Topics in Quantum Mechanics. Floyd Williams, Birkhauser-Verlag, P.O. Box 133, CH-4010, Basel, Switzerland. 2003. 396 pp. Price not mentioned.

The inception of quantum mechanics during the first few decades of the twentieth century has continuously prompted knowledgeable persons to write books on this subject. Apparently there are several reasons for this. First, quantum mechanics provides us with the best model we have of the physical world, and in particular, about the sub-microscopic world of the atom. It has led us to the understanding, development and technological applications of several areas like atomic physics, spectroscopy, nuclear physics, condensed matter physics, quantum optics, nanoelectronics etc. Currently, we are even considering the possibility of processing quantum information to realize computers based on quantum logic. Secondly, quantum mechanics is a probabilistic theory in contrast to classical mechanics which is deterministic. Hence, it requires considerable time to develop familiarity with quantum mechanical concepts which are based on epistemology rather than ontology. This reminds us of Richard Feynman's famous statement: 'Nobody understands quantum mechanics' in his book entitled '*The Character of Physical Law*', Penguin, London, 1965 which has prompted some authors to write books devoted to the explanation of how quantum mechanics works. Thirdly, there are three formulations of quantum mechanics. The first one is the wave mechanics introduced by Erwin Schrödinger. The second one is the matrix mechanics introduced by Werner Heisenberg and Paul A. M. Dirac. The third formulation is the path integral approach introduced by Richard Feynman which is based on a sort of blending the classical with quantum mechanics.

Apart from the conceptual issues and their interpretation and use, there is a certain mathematical methodology associated with the application of quantum mechanics. Incidently, three independent mathematical disciplines are associated with the three formulations of quantum mechanics. Heisenberg–Dirac method is based on 'algebra', Schrödinger's approach is on differential equations or 'analysis', while Feynman's approach is on 'geometry'. This geometrical way of expressing the quantum superposition principle is intuitively appealing since it allows one to visualize the constructive or destructive interference arising from many paths. Feynman himself has attributed 'this multiplicity of possible descriptions of quantum phenomena to our having captured the key elements in our description of atomic phenomena and is an expression of the simplicity of nature'.

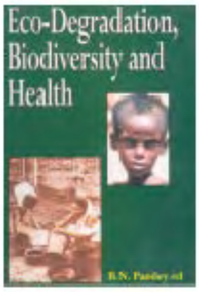
This book is basically devoted to bringing out the mathematical physics aspects of quantum mechanics and is divided into two parts. The first one consists of a chapter on units of measurement and the basic physical constants associated with quantum mechanics and the other ten chapters cover the basic concepts of quantum mechanics. The first two chapters bring out very clearly and in a self-contained manner, the basic concepts of classical mechanics, the basic themes associated with quantum mechanics beginning with Planck's quantization and ending with Heisenberg's Uncertainty Principle and Bohr's Complementarity Principle. Chapter 3 introduces the concept of quantization and Schrödinger equation followed by the solution of this equation in some simple cases like free particle harmonic oscillator and a particle moving in a potential well. The associated mathematical analysis is presented very well and includes the study of the asymptotic behaviour of the eigenvalues and the spectral zeta function. Chapter 4 is devoted to a detailed discussion of the hypergeometric equations and the special functions and their properties arising in the solutions of Schrödinger equation in the standard cases like harmonic oscillator, hydrogen atom etc. The chapter even includes an account of the spherical harmonics. Chapter 5 treats in detail the case of hydrogen-like atoms, the commutation relations for angular momentum and its quantization. Chapter 6 presents the mathematical derivation of Heisenberg's Uncertainty Principle and illustrates it for the case of harmonic oscillator. Chapter 7 discusses the representations of groups, tensor product representations and the related mathematics. It also discusses time dependent perturbations leading to spectroscopic selection rules. The procedure is illustrated for a hydrogenic atom interacting with electromagnetic-radiation. Chapter 8 discusses at length the motion of a charged particle in an electromagnetic field and the associated quantized Hamiltonian. Chapter 9 introduces the spin operators and the associated wave functions and discusses the Zeeman effect. Finally, an introduction of the multi-electron atoms and their treatment is presented in chapter 10. As an example, a helium-like atom is considered and an expression of its ground state energy is derived.

Part II of this book apparently justifies the title of the book. It consists of eight chapters running from 11 to 18 devoted to selected special topics. Chapters 11–13 present a well-written account of Feynman's path integral formulation of quantum mechanics. The discussion starts with the introduction of Fresnel integrals and their properties and develops into the definition of Feynman's path integral and its relation with the Schrödinger equation. Explicit evaluations of the Feynman path integrals are presented in a number of cases like the harmonic oscillator, free particle and the particle falling under gravity. Chapter 13 is devoted to Euclidean path integrals, also known as Wiener integrals, which are used in statistical mechanics. This chapter discusses in detail the mathematical properties of these path integrals and their expansion in terms of the wave functions along with some illustrative examples. Chapter 14 uses the concept of Euclidean path integral for defining the density matrix and partition function in quantum statistical mechanics. This chapter also introduces the concept of representing the free energy by means of the Riemann zeta function and discusses the relevant mathematical properties associated with this function and their relevance. Zeta functions provide a natural means of regularizing certain physical quantities which are a priori infinite and thus play a very useful role in physics. Some illustrative cases where this function plays an important role are discussed further in chapters 15 to 17 along with the Selberg trace formula. The latter is a non-commutative version of the better known Jacobi inversion formula mentioned in the appendix A of chapter 14. All these chapters besides being quite interesting are also well written. However, some prior knowledge of Riemannian geometry is necessary to appreciate the contents of these chapters. Lastly, chapter 18 of the book contributed by Patrick Shanahan gives a brief discussion of the gauge theory starting from the example of the Schrödinger equation for a charged particle in an electromagnetic field. The general appendices A to E also cover some useful material related to the topics covered in the main text.

