

research reactors and the mother of all research and developmental activities in the atomic energy programme, BARC, with well above 10,000 scientific and technical personnel on its payroll, is the largest science and technology centre in the country. The book tells us about the units with specific mission orientation that BARC spawned in different parts of our country over the years. Notable among these are the Electronic Corporation of India at Hyderabad, the Centre for Advanced Technology at Indore, the Variable Energy Cyclotron Centre at Calcutta, and the Indira Gandhi Centre for Atomic Research (IGCAR) at Kalpakkam. Exploration, mining, and extraction of atomic minerals are carried out by two DAE organizations, the Atomic Minerals Division and the Indian Rare Earths Ltd. India has proven uranium reserves of 86,000 tonnes of uranium oxide while thorium reserves, mainly in Kerala, are much larger at around 360,000 tonnes. To exploit the large reserve of thorium and the naturally occurring isotope of uranium $U-238$ as nuclear fuel in power reactors one needs to develop the fast breeder reactor technology. This technology is still at a developmental stage. A fast breeder test reactor in IGCAR became critical in 1985. Operation, management, and construction of nuclear power reactors were brought under the aegis of the Government owned Nuclear Power Corporation in 1987, while earlier in 1983 the Atomic Energy Regulatory Board was put in place to oversee and carry out regulatory and safety measures in all nuclear installations. The place of pride in the book is given to the successful nuclear explosions in Pokaran I and Pokaran II. For the benefit of readers the book presents a long interview on the subject with the present Chairman of AEC, R. Chidambaram, who has seen both.

Generation of electrical energy from nuclear reactors for industrial use is the touchstone of success of any civilian atomic energy programme. Precisely this has been the Achilles' heel of the DAE. By the end of 1997 the share of nuclear power in the total electricity output in the country is a paltry 2.2% (ref. 4), and that too at an enormous cost. Out of the ten power reactors in the country, the two oldest in Tarapur, obtained on a turnkey basis from General Electric, have been relatively trouble free. Commissioned in 1969, these two boiling water reac-

tors (BWR), each designed to generate 210 MWe (later downrated to 160 MWe) have been in operation for more than 29 years. Subsequently, DAE adopted the policy of building pressurized heavy water reactors (PHWR) for the production of electricity and plutonium. Among the eight PHWRs commissioned to date, the two oldest near Kota in Rajasthan were designed and supplied by Canada. The remaining six, two near Chennai, two at Narora in UP, and two at Kakrapur in Gujrat were designed and built indigenously. Remarkably prone to accidents, the Indian PHWRs have been plagued by time and cost overruns right from the beginning. Designed for installed capacity of 235 MWe each, the units have been downrated to 220 MWe or lower. If one leaves out Pakistan, the average load factor at 50% of the eight Indian PHWRs is the lowest in the world⁴. The corresponding figure for the Chinese reactors is 72.56%. In his lecture in January 1966, reproduced in the book, Bhabha observed with a sense of pride that the research reactor *Apsara*, designed and built indigenously, was already two years in operation before China had its first reactor in place, designed and built by the Soviet Union. The advantage that India had in the atomic energy programme initially has slipped away in the last four decades, perhaps irretrievably. Successful explosions in Pokaran I and II have apparently brought some cheer to this dismal scenario but they are diversions into military use of the atomic energy.

Underperformance of the PHWRs and the cost and time overruns in installing them have been the underlying reasons for the decision to purchase two Russian reactors of 1000 MWe each. In fifty years, the principle of self reliance, the cornerstone of the Indian atomic energy programme, has become the casualty. All these years, scientists and technologists of the country at large could contribute very little in this great national effort and were kept waiting with muted expectations outside the wall of secrecy which Saha tried so hard to demolish.

1. Saha, M. N., *Sci. Cult.*, 1941, 6, 694. Reprinted in *Collected Works of Meghnad Saha* (ed. Chatterjee, S.), Saha Institute of Nuclear Physics, Calcutta, 1982, vol. 1, p. 361.
2. Saha, M. N., *Sci. Cult.*, 1954, 19, 368. Reprinted in *Collected Works of Meghnad Saha* (ed. Chatterjee, S.), Saha Institute of

Nuclear Physics, Calcutta, 1982, vol. 1, p. 470.

3. *Meghnad Saha in Parliament* (eds Chatterjee, S. and Gupta, J.), Asiatic Society, Calcutta, 1993, pp. 169–206.
4. *Nuclear News Digest* compiled by Kalyane, V. L., Library and Information Services, BARC, Mumbai, 1998, vol. 11.

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Classical and Spatial Stochastic Processes. Rinaldo B. Schinazi. Birkhäuser Verlag AG, P.O. Box 133, CH-4010, Basel, Switzerland. 1999. 192 pp. Price: SFr 98/DM 118.

Undergraduate or post-graduate courses in stochastic processes are generally centered around Markov processes and Brownian motion. Most reference books, written for undergraduate/post-graduate readers, also emphasize these two aspects of the topic at the exclusion of a wide range of spatial stochastic processes. This book however, presents topics on spatial processes which could be introduced at an undergraduate or post-graduate level to initiate students to the exciting developments that have taken place in these subjects over the last three decades.

