Thinking about Physics. R. G. Newton. Princeton University Press, 41 William Street, Princeton, NJ 08540, USA. 2000. 198 pp. Price: US $ 24.95.

In our endeavour to unravel the mysteries of nature, it is perhaps very difficult to confine the description of its working to axiomatization. Nevertheless, one hundred years ago on 8 August 1900, at the International Congress of Mathematicians held at Paris, David Hilbert stated as the sixth of the twenty-three problems for the twentieth century, 'axiomatization of physics and other sciences allied to mathematics'. And now we know that in the history of man's quest for understanding the working of nature, the twentieth century has witnessed the development of two great theories, one at each extremity of the length and time scales, the general theory of relativity at the upper end and quantum mechanics at the lower end. While the general theory of relativity was a single-handed stroke of a genius, the development of quantum mechanics was a 'cooperative phenomenon'; it was known as 'boy physics' in the beginning of 1925 in the Göttingen circle centred around the legendary David Hilbert, 'because so many of the great discoveries were being made by physicists in their twenties'. Both these theories have greatly influenced the development of twentieth century mathematics: Riemannian geometry by the general theory of relativity and functional analysis by quantum mechanics.

But the deeper part of quantum theory, namely quantum theory of fields, born as a result of merging special theory of relativity and quantum mechanics in a single framework will, according to Edward Witten, exert a greater influence on the development of twenty-first century mathematics. Quantum theory of fields has come to stay; it appears to provide a natural setting for exploring, describing and understanding a variety of diverse phenomena spanning elementary particle physics, nuclear physics and condensed-matter physics. The modern non-abelian local gauge field theory has its origin in the seminal idea of Hermann Weyl that if the gravitational interaction could be described by an 'affine connection', then other interactions like electromagnetism must also be amenable to such a 'geometrical' description. The standard model (of elementary particle physics) based on non-abelian gauge field theory has brought about the unification of electromagnetic, weak and strong interactions. The grand unification, i.e. bringing gravity also into this fold, is the 'Holy Grail' of theoreticians.

The present state of affairs as well as the pointer to the future are brought out clearly in the following words of Edward Witten. 'We have the vast Himalayan range, most of which is still covered with fog. Only the loftiest peaks, which reach above the clouds, are seen in the mathematical theories of today, and these splendid peaks are studied in isolation, because above the clouds they are isolated from one another. Still lost in the mist is the body of the range, with its quantum field theory bedrock and the great bulk of the mathematical treasures'. He makes 'one rather safe, though perhaps seemingly provocative, prediction about twenty-first century mathematics: trying to come to grips with quantum field theory will be one of the main themes'. It is this *quantum field* which the author of the present book under review regards as the 'basic entity with "particles" – possessing great intuitive appeal but circumscribed utility – appearing as phenomena produced by the field'.

Although according to the author the 'book consists of a number of more or less independent essays', I feel that in the first five chapters the ground is well prepared for a discerning reader to grapple with the deeper issues in the last three chapters. The common thread 'consisting of the pervasiveness of probabilistic approaches and the central role played by mathematics, with the quantum theory of fields as the most basic description of reality' is well woven into the fabric of elucidation of various definitions, principles, notions and concepts.

Among these, of particular interest and also central to the 'weirdness' of quantum mechanics is the discussion on *entanglement* or *phase correlation*. The term phase refers to the state of motion and in classical physics it is specified by the position and momentum as functions of time. When we say that two particles are executing simple harmonic motion in phase it means that their positions and momenta are identical. Certainly the two particles cannot occupy the same position at the same time. There is thus some sort of *non-locality* implied by the term phase, which in turn alludes to 'waves'. And only in the context of comparing the states of motion of waves does the concept of *coherence* enter the picture. Unlike in quantum physics 'state of a classical system of particles, either probabilistic or causal, has no room for the concept of coherence'. A wonderful example (from quantum physics) of relevance here is the Josephson effect in which the condensate wave function describing an assembly of superconducting electrons exhibits amplitude and coherence on the macroscale. To the entanglement of or phase correlation between spatially separated particles in quantum description, there is no classical analogue.

This book provides an excellently organized guided tour through such topics as classical mechanics, quantum mechanics, field theory, the role of mathematics in physics, symmetry in physics, thermodynamics, the arrow of time and the concepts of probability and causality. The author has coherently packed into this volume the substance of the 'art of science', and that, in my opinion, involves the evolution of the level of pattern recognition to greater and greater heights. The entire discussion culminates in the question, 'what is reality?'. Reality, according to him, in the sense of the *macroworld* is not the same as that in the *submicroworld*. The language of classical physics is inadequate to describe the submicroreality. This can be best illustrated by the oft-experienced fact that the efficacy of an idiomatic expression or a proverb in a language will be lost when one attempts translation. For the process of recording, assimilating and communicating experiences the most effective language is mathematics. Unfortunately this language is not 'accessible to the understanding of most non-scientists or natural to the intuitive sense of many physicists'. When one resorts to the use of metaphors for effective communication, it entails a loss of precision and carries the risk of misunderstanding. Hence when the submicroworld is viewed in the mirror of the macroworld perhaps it seems 'weird' and 'counterintuitive'.

