**Limitation of Exposure to Ionizing Radiation.** National Council on Radiation Protection and Measurements (NCRP) Report No. 116, Bethesda, Maryland 20814, USA. 1993. Price: USA $ 25, 88 pp.

Activities that generate ionizing radiations are frequently undertaken in medicine, research and industry. Individuals and society in general benefit considerably from such endeavours. The goal of radiation protection is to prevent the occurrence of radiation-induced conditions to a degree that is acceptable in relation to these benefits.

The book under review is an update on concepts of dose limits of radiation exposure that were earlier recommended in NCRP Report No. 91, (1987). The present report contains a few deviations from the earlier one. Risk estimates for radiation protection are mostly based on data obtained from the study of Japanese survivors of the atomic bombs dropped on Hiroshima and Nagasaki at the end of the Second World War.

The need for protection may be due to occupational hazards or dangers to the common man (such as medical exposures, naturally occurring radiations, war etc). The book deals at length on occupational hazards. In all cases, it is emphasized that dose limits are upper limits of acceptability rather than design goals.

The objectives and philosophy of radiation protection are introduced in the early chapters. The main aims are two-fold: firstly, to prevent clinically significant deterministic effects by adhering to dose limits. These effects are due to acute damage to the body from large doses of radiation and include severe skin damage, impaired vision, fibrosis, organ atrophy and sterility. The severity of these injuries is influenced by individual susceptibility. The second objective is to limit the risk of cancer and genetic effects to a reasonable level. It is reiterated that there should be proper justification for any radiation exposure, all exposures should be ALARA (as low as reasonably achievable) and proper dose limits should be applied. The occupational dose limits have been selected such that the risk to an individual of a fatal cancer from radiation exposure should be no greater than that of fatal accidents in 'safe' industries. As the latter generally reduces due to safer practices (at least in USA), the radiation dose limits are being progressively reduced. However, a major uncertainty remains in extrapolating risks from exposures at high doses to those at low doses. Later chapters in the book are devoted to a detailed mathematical treatment of different kinds of dose limits.

The book makes several important contributions, especially with reference to exposures to the embryo. A new finding is that there are specific periods during gestation that are critical. The period of maximum possible harm is 8–15 weeks after gestation, and somewhat less susceptible to damage is the period of 16–25 weeks after gestation. The major consequences of radiation exposure are mental retardation and damage to the central nervous system. The dose limit to the unborn child is 0.5 mSv (monthly), compared to an annual effective dose limit of 50 mSv to a worker.

A significant point that should be taken note of is that acute exposures considerably in excess of the annual effective dose limit can be justified only for life-saving actions in emergencies. Volunteers with a low accumulated dose should be chosen in such situations. Another point is that medical exposures on individuals by definition should result in a medical benefit to them. As a corollary to this statement, I would like to add that unnecessary medical exposures (such as X-rays) should be avoided by individuals. It would have been useful if the report had included a table with data on the normal dose received during various medical procedures such as X-irradiation of different parts of the body.

It is important for radiation protection agencies in India to adopt the recent recommendations contained in this report. For example, managerial staff and safety officers should be made aware of the dangers of pregnant women being exposed to radiation as an occupational hazard. Another important point made in the report is that intentional exposure of trainees below 18 years of age should be avoided. The annual dose limit in this age group is one-tenth that of regular workers. We should keep this in mind especially in our research institutions when we take in young students for training courses. Furthermore, it is essential that all research laboratories in the country should maintain appropriate standards of radiation protection for their staff, and strictly adhere to the policy of using radiometric badges so that the radiation dose received by individual workers can be monitored correctly and dose limits not exceeded.

This is an important reference book for all research institutions and industries that use ionizing radiations, and for radiation protection agencies in the country.

VEENA K. PARNAIK
*Centre for Cellular and Molecular Biology*
*Hyderabad 500 007, India*

**Annual Review of Physical Chemistry 1993.** Vol. 44. Herbert L. Strauss ed. Annual Reviews Inc., 4139 El Comino way, P. O. Box 10139, Palo Alto, California 94303–0897, USA. Price: USA $ 48, elsewhere $ 53. 530 pp.

