Doubt and Certainty. T. Rothman and E. C. G. Sudarshan. Perseus Books, Reading, Massachusetts 01867. 1998. 320 pp. Price: US $ 25.

'There is no limit to my divine manifestations.' 'What need is there, O Arjuna, for such detailed knowledge by you? I support this entire Universe pervading it with a single fraction of Myself.'

The Bhagavadgita – Ch. 10: 40, 42

'I am not interested in the spectrum of this or that element. I want to know how God created this universe and what were his thoughts. The rest are details.'

– Einstein

To the uninitiated, it is far from obvious that the Natural world obeys precise laws which can be stated using exquisitely beautiful mathematics. Modern science is a relatively recent discipline while, of course, the human quest for understanding is as old as the hills. Scientists, especially theoretical physicists, have often declared that the final theory is just round the corner just like politicians promising the Utopia. Consider the following statements of Laplace and Dirac:

'An intelligent being who, at a given moment, knows all the forces that cause nature to move and the positions of the objects that it is made from, if also it is powerful enough to analyse this data, would have described in the same formula the movements of the largest bodies of the universe and those of the lightest atoms. Although scientific research steadily approaches the abilities of this intelligent being, complete prediction will always remain infinitely far away.' – Laplace 1820.

'The general theory of quantum mechanics is now almost complete. The underlying physical laws necessary for the mathematical theory of a large part of physics and the whole of chemistry are thus completely known, and the difficulty is only that the exact application of these laws leads to equations much too complicated to be soluble.' – Dirac 1929.

With the benefit of hindsight we now know that Laplace was wrong on more than one count. Surely Newtonian dynamics fails at the atomic scale. The old theory of gravitation can hardly explain many astrophysical objects like quasars and blackholes. So the old physics failed not only at small scales but also at large scales. One has also learnt that simplicity of equations can be very deceptive as exemplified for example by the occurrence of chaos in some dynamical systems.

With Dirac, one notices modesty when he is talking about physics though not about chemistry. A very profound change also took place in the passage from classical to quantum theory, namely the conceptual framework physicists use to describe Nature, which to this date remains a matter of controversy.

In Newtonian physics, dynamics is governed by the second law. The force term can sometimes be derived from empirical observation, as in the case of gravitation. With Einstein there was the great shift in paradigm, invariance principles began to occupy the central stage. Today we know that all the forces or interactions known to us can be derived from invariance or symmetry considerations. The advent of quantum theory meant a radical change in the way dynamics is described. We no longer have simple pictures of particle trajectories as in classical physics, which Laplace thought could be described as accurately as one wished, limited only by the computational resources one had. In quantum theory we have the state vector in a Hilbert space, which is pregnant with many possibilities. Only one of these is realized in any specific experiment and there is no way by which the theorist can predict the outcome in advance, although in dealing with averages and the like, no failures of the theory have been reported.

George Sudarshan has made pioneering contributions to the theory of weak interactions and Tony Rothman has wonderful credentials as a physicist and physics writer. In their book, these authors explore several fundamental questions of science within a much wider framework which encompasses not just religion, philosophy, mysticism, etc. but also more mundane aspects of daily existence. What is it that we know for certain? Should we not doubt the tall claims of the scientists despite the unquestioned ability of science and technology to deliver many good things in life?

It is an article of faith for theoretical physicists to claim that the final theory will be a beautiful piece of mathematics. Moreover the theory would be unique, by virtue of its logical consistency and simplicity. All empirical observations either in the microscopic or the macroscopic domain, for both simple and complex systems can be obtained by deductive procedure from the final theory. Is mathematics simply a product of a human mind or is it an intrinsic part of Nature independent of humans? If nature is granular and discrete in the smallest dimensions, from where do we get our picture of smooth manifolds? Very often, one finds that in creative arts like music, painting or poetry, the admiring followers read far more meaning in the works of the author than were probably intended in the first place. In a similar vein, is the beautiful mathematics needed to write the final theory more a product of human imagination rather than something intrinsic to Nature? Putting it differently, if physics can be simulated by a Universal Quantum Turing Machine are all these beautiful properties of Nature, nothing other than human imagination?

