BOOK REVIEWS

Frontiers of Fundamental Physics. B. G. Sidharth (ed.). Universities Press (India) Ltd, 3-5-819, Hyderguda, Hyderabad 500 029. 2001. Vol. 2. Price: Rs 460.

At the B. M. Birla Science Centre, Hyderabad, a series of symposia on fundamental physics have been held for some years now. The contributions of the speakers have been brought out in publications, the present collection being those from the symposium held at the end of 1998 and beginning of 1999. The list of subjects covered provides a glimpse of the many directions in which theoretical physics has expanded in the recent years. There are some directions in which experimental and observational information has provided impetus, guidance and constraints. There are others which represent highly mathematical skills and techniques, which soon lose contact with the physical world and yet provide nourishment for the growth of mathematics itself. The list of speakers on the other hand, illustrates the international nature of the enterprise of theoretical physics, with speakers from Brazil, India, Japan, Russia and USA, to name a few. Some of the contributions deal with the important issue of the grand unification of the fundamental forces of nature and its implications to the mass spectrum of the constituents of nature, with the most modern constraints and information coming from neutrino experiments and observations in giant underground detectors. Other speakers were concerned with precision tests of the vacuum structure of the strong interactions probed by scattering of mesons. And yet others with fundamental questions pertaining to the notion of space and time in the vicinity of strongly gravitating sources such as black holes and the nature of solutions associated with Einstein equations. Other questions addressed pertained to the notion of information and entropy in the vicinity of black holes and the cross-pollination of many of the topics discussed at the conference. The editor has done a commendable job in bringing out this collection of articles. The series of conferences is expected to generate enthusiasm for science in Hyderabad and one hopes that this effort, as well that those that will take place in future, will meet this goal.

B. ANANTHANARAYAN

Centre for Theoretical Studies,
Indian Institute of Science,
Bangalore 560 012, India
e-mail: anant@cts.iisc.ernet.in

Annual Review of Physical Chemistry 2000. Herbert L. Strauss *et al.* (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, USA. vol. 51. 868 pp. Price: $158.

In the days of the new millennium when chemistry departments and chemists worldwide are embracing biology in their efforts to survive in the 21st century, it is commendable that the editors and authors of *Annual Review of Physical Chemistry* have come out with a resplendent issue covering a wider subject area and containing more printed pages than earlier. Although the general format laid out for the *Annual Review of Physical Chemistry* many years ago has been maintained in this issue (like it starts with the odyssey of a distinguished physical chemist over a fifty-year period), this issue is special since it has a large number of articles which are interdisciplinary in nature and point to the direction of physical chemistry of the future. The topics covered in this issue are very much relevant in the modern context and today's physical chemists must get to know about the developments in the area. The volume begins with the chapter in which Dudley Herschbach narrates his journey with physical chemistry since 1950. His early excitements with molecules and mentors and later experiments with molecules and students (whom he calls 'mutual mentors') have been vividly described. His cross-molecular beam experiments to understand gas-phase dynamics in Berkeley where he started his career as an independent faculty member and his recent adventures with physical chemistry in the condensed phase have been illustrated with all the personal stories, which make it interesting and enjoyable reading. This chapter unravels a great story about how a new field came into existence and is inspiring for young chemists who are about to start a career.

All the other articles in this volume can be grouped into various subfields of physical chemistry depending upon one's own fancy and prejudice. Gas-phase dynamics and spectroscopy have been discussed in at least four articles. Very sophisticated high resolution frequency modulation spectroscopy of short-lived transients has been described by Hall and North and high resolution rovibrational spectroscopy of polyatomic molecules in regions of very high total state density ($100\ cm^{-1}$) by Keske and Pate. Rohrbacher, Halberstadt and Janda write a chapter on the study of the dynamics of vibrational relaxation of noble gas–halogen molecule clusters using molecular beam techniques and detailed theoretical calculations. Jarrold tells us how biomolecules such as peptides and proteins can be transferred from the condensed phase to the gas phase and their solution physical properties studied using gas-phase techniques. Atmospheric chemistry, which is of great importance and concern today, has been dealt in an article by Zondlo *et al.*, where they have described how chemical reactions taking place on the surface of droplets in the upper atmosphere impact the climate around us.

Chemistry of gas–surface interaction or chemistry in two dimensions has been dealt with by Trenary, who has described the use IR spectroscopy in elucidation of structures of adsorbates on metal surfaces and by Tully who considered the theoretical treatment of dynamics at metal surfaces. In the latter, a variety of surface processes ranging from sticking to energy flow and dissipation due to energy loss to phonon and electron-hole excitations are discussed, essentially from a theoretician's viewpoint. Kondow and Mafune considered both the structure and dynamics of molecules ejected from liquid surfaces using photoelectron and metastable-impact electron spectroscopies. Surface plasmon spectroscopy to characterize ultrathin organic and biomolecular films at metal interfaces in a spatially resolved manner has been discussed by Brockman *et al.* In a albeit related article, Williams *et al.* describe the thermodynamics of the size and shape of nanocrystalline solids in the rapidly growing field of nanochemistry and nanomaterials.

