
This is yet another volume running into 700 pages, which is part of the mega series on the History of Science, Philosophy and Culture in Indian Civilization. The volume is divided into three sections. The Cosmos and the Classical World; Quantum World and Elementary Particles, and Life and Consciousness, with contributions from 25 authors in all, including the introduction by the editor P. K. Sengupta. The volume deals only with the history of science and the companion volume 7, which is yet to be published, is to deal with the philosophy of science. To provide a general flavour of the book, only a few aspects of the contents of each article are highlighted here.

In the lead article ‘History, evolution and scientific revolution’, D. P. Chattopadhyaya points out the linkages between history, philosophy and science, and in particular the landmarks in the history of biology in the last 200 years. He emphasizes that in the history of science, to raise seminal questions has been found to be no less important than to discover a radically new or revolutionary theory itself, and illustrates this by discussing the all-important contributions and the difficulties faced by Lamarck and Darwin in formulating the theory of evolution, and how Mendelian genetics even though had superseded the Darwinian theory of natural selection, had not come to the notice of Darwin. Chattopadhyaya also highlights the importance of the influential book by Haldane entitled Causes of Evolution. He points out that without going into the details of material, i.e., physical and chemical basis of life and mind, particularly biology, physiology and epistemology, we cannot meaningfully and scientifically speak of higher levels of evolution. He emphasizes the importance of theory of involution in which one has to make constructive use of abstract entities to the realm of life and mind, and the necessity of going beyond the three levels of reality of Popper and Eccles.

Subbarayappa in his reflections on ‘Microcosmic and macrocosmic’, begins by highlighting the supreme importance given to the interrelationship between man, spirit and cosmos in the ancient Indian culture, whereas the Egyptian, Arkadian, Assyrian, Sumerian, Babylonian and other major cultures did have a glimpse of the man–spirit–cosmos vision, but did not attach much significance to it. The concordance of celestial and terrestrial is seminal to the Vedic ethos. The pro-Socratic Greeks on the other hand, were keen on finding the primordial essence or element of all phenomena. Thales thought of ‘water’, Anaximenes ‘air’, Heraclitus ‘fire’, Empedocles ‘earth’ in addition to the four elements, Leucippus ‘atoms and void’, and Pythagoras ‘number’. Subbarayappa presents a brief account of the Pythagorean–Platonic view of the universe and the Neo-Platonic view that the universe was made for man and discusses the emergence of the three monotheistic religions – Judaism, Christianity and Islam. He then proceeds to a discussion of the heliocentric theory of Copernicus and Kepler’s theory on the motion of planets and how Newton demolished the divide between the motion of celestial bodies and those of terrestrial ones, believing still in the Deistic design of the universe. In the end, Subbarayappa discusses briefly the current ideas of creation of the universe based on the Big Bang theory, which is receiving more and more observational support. He highlights the problems of singularity at the beginning which gave rise to not only matter, but also to space and time and the fine-tuning of various parameters that is required to make the universe as it is seen today, rather than being ‘empty’. The question naturally arises ‘who did the fine-tuning?’.

In the third article entitled ‘The concept of world in Vedic thought: some regularities’, Mira Roy portrays the Vedic thoughts of the world that are based on an admixture of mythology and phenomenology, which has given rise to naturo-physical and sacredotal speculations—the merging of the self and related phenomena with the three cosmological worlds – the earth, the atmosphere and the sky/heaven. In the article on ‘Geometry in ancient India’, Balachandra Rao not only presents an excellent summary of the Vedic origin of the various geometrical constructions, but also of the later contributions of Bhaskara Brahmagupta, Mahavira and others, and a comparison with ancient geometries of the Hellenic period and of Archimedes and Apollonius. He also makes a reference to the influence of Hellenic and Euclidean geometries on the early Indian geometries.

