the probability of noninterval webs is unclear. If artificial webs constrained to have any or all of these additional attributes had fewer noninterval webs, then the rarity of noninterval webs in nature might be partially explained.

In the later chapters of the book Cohen explores the significance of the rarity of noninterval webs. If a predator's choice of prey can be expressed along a single dimension, what is that dimension? Does it represent an obvious physical or biological parameter, or is it abstract? In most cases the data available are insufficient to answer this question. Cohen defends his results against any circularities and points out that if there is an identifiable physical or biological dimension its occurrence does not explain why only one dimension predominates.

Other explanations for the excess of interval webs are discussed, and none of them are found to be totally acceptable. One explanation Cohen considers is that noninterval webs might be dynamically unstable. This explanation is rejected on the grounds that both interval and noninterval webs modeled by linear interactions can be shown to be stable. However, though the number of interactions in the model webs is similar to the number in the real web being analyzed, the distributions of interactions within the model and the real webs may be very different. Models may produce webs with blocks of highly interconnected species balanced by a paucity of interactions between blocks. Blocks of this type might be dynamically unstable and not persist in the real world. This would leave webs with interactions more uniformly distributed. Because of their complexity the blocks would also be more likely to be noninterval, and if any subset of a web is noninterval the entire web is noninterval. For example, a block of species consisting of two carnivores, two herbivores, and two plants requires at least eight pairs of predator-prey interactions (including two between the carnivores and the plants) before it can be noninterval. Linear models of such a noninterval system have a very small range of parameters consistent with dynamic stability, and indeed Cohen's data do not include many such blocks. In short, if the real world has fewer complex blocks than the models this also might explain the rarity of noninterval webs.

Cohen concludes with a critique of both the data and the methods used to analyze them. His attention, throughout, to detail makes this book particularly convincing. It is clearly written and each step of the argument is well illustrated with examples or analogies. The mathematics (which is generally easy to follow) is innovative, and in lacking envy of the physicists' techniques (such as differential equations) Cohen has broadened the mathematical base for theoretical ecology. Moreover, though taking a theoretical approach to his subject Cohen does not become mesmerized by the wealth of possible behaviors shown by model systems and then look to nature for examples. Rather he seeks out those patterns that are widespread in nature, carefully excludes trivial explanations, and then explores possible causes. Many ecological phenomena are complex, and how they should behave under a statistical null hypothesis may also be complex. One could wish that other ecologists were as careful as Cohen has been to distinguish patterns from statistical artifacts. More studies using methods similar to his would greatly improve our understanding of ecological communities.

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Quantum Theory

Mathematical Foundations of Quantum Theory. Papers from a meeting, New Orleans, June 1977. A. R. MARLOW, Ed. Academic Press, New York, 1978. x, 372 pp., illus. $22.

In his opening essay, "The mathematical foundations of quantum theory," P. A. M. Dirac says, "One should keep the need for a sound mathematical basis dominating one's search for a new theory. Any physical or philosophical ideas that one has must be adjusted to fit the mathematics. Not the other way around. Too many physicists are inclined to start from preconceived physical ideas and then to try to develop them and find a mathematical scheme that incorporates them. Such a line of attack is unlikely to lead to success." Most of the other 18 contributors to this volume of conference proceedings have followed the line advocated by Dirac. As a result, the book presents a reasonable sample of current efforts to learn the lesson of quantum mechanics by identifying its mathematical structure in a general framework of physical theory.

I will mention a small but, I hope, representative subset of the contributions. John Wheeler discusses a family of "delayed choice" experiments in which the observation made on a system is delayed until after the system has completed its essential interactions. Thus, the outcome of the interactions apparently depends on the observer's later choice. Wheeler's detailed and instructive analysis supports the statement he quotes from Niels Bohr, "No phenomenon is a phenomenon until it is an observed phenomenon." Experiments of the type discussed by Wheeler have only recently become practical possibilities in the laboratory, and it is to be hoped that quantum mechanics will soon be given yet another subtle and significant test by experiments now under way. Andrew Vogt gives a family of examples of pairs of distinct nonrelativistic wave functions that have identical probability distributions in both coordinate space and momentum space. He notes that the first examples of this kind appear to have been given by Hans Reichenbach and Valentine Bargmann in 1948 and that there are still plenty of associated open problems, such as to determine classes, C, of self-adjoint operators with the property that if two wave functions have the same distributions with respect to operators of C they differ by a constant phase factor. Franklin Schroeck, Jr., studies the idea of a measure with minimum uncertainty on a noncommutative algebra with an eye to the idea of "fuzzy observable" in quantum mechanics. Thurlow Cook shows how a classical theorem of commutative measure theory, the Vitali-Hahn-Saks theorem, can be extended to (noncommutative) quantum logics. Roughly, the result is that a sequence of states that converges on each proposition defines a limiting state. This is a basic technical result in the theory of quantum logics. A considerable portion of the volume (315 pages) is devoted to the general theories of quantum logics and of manuals—the authors here include A. R. Marlow, Richard Greechie, S. Gudder, D. J. Foulis and C. H. Randall, Hans Fischer and Gottfried Rüttimann, and Ron Wright. This subject has by now achieved maturity, and there is a considerable mathematical theory associated with it, as well as a fund of unsolved problems. Both are well described here.

Since it is not unlikely that at least a century will be necessary for the assimilation of the ideas of quantum mechanics, it is probably too much to expect that a book of this kind written after 50 years should be more than a modest progress report. It is just that and, as such, will no doubt prove useful for all those who interest themselves in the mathematical aspect of the assimilation process.

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