In summary, this book brings out clearly the mathematical physics aspects associated with the three formulations of quantum mechanics. It fulfils the requirement of being vol. 27 of *Progress in Mathematical Physics*. The book is of much interest and use to students, teachers and researchers in the areas of theoretical physics and applied mathematics.

S. V. LAWANDE

Bayaghar A-6,
Hanuman Road,
Vile Parle (E),
Mumbai 400 057, India
e-mail: lsushan@vsnl.net



Eco-Degradation, Biodiversity and Health. B. N. Pandey. Daya Publishing House, 1123/74, Deva Ram Park, Trinagar, Delhi 110 035. 2002. 335 pp. Price not mentioned.

Biodiversity refers to the totality of all heritable variation in the world, which means variety of all life forms – the different plants, animals and microorganisms, the genes they contain, and the ecosystems of which they form a part. It is usually considered at four levels of organization: (1) Genetic diversity – the variety of genetic material contained in all species that inhabit a region, including the variation within and between populations of species, (2) Species diversity – the variety of species, (3) Ecosystem diversity – the variety of habitats, biological communities (groups of organisms that co-occur and interact within a habitat), and ecological processes, and (4) Cultural diversity – the variation in behaviour or customs among different groups of the same species.

The phenomenal diversity of organisms and cultures on the earth is the result of biological evolution over a period of about 4 billion years. Through the millennia, each living being has adapted to meet the demands of the ecosystem. Physical forces such as earthquakes, floods, droughts, volcanoes, etc. have altered the character of a region including its array of organisms. Biological forces such as disease, starvation, predation, etc. have also influenced populations or communities of organisms. On a general consensus it has been found that overall estimates are about 10 to 15 million species exist on the earth and to date around 1.5 million species have been described. A vast diversity in genes, species, ecosystems and even culture provides the raw materials with which populations and communities, including humans, necessarily adapt to change.

The habitat changes (physical, chemical and biological) have inextricably altered interwoven complex relationships between species and habitat, resulting in species extinction which unfortunately is an irreversible process. The natural disturbances, in small amounts, in ecosystems dominated by late successional communities like forests, will result in increased diversity. The healthier the ecosystem is, the more diversity will it contain, which is capable of finding an alternate pathway.

Ecosystem services of the natural habitats to humans include: (a) extractive benefits like seafood, timber, biomass fuels, precursors to various industrial and pharmaceutical products and (b) non-extractive benefits like water purification, renewal of soil fertility, climate regulation, pollination, etc. Humans also derive aesthetic, cultural, intellectual and spiritual values from Nature. Conservation of these natural ecosystems is essential for the very survival of humans as a species on the earth.

Human health and well-being directly reflect the health of biodiversity of a region. 80% of the world's population depend on plant-based medicines for primary healthcare. It is estimated that over 50% of commercially available drugs depend on bio-active compounds extracted/patterned from non-human species. Currently 80,000 species are used for drug formulations. So far, less than 1% of flowering plants have been screened for their beneficial pharmaceutical properties. Some of the plant sources amounting to 37% of all pharmaceutical sales of drugs and other products include sugar alcohol sorbitol, a product of *Sorbus aucuparia* used as sweetener; diclofenac (voltaren) like aspirin, non-steroidal anti-inflammatory drugs, derived from willow bark (*Salix* spp.); anticancer alkaloid vincristine from the Madagascar periwinkle (*Catharanthus* spp.); antimalarial sesquiterpene artemsinin (qinhaosu) from the Chinese herb (*Artemisia annua*); cichoric acid which causes significant stimulation of phagocytotic activity in *in vitro* granulocyte bioassay and was first isolated from *Echinacea purpurea* and antineoplastic paclitaxel (Taxol) which was discovered from the bark of the Pacific yew tree (*Taxus brevifolia*) are some of the most promising drugs for the treatment of ovarian and breast cancer. It is now being extracted from a fungus reserpine for hypertension derived from *Rauvolfia serpentina*, etc.

Anthropogenic activities to meet the growing demand of a burgeoning population have increased (non-sustainable) resource use per capita, cultural homogenization, agricultural development, habitat fragmentation, environmental pollution, introduction of alien species and genes (through genetically modified organisms), and diseases, resulting in rapid climate change and natural habitat destruction. This has contributed to the degradation of the ecosystem or **eco-degradation** and lowering of its productivity and increase in pests, invasive species, etc. In order to maintain the productivity, more and more chemicals (in the form of inorganic fertilisers), herbicides, pesticides, etc. are being added to the natural environment. These enter the food chain through water, soil and air, affecting human health seriously.

Climate change has warmed the earth by 5 to 9 degrees, since the end of last ice-age (about 20,000 years ago). Also, it is predicted that the planet will warm by 2 to 6 degrees over the next 100 years. The changes in climate with steady increase in atmospheric greenhouse gases, depletion of ozone in stratosphere, etc. leading to global over-warming will increase the incidence of diseases related to ultraviolet radiation, such as skin cancers, immune defects, etc. El Nino weather change leading to *Vibrio* cholera, deforestation leading to the spread of malaria and lyme disease are linked basically to land-use changes. These are mainly due to unplanned anthropogenic activities that