In the article ‘Terrestrial and celestial aspects of natural sciences – Ptolemy, Copernicus, Galileo, Kepler: a historiographical study’, Subhash Kak traces the influence of terrestrial and celestial science on the development of natural sciences, highlighting the early contact between Greek and Indian astronomy and pointing out the specific feature of Rig Vedic and Shatapatha Brahmanic references with respect to some of the astronomical ideas and the differences in approach: the Greek one being purely geometrical, whereas the Indian astronomy depended on geometry, arithmetic and algebraic geometry. This article traces in a historical fashion the contributions of Ptolemy, Aryabhata, Copernicus, Tycho Brahe, Galileo and Kepler to the development of early astronomy with interesting insights on the relationship between the various scientists of the time and also some aspects of the philosophical implications. It also reflects on the struggle that the astronomers had to face because of the controlling power of the church in contrast to what the situation was in India.

In the next article by A. K. Ray, Newton’s theory of universal gravitation and the experimentally established constancy of the velocity of light are discussed. This article focuses on gravity, its uni-
versal character as propounded by Newton and the modification brought about by Einstein. Several historical facts are incorporated. The next article is on ‘Ernst Mach: the scientist and philosopher’ by Sibnath Chatterjee. This is one of the best accounts on Mach, his life, his contributions to physics, his influence on Einstein, his ideas on the unity of science and his ideas on the philosophy of science, that I have read. It is a gripping, critical and fair analysis of Mach. The author appropriately concludes ‘Mach’s incorruptible scepticism, his arduous battle against dogmatic metaphysics and speculation have borne fruit that still nourishes the minds of the scientific thinkers, maybe without being aware of it.’

The next article in the volume is by Kamal Datta on ‘The science and philosophy of Albert Einstein’. The author starts by saying ‘he changed forever the way we view the natural universe and our place in it’, which is truly an appropriate summary of Einstein’s contributions to science and philosophy. After an account of the early life of Einstein, and making a reference to his very early papers in Annalen Physik, the author deliberates on their rather drastic consequences to the physics of the early part of the 20th century, and the remarkable experimental confirmations of the theories. The bearing on the theory of space, time and cosmology is then discussed. The final sections are on the philosophical implications of Einstein’s work and his views on reality, particularly in the context of quantum mechanics and non-locality. Einstein’s vision for the future was ‘... a theory that shall be strictly causal, that it shall unify gravitation, electromagnetism, that particles of physics shall emerge as special solutions of the general field equations’. In the next article, in a short and condensed presentation, A. N. Mitra has summarized in a masterly way the work of Einstein that had a bearing on cosmology, inflation, unification, missing matter in the universe, dark energy and pointed to the necessity of a new breakthrough theory, which may come in the form of a new string theory.

Section II of the book has nine articles and is of a different character compared to the first one. The articles are necessarily technical with mathematical equations inevitably thrown in. Gautam Bhatcharaya’s article ‘Quantum mechanics and relativity: a conceptual study’ is a well-written piece that covers the range of an important era in physics from classical dynamics to quantum mechanics and relativity, and has brought out with great clarity the problems faced by the scientists at various stages as they proceeded to explain the happenings in the micro-world of elementary particles moving at higher and higher velocities. The conceptual changes that have necessarily resulted have been efficiently addressed. The concluding paragraphs highlight the outstanding unresolved issues in this area of fundamental physics. In the article ‘Condensation phenomena from Andrews to Bose and Einstein’, Jayantha Bhatcharaya has presented a lucid account of the history of low-temperature phenomena and the quantum mechanics-based explanations of superconductivity, superfluidity and Bose–Einstein condensation. With the realization of the Bose–Einstein condensation experimentally, this area has opened up many new and interesting directions of research.

The story of the attempts at unification of the forces of nature which was the dream of Einstein, but could only be partially realized by Salam, Weinberg and Glashow, has been presented by Partha Ghose with all the necessary technical details regarding gauge theories, spontaneous symmetry breaking phenomena and the current status of the standard model of particle physics. Paying full credits to the various efforts at unification, the author concludes that final unification will probably require new physics involving supersymmetry, string theory and loop gravity which are still in the developmental stages.

