How the Brain Learns. David A. Sousa. Sage Publications India Pvt Ltd, M32 Market, Greater Kailash 1, New Delhi 110 048. 2001. 305 pp. Price: US $ 39.95.

How the Brain Learns is a book for teachers of all disciplines, parents and education administrators and school principals. The eight chapters of the book cover several learning processes, including cognition, memory, retention, retrieval, information processing, learning of motor skill, skills of language, music, vision, arts and thinking. The author has tried to incorporate the latest information in neuroscience as availed by the use of positron emission tomography, magnetic resonance imaging (MRI), functional MRI and magnetoencephalography to revise this book from the old edition, and to substantiate his theory that neuroscience-based teaching has present-day relevance.

At a time when there are two opinions on whether to have a neuroscience-based or not education, the attempt by the author is courageous and is sure to influence the current approach of classroom teaching. When he advocates neuroscience-based education, he argues that 'teachers try to change the human brain everyday. The more they know about how it learns, the more successful they can be (in teaching)'.

The structure and anatomical features described in the first chapter could be found in many text-books, but it is hard to find precisely what links these with tasks such as emotion and reasoning. According to the author, emotion, reasoning, IQ, logic, mathematics, music, etc. are related to specific areas of the brain and that each of these have certain windows of opportunity, which need to be tapped effectively during the course of development of the child. This brings into focus the role of parents and the environment in shaping the personality of a growing child. A simple and good explanation of 'sensory filtration' given by the author is helpful in understanding why children remember a few things well and not others. The importance of a situation determines the amount of attention devoted to it, and thus new cognitive learning takes a back-stage as compared to survival, food or emotion. This means anything that makes sense and can be translated to something meaningful, gets top priority and is stored for a longer time.

The second chapter gives practical and positive suggestions for improving the classroom 'climate' conducive to learning, use of humour to enhance and promote retention and introducing sense, meaning and motivation in learning. The concept of 'information processing' dealing with working and long-term memory, will enable an educationist to deal with the students effectively. The explanation of 'self-concept' helps not only the teachers but also the students to overcome inhibitions the latter face due to failures. This also gives clues to parents and teachers as to how to deal with students with low IQ. This chapter is well written, to direct the teachers to build a student's self-concept. Facts based on research on memory, retention and learning, sensory preferences are effectively presented. A few more clear-cut examples and flow-charts would have made it better understandable.

The most impressive aspects of the book are the solid proposals meted out of extensive review and analyses of scientific evidences and their relation to practical realities in classrooms. Why and how art can be related to child's development and how it affects the brain is a novel idea of the author. This part will enable both teachers and parents to understand the logic behind introduction of extracurricular activities like dance, music and drama in the school curriculum.

The book is a good guide for teachers and educationists. It also provides parents the facts related to the brain, its development and functioning based on the latest information available through modern neuroscience research. A few more pictorial examples would have made the learning task by the readers, a bit easier. In a few places (like in p. 264), examples are not very clear to an ordinary reader. The 'notes' sections, meant for providing readers with information on additional readings, are adequate. In many cases, the relevant web-sites are provided. The paperback binding and the lamination make the covers role over, which is at the least, a nuisance.

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Kinetics and Applications of Atomic Diffusion in Solids: Nanoscopic Electron-affected Stochastic Dynamics (Solid State Phenomena, Vol. 53). Yu. L. Khait. Scitec Publications Ltd., Brandrain 6, CH-8707 Zuerich-Uetikon, Switzerland. 1997. 206 pp. Price not given.

The book is a review dealing with a local non-equilibrium many-body phenomenon (see title) and applications of the related theory to a variety of processes occurring in elemental and compound materials. Yu. L. Khait (Solid State Institute, Technion – Israel Institute of Technology, Haifa, Israel) has investigated the role of short-lived large energy fluctuations (SLEFs) of atoms in solids and SLEF-induced rate processes in solids for over four decades.