Putting aside such doubts, even if we grant the veracity of fundamental laws, how successful are we in understanding things like the flow of time? Boltzmann, one of the great scientists of 19th century, took on himself the task of deriving the second law of thermodynamics from Newtonian dynamics, leading him to prove the famous H-theorem. The problem in accepting Boltzmann's derivation is basically this. Newton's second law which describes molecular collisions is symmetric under time reversal as typified by the example of collision of billiard balls. Using a symmetrical theory as a starting point, how can one get a result which is asymmetric at the end? Did Boltzmann perpetrate a swindle much like a magician pulling a rabbit out of the hat? Like spectators trying to figure out where the rabbit really came from, theorists have spent great efforts, trying to find where exactly is this sleight of hand in the derivation of the H-theorem by Boltzmann. Unfortunately quantum theory does not improve the matter although many theorists have tried to use irreversibility to solve another intractable problem, namely the measurement problem in quantum mechanics.

There are other manifestations of lack of symmetry in the large. For example, the predominance of biological molecules of say, the right-handed ones over their mirror symmetric partners, the left-handed ones, in some cases, and vice versa in yet some other cases. How and where do these asymmetries arise from?

There are many for whom reductionism is anathema. Even disregarding them, one might still ask how far have quantum theorists succeeded in solving problems in condensed matter, not to mention other fields like biology? A simple property like conductivity may require new paradigms when one is dealing with high temperature superconductors for example. Many contemporary brilliant minds have generated more heat than light on this subject.

Now what about realizing Einstein's ideal and dream? What is the status of the superstring theory which has been advocated by its proponents as the theory of everything? An analogy with mathematics can be useful. For a long time, mathematicians, under the baneful influence of theoretical physicists, thought that all mathematics had something to do with Nature. As Marshall Stone put it, in the 20th century they finally got rid of the theoretical physicists enabling the development of mathematics by leaps and bounds. So much so that one applied mathematician quipped that, sometimes, theorems in pure mathematics have their sole justification in the fact that the author could think of them and prove them. I think it is fair to say that string theory is in a similar happy position of allowing theorists to give free rein to their imagination unfettered by ugly experimental facts. Even more than Einstein's dream, his ideal about the role of quantum theory in describing reality has come under experimental scrutiny thanks to John Bell's pioneering work. It suffices to say that opinion about Einstein's idea of reality is divided among contemporary physicists.

There are more difficult questions. If the big bang theory is correct then did time and space have a beginning? If time had a beginning, will it have an end as well? What is the meaning of time translation invariance in such a universe if you are close to the initial singularity?

Roger Penrose has tried to argue that the human mind perhaps does not follow algorithmic procedures as in a computer program. If he is right, we must concede that either physical laws cannot describe the brain and mind or that physics itself cannot be reduced to pure computation, as some have tried to demonstrate.

So there are these great questions discussed in this book, waiting to be answered by the present and future generations of academicians. The reader should not expect a pedagogical exposition since this not the intention of the authors. To paraphrase John Bell, there is a tendency to betray the great enterprise of science and reduce it to the piddling exercise of laboratory experiments or 'researching and publishing' as one local hero put it. Every serious person, not just scientists should read this book. Contemplating the loneliness and insignificance of human beings in this vast universe can be an unsettling experience for weak minds. This book combines deep insights with wit and wisdom in every page.

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Aerosols: Generation and Role in Medicine, Industry and Environment. K. S. V. Nambi and B. K. Sapra (eds). Allied Publishers Ltd, 13/14 Asaf Ali Road, New Delhi 110 002, India. 1998. 314 pp. Price not stated.