The next article by Ravi Gautam is concerned with the difficulties faced in the interpretation of quantum mechanics and the problems regarding causality at the level of single events for which superposed quantum functions are constrained. In this context, Heisenberg’s potential interpretation and Popper’s propensity interpretations are discussed in detail. In Heisenberg’s interpretation, the electron or photon in the double-slit experiment in the state of superposition is to be thought of as being potentially present at both the slits when not observed and actually present at only one of the slits when observed. This leads to Heisenberg’s interpretation of quantum mechanics that predictions of quantum theory pertain to not what is happening out in the world, but to our knowledge of what is happening out there. For Popper, what is different between classical and quantum mechanical description is not the nature of the underlying world itself, but appealing to propensities (instead of underlying causes or deterministic laws) for explanation. This strikes at the quantum nature of the real world, which is unacceptable. Gautam has proposed a new approach according to which quantum theory ought to use the terms ‘statistics’ or ‘probability’ to refer only to the occurrence of observable events and altogether renounce the notion of probabilities when talking about quantum ontological states. This interpretation according to the author is based on a notion of relational physical properties which are also potential in the absence of an actual observation (a la Heisenberg) but nevertheless belong to an object (a la Popper), albeit one that is non-classical.

In the article with the provocative title ‘The Schrödinger cat – physics, myth and philosophy’, Unnikrishnan discusses the debate that is still raging on the meaning of quantum theory, on the ontology of the quantum wave function, on the puzzle of the collapse of the wave function, on the meaning of quantum measurement and on the boundary between the quantum world and the classical world. The superposed demonstration of quantum mechanical wave function, the wave–particle duality, mathematics failing to collapse the wave function, and the entanglement are highlighted, before focusing on the Schrödinger cat problem.
a macroscopic demonstration of the underlying quantum riddle (the wave-particle riddle), which Popper has called quantum muddle. Unnikrishnan disagrees with Popper's contention that one should dissociate the single physical system from the wave function that describes the behaviour of the ensemble. The author holds that there are experimental situations in which one has to conclude that even at the single-particle level something splits into two at the double-slit arrangement of the experiment which somehow encodes the physical system, including information on its energy, momentum, etc. What is its reality is a question that needs to be formulated and addressed in the future. This is a crucial issue from the point of view of interpretations of quantum mechanics and reality. The author discusses the various interpretations of quantum mechanics in the light of Schrödinger cat debate.

The paper entitled 'Hidden variables, non-contextuality and Einstein-locality in quantum mechanics' by Virendra Singh is scholarly, but quite technical in presentation and requires the reader to have a background in mathematics and physics for a proper understanding. In the concluding paragraph Singh writes, 'The subject of foundations of quantum mechanics which includes EPR correlations, has somewhat philosophical and generally hard-boiled physicists would turn up their noses at it. John Bell's work in the early 1960s showed that these philosophical discussions can be subject to precise experimentation. If the experiments had been found not to violate Bell's inequalities, quantum mechanics would have been in serious trouble. The Einstein non-local nature of quantum mechanics, which was exposed through EPR correlations, have been found in the last two decades to be far from being an embarrassment, a resource in many technical engineering applications. These applications include emerging areas of quantum cryptography and quantum teleportation. The whole area of quantum information and computing is intensely active. One has come a long way from philosophy to technology.'

The article by Ramanathan starts with a discussion on the nature of scientific explanation and presents a perspective on thermodynamics and its relation to statistical mechanics. It also highlights the role of the concept of entropy in a wide variety of contexts leading to some of the metaphysical aspects and philosophical questions. Issues relating to the postulate of laws of entropy in the Big Bang theory of cosmology, and the direction of flow of time are raised. The author says at the end: 'Whether it is the cosmic arrow of time which determines the entropic asymmetries in the universe or has its origin in the unidirectional expansion of the universe that the Big Bang model of the universe postulates to account for the Hubble shift in the spectrum of galaxies is hard to decide without partisan prejudice engendered by contemporary mainstream dogmas in physics which may or may not retain their position in the future'.