Khait drew attention to a phenomenon that occurs in a microscopic region of a solid (in nanometres) spontaneously. Atoms in a solid are in continuous agitated motion as they are immersed in a sea of phonons. The average energy of these atoms is of the order of a few tens of milli-eV. Occasionally, however, an atom receives energy much larger than the average energy, sufficient to initiate diffusion of the atom over distances of the order of a few angstroms and times of the order of 10^{-13} to 10^{-12} s. Then the energy decays or is shared with the surrounding 100 atoms or so. In fact, some 100–1000 atoms in the immediate neighbourhood of the original atom would have been responsible for the large kinetic energy that the atom comes to acquire, to begin with. The consequences of this phenomenon are far-reaching.

The diffusion events are associated with large transient atomic displacements and formation of dynamic defects of picosecond duration referred to as transient point dynamic defects (TPDDs). These, in turn, break local atomic and electronic symmetry and stability and cause electronic transitions. It is this combination of atomic diffusion event and concurrent electronic transitions that reduces or enhances atomic diffusion rates by *orders of magnitude*.

My brief acquaintance with this unusual phenomenon and approach to understand the 'anomalous' phenomenon was through an article in *Physics Reports* by Khait around 1983. Over the years, through computer simulation technique,

we could find supportive evidence to what Khait had been investigating and a brief article was also published in *Current Science*. Keeping in view the length limitations of a book review, the contents of various sections will now be summarised rather briefly.

Section 2 gives a summary of experimental data on atomic diffusion in solids expressed through Arrhenius equation, namely $D = D_o \exp(-\Delta E/kT)$ where D_o is referred to as pre-exponential factor and ΔE as activation energy. The section refers to significant deviations from predictions of simple Arrhenius equation in D_o and ΔE in several materials by temperature, phase transformations, addition of dopants, etc. They could be wrongly interpreted if one were to go by the traditional theory. This section also refers to 'a striking and less-known feature of atomic diffusion associated with correlations between observed variations in D_o and ΔE in the same or related materials through the simple empirical equation, $\ln D_o = a\ \Delta E + c$, known as 'Compensation Effect' (also known as Constable's law, θ-rule, Meyer-Neidel rule, etc. in various fields)'. The SLEF-based theory provides an explanation of origin of the Compensation Effect. The new approach explains diffusion-melting correlations and deviations thereof. The theory has explained the 'anomalous' observations and has also given predictions, some of which have been verified experimentally.

Section 3 states the nature of the problem. It details the conceptual and technical difficulties in traditional rate theory and statistical physics of solid state. Although Boltzmann had noted possibility of 'local strongly non-equilibrium fluctuation in entirely equilibrium systems' about a hundred years ago, it was Frenkel 'who was the first to understand the problem and related contradictions of the traditional approach'. He had noted that theories based on small atomic displacements are not suitable for modelling atomic diffusion in solids since diffusion jumps are inherently large transient displacements. So also, in considering equilibrium macroscopic parameters, generally the transient states associated with far tails of the equilibrium energy distributions are neglected. But these are important. Diffusion events in traditional approach take into account the so-called 'individualistic' description of the events whereas Frenkel pointed out that one has to treat the solid as a 'single coherent system'.

Section 4 goes into the theoretical aspects of the stochastic many-body dynamics before going into the time and space scales of SLEFs and SLEF-induced diffusion events in Section 5.

Using the theoretical formalism, computation of a variety of properties of materials is carried out. Certain parameterization is involved in the computations; parameters like the Debye temperature, coordination number of the fluctuating atom, etc. are used. Parameterization is inevitable in studying complex materials. The most satisfying outcome, however, is that when one uses, for example, the Arrhenius-like equation (based on kinetic electron-based diffusion) results obtained are in agreement with the 'anomalous' experimental data. With this approach, one can understand even the causative influences, for the 'anomalous' behaviour.