Aerosols are fine particles dispersed in a gaseous medium. Generation and removal of these particles, their properties (size, chemistry) and their dispersion are all topics of considerable research and development both in basic and applied sciences. For example, the study and modelling of physical processes contributing to aerosol formation (e.g. evaporation, condensation, nucleation and coagulation) are all relevant not only to aerosol physics but also to understand and characterize natural phenomena such as cloud condensation, droplet formation and particle deposition. Similarly, both the beneficial and adverse effects of aerosols in industry and health have subscribed to major researches in many areas, e.g. production of fine particles of specific size and composition, techniques for coating material surfaces with individual layers of fine particles and development of filters and filtration methods for quantitative removal of particles of various size classes. Aerosols, though encompass a wide range of colloidal systems, are more synonymous with particles in the atmosphere and their studies have gained considerable momentum during the past decade or so as they affect 'our weather, our seeing and in some instances our well being and even survival'[1]. The size distribution, chemical composition and optical properties of atmospheric aerosols are all topics of detailed investigations among atmospheric scientists, climatologists, chemists and physicists, as they influence radiative forcing (hence the climate) and the quality of air we breathe. Aerosol research is thus very topical.

The book under review is the first major publication of the Indian Aerosol Science and Technology Association. This book, edited by K. S. V. Nambi and B. K. Sapra of the Bhabha Atomic Research Centre, Mumbai is targetted for 'promoting this modern science and also awareness about the many facets of aerosols'. Such a goal naturally requires the contents of the book to be broad-based reviews of current topics in aerosol research which can generate scientific interest among a wide range of readers. The book, in addition to a foreword and introduction, has 21 chapters which are divided into five sections – (i) Basic Studies, (ii) Aerosols in Medicine, (iii) Aerosols in Industry, (iv) Nuclear Aerosols, and (v) Aerosols in Environment.

The section on 'Basic Studies' has four chapters dealing with measurable effects of microgravity on aerosol formation, nucleation process in binary mixtures and growth of binary particles, coagulation and coalescence models and theoretical and experimental studies on nucleation of atmospheric aerosols. Mayya and Sapra in their chapter on models of aerosol coagulation have ventured into discussions on reversibility concepts involving thermal dissociation of nanoclusters, an idea which needs to be further explored as it may have implications to irreversible growth of particles.

The three chapters on 'Aerosols in Medicine' describe both diagnostic and therapeutic applications. Atmospheric pollution is a major cause of respiratory diseases. These pollutants enter the human body through inhalation. The

chapter on 'Diagnostic Applications of Radioaerosols' describes the use of inhalation imaging for diagnosis of a wide range of pulmonary diseases. Advances in radioaerosol generation, their emplacement and their imaging all have contributed to enhanced sensitivity of radioaerosol techniques to investigate pulmonary diseases and bring to light yet another application of nuclear medicine. The chapter by Soni and Raghunath on 'Aerosol Generation and Delivery in Medical Applications', describes in detail the aerosol generation/delivery system developed by BARC scientists and its applications to study respiratory ailments. It is heartening to note that IAEA experts have rated this system highly in terms of aerosol characteristics for pulmonary system studies, contributing to India's standing in this field.

The four chapters on 'Aerosols in Industry' describe the use plasma generators for production of high intensity aerosols, the application of aerosols to assess efficiency of filters, advances in material synthesis and surface coatings by plasma techniques and modern trends in development of aerosol paints. Some of these chapters, in addition to providing limited overviews of current status of the field, also describe developments being made at BARC, such as plasma torch for production of high intensity aerosols, approaches to test HEPA filters, etc. The use of aerosols in the manufacture of specific materials with unique properties has brought about major advances in production of nanoparticles. The removal of aerosols from ambient environment is equally important as they can contribute to health hazards; this makes filtration industry a key component of aerosol science. A limited compilation of performance evaluation of air cleaning systems is contained in the chapter by Kumra and Ramarathinam. This summary, however, may not be up-to-date as the most recent reference cited is 1987 with bulk of them dating pre-1980. In contrast, the chapter by Venkataramani and Ananthapadmanabhan which presents approaches involving thermo-chemical effects in material processing has majority of references post-1990, with some as recent as 1998. This comparison shows how current the various chapters in this book are.

