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.

J. PASUPATHY

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

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.

S. KRISHNASWAMI

Chemistry Building,
Earth Sciences Division,
Physical Research Laboratory,
Navrangpura,
Ahmedabad 380 009, India
e-mail: swami@prl.ernet.in