With the advent of many new techniques for measurement of various properties of molecules or for simulating certain molecular events through fast computers, it has become almost impossible to define clearly what is physical chemistry research and what is not. However, the editors and authors of the *Annual Review of Physical Chemistry* series, rightfully, have provided a broad definition of the subject over the years. In this volume the content has varied from state selected photodissociation of isolated tri- and tetra-atomics to structural deformations in proteins under high pressures. Researchers already in the field or planning to start working in a new area of physical chemistry, need a quick update on the information available on a variety of subjects and the annual reviews have become handy in this regard.

The annual review of physical chemistry, by now, has a standard format. This volume begins with the chapter where N. Hackerman and A. Campion reminisce the development of physical chemistry at the Chemistry Department of University of Texas at Austin over the last 48 years. Hackerman arrived at Austin on the bright New Year's Day of 1945, supervised and contributed to the growth of physical chemistry there. Much of the problems then faced by his group either to raise funds for research or legalize 'prostitution/consulting in science for hefty fees' in the university is similar to

some of our own even today! Yet, the optimism for development of the subject in the department by he and his colleagues was never lost. This definitely helped Campion and his contemporary physical chemists to enjoy the type of freedom and reputation that they have today. I have enjoyed reading this account and believe that it will be inspiring to the younger generation of physical chemists.

A large number of reviews deal with theoretical aspects of various subjects including computer simulation of intermolecular forces. M. Ross and D. A. Young discuss theories of matter at high pressures (a few Mbar) which lead to changes in properties of a substance, including transition to new structures, phases or electronic configurations. The diamond anvil cell and new shock-wave techniques have allowed precise measurements on solids and liquids at high pressure and temperature. Local density approximations (LDA) reduce a many-body problem to a mean-field problem of calculating the ground state energy and LDA is shown to be excellent for predicting the equation-of-state and crystal structure of elements and simple compounds. While classical as well as quantum Monte Carlo and molecular dynamics simulations have revealed the basic structures of liquids, the quantum and statistical approaches have merged in new quantum statistical models which help study solids and liquids under exotic conditions. However, these newer techniques are highly computer intensive and parallel computational architecture need improvement before pushing these formulations ahead. Another important problem central to solid state physics is the insulator-metal transition. This has been discussed theoretically by Philip Phillips in his review. The author has dealt with Anderson's localized/delocalized model and cited contributions of several theoretical chemists in the understanding of disorder in solids. Exceptions to the localization picture have also been considered. In the next article R. T. Skodje has dealt with adiabatic theory of heavy-light-heavy (H-L-H) chemical reactions. This problem has been addressed by dynamicists working in the area for, at least, the past three decades. However, the author has concentrated on the finer aspects of dynamical outcome in a H-L-H reaction. The next theory review is on the local treatment of electron correlation by S. Saebø and P. Pulay. Electron correlation was identified in the sixties as an important phenomenon for computing physical properties of molecules. In this article the authors have treated electron correlation in large systems in detail. The final chapter on theory deals with computer simulations of the structural and dynamic properties of H-bonding liquids. In this article M. Ladanyi and M. S. Skaf first discussed the intermolecular potentials involved in such systems and then moved to different solvation aspects (both equilibrium and dynamic) in the linear response regime. Another related article is on hydration forces which is important in biological macromolecules, lipid bilayers, minerals and glasses, narrated by S. Leikin *et al.* Experiments have revealed that such forces are not well understood and most current treatments are empirical.

The remaining articles may be broadly classified into two areas (i) spectroscopy and dynamics and (ii) phenomena in condensed systems. F. F. Crim has given an excellent account of vibrationally mediated photodissociation of small molecules and controlling exit channels to yield desired product(s). This is a recent development in the area of state-to-state chemistry and the experiments as well as calculations have led to new insights into the nature of the dissociation. The article is extremely lucid and comprehensible. I have enjoyed reading it. Another article related to dynamics of reactive systems has been illustrated by P. D. Kleiber *et al.* They have discussed transition state spectroscopy in the frequency domain which, in principle, can map the asymptotic regions of bound state potentials. This area has grown in a large way after T. C. Mcguire *et al.* reported the observation of emission from the intermediate in the reaction $K + NaX \rightarrow [KNaX]^* \rightarrow Na^* + KX$ (X = Cl, Br, I) in a crossed molecular beam set-up. This article concentrates mainly on triatomic reactions and does not provide a broad view of the subject. However, the article is well written once the latter limitation is overlooked. Shock tube kinetic measurements have been discussed (for the fourth time in the annual reviews of physical chemistry) by two very competent scientists, J. V. Michael and K. P. Lim of Argonne National Laboratory in USA. The technique is very old and controversial. Nevertheless, it has been used to measure rate constants for a variety of gas phase bimolecular reactions at elevated temperatures. The article gives an uptodate account of the activities in the area. In a classic article which is more like a paper than a review, T. Oka described high resolution spectra of solid hydrogen and 'the quantitative and qualitative difference between gaseous and solid state spectroscopy'. High resolution rotational spectra of a para-hydrogen crystal have been discussed at length. Although this type of spectroscopy of solid hydrogen is just beginning, the author has in mind numerous interesting future experiments where the ultimate resolution will be of the order of few hundred kilohertz.