In the next fascinating article, Biswarp Mukhopadhyay discusses some of the most challenging issues in the frontiers of modern theory of elementary particles and cosmology which are occupying the attention of theorists on the one hand and experimenters on the other, resulting in the justification for the construction of a large, high-energy accelerator costing 10 billion US dollars. The main objects of this accelerator LHC, is to search for a particle called the 'Higgs boson', which is expected to have a mass in the neighbourhood of a TeV (10^13 eV). According to current ideas, it is the Higgs boson field confined to the dimensions of Planck scale that was responsible for the repulsive force necessary for inflationary expansion of the early phase in the Big Bang theory. The author presents in an interesting way the anthropic principle, according to which different physical constants need to have special and specific values for the evolution at various stages in order to have proceeded in just the way that could result in the emergence of life and humans at the last stage. The problems connected with this restriction and the wide disparity between the calculated and observed values of the Einstein cosmological constant \(\Lambda\), and the very large value of the Higgs boson mass in limited violation of supersymmetry are explained in a non-technical language. Mukhopadhyay points out in the end how we have come to a situation in science, in particular, physics and astrophysics, in which the criterion of falsification cannot be always met. May be there is to be yet another paradigm shift in science!

In the introduction to his article 'Quantum gravity and the structure of physical reality', Unnikrishnan warns that 'All attempts to harmonize the merging of quantum theory of gravity are judged to have failed so far. There are good formulations of the problem to be solved, but there are no answers that are generally agreed on as viable. More importantly, there are no experimental tests proposed or conducted that can check whether a particular approach is on the right track'. In the rather lengthy article the author has lucidly narrated in a historical perspective the story of gravity from the time of Newton to Einstein and its relation to the fundamental concepts of space and time, the advent of quantum theory and the problems connected with gravity at the Planck dimensions, and the wave function of the universe. He also discusses the experimental approaches to test quantum gravity and presents a critique on these approaches. In the end, he emphasizes that what is required is a deep understanding and a consensus on the physical reality and ontology related to gravitational phenomena. At present there is no acceptable theory of quantum gravity.

In the first article on 'Origin and evolution of life' in section III, R. D. Iyer discusses the various scientific and non-scientific theories of life, the debate that is going on even in the 21st century, particularly in USA about the evolutionary theory of Darwin and the creationist theory of the Bible. He makes a presentation of the efforts that are pursued to search for presence of life in various plants, materials and also in exploratory laboratory experiments designed for producing life. Some aspects of the spontaneous generation themes of life and the concepts of biodiversity in ancient Indian thought are also considered, and the whole question of biodiversity is discussed as a function of time. Finally, the need for conservation enhancement of biodiversity, and bioreserves are emphasized in the light of damages in recent times posed by human-triggered extinctions.

In his article ‘Playing God or being human? Scientific and ethical perspectives in the cloning of human beings’, Anindya Sinha begins with the remarks in the introduction ‘... That is why our scientific endeavours, particularly in the realm of molecular genetics and recombinant DNA technology must look beyond science, they must reach out to examine issues that have been traditionally left to philosophers and social scientists to ponder upon. We are no longer
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scientists working in our everyday ivory towers of science heedless of the world outside.

After presenting the objectives of therapeutic and reproductive clonings, he deliberates on the debate that is raging on therapeutic cloning and the ethical issues involved, and expresses his own view that decision on therapeutic cloning should be on the basis of individual conscience and personal belief system. On the question of social values of cloning, Anindya says ‘...science, however valuable must obviously observe important moral boundaries—it should not endanger community safety, impinge on the rights or interests of its human subjects or inflict unnecessary sufferings on animals’.

The next article by Mukhopadhyay ‘The self, and its memes and genes’ begins with a nice piece of poetry written by the author himself more than 20 years ago, in which he reflects the Upanishadic truth that asserts oneness of human consciousness, self-consciousness and universal or trans-universal consciousness, and as the author has clarified, the embodied approach of this article is on ‘the mechanics of molecular biology and the principles of individualization’, genetic uniqueness and personal uniqueness. Individualization according to the author results from the interaction of genes, consciousness and its vehicle the brain, ‘ideas’ introduced in the brain (‘memes’) socio-economic-cultural pressure and ecological influence. He discusses in detail the role of all these issues incorporating the necessary historical factors, and emphasizing that the bottom line is the gene, and meme is what we transact business with and goes into epidemiology of genes and memes. He is of the opinion that while behaviour of an individual is attempted to be explained on the basis of ‘reflex’ action, and mental behaviour by ‘memeitics’ by neural behaviourists, and by the action of genes only, by genetic behaviourists, there is still a missing link and that is ‘consciousness’. He goes into various actions of consciousness and self-consciousness. He proposes a new world view which he calls ‘The akshanda world view’ and concludes by stating that the individual is an integral of the self, non-self and supreme self (consciousness).