On the theoretical front, development of new models and methods and their application to interesting chemical problems as well as application of old models and formulations to new problems of interest have been dealt with in several articles. The statistics and dynamics of delayed ionization and fragmentation patterns of energy-rich large molecules is the topic of Campbell and

Levine. This is an emerging area and spectroscopic experiments done with energy-rich molecules have opened up a wish-list of future theoretical work to be done. Semi-classical approaches to chemical dynamics have been around for a rather long time. However, only recently has this method been successfully used to calculate *reaction* probabilities. This exciting development is the focus of the article by Tannor and Garashchuk. Calculation of solution properties of nucleic acids (~6- to 24-mer) is described by Cheatham and Kollman. While this is very interesting, one hopes and waits for results on longer systems, as they are of immense biological interest. The quantum Monte Carlo technique has over the past ten years grown into a very powerful technique for electronic structure calculations. Luchow and Anderson (the originator of the method) point out in their article that at present, this is the best method for electronic structure calculation of large systems such as a silicon crystal with 250 atoms and 1000 valence electrons. Quantum tunnelling is very sensitive to details of the barrier that the system has to tunnel through. Johnson and Kearly describe how this sensitivity can be successfully exploited to extract inter-atomic potentials from rotational tunnelling spectroscopy of small molecular groups. For a very long time, multiple pulse sequences have been a very useful tool in NMR spectroscopy. Recently, femtosecond visible and infrared analogues of these multiple pulse sequences are providing a multi-dimensional view of molecular structure as well as electronic and vibrational motions. Mukamel has written on the theoretical developments *vis-à-vis* experimental advances in optical measurements into the dynamics of complex structure–function relationships in molecules in the condensed phase.

Articles that consider the structure and dynamics in the condensed phase include the work on large-scale conformational (shape) changes of proteins and RNA in solution, studied by small-angle neutron scattering and other techniques. Small-angle neutron scattering is emerging as a powerful tool for probing molecules with dimensions from 10 to 1000 Å in solution, thus spanning length-scales from single molecules to quaternary structure of macromolecular assemblies. Description of macromolecular solvation is a tough theoretical problem. Bashford and Case review the application of a simple method for treating the solvent – using the generalization of the Born model. The application of the method to calculate both static and dynamic properties is illustrated. The theory of crystal growth from atomic scale processes has been reviewed by Jonsson. The review points out the richness of the phenomena involved and the fact that rather small effects can lead to a large change in the morphology of the growing surface. Burgi demonstrates that the old technique of X-ray crystallography can provide dynamic information about motion and disorder in the solid state. Dabbs and Aksay examine the use of self-assembly in the fabrication of ceramic mesoscopic structures. The spatial heterogeneity and dynamics in supercooled liquids turn out to be very complex and this is the topic reviewed by Ediger.

Hansen and Lowen have described the comeback of the traditional classical physical chemistry field of colloids in terms of the theory of electrical double layers, with special emphasis on the effective interaction between charged colloid particles in the bulk or in constricted space. Hemley provides information about the behaviour of molecular materials subjected to pressures well into the multimegabar range (hundreds of gigaPascal). He discusses the evolution of structure and bonding with compression. New technology developments in ESR spectroscopy and information obtainable through their application to problems in the condensed phase has been considered by Freed.

Finally, while some articles in this volume of *Annual Review of Physical Chemistry* are well written and provide a broad perspective of the field, others are very limited and narrow in scope. However, they all provide important references in the field and are useful to the readers. This volume will certainly be a nice addition to all libraries.

PUSPENDU KUMAR DAS
K. L. SEBASTIAN

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

The Two-Mile Machine: Ice Cores, Abrupt Climate Change, and Our Future. Richard B. Alley. Princeton University Press, 41 William Street, Princeton, New Jersey 08540, USA. 2000. 229 pp. Price: $24.95/£15.95.

Earth's climate is now known to change appreciably over a wide range of time scales; inter-annual to inter-decadal, centuries to millennia, to millions of years. Fairly detailed historical records exist for climatic changes occurring over the past several centuries, but the records become sparse as one goes further back in time. For deciphering longer-term climatic changes one has to learn to *read* the so-called 'proxy' records which are contained in the materials which accumulate as a result of their falling out of dynamic geochemical cycles. Man's curiosity to read these records has led to the discovery of new methods of reading them, as well as for identification of very potent records in diverse geographical locations on the earth, which are suitable for learning about a variety of questions on the past history of the earth: such as the evolution of the atmosphere and the oceans, volcanic and seismic activity, plate tectonics-related phenomena, the geomagnetic field of the earth and last but not the least, how earth's climate has changed in the past.

This book under review deals in considerable detail about the nature of information stored in the permanently frozen, thick ice sheets (which one finds in the earth's coldest Arctic and the Antarctic regions) on the last mentioned aspect, namely palaeo-climates. In the polar regions, the wind is pure, relatively free from volatile compounds, dust and sand particles and the ice which condenses out of the atmosphere is the purest one can find anywhere on the earth. And paradoxically (or interestingly), it is this very pure ice, which holds detailed records of past climatic changes. Ice cores have been studied for the past several decades with climate in mind, but the principal reason for this book is that about a decade ago, two long ice cores were extracted from Greenland ice cap near its highest point. The Greenland Ice Core Project (GRIP), an European consortium, drilled a core at the summit during 1989–1992. The US Greenland Ice Sheet Project 2