The first three chapters of the book deal with Markov chains, both discrete and continuous time. These chapters cover the standard results on classification of states, recurrence and transience, existence of stationary distributions, renewal theorem, passage times, etc. An interesting feature of the treatment of these topics here is that unlike in classical books^{1,2}, many of the proofs employ Doebelin's coupling technique, thereby simplifying the proofs and also making them more intuitively appealing.

The remaining four chapters are on spatial processes, viz. percolation theory, cellular automaton, continuous time branching random walk and contact processes. A lot of work has been done in recent years by mathematicians and physicists on these topics and these chapters provide a nice introduction to them.

The chapter on percolation theory focuses on percolation on binary trees. The critical value of percolation and the related critical exponents are obtained using Bienaymé–Galton–Watson branching process techniques. Besides this a few results on percolation on the integer lattice (including the exponential decay of the probability that there exists an open cluster of the origin of diameter n) are represented. An important ingredient here is the Riemer–van den Berg–Kesten inequality whose proof, unfortunately, is beyond the scope of this book. (For an interesting proof of this inequality using the statistical notion of sufficiency see Gupta³.)

In the chapter on cellular automaton the author establishes that the critical value p_c equals 0 and introduces renormalization techniques. Such techniques, which have their origin in physics, have been adapted very successfully by researchers to obtain rigorous results in all topics of spatial processes.

Branching random walks and their continuous time versions also exhibit phase transition and they are presented in Chapter 6. Both the global and local survival probability are studied and their continuity properties are discussed.

The final chapter on contact processes is studied on a homogenous tree. Here too phase transition and critical phenomena are developed and a flavour of the results on contact processes on the integer line are given. In addition some open questions are presented.

The author introduces each chapter in the style of the 18th century European literary works with a short description of what each section of the chapter contains. In addition, each section ends with problems. This will be helpful to teachers who use this book as a text.

This is a very well-written book and may fruitfully be used to develop a one-semester course on stochastic processes where the emphasis is on introducing the various spatial processes which are receiving considerable attention among the current generation of mathematicians and physicists.

1. Spitzer, F., *Principles of Random Walk*, Springer-Verlag, New York, 1976, 2nd ed.
2. Chung, K. L., *Markov Chains with Stationary Transition Probabilities*, Springer-Verlag, Berlin, 1967, 2nd ed.

3. Gupta, J. C., *Percolation Theory and Particle Systems* (ed. Roy, R.), University Press, Hyderabad, 1999.

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I Predict: Exploring India's Population Scenario. Vasant Gowariker. Bharatiya Vidya Bhavan, Pune Kendra, 407–408, Late Dr K. M. Munshi Marg, Shivajinagar, Pune 411 016, India. 1998. 101 pp. Rs 75.

There are three views on India's efforts to control population growth. At one extreme is the view that in spite of investing crores of rupees in family welfare programmes, decline in population growth is not encouraging. This may be called a pessimistic view. At the other extreme is the view that population growth rate in India has come down sharply, that it is now self-propelling and that we can sit back and relax. This may be called an optimistic view. Between these two extreme views is one which may be called a realistic view – that population growth rate has come down throughout the country, though in varying degrees, and that with continued efforts India should be able to turn the corner. Vasant Gowariker's view falls in the middle category, that is, the realistic view.

The book under review is an abridged version of Gowariker's earlier writings on India's population dynamics. The author elicited the views of about 75 academicians, intellectuals and experts on the complexity of India's population dynamics. One chapter contains a synthesis of views of academicians and intellectuals and another includes a synthesis of those of experts. I, for one, could not make out as to who is an academician, who is an intellectual and who is an expert.

As may be expected, their views varied widely. The author synthesizes all these views. It would have been better if he had synthesized these views into different topics and sub-topics like birth rate,

death rate, growth rate, age at marriage of boys and girls, family welfare programme, etc.

Although Gowariker is not a demographer and not even a social scientist, he has shown a remarkable understanding of India's population dynamics. He is a chemical engineer. Perhaps not being a demographer or social scientist has enabled him to look at the problem more objectively.

After considering the views of leading academicians, intellectuals and experts, Gowariker forms his own views and arrives at the conclusion that India will attain a net reproduction rate (NRR) of one within a decade from now. The census results of 2001 are likely to confirm his views. He further says that India could solve the population problem without resorting to coercion and compulsion and without deviating from its prideful identity as the largest democracy in the world.

Many demographers, especially foreign demographers, have predicted that India will be the most populous country in the world by 2035 or so. But Gowariker predicts that India's population will not exceed China's.

Although Gowariker appreciates the efforts made by India in controlling population growth, he does not advocate complacency. He offers three suggestions for further bringing down population growth: Firstly, India has been successful in controlling population growth and that this should be recognized; but efforts to control population growth should be continued. Secondly, the electronic media, especially the power and reach of television, should be exploited to educate and motivate people to accept family planning methods. Thirdly, India should achieve total literacy as early as possible. Obviously, the suggestions are not exhaustive.

Gowariker has a read-me style of writing. He has written this book on a technical subject in a non-technical language avoiding demographic gobbledegook. The book is worth reading not only by demographers, but also by those who want to know about India's complex population dynamics.

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