The last two sections of the book are on 'Nuclear Aerosols and Aerosols in Environment'. Nuclear aerosols are generated during fuel processing, reactor operations, waste management and nuclear accidents. Studies on nuclear aerosols have advanced considerably in recent years because of larger dependence on nuclear energy and potential risks involved in their generation. Atmospheric aerosols are also often radioactive, resulting from the attachment of cosmic ray produced and U–Th series radioactive nuclides onto them. Nambi's chapter in this section is a limited survey of atmospheric radioactivity and its applications, to study atmospheric transport processes and ventilation rates of indoor aerosols. This chapter would have been more rigorous and current if it had included discussions on various processes and models of transport and recent studies on application of environmental radioisotopes to source atmospheric consti tuents[2,3].

The first four chapters in the section on 'Aerosols in Environment' deal with the physical, chemical and optical properties of atmospheric aerosols, their size distribution and their impact on radiation budget of the atmosphere and hence climate. These aerosols also provide surfaces for heterogeneous chemical reactions which influence ozone budget of the atmosphere. The lack of adequate time series data on the abundance and properties of atmospheric aerosols has hampered their incorporation in Global Circulation Models and hence proper assessment of their role in influencing radiation budget. In recent years attempts are being made to overcome this lacuna through systematic study of atmospheric aerosols at several stations over India and its adjoining seas. Some of these data and their applications are contained in these chapters. Special mention must be made of the INDOEX campaign being carried out over the Arabian Sea and the Indian Ocean for simultaneous measurement of aerosol, trace gas and other atmospheric properties to derive quantitative information on aerosol climatology. The last three chapters of the book focus on air quality, with emphasis on the sources, abundance and distribution of PAHs and pollens and their impact on human health.

On the whole, the strength of the book is in the variety of topics it has presented which offers a good starting point for beginners in aerosol research. In this context, the book may serve at least part of its purpose, 'to cover a wide spectrum of aerosol applications, . . . to keep the contents sufficiently general and make the book interesting to a wide range of readers. . .'. This approach as mentioned in the foreword, has to some extent made the quality of some of the articles in the book superficial and hence less interesting and less stimulating to read. I would have liked the chapters to be more exhaustive, critical and up-to-date with suggestions for future research in various topics. How can one promote aerosol science without adequate vision for the future? In spite of these observations, I feel that this is a useful book which can provide interested scientists, particularly those from India, entry into several aspects of aerosol research, with emphasis on research being carried out in India. A topic of current interest among Global Change Science Community is on the atmospheric deposition of nutrients and trace elements over the oceans and its impact on biological productivity. Inclusion of such topical issues in this book, I feel, would have enhanced its utility. The book is hard bound and reasonably well printed but the quality of many figures is not up to the mark. It would have been nice if the book had a subject index.

Summing up, the Indian Aerosol and Technology Association has done a good job in its maiden effort by bringing out this book as its first major publication.

1. Twomey, S., *Atmospheric Aerosols*, Elsevier Scientific, Amsterdam, 1977.
2. Turekian, K. K. *et al*., in *Chemical Oceanography* (eds Riley, J. P. and Chester, R), Academic Press, San Diego, 1989, vol. 10, pp. 51–81.
3. Savoie, D. L. *et al*., *J. Geophys. Res*., 1992, **97**, 11575–11589.

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The Great Indian Elephant Book: An Anthology of Writing on Elephants in the Raj. Dhriti K. Lahiri-Choudhury (ed.). Oxford University Press, New Delhi. 1999. 459 pp. Price: Rs 595/US $ 14.