There is one article in the area of gas-surface interaction dynamics written by S. L. Bernasek. The article describes different reactions e.g., decomposition of water or methanol, or ethylene occurring on Fe(100) surface maintained under high vacuum conditions, in an elaborate fashion. However, the article is very limited in scope. The compulsions of an author to limit an article within the boundaries of his own work are understandable but, in a review article, the readers expect a broad coverage on related surfaces or systems in general. An article dealing with surface characterization has been written by H. Dai and C. M. Leiber. They have discussed charge density wave pinning and melting in two dimensions from quantitative analysis of STM images in solids. Ordering in mono-, di-, and tri- valent halide melts has been reviewed by M. P. Tosi *et al.* Spectroscopic techniques such as neutron diffraction and anomalous X-ray scattering have helped elucidation of the structure of metal halide melts.

The last article in this issue is on a rather interesting subject—in situ electrochemical surface science by M. J. Weaver and X. Gao. Electrochemistry used to occupy a major part of physical chemistry in the early decades of this century. Lately the emphasis has shifted. Surface electrochemistry at metal-electrolyte interfaces is complementary to their metal-uhv counterparts in that solvent. The nature of *in situ* probes in surface electrochemistry may be categorized as 'intrinsic surface sensitive' techniques such as surface enhanced Raman spectroscopy (SERS), second harmonic generation (SHG), and scanning tunnelling microscopy (STM) and 'extrinsic surface-sensitive' techniques, e g. X-ray diffrac-

tion, X-ray absorption spectroscopy, etc. Elucidation of spatial atomic arrangements of the metal-substrate atoms has been discussed in great detail in this article with special emphasis on potential dependent surface reconstruction and adlayer structures.

Finally, I have one criticism about the organization of the articles. There seems to be no particular format for these reviews. As a result, some reviewers have provided enough background information to put the reviewer's own contribution in the field in perspective and have given due credit to the contemporary workers in the field as well. On the contrary, some articles are poorly organized and narrow in their outlook. The editors need to look at the organization and content of the articles more carefully and bring some commonality in their presentation. This volume of *Annual Reviews of Physical Chemistry* certainly covers current topics and will be a worthwhile addition to all libraries of research organizations and groups working in the area of physical chemistry or chemical physics.

P. K. DAS

*Department of Inorganic and Physical Chemistry*
*Indian Institute of Science*
*Bangalore 560 012, India*

## Royal Medal to Prof. S. Chandrasekhar

Professor S. Chandrasekhar, Director of the Centre for Liquid Crystal Research, Bangalore has been awarded the prestigious Royal Medal of the Royal Society of London 'in recognition of his many new discoveries in the understanding of liquid crystals, for a synthesis of the subject in his seminal book, the invention of discotic liquid crystals and for elucidating their remarkable properties'. S. Chandrasekhar was elected a Fellow of the Royal Society in 1983. Previous medallists of the Royal Society include two distinguished Indian physicists, both Nobel Laureates: C.V. Raman (Hughes Medal 1930) and Subrahmanyan Chandrasekhar (Royal Medal 1962, Copley Medal 1984).

S. Chandrasekhar initiated studies on the physics of liquid crystals in 1961 when he joined the University of Mysore when few scientists were aware of these unusual phases of matter that occur between the solid and liquid states in certain materials. The subject has since developed to become an exciting area of modern condensed matter physics with important applications, especially in display technology.

In 1971 Chandrasekhar moved over from Mysore to the Raman Research Institute, Bangalore and in the two decades he was there, he built one of the most renowned liquid crystal groups. It is generally agreed that S. Chandrasekhar and his students played a significant role in promoting the growth of the world-wide interest in the physics of liquid crystals.