Khait points out in Section 6, that the SLEF 'looks like a spontaneous random nonlinear energy (and momentum) 'burst' in the elastic field of the solid'. In this context a detailed discussion of the phase space concept relating to the energy fluctuation and a particle jump is also given. Subsequently the association of the energy fluctuation with local transient electronic phenomenon is taken up for detailed discussion in the same section. The SLEFs occurring simultaneously in different locales of the solid are like a 'permanent gas' system obeying Gibbs-like equation. 'The "gas" of the co-existing SLEF-excited hyperthermal fluctuating atoms and surrounding region is responsible for diffusion of atoms and other phenomena in solids'.

The behaviour of electrons and the SLEF affected atoms, through 'breaking some of existing bonds and formation of new bonds' is discussed in Section 7. The involvement of electrons 'can change drastically the height and shape of energy barriers which the hopping atom overcomes during diffusion'. It must be mentioned that the book deals with many other aspects of how valence and free electrons in the solid are involved. The electron-related theory of diffusion is what makes a natural contact with the Compensation Effect and the predictions of 'anomalous' behaviour.

Applications of the theory developed to Si & Ge, influence of impurities, extension to Si-Ge alloys and the case of HgCdTe are subsequently dealt with in Sections 9, 10, 11 and 12 respectively. In particular, in the case of $Hg_{1-x}Cd_xTe$, the theory is able to account for high and low temperature diffusion regimes separated by a certain temperature $T_d(x) \ll T_m(x)$.

Section 13 deals with the technologically important devices, namely, semiconductor lasers and LEDs which are used in optoelectronic applications. The nature of materials' evolution of the observed degradation had not been satisfactorily understood for a long time. It is believed that these deleterious effects are due to creation, migration and clustering of defects. The SLEF related mechanisms taking into account injection of electron-hole plasma and model calculations provide a basis to understand the degradation processes in InP and GaAs based devices. The study also has led to ideas that deal with how material evolution can be 'controlled and directed' for low temperature modification of crystalline and amorphous semiconductors.

The 'anomalous' experimental data presented in Section 2 earlier relating to S, P and Se, Bi and BaO are examined, in the light of theories presented, in Section 15.

The theory of atomic diffusion in metals is usually based on interaction of atoms with defects without paying much attention to the role of electrons in the atomic transport. In Section 16, the author states 'the local transient atomic diffusion and TPDDs taking place during diffusion events also cause another kind of phenomenon related to transient electron localisation; namely the diffusion events are accompanied by *nanoscopic picosecond metal – insulator transitions*. (NPMITs) There exist also *permanently* a certain number of simultaneously occurring diffusion events (SODEs) which form a random dynamic array. The sequence of such random arrays of SODEs and NPMITs 'migrate' *permanently* in the materials, since every disappearing generation is immediately replaced by another one with different locations of individual diffusion events'. These can affect lattice stability, electrical resistance, heat capacity, thermal expansion and hi-T_c superconductivity.

Section 17 deals with how effect of pressure on many properties can be

understood on the basis of theory presented. Finally, a detailed summary, conclusions and outlook for future are presented in Section 18. In addition, this section includes reference to studies on superlattices by Raman scattering, ion implantation and ion mixing, radiation damage in presence of weak magnetic fields, implantation damage in hi-T_c superconductors, etc.

The publishers could have paid attention to details in the process of publication of the book. It appears as if the book is printed by offset printing directly from the author's manuscript. In these days of advanced desktop publication, the format and printing could have been better. Sectional headings should have been prominent. The contents page should have referred to page numbers corresponding to different sections. An index of important keywords would have been useful. A preface by the author would have put the technical contents within the framework of historical developments of the subject, which dates back to almost a century, as stated later in the book. Repeated references to SLEF phenomenon in detail at a number of places could have been avoided. These lacunae can be taken care of in future editions.

As Khait has rightly emphasized, atomic diffusion has assumed increased importance especially in miniaturized devices and in nanosized materials. The material stability, quality of nanostructures and kinetics of many a chemical reaction in solids are affected by atomic diffusion.

To sum up, the book is an important review contribution covering theoretical, computational and experimental literature dealing with a subtle but ubiquitous phenomenon in solids. Textbooks in solid state physics should include references to this important phenomenon that affects many a solid state property. The book is recommended to libraries as an important addition to collections on physics of solid state.