It is said that any matter being published by the Oxford University Press (OUP) is like being married to a Duchess; the honour is greater than the pleasure. But on reading Lahiri-Choudhury's book, it appears that the former Professor of English at Calcutta's Rabindra Bharati University and one of the founder members of the IUCN's Asian Elephant Specialist Group, must have derived great pleasure too in compiling the collection of excerpts on the changing perception of the Indian elephant and the sportsman's ways with it under the British Raj. In his introduction, which is the best item in the book, Lahiri-Choudhury provides an extremely interesting analysis of the use and abuse of the elephant in war and peace in the nineteenth century by the British colonial rulers even as they were hunting it across its range in the Indian subcontinent. He is well placed to comment on both the hunter and the hunted, as he too had brought down a couple of magnificent rogues with his rifle (although not for sport but in response to growing conflict between man and beast in north-eastern India).

Lahiri-Choudhury's book deals with the period that began in 1773 when British rule was imposed in India, and where the elephant itself subsequently became the emblem of imperial power. The book also covers Ceylon (Sri Lanka) given its geocultural and historical links with India. In his book, Lahiri-Choudhury attempts to discuss two aspects of the elephant: the changing perception of the elephant and the sportsman's ways with it. When the British took control of the Indian subcontinent, elephant and other wildlife were so numerous that people were encouraged to hunt and eliminate them in vast numbers. Sport was an abiding passion for the British, hunting and polo for the upper classes, a bit of football for the lower orders. As Ann Morrow points out in her book *The Maharajas of India*, sport was thought an important way of 'sweating the sex' out of the other ranks. The British upper classes loved big-game hunting wherever they went, blood sports being the closely guarded privilege of the top drawers. But not everyone who was sent to rule India during the British Raj, came from the ruling class. Hunting was not just a sport, but a symbol of status as well, the criterion being the number of animals one shot. The size of the hunted increased the status of the hunter so much that some measuring tapes that were used had 11 inches to a foot! Thus, big-game hunting, as Lahiri-Choudhury argues, became a short-cut to the status of being a gentleman. That was their way of proving their credentials to their peers. But hardly any colonial who shot elephants recognized the courage of the native trackers and *shikaris*, who often went ahead of the well-armed white *sahib*! Even G. P. Sanderson sent two of his unarmed trackers ahead of him after wounding an elephant. Shooting elephants was far more thrilling than hunting foxes back home. No wonder then Lord Curzon once implored a friend of his to 'come and stay with us and we will arrange for you to shoot tigers from the back of elephants or elephants from the back of tigers'. Both the Indian princes and their British guests were inveterate hunters. In some princely states of the Maharajas, hunting was a major form of recreation and dead elephant's feet held umbrellas; tusks were used for gongs, and the penis made a stalwart golfbag! For the Hindus however, the elephant being a symbol of Lord Ganesha, its killing is and has always been taboo. While the upper class Englishmen loved the sport of elephant hunting, the upper class Hindus loathed it. Even in predominantly Buddhist Ceylon, elephant hunting was never popular among the people, although capturing and training elephants for use in war and peace was an established art. Elephants were protected by kings in Ceylon, and it was in 1826 that their hunting became an accepted form of sport. At least 40,000 Asian elephants were killed or captured during the past century in India alone.

The book is divided into four sections: the first deals with the changing perceptions of the people who hunted elephants; the second deals with the dangers associated with the game of shooting elephants in India; the third deals with encounters of elephants in Burma, and the fourth is confined to Ceylon. These carefully selected excerpts from 23 contributors, provide us a historical perspective of the changing attitude of the colonial hunter to the elephant and his role in its endangerment. Lahiri-Choudhury begins his anthology with W. W. Hunter's account of William Makepeace Thackeray, grandfather of the novelist, who at the age of 17 joined the East India Company in East Bengal (Bangladesh today) at an annual salary of Rs 495 (or 62 pounds). Thackeray augmented his meagre salary by private trade of supplying elephants for the Company's troops. He became a mighty hunter of elephants. His main source of income was the destruction of tigers and the capture of wild elephants. The attitude of the colonials changes from regarding the elephant as an instrument of short-term profit to valuing it subsequently for pleasure, when it became an object of sport hunting. The Government of the day in fact promoted the slaughter by offering a bounty for each animal that was killed. The impact of this policy was seriously felt in South India and Ceylon where elephants declined substantially in both range and number. In Sri Lanka, Samuel Baker and his colleagues were responsible for wiping out entire herds of elephants, collecting only their tails as trophies from the largely tuskless individuals. Baker even explains the difference between killing and shooting an elephant. Furthermore, since elephants were so numerous and widely distributed, there was hardly any recognition of the need to conserve the species. It was F. W. Champion who became appalled at the mindless slaughter of the magnificent animal, which he referred to as 'perhaps the finest of God's wild creatures'.

