

In short, this is a highly recommended book for the student of particle physics who has studied the basics of quantum field theory and the phenomenology of the known elementary particles. In addition, it is a handy source of information (and more valuably, explanations) for senior students and practising physicists in other areas, who will increasingly feel the need to know about the area of fundamental science most finely poised today for a dramatic experimental breakthrough.

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**Annual Review of Earth and Planetary Science 2005.** Raymond Jeanloz, Ardan L. Albee and Kevin C. Burke (eds). Annual Reviews Inc., 4139 El Camino Way, Palo Alto, CA 94306, USA. 710 pp. Vol. 33. Price not mentioned.

The editors of this volume under review open their preface with statements that '*Earth and planetary sciences have experienced a remarkable blossoming over the past decades. The research disciplines have a broader range of social and political impact than ever before, from addressing resource and security needs to mitigating natural hazards, remediating environmental impact, and documenting global climate change*'. The pace of growth of new knowledge in the area of earth and planetary sciences has increased enormously; as a consequence, the *Annual Review of Earth and Planetary Sciences* continues to serve as a useful resource for capturing the breadth of new developments in this area of knowledge.

The volume deals with several interesting aspects of the subject. These include the early history of atmospheric oxygen, the famous 1200-km-long dextral strike-slip fault zone of northern Turkey (the North Anatolian Fault); processes of orogenic collapse with reference to the Alps; early crustal evolution of Mars; representation of model uncertainty in weather and climate prediction; real-time seismology and earthquake damage mitigation; lakes beneath the Antarctic ice-sheet; subglacial processes that include aspects of subglacial hydrology,

subglacial mechanics, sliding, sediment deformation and glacial landforms; feathered dinosaurs, molecular approaches to marine microbial ecology and the marine nitrogen cycle; earthquake triggering; evolution of the continental lithosphere; ichthyosaurian evolution; Ediacaran biotas; mathematical modelling of whole landscape evolution; volcanic seismology; models and outstanding questions of the interiors of giant planets; the Hf-W isotopic system and the origin of the Earth and Moon; planetary seismology; atmospheric moist convection; and orographic precipitation. A survey of some of these topics clearly points towards a continuing interest amongst earth and planetary scientists on questions related to the origin of the planets, the earth and the Moon; issues related to planetary seismology and real-time seismology for earthquake damage mitigation; questions related to climatic and tectonic aspects of orogens; issues related to continental ice-sheets; and evolutionary aspects of fish-shaped reptiles, feathered dinosaurs, and Ediacaran biotas. Such is the spread of earth and planetary sciences, knitted together with the threads of geologic time.

Much of the material is of considerable interest to earth scientists in India. Given the active tectonic environments of India, the reviews related to (a) the seismically hazardous Anatolian fault, (b) methods for predictions of subsequent ground motions from initial earthquake displacements, (c) processes of orogenic collapse that involve transfer of gravitational potential energy by extension in the core of the orogen and synchronous shortening in the foreland regions, are of strong relevance to Indian earth scientists.

India is bestowed with extensive Archaean and Proterozoic geological records; it is in this context that the review on the early history of atmospheric oxygen is of special significance. The evolution of oxygen concentrations in the Precambrian is incompletely understood. More needs to be known on the timing of cyanobacterial evolution, evolution of ocean chemistry, nature of carbon cycling and the influence of nutrient limitation on primary production to be able to understand the early history of atmospheric oxygen.

Another aspect of significance in the Indian context is the subject of orographic precipitation. It will always remain our aim to predict orographic precipitation in future climates. We live in the shadow of the Himalaya, and an 'understanding of the probability distribution of orographic pre-

cipitation events in the current climate, as well as the mechanisms responsible, will be useful in evaluating how changes in that probability distribution would lead to different precipitation rates'. The volume also contains an article on Antarctic subglacial lakes – lakes several kilometers beneath the ice sheet. This subject should be of interest to our Antarctic research programmes.

This review has attempted to provide a flavour of the rich content of the volume – this is a volume which is worth exploring both by the specialists and the generalists as it provides a broad view of the advances being made globally in earth and planetary sciences, both in the context of basic and applied aspects. Many of the subjects covered in the volume have a strong societal relevance and should therefore be of interest to a broad spectrum of science managers who deal with earth resources, disaster management and mitigation, and climate change issues.

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**Last Frontiers of the Mind – Challenges of the Digital Age.** A. Mohandas Moses, Prentice-Hall, New Delhi. 2005. 440 pp. Price: Rs 395.

The book 'Last Frontiers of the Mind' deals with two distinct, though related issues: (i) the relation between body–mind and consciousness (ii) the prospects of the computer-based Artificial Intelligence dominating over human intelligence and eventually assuming the role of the master that will dictate the future of humanity.

On the first topic, Mohandas Moses starts appropriately with a reference to Hippocrates of 5th Century BC; Hippocrates is regarded as the father of scientific medicine (most of us are familiar with the Hippocrates Oath which is a guide to medical ethics and practice). He was the first to recognize that the seat of consciousness is not in the diaphragm of the heart but in the brain. Hippocrates asserted: 'Some people say that the heart is the organ with which we think and that it feels anxiety. But it is not so. Men ought to know that from the brain and from the brain only arise our pleasures, joys, laughter and tears. Through it in particular we

think, see hear, and distinguish the ugly from beautiful, the bad from the good, and the pleasant from the unpleasant ... I hold that the brain is the most powerful organ of the human body ... eyes, ears, and tongue act in accordance with the discernment of the brain... To consciousness the brain is the messenger ... wherefore I assert that the brain is the interpreter of consciousness. The diaphragm has a name due merely to chance and custom, not reality and nature.' One can only marvel at a profound statement made almost 2500 years ago.

