Beyond the Quantum Paradox. Lazar S. Mayants. Taylor and Francis, London. 1994. pp. xi + 105. Price: £9.95.

Among the numerous attempts, of late, to develop a correct point of view in respect of quantum mechanics, this book claims to offer a rather straightforward solution. In doing so some will say it goes a bit too far as, for example, in postulating the existence of emons, i.e. 'concrete' electromagnetic quanta with nonzero mass, even though such ideas have been suggested by others in the past from time to time. To take the last issue first, the case for nonzero mass for the quanta of electromagnetic fields is taken to be based on the formulae[1]

$$p_x = mc\beta_x, \quad E = mc^2, \quad m = m_0\eta^{-1}$$

$$(1 \le \eta^{-1} < \infty), \quad \eta^{-1} = \frac{1}{\sqrt{1-\beta_x^2}},$$

so that if $m_0 = 0$, then $m = 0$ even if $\eta^{-1} \to \infty$ when $\beta \to 1$, and if $m = 0$ then both p_x and E are identically zero. For a nonzero electromagnetic field to exist, m_0 and m must also be nonzero. One may rightly express one's worries here about trying to extract meaning out of expressions like $0 \times \infty$, or 0/0, etc.

The above is, however, only one of the conclusions to which the author is led to, in view of what he calls his principal principle, which is that in dealing with statements involving probabilities and statistics, one should never confuse the 'concrete' object for the abstract object. The simplest way to explain this by the author is to take the case of balls of different colours in a bag. When we talk, he says, of 'a ball in the bag', this is an abstract object which theoretically can possess any one of those different colours, but when we pick a concrete ball out of the bag it has one definite colour only. Statements of probabilities are always about abstract objects, whereas statistical experiments are always done with concrete objects.

Regarding Schrödinger equation, he says, it refers to the situation when the expectation value of the Hamiltonian of the system coincides with the expectation value of the energy of the particle, the wavefunction serving merely as an auxiliary mathematical device for calculating probabilities.

As an illustration of his views, Mayants proceeds to demolish the various quantum-mechanical paradoxes, like Schrödinger's cat paradox or the EPR-Bohm paradox, etc., by simply using his principal principle. In doing this he attempts to emphasize the role of classical concepts even though he does recognize the peculiar role of the superposition principle in calculating quantum-mechanical probabilities. About the Schrödinger's cat paradox, for example, he says that the 'concrete' cat has only one of the two possible values 'dead' or 'alive', of the property 'state of being', whereas an abstract cat does not exist in reality at all. The double-slit experiment is a Gedanken experiment, claims Mayants, because in an actual experiment the separation between slits should only be of the order of a few wavelengths. Bell's theorem, claims the author, has impeccable mathematics, but its premises are wrong. Bell's theorem is not followed in practice because spin values for the same concrete particle for different axes are not permissible. The only thing Bell-like arguments can prove, claims the author, is that quantum physics is incompatible not so much with realism as simply with determinism, which, in any case, being a probability-based theory, is as opposed to a nonprobability-based theory like nonstatistical classical mechanics.

Mayants argues that the situation in the EPR paradox is the result of the law of conservation of momentum and his principal principle, and that there is no action-at-a-distance, no 'knowing' of the result of measurement on one particle by the other. He, in fact, denies any connection between the Bell-inequalities-related experiments and the concrete mechanical system of the EPR, which latter belongs, he claims, to classical mechanics. Regarding Bohm's experiment, he says that it is meaningless to talk of simultaneous values of spin for different axes for a concrete system. Assuming conservation of angular momentum and his principal principle, the experimental outcome of Bohm's experiments is explainable, he claims, without further ado. Similarly, assuming Malus'es law, the principal principle and what is termed as the law of conservation of polarization, the experiments of Aspect *et al.*[2] are also sought to be explained, and it is claimed that there remains no paradox. In dealing with Wheeler's delayed-choice experiment, says the author, the outcome is determined by the last-moment choice, and not by the delay, as the concrete photons can be thought of as being emitted by two different sources, and interference-like effects then arise because of cross terms occurring when squaring the total wavefunction in getting the probabilities.

In contrast to the claims made by Mayants regarding the observance or otherwise of inequalities due to Bell (as also, by implication, due to Clauser–Horne, and others), Pitowsky[3], for instance, goes on to show convincingly that quantum frequencies often violate the facet inequalities of the correlation polytopes. Indeed, Pitowsky claims that violations of the above inequalities by quantum frequencies pose a major problem to all schools of classical probability. Much earlier, Strauss[4] had shown that the algebra of projectors in Hilbert space is only partially Boolean if complementarity in the Copenhagen sense was to be maintained. Even though experiments testing Bell inequalities have more than reaffirmed quantum-mechanical peculiarities, including nonlocalities, Mayants would have none of this. Like Einstein at one time, he would, as stated above, deny even the very existence of uncertainty relations if interpreted in terms of measurement as done by Heisenberg. The author feels strongly that Heisenberg's uncertainty principle deals with abstract quantities and that, therefore, Heisenberg's original interpretation in terms of experiments with concrete objects was wrong. The free particle and the harmonic oscillator cases, he says, violate the principle $\Delta p \cdot \Delta x \ge \hbar/2$, because for the free particle, for instance, p = constant implies $\Delta p = 0$, giving $\Delta p \cdot \Delta x = 0$ and not $\hbar/2$.