Thinking about Physics will really set the readers thinking about physics. Physics is much more than merely solving problems and our students certainly need orientation in this direction. To cite an example from my own experience, definitely not at the level contemplated by the author, for the problem of vibrations of a one-dimensional monatomic lattice, once the dispersion relation is obtained, the students think that is the end of the game. Questions such as 'Why does the dispersion curve start deviating from linearity at a certain point?' or 'In what manner does the dispersion curve intersect the zone boundary?', do not arise in the minds of the students. Such being the 'reality' in our institutes of higher education, the author is well justified in exhorting the students to 'spend time *thinking about physics* rather than simply *doing* it' which will enable them to delve into the deeper issues and their implications.

Although the book is addressed to students with good undergraduate training in physics, I strongly recommend that our postgraduate and doctoral students and young as well as senior faculty members in colleges and universities go through this book thoroughly.

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Electron Microscopy in Medicine and Biology. P. D. Gupta and H. Yamamoto (eds). Oxford & IBH Publishing Co Pvt Ltd, 66, Janpath, New Delhi 110 001, India. 2000. 204 pp. Price: Rs 950. ISBN 81-204-1374-1.

Science has always been driven by technology and instrumentation. The electron microscope, for the last four decades, has been a popular and powerful tool to study the subcellular and macromolecular structure and has contributed to substantial advances in biology and medicine. Its versatility is evident from the fact that it has been possible to combine its use with immunohistochemistry as well as molecular biology and molecular genetics, besides advances in its own technology for study of elements and 3D visualization of subcellular structures. It is, therefore, probably not inappropriate to have a book on electron microscopy in medicine and biology in the present times.

The book, based on a conference and an Indo-Japanese symposium at Hyderabad in 1998, has a varied collection of chapters that span a wide range of topics dealing with basic and applied sciences. The volume covers technological advancements, plant and animal cell biology, membranology, chromosomes and nuclear organization, pathology of diseased tissues and cancer biology. The chapters on nuclear spatial organization, stereoscopic ultrastructure of cell nucleus and chromosome, as well as organization of gut-associated lymphatic tissue have some very remarkable photographic illustrations. The chapter on development of non-carbon support films for observing carbon images of biological materials is useful. The chapters in medicine and pathology which discuss mechanism of graft healing, primary epithelial amyloid keratopathy, neuropathy in tuberculoid and lepromatous leprosy as well as inherited metabolic neurologic disorders, make interesting reading. Ultrastructural features to clinch accuracy in diagnosis of mesotheliomas and changes in sarcoma cells following mitomycin and gamma radiation have also been discussed. Terpenoid secreting cells of neem and actinorhizal nodulation in *Casuarina equestifolia* form the topics of discussion in plant science.

Through a wide coverage of topics, the role of electron microscopy in interdisciplinary science along with other microscopical and technical approaches has been brought out. To this extent the book has been successful.

However, like most multiauthor books, the standards of this one are also variable. The book might interest those working in the very specific areas dealt with in the book.

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Should We Risk It? Exploring Environmental, Health, and Technological Problem Solving. Daniel M. Kammen and David M. Hassenzahl. Princeton University Press, 41, William Street, Princeton, NJ 08540, USA. 1999. 404 pp. Price: US $ 39.50.

Risk has been a part of human life ever since it appeared on this earth. It was exposed to hostile environment as well as to wild animals, reptiles and insects like mosquitoes and beetles. People had to risk their life to get food. But this did not deter them and humanity progressed to the present status taking a risk all along. We learnt the most important lesson: 'No Risk, No Benefit'. But the question started coming up in one's mind: 'How much risk?' Can we find out the extent of risk? Is it temporary or permanent? Will the effects continue over the generations to come?

With advances in science and technology, people thought that they have conquered nature and that they can get more out of it. But soon they realized that they could not play a 'Non Zero Sum' game with nature. The new technologies of power generation, transportation and chemicals have made human life enjoyable, but the delayed effects of air, water and soil pollution have started taking their toll of human life. The advancements in atomic and nuclear sciences made people proud of their intelligence. They were seeing only the brighter side of the coin, but soon they started seeing the darker side of it, namely cancer and genetic defects.

Can we totally avoid events whose effects are bad, and if not, can we at least limit the extent of bad effects? This thinking gave rise to the science of safety and risk modelling, measurement and analysis. The bad effects are not same for all and everyone is also not exposed to the same extent. This introduced statistics in the subject and resulted in the development of statistical tools for risk analysis.

The authors of the book under review start with the definition of risk, namely 'the probability that an outcome will occur times the consequence, or level of impact, should that occur.' Outcome and consequence are referred to as dose and response, respectively, by the authors. Linear, concave, convex as well as