Then the author comes to Descartes (just 400 years ago) and discusses his interpretation of dualism 'Brain and Mind are two not one' and the 'pineal gland is the seat of consciousness', and the subsequent developments.

Moses makes a rapid survey of the brain research in the 20th century especially with the aid of new non-invasive technologies, the discernment of the hundreds of billions of neurons connecting the brain with every part of the body and the role of a thousand or so synapses along each neuron – the electrochemical activities in them triggered by the external radiations and materials – light, sound, particles, etc.

The specific area of response in the brain – the cortices – audio, visual and somatosensory come next. Also discussed are the findings of the neurosurgeons like Penfield and others, the intricate and complex neural network and the theory that the brain is a computer. The evidence in favour of and against this hypothesis is discussed.

He then plunges into a discussion of the crucial question whether consciousness is a product of evolution of the brain – the hierarchy of disciplines and concepts – biochemistry, biophysics, physics, space, time, force, the necessity of quantum mechanics as opposed to classical physics in understanding consciousness and so on.

Teleological aspects are dealt with. The idea of 'Noosphere' proposed by Teilhard de Chardin – the direct intercommunication of brains – the 'etherized' universal consciousness in the light of modern communication with radio waves is also discussed. The author raises the question whether there is a definite, well-defined road ahead of us.

The author also makes a reference to the statement of J. B. S. Haldane: 'With Eugenics and systematic improvement of human nature in about a million years, the average man and woman will be able

to think like Newton, write like Racine, paint like Van Eyck, compose like Bach and be incapable of hatred like St. Francis'.

Haldane felt that man was doomed unless he took steps to deliberately control his own evolution. To do this he has to attain a higher level of consciousness – is the opinion of Kenneth Walker.

After discussing various issues related to consciousness – how did it arise? What is the purpose of consciousness? And is there evidence for its evolution? What is its relation to soul? etc., the author then shifts to a detailed discussion of the development, in recent decades, in the field of computer-based robotics and the possibility of realization of what has come to be known as AI – Artificial Intelligence, which may open up the prospect of the future of humanity falling into the hands of these intelligent machines. There are those who feel that with the rapid development of miniature electronics buttressed by the nano-technologies, the day may not be far when AI will be realized. There are others who are skeptical about this prospect. The computer has a hardware and a software which controls the capabilities of the hardware. So far, there is no evidence that a computer can develop the software by itself. The software developed by humans using their brains has to be fed from outside the computer to carry on its functions. Without the software the computer is as good as dead. Yes, there could be tremendous developments in hardware. There is no way yet in which the computer can develop its own software.

Minsky of the Massachusetts Institute of Technology, who is a leading figure in the field of AI says that he can construct a machine that simulates the human brain, however complicated, provided he knows how the brain works. What the neuroscientists have been able to achieve so far is to establish the correlation between the brain function and the electrical and neurochemicals released at various locations, without any knowledge of how these correlates generate the mental functions – perceptions, sensations, memories, thoughts and so on.

At the present stage what one can envisage is the use of computers as powerful additional aids to human activity both physical and mental. In fact even the mathematicians are using it effectively, not to formulate new equations, but to rule out many alternatives, that in the old days had to be done with time-consuming laborious paperwork.

In my opinion there is thus no danger to human creativity. There is no cause to feel that machines will take over the control from human beings exclusively. According to Penrose the AI is no 'mind' at all.

However, Moses is extra cautious on this issue. He concludes his book on two warning notes:

(a) Man with the Digital Hoe: inefficient minds, efficient Machines: While digital machines are becoming more efficient exponentially, human ability is relatively stagnant in the short run. Human beings are, as a consequence, becoming adjuncts of the machines to a greater extent than at any time in the past. The apotheosis of our age, if the current trend continues, is the man with the digital hoe. We are in the process of losing something invaluable. Like Yao-Chiang at the time of the loss we may consider the trade-off to be attractive. Later we will bemoan our loss (the Yao-Chiang philosophy in China was unorthodox and counter to the popular philosophies of the time, became abused and lost over a period of time).

(b) The Eternal Mind: The human mind is undoubtedly the most remarkable phenomenon in the universe. Safeguarding its autonomy and its grandeur is perhaps the greatest challenge of the millennium. Through his various technological innovations, man has claimed to have conquered Nature. He now stands in danger of being vanquished by the technology of the computer.

The human individual is conscious that he occupies a thin sliver of time between the eons that have passed and the eons which stretch ahead. The past is part of him but he will forever be stranger to the future. For the machine, there is neither past nor future; the machine is not a part of Time. The human mind however has a continuum that embraces Time.

The book under review, is undoubtedly extraordinary with a wide coverage of many topics. It also deals with deep philosophical implications that are consequent to the new developments in brain research. It is a book that will interest both casual readers and professionals, and is lucidly written and moderately priced.

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