The next article is by Subash Kak on ‘Machines and consciousness’. His main contention is that machines fall short on two accounts compared to the brain; machines do not self-organize in a recursive manner and secondly, machines are based on classical logic, whereas nature’s intelligence depends on quantum mechanics. One cannot run a physical process if its probability amplitude is negative or complex. Quantum mechanics may be interpreted in a manner that allows free will and consciousness. The artificial intelligent machines based on classical computing principles have a fixed universe of discourse and therefore are unable to adjust to a changing universe. The concluding part projects what can happen if machines do become conscious. Their mind will spread throughout the world and the entire universe will become a conscious machine—a scenario that is the opposite of the traditional Indian view that a universal mind gave rise to the physical world.

In the article ‘Does neurobiology of mind matter?’, Kanthamani has explored the neurobiological basis of the mind in the light of developments in the field of cognitive science. The strongly reductionist connectivity view holds that mind-brain is reducible to cells (neurons) and is strongly supported by holding that mind-brain is a massively parallel machine rather than a massively serial machine. The former is identifiable a neurobiological stance and the latter identifiably the computational stance. Further developments with models incorporating multiple feedbacks and feed-forward paths, and the dynamic models of connections are also discussed, as also the fourth and fifth-generation models which have provision for plasticity, Kantian subspace, continuous reciprocal causation, etc. Kanthamani proceeds to a discussion of the enactive cognition scale model of Varela in which cognitive organization reflects our physical involvement with the world (neural input-output), accounts for emergent characteristics (new traits) and supports circular or reciprocal view of causation and also Andy Clark’s liberalized version which holds that objects are independent of the mind, but not represented; the brain represents the real world in the sense that it is action neutral. Ramachandran’s new paradigm of neuropsychiatry and neuro aesthetics are presented in some detail. There is also a brief reference to the metaethics of Churchland, which is regarded as a futuristic subarea of cognitive neurobiology. The author goes into an elaboration of the misgivings that are being debated about the relation between cognitive science, neurobiology and philosophy. This is a long article of 71 pages with 161 references. In summary, the article is a critique on the various analytical, dynamical and combinational models.

Swami Jitammananda’s article ‘Science, consciousness and human evolution’ is a synthesis of modern scientific and ancient Indian thoughts on life, individual and universal consciousness. The scientific aspects have been effectively reflected by a liberal reproduction of quotations from the topmost scientists, particularly of the 20th century. The ancient Indian viewpoints have been presented by the relevant statements from various Upanishads and the sayings of Ramakrishna and Vivekananda. The most quoted physicist is Schrödinger, a Nobel laureate in physics and the author of the book What is Life?, the most quoted biologist is the Nobel laureate Geroge Wald. Both of them had great affinity and respect for the Upanishadic philosophies, the oneness of matter, mind and consciousness—the Absolute Consciousness. The views of a wide variety of scientists, neurosurgeons (Penfield) and neurophysiologists (Karl Lashley) on the question of the brain-mind-consciousness relation are presented. Aspects relating to meditation, faith and spirituality are discussed in the light of significant statements made by Nobel laureates like Townes, Sperry, Schrödinger and Josephson.

In the end the author, after an appropriate and realistic presentation of the scientific viewpoints, states: Realization of existence-consciousness-bliss absolute inside the human body brings conquest of death and highest human evolution. The Kena Upanishad (2.5) says: By seeing oneself in all living beings, the wise man transcends his body-mind and this relative existence, and finally gets established in immortality. The Çândogya Upanishad describes such human being of highest realization: The Self-realized man fully established in universal consciousness and enriched with Light of Self within, is established in his divine blissful form. He verily is the best of human beings (8.12.3). This according to Vedanta is the highest human evolution transformation of Jesus into Christ the savior or Siddharta Gautama into Buddha, the enlightened one. The central
message of Sri Ramakrishan inspires humanity to this final destination. The goal of human life is the realization of God.