The author does not think it proper to so much as even mention either the deterministic or the stochastic hidden-variable theories, or the many-worlds or many-minds interpretations of quantum mechanics nor does he think it fit even to mention or discuss such important topics as the reduction of the wavefunction, while rejecting nonlocality offhand. The result is that there are strong statements in the book without the provision of adequate justifications.

One is tempted to think that Mayants' plunge for a 'concrete' ontology, and semblance of an attendant realism may have been motivated by the fact that violation of classical constraints like the Bell inequalities can be taken to imply antirealism, because, like a Humean skeptic, the antirealist may hold that quantum physics does not deal with causes but with phenomena only, and in a world without causes, 'anything goes'. In the event, however, Mayants ends up making sweeping statements which a more careful analysis may show to be wrong.

The chapter entitled 'Personality versus society' of the book seems out of place in what purports to be an account of the way out from the quantum-mechanical paradox, unless the author intended to show that he was demolishing the myths, he saw, of quantum mechanics, in much the same way as he would demolish the myths perpetrated in the name of dialectic materialism and social formation under communism!

All said and done, the principal principle enunciated by Mayants is something to be kept in mind when talking about probabilities and statistics in quantum mechanics, as in any probability-based theory, but, in spite of claims to the contrary by the author, this in itself can hardly be expected to obviate the need for further analysis of the foundational aspects of quantum mechanics.

The final answer, instead of lying with Mayants, may indeed lie somewhere else, based as it would be, on a more careful analysis of issues such as the superposition principle and entanglement, time evolution and reduction of wavefunction, and, of course, nonlocality, and then it would indeed be found, as shown by Redhead[5], that 'quantum mechanics has landed some pretty queer fish'.

1. Mayants, L. S., *Found. Phys*, 1981, **11**, 577.
2. Aspect A. *et al.*, *Phys. Rev. Lett.*, 1981, **47**, 460; 1982, **48**, 91; 1982, **49**, 1804.
3. Pitowsky, Itamar, *Quantum Probability, Quantum Logic*, Springer, Berlin, 1989.
4. Strauss, M., *Modern Physics and its Philosophy*, Reidel, Dordrecht, 1972.
5. Redhead, Michael, *Incompleteness, Non-locality and Realism*, Clarendon, Oxford, 1990

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The Action Principle in Physics by R. V. Kamat. IPA monographs in physics series. New Age International Publishers Limited, Wiley Eastern Limited, 4835/24 Ansari Nagar, Daryaganj, New Delhi. pp. 201. Price: Rs 400/-.

Given the large number of students which flock to various postgraduate departments in Indian universities every year, the near total lack of books by Indian authors written specially for Indian students, either as basic textbooks or for supplementary or follow-up reading, is quite remarkable. While it is certainly true that most of the students would rather watch TV than study books in their spare time, and bogged down with heavy course loads as they are, certainly not 'outside-the-course' monographs, this is not a sufficient explanation. For, even if only, say, 5% of the students are seriously interested in their subjects, we are still dealing with large numbers. That they do not do so much is partly because reasonably priced books, pegged at an appropriate level, are not easily available. Clearly, here is a Catch-22 situation.

While there are a large number of monographs of good quality published abroad, these are usually not available to Indian students. Most university libraries are in bad shape. The high price of books is a very major deterrent. Also, not many bookstores kept many specialized monographs in stock, and ordering them from publishers can take 6–9 months (who can afford air mail?). It seems quite unreasonable to expect a student to have sufficient patience and sustained interest for so long. 'In the final year, sir, we study other subjects.' The students are like that only.

The Indian Physics Association, by publishing monographs meant for Indian students of postgraduate level, or first year of Ph D is providing a much needed input. The volumes are reasonably priced, and the prices, hopefully, could be brought down further if the series proves popular. It is reasonable to expect that Indian authors would have a much better understanding of mathematical or conceptual difficulties faced by Indian students and, thus, would be better able to adapt the material to our needs. It is an idea whose time has come.

The present volume is by R. V. Kamat, who has been teaching physics students in St. Xavier's College, Bombay, at both undergraduate and postgraduate levels for over 20 years. It deals with the action principle in classical mechanics, electrodynamics, general relativity and quantum mechanics. The book starts with simple problems in calculus of variation, e.g. the famous brachistochrone problem and Fermat's minimum time principle in geometrical optics. These chapters have a large number of problems, of which at least some will be enjoyed by interested readers. This is followed by discussions of Hamilton's principle in classical mechanics. This is a fairly standard fare for M Sc (Physics) students and is dealt with quite satisfactorily here, as also in most standard textbooks on mechanics. The next chapter deals with the action in classical electrodynamics, and derivation of Maxwell equations, starting from the corresponding action.

The author has been careful enough to recaptitulate some of the concepts, and the covariant notation of the special theory of relativity. These are followed by chapters on the action principle for general relativity and for quantum mechanics, however avoiding a full-blooded path integral formulation (that would perhaps require a book on its own). A chapter on action-at-a-distance for much of electrodynamics, which avoids introducing electromagnetic field as a separate entity and defines direct but 'delayed' action-at-a-distance between charges (as proposed by Fokker and Schwartzchild and developed later by Wheeler and Feynman), has been added perhaps as a teaser for students to pursue the subject further.

The book is suitable for M Sc (Physics) or first-year M Phil students. It has a judicious mix of conventional 'textbook material', and somewhat more advanced topics which are usually found only scattered in different textbooks on electrodynamics and relativity of quantum mechanics. The book thus brings out an important unifying principle in physics, in a language accessible to students.

On the debit side, the price of the book at Rs 400 for 200 or so pages is not really low. The number of typographical errors is quite large for a textbook meant for students. It is hoped that