flow-induced vibration of these same bundles, as well as reactor fuel bundles, is treated to a lesser extent.

It now appears to be fairly well accepted that the main mechanisms of vibration excitation in cross flow are fluid elastic instability, vortex shedding, and excitation through fluid turbulence. Rather extensive and fundamental discussions of vortex shedding and fluid elastic instability are provided in Chaps. 3 and 5, respectively. One or two illustrative examples are worked out in each chapter.

The subject of vibration induced by turbulence, for both parallel and cross flow, is discussed in Chap. 7, again with illustrative examples. The rather difficult theory of random vibrations, which is required for an understanding of turbulent flow-induced vibration, is introduced in some detail. A fairly extensive treatment of the important subject of damping is to be found in Chap. 8, while the subject of sound induced by vortex shedding is discussed in Chap. 9. In this reviewer's opinion, it is these aforementioned chapters that will be of most interest to people in the nuclear industry. Other chapters deal with surface-wave-induced motion of ships, wind-induced vibration of electrical transmission cables and buildings, and internal-flow-induced vibration of pipes. The subject of pipe whip resulting from postulated ruptures is considered in connection with this latter topic.

It seems to this reviewer that the main function that this book is capable of fulfilling is that of providing the newcomer to the field of flow-induced vibration with a valuable and orderly introduction to the subject. For those already engaged in this field, it may provide an opportunity to study another outlook. Each chapter is followed by a fairly extensive list of references.

It would be incorrect to suppose that this book constitutes a design manual. Such is not the case. The subject of damping, for example, is still not fully understood. The book does not contain sufficient information on driving force spectra for design purposes. This is not surprising, since such information, for wide ranges of designs, does not so far exist. There is no discussion of two-phase cross flow or parallel flow, even though these subjects are of great importance in connection with steam generator designs. In fact, very little information has been published in this area.

In summary, the book is recommended as a highly