The last article in the volume is by Sangeetha Menon on “Cognitive and experiential foundations of consciousness and “Spiritual Agency”: towards a new epistemology”. She is primarily concerned with the identification of the ‘agency’ that is responsible for cognition and experiences in human beings, and its relation/identification to the self. There is no experience without consciousness. But the study of consciousness requires experience. The scientific methodology had been to study ‘subjectivity’ on the basis of empirical standards such as causal connection, neural influences and neural locations. Recently, there has been a change. The first-person accounts of experiences of patients affected by spinal injury and whose nerves have suffered a disconnect with certain parts of the body are taken into account in the analysis of the empirical data. Obviously, this methodology is different from the previous ones based on analysis of recorded brain processes alone. This neurophysiological methodology shifts the focus from third-person neural data to first-person qualities of will-power, self-effort, etc. Sangeetha has mainly addressed the issue of agency from the point of view of spiritual experiences of a certain class of people with neural challenges. She also discusses three Indian spiritual experiences such as (i) the detached engagement during enactment (nātya), (ii) the heightened state of divine love (bhakti) and (iii) the meditative state of self-knowledge (atmā-jnana), which has physical and transcendental functions. Nātya is characterized by intersubjective and intrasubjective combination of experiences and feeling, bhakti by a sense of detached love and atma-jnana by a sense of complete detachment. According to Sangeetha, the study of the complexity of the various levels of agency and their relation to consciousness may lead to a better theory of consciousness compared to many that exist at present.

The editor of this volume has succeeded in bringing about a confluence of philosophy and science in a historical perspective ranging from the ancient Vedic period to the 20th century. The articles are written by experts in various fields. Some of the articles are so exhaustive in coverage and length that they could be brought out as monographs in their own right. The volume is certainly a rich treasure-house of authentic information, enriched by an exhaustive list of references, bibliographies, etc. that it will be beneficial to all libraries interested in books in the field of history and philosophy of science. It will surely be a good resource book for students doing research in this or any related subjects and those who desire to write books on the history and philosophy of science.

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The term ‘disability’ be refers to physical or mental impairment, due to which a person is unable to respond properly to a standard stimulus using traditional methods. As a result, such a person’s social participation is restricted. With the advancement of technology, persons with disabilities can undertake a variety of personal challenges with alternative solutions based on their abilities. An enriched balance between problem-solving and more playful exploration with open-minded inspiring solutions for them can open up a new direction in a non-traditional way. Thus, disability can initiate radical new directions in mainstream design. The World Health Organization (WHO) acknowledges that almost every human being experiences some degree of disability in life. Therefore, why there is a social stigma towards disability?

This book will help change our response towards disability and generate interest to design against disability for inclusive solutions. The book explains well how disability and design encourage each other with rich examples, brilliant pictures, and fascinating collections from brilliant designers. Graham Pullin discusses the important aspects of such design, and mentions that while designing for disability a healthy coexisting tension is present between exploration with playful and open-minded approaches and problem-solving with clinical and engineering basis.

In the first chapter ‘Fashion meets discretion’, the author has mentioned eye-wear from Cutler and Gross, a device for disability, which has now become an elegant and fashion accessory. On the other hand, hearing aids (earphone or headphone), prosthetics and orthotics still carry the image of disability. Adopting a fashion culture for design may cross the restriction of medical requirements to compensate disability. The author has presented a number of different leg prostheses, including carved wooden legs to wear during appropriate occasions. In case of assistive device, if the primary functionality is not properly achieved, it might not be a good solution. Different types of chairs are available in terms of design and the materials used, but the wheelchair remains almost the same. Designer Rodo Sperlein has designed a China plate embossed with small dots, similar to Braille. Likewise, raised characters on the telephone keyboard will benefit visually impaired. Therefore, further exploration is required to bring a radical change in design approach.

Simple design always favours better overall experience. For the visually impaired, Swiss manufacturer Tissot introduced the Silen-T-Watch with robust engineering for damage protection, where the user can read the time by touch. Another complementary solution is the talking watch. Pullin has encouraged more solutions like the Discretion watch by Crispin Jones – the movement of the wrist produces different types of regional vibration in terms of tactile sensation. Use of copper induction loop on the tabletop will improve sound quality.