QUANTUM QUEST

The Breakthrough, by G. Venkataraman, Universities Press, 1994, Rs. 65/-.

QED: The Jewel of Physics, by G. Venkataraman, Universities Press, 1994, Rs. 50/-.

What is Reality, by G. Venkataraman, Universities Press, 1994, Rs. 50/-.

Quantum Mechanics and the Theory of Relativity are two revolutions which shook the world of Physics in the early part of the twentieth century. Not only can they claim to be immensely successful in explaining the diverse physical phenomenon encountered in nature, they are much more than just mathematical descriptions of the world out there. They have influenced our world view in a very profound way and in that sense their influence is felt much beyond the world of physics. Though the details of the theories are often in terms of abstruse mathematical concepts and hence somewhat inaccessible to the non-specialist, the fundamental philosophy behind these theories (specially quantum mechanics) has always held a fascination for the interested lay reader.

The books under review form a trilogy of sorts titled "Quantum Revolution". The author, who has written a series of books under the title "Vignettes in Physics" is a distinguished physicist. He is also the author of the authoritative and widely acclaimed biography of Sir C.V.Raman titled "Journey into Light".

The first book of the trilogy is the one in which the author sets out to explain the mysterious world of quantum mechanics. Here the treatment is unconventional for a popular book in as much as a somewhat pedagogical instead of a historical approach is followed. In the first chapter, the "only mystery" (to quote Richard Feynman) of quantum mechanics, the dual nature of matter is discussed pretty much along the lines of Feynman himself. The stage is then set for an brief overview of the whole subject. This the next two chapters try and accomplish with a lot of new concepts and a liberal dose of unfamiliar mathematics for the lay person. From the bra-ket formalism to Hamiltonian mechanics, from Stern-Gerlach machines to the Dirac equation, the author covers a lot of ground here. Unfortunately he is somewhat unsuccessful in communicating this. The amount of material covered forms essentially a full course on quantum mechanics at the advanced undergraduate or postgraduate level. The author certainly needs to be complimented for making an effort to convey the way the real world of quanta is (rather than mumbo-jumbo about dancing masters), but his treatment is cursory, the level very uneven and on the whole, he leaves the reader fairly confused.

The rest of the book is about the pioneers in the field, their lives and work and is certainly much more easy to read. Here the history of development of the whole subject is traced alongwith interesting information about the "dramatis personae". Brief biographical sketches

of Einstein, Heisenberg, Bohr, Schroedinger and Dirac are presented here. In the section on the development of quantum mechanics, the reader certainly gets a good flavor of how experiment and theory went hand in hand in the process. What is also brought out is that the road to the correct theory was by no means smooth and many times the pioneers worked on just intuition and hunches rather than well thought out formulations. The style is extremely readable and the text is supplemented with a lot of boxes, diagrams and flow charts (which I personally find somewhat annoying, but then this might be a personal bias). Overall, this volume is disappointing because the author sets up too wide a canvas and is extremely ambitious.

Quantum Electrodynamics (QED) is by far the most successful theory known to us. It is a marriage of sorts between the two great theories: quantum mechanics and the special theory of relativity. Developed in the fifties, it is phenomenally successful in explaining a host of sub-microscopic phenomenon like Lamb shift or the magnetic moment of the muon (a kind of elementary particle). The second volume of the trilogy is about this remarkably successful theory which the author has aptly called "the jewel of physics". Here again the author follows a similar structure by giving a pedagogical exposition first and then a brief historical treatment. The sections which try to explain the theory once again fall short of expectations because though the author manges to convey some of the exciting aspects of the theory, a non-specialist reader is soon lost in the conceptual issues and the mathematical details. In part this is because the subject itself is fairly mathematical and the concepts are by no means intuitive to the lay-person. The historical and biographical part is fun to read with many interesting anecdotes and stories many of which have become a part of the standard folklore of physicists.

Though the quantum theory has been outstanding in its agreement of theoretical predictions with experimental results, there has always been a school of thought which has found the philosophical implications of the theory to be very disturbing. The quantum view of the world is fundamentally different from the classical view which we are accustomed to. The essentially statistical nature of quantum mechanics, the role of the observer in "defining" the reality of the observed phenomenon are just some of the features of this new theory which many people found disturbing. Probably the most famous of the detractors was Einstein himself who made the famous statement that "God does not play dice". Till his death, Einstein remained convinced that the quantum theory, though an excellent prescription for doing calculations was not a complete theory of "reality". He, along with others favored the idea of a deeper "hidden variable" theory which could reproduce the results of quantum mechanics and still be appealing philosophically to them.

The third volume titled "What is Reality" deals with the issue of whether the description of the world given by quantum mechanics is satisfactory or not. The thought experiments of Einstein and others to attack quantum mechanics, the major philosophical debates between Bohr, the high priest of the theory and others are very well expounded in this volume.

The whole debate became more than just a philosophical one with the entry of John Bell who gave his famous inequalities, which by some have been hailed as "one of the most significant advance in physics". Now the issue could actually be settled if only we could perform experiments to test these inequalities.

That also was accomplished in the seventies with several groups carrying out the tests of Bell's inequalities with innovative experiments. All the results till now have given an unequivocal verdict in favor of quantum mechanics. The volume gives one of the clearest expositions of Bell's inequalities and the experiments to test them. It is very refreshing to read a well written and clear account of this field because several recent books have treated it very cursorily and in a sensational manner. This volume is certainly the best of the lot and can be read independently.

Quantum mechanics is certainly mysterious. Even a person of the calibre of Bohr has said that" anyone who is not shocked by it has not really understood it". It calls for a radical revision of certain of our concepts when we apply them to the microscopic world. It may be unsatisfactory on the philosophical level to some, but then nature doesn't need to fit into neat compartments devised by us. It is a triumph of the human intellect to be able to conceive of a theory which is counter to our ordinary experience and yet has proved to be so successful.