

QED: The Jewel of Physics. G. Venkataraman. Universities Press, 3-5-820, Hyderguda, Hyderabad 500 029. 1994. 133+viii pp. Price: Rs 65.

Eugene Wigner delivered a lecture in 1960, 'The unreasonable effectiveness of mathematics in the physical sciences'. Since then, this happy phrase has resounded through the literature of the exact sciences as the laying down by the physical scientist of the articles of his creed. For all this, mathematics has shown itself on occasion to be an unreliable ally, demonstrating a perverse willingness to comprehensively wreck the most elaborately constructed theory. And one of the most shocking instances of the breakdown of this *entente cordiale* in this century occurred during the development of quantum mechanics. To set the scene briefly, in 1933 Dirac's landmark paper had appeared, in which he initiated the second stage in the development of quantum theory by quantizing the electromagnetic field of Maxwell; and its relativistic version followed shortly thereafter. But no sooner had the new theory been erected, than it promptly loosed a 'plague of infinities' on its hapless creators. In this book under review, the second of his three-part history of quantum theory, Venkataraman takes up the story at this point and follows it to the late forties, when sanity was restored to the theory to the extent where it at least allowed a functional facility with calculations, by exorcising the infinities from it. It is also the story of three extraordinary physicists and their diverse personalities, who in large part were personally responsible for restoring quantum mechanics to its state of grace.

The book opens with a summing up of the topics treated in the first part, 'The breakthrough'. The rehash is occasionally seasoned with some of the more exotic spices of physics' larder. There is for instance, Feynman's theory of the electron moving back in time. (As in the earlier volume, Feynman's spirit animates the present one, stalking through it as a ubiquitous presence. In actuality, he may have been one of the three men who had cut quantum theory's Gordian knot. But Feynman's stature has grown through legend in popular imagination, till the exuberant vitality of his genius has been allowed to preside with the

magisterial dignity of an elder statesman over the whole of quantum electrodynamics.) This introductory chapter – rather surprisingly a fifth of the book in length – begins with a discussion of the expression for the energy of an electromagnetic field. This expression is transformed into an equivalent form (by minding one's p's and q's, literally) in which it is analogous to the Hamiltonian of a one-dimensional oscillator. Apropos this procedure, it has to be remarked that here, as elsewhere, the author appears understandably defensive about importing some high voltage mathematics into the text – the inevitable occupational hazard of an undertaking like the present one, which aims at a level roughly between a popularization and a textbook. Thus, with a quick apologetical murmur about 'a bit of algebra', the end result is produced (page 4) with the air of a conjuror materializing a rabbit out of a top hat. (One is irresistibly reminded of the eponymous hero of Salman Rushdie's *Haroun and the Sea of Stories*, who, when asked for a clarification, disarmingly confesses it to be a P2C2E – a process too complicated to explain!)

A similar observation could perhaps be made about a cascade of undefined terms – e.g. relativistic covariance, energy of a radiation field, coupling energy, zero point energy, etc. – in the opening chapter itself. While on the subject, it has to be pointed out that if there is an Occam's Razor for writers, it would surely admonish aspiring authors not to proliferate jargon beyond strict necessity. For instance, it does not add anything to a reader's enlightenment that the symbol A (in page 7) is called the vector potential of a magnetic field. To paraphrase the little girl who was immortalized for her adventures in Wonderland, that is rather a lot for a symbol to mean.

The second chapter introduces the Feynman diagrams – the technique that Feynman invented to understand the mechanism of particle interactions. These schema constitute Feynman's abiding contribution to the language of modern theoretical physics. A large part of this chapter is devoted to developing familiarity with manipulating these diagrams and extracting information from them. The ideas are set out with all the beautiful clarity, which is the hallmark of Venkataraman's writing.

This is in spite of a few minor lapses – the diagram 2.2 for instance, has been wrongly labelled. Finally, near the end of the chapter, we are shown the mathematical sleight-of-hand by which Schwinger, Feynman and Tomonaga tamed the infinities that the Dirac equation had unleashed.

The following short chapter presents the three pieces of evidence which clinched the issue in favour of QED and launched it into its career as the most successful scientific theory of all times – the Lamb's shift in hydrogen, the anomalous magnetic moment of the electron and the splitting of the ground state of positronium. But what features of the new theory ensured this resounding success? In the fourth and longest chapter of the book, Venkataraman takes up this question and shows that strict conformity at every stage with the requirements of relativity was the crucial ingredient of the new recipe. In Oppenheimer's perception, 'not merely the field equations themselves, but the whole method of approximation and solution must at all stages preserve relativistic covariance'. A review of the theory of path integrals and renormalizability concludes the chapter. One reflection on the use of equations in this book – Stephen Hawking's publisher reportedly advised him that with every equation he introduced into his book, he was halving his potential audience. One rather sees his point when one comes across instances of equations like,

$$\psi(t) = \psi(t_0) - (i\hbar) \int_{t_0}^t \psi(t') H_1(t') dt'$$

(in page 69) which are mere shotgun marriages of the left and right hand sides performed by the equality symbol as the officiating priest. There are perhaps inevitable constraints when advanced scientific theories are discussed at popular levels of exposition. Unfortunately, the arduousness of such an undertaking cannot absolve Venkataraman from the more serious lapse of using quotations without giving references – rather disconcertingly like plucking apples from an invisible tree.