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Phytochemical Biopesticides. Opender Koul and G. S. Dhaliwal (eds). Harwood Academic Publishers, 6th Floor, Amsteldijk 166, 1079 LH Amsterdam, The Netherlands. 2001. 223 pp. Price: $ 90.00/£ 59.00.

Practitioners of conventional agriculture consider synthetic pesticides as a cure-all[1]. To them, the fleeting magic those pesticides work is obscure. Especially in the last five decades, the effects of synthetic pesticides have been spilling far beyond their desired limits – mainly because of injudicious use – and has consequently been affecting the health of humans and the environment. Injudicious use of synthetic pesticides has also resulted in several other complications in arthropod-pest management. One example for such a complication is the development of resistance in insects to those chemicals[2]. A journey back to 1963 will remind us the prophetic words of Rachel Carson[3]: '. . . in less than two decades of their use, the synthetic pesticides have been so thoroughly distributed . . . that they occur virtually everywhere . . . are now stored in the bodies of the vast majority of human beings, regardless of age. They occur in the mother's milk and probably in the tissues of the unborn child.' Our awareness of the undesirable effects arising out of indiscriminate use of synthetic insecticides, at least in the last two decades, has, fortunately, enhanced[4]. Consequently, we are now exploring the secondary chemical compounds that occur naturally in plants, which have the potential for application in environment-friendly management of arthropod-pests, either as natural insecticides or as feeding deterrents/repellents or growth inhibitors/regulators. Vascular plants spend more energy in the production of secondary metabolic compounds than what they spend for the production of primary metabolites; yet, they synthesize and store them as 'innocuous' compounds. When arthropods inflict wounds (e.g. during feeding), plants liberate the stored compounds through either enzymatic action or oxidation and concentrate them at the sites of damage, firstly, to counter herbivory and secondly, to optimize their own survival rates[5]. Today, we know of the structure and function of nearly 100,000 secondary plant compounds (nitrogen-containing compounds: alkaloids, cyanogenic glycosides and glucosinolates; terpenoids: monoterpenes, diterpenes, sesquiterpenes, saponins, limonoids, cucurbitacins, cardenolides and carotenoids; phenolics: simple phenols, flavonoids and quinones; polyacetylenes) from a staggering range of plants[6]. Given that we are looking for slow-acting and quickly degradable natural compounds which have low toxicity, we need to know these compounds better, so that we can use them efficiently as an environment-friendly tool in pest management. In such a context, the book under review is most welcome. It comprehensively synthesizes all the latest information, offers logical conclusions and identifies appropriate research directions for the future. Secondly, volumes discussing the potency and mode of action of natural products in the context of arthropod-pest management are relatively few.

Extensive knowledge of the chemical ecology of phytophagous arthropods has enabled us to understand the biochemical processes that mediate interactions between arthropods and their host plants, especially those that regulate insect feeding and reproduction as well as host-plant susceptibility and rejection, including defence reactions. Koul and Dhaliwal identify the following as the key objectives of this volume: (i) to present the advances made on phytochemical biopesticides, including behavioural, chemical, biochemical and molecular aspects and (ii) to address the role of phytochemical biopesticides in integrated pest management (IPM), concurrently discussing the problems and prospects of biopesticides for commercial exploitation. They have attempted to realize these objectives with nine chapters written by M. B. Isman and M. J. Smirle from Canada, T. N. Ananthakrishnan, R. Arora, G. S. Dhaliwal, O. Koul, B. S. Parmar and S. Walia from India and J. H. Kim, C. A. Mullin, B. Oppert and S. J. Yu from USA. We could broadly the divide the contents of the book into two sections: (1) bioactive compounds, the biochemical principles that enable them to perform as efficient 'pesticides' and the molecular physiology of receptors; and (2) application of the knowledge provided in (1) in the context of arthropod management practice.

The introductory chapter 'Biopesticides based on phytochemicals' by Isman offers brief insights to information on the