But the real study of wild elephants according to Lahiri-Choudhury, began with Captain Thomas Williamson in 1807, and continued with the publications by Sir Emerson Tennent in 1867 and G. P. Sanderson in 1878. Tennent's authority lost out to Sanderson's in due course. A few of Tennent's contemporaries did not take his writings seriously. John Macdonald Henderson used an old quip to describe it – 'all that is true in it is not new and what is new in it is not true'. Sanderson rubbished Tennent's work, *The Wild Elephant*, being 'full of the errors which are unavoidable when a man writes on a subject with which he has no practical acquaintance . . .'. Sir Emerson Tennent was nicknamed 'Sir Timorsome Emmet' by his colleagues in Ceylon, on account of his exploit in running away from a crowd! Elephants in the wild were studied over the barrels of a rifle first before

binoculars and notebooks replaced them. G. P. Sanderson's *Thirteen Years Among the Wild Beasts of India*, published in 1878, still remains a classic. Col. F. T. Pollock on the other hand, was spot on when he compared the temperament of an elephant under stress, to that of women – 'uncertain, coy and difficult to please'. He also correctly measured the approximate shoulder height of an elephant by multiplying the circumference of its forefoot by two – a fact that was well known to the elephant catchers in Ceylon long before Pollock's time.

Reading Lahiri-Choudhury's carefully selected excerpts makes it clear that a number of hunters contradict each other on the basis of their own experiences and ignorance. There is considerable confusion over the longevity of the species in the wild. While Tennent, on the information he received from knowledgeable natives estimated it as 70 years, he also quotes one Colonel Robertson, who found a domesticated elephant in Ceylon, whose records indicated that it might have lived to more than 140 years! Sanderson betrayed his ignorance of the average life span of an elephant in the wild by putting it around 150 years. One of the most renowned travellers of the seventeenth century, Jean-Baptiste Taverneir too mentions in his classic, *Travels in India* that 'an elephant's age sometimes amounts to 120 or 130'. Furthermore, the exploits of the British hunters were published largely for the consumption of the British audience both in the colonies and in the mother country. Such publications appeared in *Country Life* and *Field* in England. The natives did not exit in the subconscious of the colonials. An exception is Sanderson, who acknowledges the fact that 'the elephant is essentially a native's animal. Natives alone have fully studied his peculiarities and classified him into castes; his capture, training and keeping are in native hands, as well as the trade; and the native standard of merit regulates the market . . .' The exploits of the colonial hunters do not advance the cause of elephant conservation today. Elephant and wildlife conservation in the Indian subcontinent grew out of the innate concern of the Buddhists and Hindus for the welfare of the animals. However, the need to set up special reserves for protecting wildlife, including the elephant, arose from a concern by the very people who exploited wildlife – namely the British colonial hunters – who feared that at the rate they were exterminating wildlife, there would be no game left for hunting!

Lahiri-Choudhury's book provides interesting reading for the wealth of first hand information it contains on the elephant both in the wild and in captivity. As many of the primary sources, Lahiri-Choudhury has consulted are no longer readily available to those of us working outside India, the book becomes a valuable adjunct. It also helps us understand the time and culture and mind-set of the colonials who took to the sport of big game-hunting. If there is a message in the book, it is that an understanding of the past could be the beginning of wisdom.

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The Khulgad Project – An Experiment in Sustainable Development. K. S. Valdiya (ed.) Gyanodaya Prakashan, Nainital, India. 1998. 134 pp. Price not stated.