At this stage, much like an alpine guide pausing to point out features of local interest to a tourist group while waiting for the stragglers to catch up (and the reviewer must confess himself to be of this company), the author

breaks the narrative with a biographical interlude of the three architects of QED. Incidentally, for anyone interested in the Feynman story, James Gleick's *Genius* must be mandatory reading – as much for the portrait of the whimsical genius of one of the most extraordinary scientists of all times as for the wealth of its anecdotal detail. In the final quarter of the book, some historical and biographical footnotes bring to a close this excellent account. It is a presentation written with a vigour and verve which do justice to one of the most turbulent epochs in theoretical physics. And, in this as in his other books, Venkataraman has established and maintained a high level of professional rigour in a field which has remained largely neglected in this country.

And what are we to say of QED? Richard Feynman was as clear in his assessment of it as he was in its affirmation, when he called it 'the jewel of physics'. But philosophically, he was an operationalist to whom the quintessence of science resided in its predictive capability. And if he could find an equation which could do just that, he would not concern himself with ontological enquiries into the nature of physical reality – an attitude entirely consonant with an age which had derived its philosophical orientation from logical positivism and the Copenhagen Interpretation. Dirac, on the other hand, died believing that the problems raised by self energy had merely been papered over by a theory cobbled together to permit computational facility. In the final analysis, it must be clear that the last word has not been said about the quantum. A cheerful acceptance of inevitable ignorance might perhaps not be a bad attitude with which to ride out this age of uncertainty – rather like old Kaspar in Southey's *Battle of Blenheim*.

'But what good came of it at last'
Quoth little Peterkin.

'Why, that I cannot tell', said he,
'But, 'twas a famous victory'.

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Banking on Biodiversity: Report on the Regional Consultation on Biodiversity Assessment in the Hindu Kush-Himalayas. Pei Shengji, ed. International Centre for Integrated Mountain Development, Kathmandu, Nepal. Price not known.

Managing biodiversity is managing contradictions. This is more so in frontier areas where international issues become additional problems. At the same time, knowing the fact that the more mobile components of biodiversity do not respect political boundaries, it is necessary for the nations to cooperate if at all they want to see success in the conservation of biodiversity especially in the border areas. Viewed from this perspective, this book is a timely contribution to society.

This book is the outcome of a workshop, on the assessment, monitoring, and management of the biodiversity of the Hindu Kush-Himalayas (HKH) region, that was organized by International Centre for Integrated Mountain Development (ICIMOD) in December 1995 at Kathmandu, Nepal. Experts from eight HKH countries, namely, Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal, and Pakistan participated. The participants reviewed the status of biodiversity in the region and made recommendations about future plans of actions for each country.

The book is organized into three parts. The first part spells out the proceedings of the workshop and working groups' reports on the issues and needs of biodiversity management in the HKH region, the second contains the country review papers from experts of eight HKH countries and the third contains seminar papers from experts representing international organizations engaged in biodiversity conservation. The book also contains 26 beautiful colour photographs of wildlife.

The title of the book gives a mistaken impression that it contains information about the biodiversity of those HKH regions on which people rely for their future, while the contributors, in their respective country reports, talk about more than what is present in HKH regions of their respective countries. This extra information is welcome in the sense that it informs us about what we have and what we do not. The country

reports give an overall review of the current state of biodiversity in the respective countries.

The HKH region is ecologically highly diverse as it covers polar-like environments and cold deserts to the rainforests. Mountain regions are rich in biodiversity because of their inherent environmental heterogeneity. At the same time, they are fragile and prone to degradation due to disturbances. Most of the country reports emphasize this fact. However, a limited human intervention enriches the biodiversity of the mountain regions also.

This book will be useful for biogeographers, policy makers, environmentalists, nature enthusiasts, soldiers of the green brigade, teachers and environmental awareness generators. Initially it looks less useful for the technical professionals who like to go deep into the functioning and processes of nature and then devise measures for the better functioning of the system. However, any technical advice will have to be implemented taking into consideration the other ground realities of the system. A number of such points and issues have been discussed well in this book. Experiences based on the effect of Afghan war on biodiversity and its conservation, importance of predators in rodent (pest) control in Afghanistan, effect of deteriorating law and order and erosion in the sense of value in Bangladesh, emphasis on maintenance of essential ecological processes, and the work of international organizations like WWF, IUCN, IBPGR (now IPGRI) in various countries in conserving biodiversity, could prove useful for technical professionals.

The quality of write-up, information given and the presentation from various contributors to the book are indicators of the technical know-how, scientific capabilities and the work already done in various HKH countries. China and India have done relatively well in this regard and have vision and future plans like undertaking integrated regionalization of biota, replanning of nature reserves on the basis of the regionalization and overall regional considerations. Small countries also have success stories and experiences of all sorts that will be very useful to the policy makers and the researchers. Most of the countries have emphasized studies on species of economic impor-