signal propagation delays and so on. High connectivity means rapid communication, but it also entails longer links with concomitant energy and delay costs, lack of robustness, and so on. This favours a modular structure which is more robust and economical. It has been proposed that the preponderance of small-world networks is because they strike a balance between several competing requirements, such as cost of wiring versus communication delays (I cannot resist pointing out at this juncture the last chapter of a book by a major thinker of the last century, which presaged much of the current thinking on complex systems[8]). The author makes a convincing case based on such considerations for evolutionary roots of the observed attributes of brain networks.

Chapter 8 addresses a distinctive phenomenon: the spontaneous activity in a brain at rest. After reporting the experimental results on this theme, the author highlights the important observations such as the relationship between 'hubs' in the functional network associated with spontaneous activity and the underlying structural network, and also speculates on the cognitive role of this activity. The latter theme is developed further in the next chapter, which makes a case for cognition as an 'emergent' network phenomenon. It discusses the possible role of the modular hierarchical and recurrent structure, particularly the latter, in cognition, discussing at the same time issues such as dynamic reconfiguration of the functional networks and their variability. Chapter 10 discusses a special topic intimately connected with brain studies and whose understanding is of great value to humankind – brain diseases such as Alzheimer's, schizophrenia and autism. The chapter spells out possible network implications of these diseases. The following chapter discusses network growth and development in humans, describing both models and experimental results.

The last three chapters address the final frontiers in this line of work. Chapter 12 is devoted to the role of dynamics, underscoring the fact that the brain is a *dynamic* network and this aspect thereof is crucial to its functioning. Whereas the functional network picture would view the brain in terms of 'frozen' cause–effect relationships, a dynamic view expands the possibilities a lot more: a dynamic system allows one to think also in terms of a map from initial condition to equilibrium behaviour, or in the case of external inputs, from input *process* to equilibrium behaviour. Then there is the possible coupling of dynamical systems, sometimes across the same spatio-temporal scale, at other times across scales, leading to an array of critical phenomena, metastability, emergent behaviour and so on. This naturally leads to the broader theme of complexity, which is taken up in the next chapter. After describing various notions of complexity such as those that quantify the minimum effort needed to specify a structure on the one hand, to those that try to capture where in the spectrum ranging from deterministic regularity to statistical regularity the system is poised, it makes a case for studying the brain as a complex system, highlighting its evolutionary *raison d'etre*: to survive in and adapt to a complex and not fully predictable environment. It also makes a case for computational models to aid the intuition in this pursuit. The final chapter faces the ultimate issue: brain as it is situated in a body, which in turn is situated in its social environment. Here the author falls back on the studies in robotics, a field which confronts these issues with great immediacy, and draws parallels with brain networks.

The book, as the author himself says, is one long argument to make a case for a network view of the brain. He draws upon an amazing repertoire of experimental work, statistical analysis, computational models, etc. at times also borrowing from artificial intelligence and robotics. The scholarship that has gone into writing this book is impressive. It is a true bird's eye view of what's out there, squeezed between the covers of a single accessible book. The style is engaging, I particularly enjoyed the way he begins each chapter with a quotable quote from a scientist whose work is relevant to the theme of the chapter and takes it on from there, with a little bit of history at the beginning, and a status report along with some speculation for future at the end. The topic is truly interdisciplinary and that reflects in the style, which, as already mentioned, is sans excessive technical jargon of any kind that would turn away an interested non-specialist. The book is an open invitation to jump into the fray and take on any of the multitude of questions begging for an answer.

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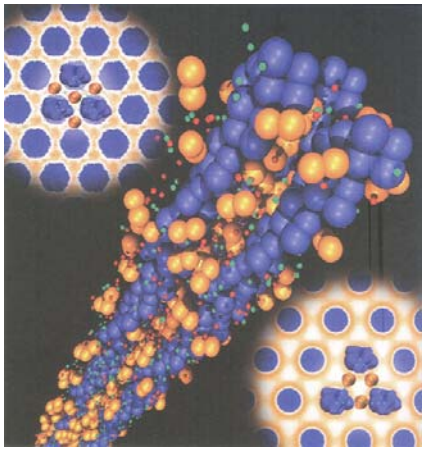
Annual Review of Physical Chemistry, 2010. Stephen R. Leone, Paul S. Cremer, Jay T. Groves, Mark A. Johnson and Geraldine Richmond (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, USA. Vol. 61. xii + 499 pp. Price: US$ 84.

In the early days of our graduate studies in the physical chemistry department of the Indian Association for the Cultivation of Science, Calcutta, we were told by our mentors that the articles in the latest volumes of the *Annual Review of Physical Chemistry (ARPC)* presented the current status and direction of research in the subject. Since then, it became a craze for many of us to look forward to the arrival of the latest volume of *ARPC* in the library every year. When *Current Science* approached me to review the present volume with the offer that I can retain the book at the end of the job, I immediately agreed.

This volume consists of 23 review articles. The prefatory chapter 'On walking in the footprints of giants' is authored by Marylin Jacox, an eminent spectroscopist, working at the National Institute of Standards and Technology, USA. She narrates her lifelong fascination for probing molecular properties using light. Her contributions through the matrix isolation infrared spectroscopy studies of some vital radicals and ions generated by photolysis and/or electric discharge are summarized. The story of her research at Cornell University, at a time when no one in the chemistry department was directing research in spectroscopy, is enthralling.