The book under review reflects the coordinated efforts of a team of sincere scientific and social workers. Sustainable development is the need of the hour today. The organization called Central Himalayan Environment Association (CHEA) at Nainital has done a commendable job in performing this experiment on sustainable development selecting the Khulgad catchment as the project area. The selection of the site is ideal and the vision for attempts to develop the hill region is extraordinary.

K. S. Valdiya has compiled and edited the set of relevant papers in a lucid and befitting manner. All the papers truly reflect the aspirations of the people. The paper entitled 'Building effective and lasting organizational culture for developmental changes' by D. P. Joshi, portrays a vivid description of the project pertaining to the national scenario of the state-of-the-art CHEA's objectives and modus operandi, its goal and the administrative and financial management of the embarked project. The paper entitled 'Appropriate land use and development of sustainable agriculture in Uttarkhand: 'Learning lessons of the Khulgad microwatershed project' by S. L. Shah and T. C. Upreti, reflects the appropriate land use strategies, the method of identification of technology package, modus operandi of programme implementation as well as application of the project. However, the diagrams have not been properly captioned.

Water is generally scarce in the hill regions. As such, it must be well-managed and conserved. The paper entitled 'Management of water resources: Spring sanctuaries' by S. P. Rai *et al.*, opines that the discharge patterns indicate that the amount of spring discharge is controlled by geological structures and secondarily by land use pattern and the nature and extent of vegetal cover. Such an original finding has further been emphasized by their assertion that the principle underlying the development of a spring sanctuary is that the rainwater infiltration in the identified re-charge area be induced or increased by resorting to engineering and biological methods so that there is an augmented discharge in the springs downslope.

U. C. Shah's paper entitled 'Increasing farmer's income through horticulture' is very attractive and encouraging in view of the simple method of generating income and employment through community horticulture.

Male dominance is sometimes a curse in the Indian society, particularly in the tribal community in the hills. Anuradha Pande in her article on 'Gender perspective in the Khulgad project' has brought out the worries and aspirations of the women as well as the challenges they have taken up in resource management; also, the efforts made by them in bridging the gap by setting up different women's groups in managing the resources.

The fragile environment of today needs immediate ecodevelopment for the sake of human beings and other organisms living in it. A. D. Moddie has very lucidly and vividly described sustainable ecodevelopment through a case study.

Modern industrial development could sometimes be considered as a curse in view of the different health hazards involved in such industrial developments. But ecofriendly developments are blessings to us. R. D. Khulbe and L. S. Bisht have summarized the importance of environmental health awareness programme in such projects.

Finalization of the project report by D. P. Joshi *et al*. highlighting the whole project implementation programme with particular emphasis on the importance of planning and sustainable use, is unique. The efforts displayed by the project staff in aggregating the womenfolk and forming different women's organizations like Mahila Mangal Dal and Pani Panchayat are worth emulating.

Most of the photographs are well-printed and to the point. The book begins with detailed contents and ends with the appendix indicating the names of the CHEA project staff and the project management committee, as well as the list of contributors who are well-experienced in their respective work.

The publishers deserve commendation for publishing this book which has a large audience.

The Ford Foundation has really chosen the right organization with the right persons in advancing the grant for this kind of social work and basic research.

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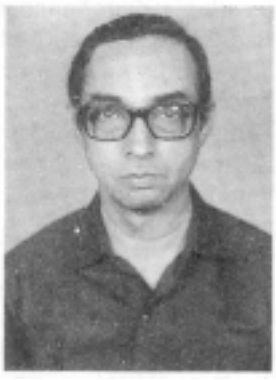
PERSONAL NEWS

Chanchal Kumar Majumdar (1938–2000) – *An obituary*

Chanchal Kumar Majumdar, an exceptionally gifted condensed matter physicist, passed away in Calcutta on 20 June 2000. His death was so unexpected that it came as a rude shock to the scientific community.

