Measurement and Quantum Probabilities. M. D. Srinivas. Universities Press (India) Ltd, 3-5-819, Hyderguda, Hyderabad 500 029. 2001. 272 pp. Price: Rs 260.

The validity of a postulate of a physical theory is judged by its ability to describe the observed physical phenomena. However, in spite of its success on this count, the postulate of quantum mechanics which relates theoretical predictions with experimental observations has been at the centre of controversy since its conception. The postulate in question states that '*each act of measurement of an observable* $\hat{A}$ *of a system in state* $|\psi\rangle$ *collapses the system to an eigenstate* $|a_i\rangle$ *of* $\hat{A}$ *with probability* $|\langle a_i|\psi\rangle|^2$. *The average or the expectation value of* $\hat{A}$ *is given by*

$$\langle\hat{A}\rangle = \sum_i a_i\ |\langle a_i|\psi\rangle|^2 = \langle\psi|\ \hat{A}|\psi\rangle, \quad (1)$$

the a_i *being the eigenvalue of* $\hat{A}$ *corresponding to the eigenstate* $|a_i\rangle$'.

The complex number $\langle a_i|\psi\rangle$ is called the *probability amplitude*. If the eigenvalues ξ of the operator associated with the observable are continuous with $|\xi\rangle$ as the corresponding eigenvectors, then $|\langle\xi|\psi\rangle|^2$ is identified as the *probability density*, so that $|\langle\xi|\psi\rangle|^2\,d\xi$ is the probability that the act of measurement results in a value in the range $d\xi$ around ξ.

The so-called measurement postulate thus makes only probabilistic predictions of the outcome of a physical process. The controversies resulting from this postulate revolve around two questions: (a) the question of consistency of the postulated process of 'collapse' with other postulates, and (b) the question of 'objective reality' due to fundamentally different nature of quantum and classical probabilities. For example, in quantum mechanics there is no concept of joint distribution function of observable values of two non-commuting observables; the probability of observing an eigenvalue of an operator at a time depends on the measurements made previously on the system and so on.

There are also subtle mathematical issues that arise while extending the collapse postulate for observables with discrete spectra to the ones having continuous spectra. Besides, the extension of the theory to incorporate continuous measurements is of practical importance, like, in the experiments on photon counting.

Moreover, the probabilistic nature of predictions of the theory naturally raises the question of characterizing the extent of uncertainty in the measurement of an observable and the correlation between the uncertainties in the measurement of two observables. Recall that variance is generally taken as such a measure and that the relationship between the uncertainties in the measurement of two observables in quantum mechanics is provided by the generalized uncertainty relation

$$\Delta\hat{A}^2\Delta\hat{B}^2 \geq \tfrac{1}{4}[\langle\hat{F}\rangle^2 + \langle\hat{C}\rangle^2], \quad (2)$$

where $\Delta\hat{X}^2 \equiv \langle\hat{X}^2\rangle - \langle\hat{X}^2\rangle$ is the variance in the measurement of an observable associated with the operator $\hat{X}$,

$$[\hat{A}, \hat{B}] = i\hat{C}, \;\; \hat{F} = \hat{A}\hat{B} + \hat{B}\hat{A} - 2\langle\hat{A}\rangle\langle\hat{B}\rangle. \quad (3)$$

Note that eq. (2) reduces to the relationship familiar in classical probability theory if the operators commute and that it yields the Heisenberg relation which is eq. (2) without the $\langle\hat{F}\rangle$ term. The drawback of the uncertainty relation is that, unless $\langle\hat{C}\rangle$ is a constant multiple of unity (like in case of position and momentum operators), the lower bound on the product of uncertainties of two operators depends on the state of the system as a result of which it cannot give an absolute lower bound on the variance of one observable given the variance in the other.

These issues have been of concern to those seeking a sound logical and mathematical structure of the quantum theory for describing the observed phenomena. An explorer of these issues is likely to lose his way if not assisted by an appropriate route map. The book under review not only fulfils this requirement, but also exhibits that fascinating structure. M. D. Srinivas himself has made important contributions to this area. This book, in fact, is a collection of his articles published over the years. The articles are arranged according to four major themes introduced in Chapter 1: quantum probability theory, hidden variables theory of quantum mechanics, generalization of the measurement postulate to observables with continuous spectra, quantum theory of continuous measurements with an application to the process of photon counting. The articles pertaining to a theme make coherent reading.

Chapter 2 introduces the formalism of probability of successive measurements in quantum theory and the features of quantum probabilities that distinguish it from their classical counterparts. The issues involved in the formulation of a generalized probability theory appropriate for quantum mechanics are discussed. The lattice theoretic approach, based on the work of Birkhoff and von Neumann, and the 'operational approach' based on the work of Davies, Lewis and Edwards are described. However, this chapter relies heavily on pure mathematics language of the theory of probability. A physics student from an Indian university is highly unlikely to be familiar with such a language.

Chapter 3 addresses the issue of the drawback, briefly mentioned above, in the familiar uncertainty relation. It introduces the approach initiated by Deutsch for characterizing uncertainty in terms of entropy. The entropic uncertainty relation between successive measurements is also derived. The mathematics in this chapter is at the level of Indian university physics.

Chapters 4–6 are on hidden variables theory for quantum measurement and its incompatibility with causality. Chapters 7 and 8 are on the theory of extension of the collapse postulate to observables having continuous spectra. Perhaps the demand of mathematical rigour has necessitated that the language of these chapters be of pure mathematics. There are several accounts of the hidden variables theory, with as well as without inequalities, referred in these chapters, whose mathematical language is more palatable to an Indian university student of physics.

