vector ϕ_n. However it has now been proven quite generally that the evolution of the state vector according to the Schrödinger equation for the object interacting with the measurement apparatus is incompatible with any such "reduction." As is well known, this problem is resolved, without hidden-variables, by assuming instead that the state vector describes only the statistical properties of a certain ensemble of similar systems. The "reduction of the state vector" is then not a physical process, but merely the selection of a subensemble for which the measurement had a certain result. From this point of view the above models constitute a backward step. An individual system may equally well be regarded as a member of the original ensemble or of the sub-ensemble, but the predictions made by one of those models for some future measurement may depend upon whether the full or reduced state vector is employed, even if the hidden variables ξ are identical in both cases. To avoid such paradoxes and obviate the "problem of measurement," the HV prediction $A = a_n$ should be determined by a function of the form $n = n(\xi, |\phi_i|)$. It should not depend explicitly on the state vector ψ, whose role should be to determine the probability distribution of the HV ξ. Is such a theory possible? Apparently no research has been done on this important question.

The last part of the book concerns correlations between spatially separated, noninteracting systems. A representative example would be the correlation between the polarizations of two photons emitted in the decay of singlet-state positronium, although certain atomic cascade transitions are technically easy to study. A theory of the *second kind* is based on the *locality hypothesis* that whether or not one of the photons passes through a polarization filter is not affected by the experiences of the other photon at a distant filter. J. S. Bell showed that the locality hypothesis implies a certain inequality for the polarization correlations, and, moreover, that some predictions of QM violate this inequallty! The experimental results of Stuart J. Freedman and John F. Clauser at Berkeley agree with QM and disagree with Bell's inequality, while those of Richard Holt at Harvard (for a different cascade transition) agree with Bell's inequality and disagree with QM.

I have deliberately spoken of a disagreement of QM with Bell's inequality, rather than with HV theory, because it has lately been realized that the locality hypothesis from which Bell's inequality is derived does not require the existence of hidden variables. Neither Bell's original paper nor this book reveal this greater significance of the contradiction between QM and locality, the experimental investigation of which has been compared in importance to the Michelson–Morley experiment.

Having originated from a dissatisfaction with the indeterministic nature of quantum mechanics, the study of hidden-variable theories has transcended that limited origin and has yielded important insights into the nature of quantum theory. Belinfante is to be congratulated for providing this readable survey of the subject.

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Elements of Group Theory for Physicists

A. W. Joshi
316 pp. Halsted, New York, 1973. $5.95

Classical Groups for Physicists

B. G. Wybourne
415 pp. Wiley, New York, 1974. $19.95

It is increasingly becoming the practice of university teachers to expand their lecture notes into books, whether the need exists or not. Although there are already numerous books in print on group theory for physicists, A. W. Joshi and Brian Wybourne have seen fit to give us two more. Joshi treats both finite and infinite groups; Wybourne restricts himself to Lie groups. Both authors have written suitable texts for graduate students in physics.

I discovered nothing new in either book. However, the subject of group theory is a large one, and the physical applications are many. The books by Joshi and Wybourne differ in their selection of material, not only with each other, but with previous works on the subject. Whether one chooses to learn about group theory in physics from either of these books or from earlier works, such as Eugene Wigner's *Group Theory and Its Applications to the Quantum Mechanics of Atomic Spectra,* Morton Hamermesh's *Group Theory,* Volker Heine's *Group Theory in Quantum Mechanics,* or a number of others, is a matter of taste.

Joshi and Wybourne both discuss abstract groups and their representations. Both treat Lie groups and Lie algebras. Both give applications to physics within the framework of quantum mechanics.

But the differences between these books are as great as their similarities. Wybourne assumes greater mathematical knowledge on the part of the reader than Joshi. For example, he assumes

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the reader is familiar with vector spaces, whereas Joshi devotes a chapter to discussing them. Joshi also spends considerable time on the finite point groups, a subject that is absent from Wybourne's more restricted work. On the other hand, as expected, Wybourne goes into considerably more detail than Joshi on Lie groups. Wybourne follows the Cartan classification of these groups and treats root and weight diagrams in detail. He also collects material that is not often found in texts on group theory for physicists, such as Dynkin diagrams and the Chevalley basis.

In the applications, the principal problems that Wybourne treats are the harmonic oscillator, the hydrogen atom and fermion shell structure. Joshi's chief applications are to crystals, atoms and molecules, and to solid-state physics.

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Hadron Physics at Very High Energies

D. Horn, F. Zachariasen
378 pp. W. A. Benjamin, Reading, Mass. 1973. $17.50 hardcover, $9.50 paperback

This book is primarily directed at advanced-graduate students and researchers in the field of elementary-particle physics. Although the authors presuppose a fair degree of sophistication on the part of the reader, a much larger audience may find the book a useful introduction to the phenomena of particles interacting strongly at very high energies.

Certainly the field of strong interactions is essential to a fundamental understanding of the structure of matter. It is also true that progress in constructing a theory of strong interactions is slow. Thus many of the advances that have been made have been closely tied to experiment. Recently, a tremendous quantity of data has been collected at the new very high-energy accelerators at the Fermi NAL, the CERN Intersecting Storage Ring as well as the older Serpukhov machine. For the first time, energies in the regime of hundreds and thousands of GeV are accessible for study in the laboratory under controlled conditions. Although an understanding of the data exists only at a phenomenological level, some tentative regularities have been generally accepted as important new insights into strong interactions.

It is the stated purpose of the authors to "summarize the data and the models we now have for correlating and interpreting it." This they are eminently qualified to do. Both have made many contributions to the field of strong interactions. David Horn has had a longtime interest in production mechanisms at very high energy and has written many papers on the subject. Fredrik Zachariasen has, among many other things, contributed a good deal to the understanding of Regge exchanges, particularly how they relate to diffraction scattering effects in elastic cross sections. He is also the author of *Electromagnetic Structures of Nucleons.* Both authors have been active participants in trying to understand the results from the new accelerators.

The authors have made a very useful contribution with their book by providing a bridge to very high-energy phenomena for people who are already familiar with low- to medium-energy data and models. Because the authors are particularly biased towards Regge-