Majumdar had a brilliant academic record in Krishnanagar and Calcutta. Subsequently he obtained his doctoral degree in physics from University of California, La Jolla in 1965 under the supervision of Walter Kohn who went on to win the Nobel prize in Chemistry in the nineties. With Kohn he proved a theorem (the Kohn–Majumdar theorem) on the continuity of the bound and unbound states of the Fermi gas. From 1965 to 1966, Majumdar held a post-doctoral position in Carnegie Institute of Technology (now called Carnegie-Mellon University), Pittsburgh before joining the Tata Institute of Fundamental Research (TIFR) in Mumbai. From TIFR, he had another post-doctoral stint in the University of Manchester. In Pittsburgh and Manchester, Majumdar came in contact with stalwarts like James S. Langer and Sam F. Edwards, though he chose to work independently on the analytic properties of the Onsager solution of the Ising model and non-exponential stress relaxation in glasses.

TIFR days were the most productive for Majumdar. He had a group of several bright students and with them, he tackled a variety of problems with deep mathematical insight. They include the three-magnon bound state equation, Heisenberg antiferromagnetic chain with known ground state, the critical isotherm of the Ising model and of the Lennard–Jones gas, the band structure of cerium, spin waves in finite magnetic chains, etc. It is interesting to note that during those days in India, what we now know as condensed matter physics was dominated by lattice dynamics. Majumdar was a rare



exception amongst his peers. He was well-versed in then-current subjects of statistical mechanics and critical point phenomena, and their applications to electron states and magnetic properties of solids.

Perhaps the most important contribution of Majumdar for which he is internationally known is the work (with Dipan Ghosh in 1969) on the exact enumeration of the ground state of an anti-ferromagnetic chain, with specially ascribed values for nearest neighbour and next nearest neighbour interactions. This work on what is now part of the folklore as the Majumdar–Ghosh Hamiltonian is a wonderful illustration, as it were, of how open-ended basic research can be. Almost two decades later the model led to a prototype 'resonating valence bond' state, in the context of high temperature superconductivity. One other point is noteworthy here. The years 1965 to 1975 had not yet seen the growth of computational physics as is extant in India today; Majumdar indeed was a pioneer computational physicist of our country. In 1976, he was awarded the Shanti Swarup Bhatnagar prize in Physical Sciences, and in the same year was elected Fellow of the Indian Academy of Sciences.

The decade from 1976 to 1986 marked a new phase in Majumdar's life. As Palit Professor of Physics in Science College of Calcutta University and Head of Magnetism/Solid State Physics Department of the Indian Association for the Cultivation of Science (IACS), he devoted himself to education, teaching and curriculum development. In addition, he switched interest to down-to-earth experimental studies, applying his early work (1965–1970) in the theory of positron annihilation spectroscopy to radiation damage, and also involving Mössbauer spectroscopy of corrosion and inhibition of iron ores in eastern India. His other experimental contribution included the enhancement of

the critical temperature of high temperature superconductor due to alpha bombardment. Much of these experiments were carried out by Majumdar's collaborators and students at the Palit Laboratory, IACS and the Variable Energy Cyclotron Centre. He was elected to the Fellowship of the Indian National Science Academy (INSA) in 1982.

The final phase (1987–1999) of Majumdar's professional life began when he was appointed the Founder Director of the newly established Satyendranath Bose National Centre for Basic Sciences. This period saw him in the role of an institution-builder. He devoted himself tirelessly to the development of infrastructure facilities of the new centre. He also lent active support to various workshops, seminars and conferences organized in the centre by different national bodies as well as teachers' training programmes.

Chanchal Kumar Majumdar was a versatile individual. An evidence of his enigmatic dexterity is the project he undertook in 1992 on the simulation of fluid flow on the Hoogly Estuary by parallel programming. The word 'Chanchal' in Bengali means *restless*. He no doubt had a restless mind. After retiring as Director of the Bose Centre in February 1999, he took up the position of an INSA Senior Scientist at the Indian Statistical Institute from March 1999 and started working on 'History of Science'. Majumdar's sudden death has snatched away at an early age a truly extraordinary personality.

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