Chapters 9–12 present the formalism to account for continuous measurement in quantum mechanics. That formalism is applied to develop quantum theory of photon counting and compared to its classical counterpart. The material of these chapters is of fundamental importance in quantum optics. The mathematics is at the level of Indian university physics.

Since the articles reproduced in the book are from research journals, they are primarily written for experts in the field. However, it goes to the credit of the author that the chapters (identified above) which do not require the knowledge of pure mathematics on the part of a reader are readable, even by non experts. Even the chapters (identified above) which require a reader to know the language of pure mathematics, convey the essence of the issues qualitatively to a non expert. That is why the book under review would benefit anyone interested in exploring the world of quantum probabilities.

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TGF-β and Related Cytokines in Inflammation. S. N. Breit and S. M. Wahl (eds). Birkhauser Verlag AG, P.O. Box 133, CH-4010, Basel, Switzerland. 2001. 201 pp. Price: sFr 168/DM 220.

The book under review is a collection of articles on the TGF-β cytokines in inflammation written by authors, well-known in the field. TGF-β-related molecules are grouped as a super-family of growth and differentiation factors. These molecules have limited sequence similarities but are structurally well-conserved and have been identified from many species across evolution, from nematodes to mammals. To date, around 40 different TGF-β super-family proteins have been described and the number is ever-expanding. Each of the members are sub-grouped into sub-families that include TGF-β, activins/inhibins, bone morphogenetic proteins, growth and differentiation factors, etc. The super-family is named after TGF-β since this was the first member to have been described. TGF-β molecules are very diverse in their functions, with little overlap in their actions. They all are secreted molecules made from a larger precursor protein and effect their actions through a complex signalling cascade, including simultaneous cooperation of two different sets of receptors called type I and type II. Given the spectrum of the activities of each of the members, they are all multifunctional factors, which influence several phenomena ranging from early development to several functions in the adult. The broad functional properties of many members can be grouped under three common themes, wound healing and repair; regulation of inflammation and immunity; cell growth and differentiation. Several reviews appeared in recent times on the various aspects of TGF-β family members.

A role for TGF-β in immune function has been proposed, shortly after the discovery of TGF-β. TGF-β1 was found to be a potent immunoregulatory agent, enhancing monocyte function and suppressing lymphocyte proliferation and function. In addition, the ability to inhibit proliferation of *T* and *B* cells at very low concentrations makes them significantly more active than the *T*-cell-specific immunosuppressant, cyclosporin. This was substantiated by the discovery that a very potent immune suppressor called 'gliobalstoma-derived immunosuppressing factor' turned out to be a close brother of TGF-β1 and was hence named as TGF-β2. Subsequently, the role of TGF-β isoforms in immune function has been documented by several studies and the most striking evidence has been the generation of the TGF-β1 gene knockout mice. TGF-β1 knockout mice show a phenotype suggestive of severe immune disregulation and die shortly after birth due to massive inflammatory response that involves all major organs. Hence, the role for TGF-β molecules in inflammation and immuneregulation is incontrovertible. TGF-β has been on the top of the agenda of many immunologists who were zealously pursuing autoimmune and other immune disorders. In addition, several other members of this super-family were also implicated during many physiological and pathological conditions that include wound and repair, inflammation and immunity and cell growth and differentiation. This book, hence is timely in putting together aspects on a theme perspective rather than a molecule. The major aspects of this area have been covered, including the description and role of a relatively new member of this super-family called 'macrophage inhibitory cytokine 1 (MIC-1)' that was discovered in 1997. In addition to the major focus on inflammation, would healing and repair, the chapter by Heldin *et al.*, describes in a very comprehensive manner, the highly complex TGF-β signal transduction pathway and the implications of different molecules involved for possible therapeutic targets in diseases that involve TGF-β super-family members. Many articles, in addition to reviewing the current status of the subject, also discuss the possible pathological conditions that may implicate TGF-β members, as is relevant. In particular, reviews on the TGF-β family and the endothelium' by Gamble *et al.* and 'TGF-β and the cardiovascular system' by Grainger and Mosedale, provide exhaustive coverage of the possible pathological conditions that may involve pathways of TGF-β super-family. The coverage on the wound-healing aspects related to TGF-β cytokines by Niesler and Ferguson brings out the essential roles played by TGF-β isoforms in this complex process. All the reviews in this book are good reference material to workers in the respective fields and also a general reading to both basic researchers and clinicians. One major drawback that this reviewer felt was the redundancy in most of the chapters on the description of TGF-β family and the signalling pathway. This could have been restricted to any one of the reviews and others could have been avoided with some understanding with the editors. Otherwise, this book gives a very good review of TGF-β family and the roles played by many members of this family in inflammation, wound healing and repair processes. I recommend this book as a reference material to all researchers in the field of immunology.

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Annual Review of Entomology, vol. 46. M. R. Berenbaum, R.T. Cardé and G. E. Robinson (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, USA. 2001. 806 pp. Price not mentioned.

Annual Reviews Inc. and the editorial team is to be commended on this fine collection of review articles on a wide variety of subjects ranging from practical issues on how to mark insects for demography studies to the evolution of colour vision. Twenty-four articles are far too many to mention in this review of reviews,