The other articles show how physical chemistry research has evolved in the past few decades. At first glance, the topics of most of the articles might appear to be in an unknown realm, particularly with respect to the physical chemistry courses taught in Indian universities. Traditionally, the goal of physical chemistry research has been to provide a fundamental understanding of chemical and biochemical events. The direction of physical chemistry research, like all basic sciences, has been shaped by the burgeoning societal demands for clean energy and drinking water, health care and safety of our environment. This is reflected in the selection of articles in the current volume wherein recent research has been covered.

In the article 'Hyper Raman scattering by molecular vibrations', Anne Myers Kelley has shown that this method is useful for probing some vibrations of large molecules which apparently do not show up in normal Raman spectra. Hyper Raman spectroscopy (HRS) is one of the nonlinear (two-photon) versions of Raman spectroscopy. It is an intrinsically weak process and requires high power lasers as excitation sources. Although the first report of this process appeared many decades ago, the technique has gained less popularity, unlike its normal version. HRS has a unique merit – probing is done at a much shorter wavelength compared to the wavelength of the excitation light. Therefore, ideally, it could have been used to study very low frequency vibrations like the solvent modes and torsion and bending vibrations of peptides and proteins. However, it is not clear from the review whether such studies have been attempted by any group.



A bundle of action filaments (blue) held together electrostatically by lysozyme (orange) in a salt solution, as obtained from molecular dynamics calculations in conjunction with synchrotron X-ray diffraction experiments.

The past two decades have witnessed a revolution in technical developments for probing biophysical events at the molecular level. A merger of optical microscopy and optical spectroscopy has kindled the hope of directly observing the events inside cells. The inclusion of two pertinent reviews in this volume, one by Patterson *et al*. on 'Super resolution imaging using single molecular localization' and the other by Senning and Marcus on 'Sub cellular dynamics and protein conformation fluctuations measured by Fourier imaging correlation spectroscopy' is noteworthy. Patterson *et al.* review the developments in optical microscopy that brings the diffraction limit of optical resolution down to nearly 20 nm. Fourier imaging correlation spectroscopy (FICS) is a phase-selective approach to fluorescence fluctuation spectroscopy that can provide information about molecular coordinate trajectories. Both reviews have lucidly presented the measurement principles, instrumentation and selected recent studies in their topics. The article by Ou-Yang and Wei on 'Probing the mechanical properties of biological systems with optical tweezers' is also intriguing. The mechanical properties of cells are considered to be intimately related to their functions. However, a comprehensive understanding is yet to be achieved because of the complexity of living cells. The present review summarizes a few recent studies in this direction. These three articles could have been clubbed together and appeared serially as articles 2–4.

Chemical kinetics and reaction dynamics is a traditional area of physical research. This acquired a new face with the birth of the subfield femtochemistry, which deals with the direct optical probing of chemical bond breaking in a timescale shorter than that compared to a typical bond vibrational time period. Optical spectroscopy does not provide direct information about chemical structure, but X-ray spectroscopy does. A considerable amount of data is available in the literature at this time, with images for structural changes in chemical reactions captured using ultrafast X-ray spectroscopy – the topic has been reviewed here by Bressler and Chergui. Electron transfer (ET) reactions, which are vital to numerous chemical and biochemical events, have been extensively discussed in the past. The formulation of the theories of nonadiabatic ET reactions is based on Fermi's golden rule, which emphasizes on nuclear motion for encountering a transition state that enables electron flow to occur. However, recent studies have focused on exploring how structural fluctuations, which affect donor–acceptor electronic coupling, can influence the transfer rate. Skourtis *et al*. review the new generation of theories that takes into account the effect of structure fluctuations of proteins on ET kinetics and mechanisms. The development of theories for the diabatic picture of ET reactions has been reviewed by Voorhis *et al.* Diabatic electronic states are important in a variety of chemical phenomena, and Pauling's idea of resonance structures within the valence bond theory provides a natural definition of diabatic states. The authors have presented the basic concepts for construction of diabatic states and discussed their use in chemistry.

At present, physical chemistry research is evolving at a fast rate, and many researchers intend to study problems related to complex systems, materials and biology. The selection of articles for the present volume is an expression of that change; more than half of the articles are related to biological events. Zhang and Cremer deal with studies of the effect of Hofmeister anions and osmolytes on charged and uncharged biopolymers like peptides and proteins in aqueous solutions. The authors have also discussed the mechanism of the effects at the molecular level. Arup Chakraborty has explained the use of statistical mechanics in a cell biology process – how

the cellular components of the adaptive immune system are selected to enable pathogen-specific responses, i.e. for successfully combating diverse microbial pathogens. DuFort and Dragnea have discussed a strategy for the creation of new material by the bioderivation approach, which involves combining an existing biomaterial (such as protein or DNA) with an abiotic material to create a hybrid, termed as metamaterial, whose physical properties are determined by their organized structures. Diebold *et al.* have dealt with the recent advances in understanding the properties of metal oxide surfaces. Under ambient conditions, most metals undergo oxidation and the oxides show technologically promising properties. Chandler and Garrahan have reviewed the current understanding of the dynamics of glass-forming liquids. The data that they have presented are the results of a numerical simulation of an atomistic model of a glass forming material. Lin-Wang Wang has discussed the recent advances in numerical algorithms for performing electronic structure calculations. These are based on *ab initio* methods for prediction of electronic structure, and surface and transport properties of nanocrystals that contain several hundreds of thousands of atoms.

In a nutshell, the articles in this volume reflect the trend in modern physical chemistry research. The hardbound cover and quality of paper, printing and graphics are splendid. In my opinion, a copy of the book is worth procuring for the science library of every institution.

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