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Book Review: *Handbook of Stochastic Methods for Physics, Chemistry, and the Natural Sciences*

Handbook of Stochastic Methods for Physics, Chemistry, and the Natural Sciences. C. W. Gardiner.
Springer-Verlag, New York, 1983. 429 pages.

The ubiquity of probability in the physical sciences is reflected in the appearance of many recent monographs on the subject. Gardiner's book differs from most of these in that he has tried to make it more of a text than an exposition of recent results. In this he has succeeded admirably. It is clearly impossible to cover all topics in physical probabilistics, but Gardiner has covered enough of them, writing in simple and clear style, to make this book a valuable starting point for the subject. The closest comparison to other volumes covering the same material would be to van Kampen's recent monograph. The two books have an entirely different feel about them. It would be hard to learn an appreciable amount of probability from van Kampen's monograph, but it nevertheless should be read for the great insight shown by the author into several of the issues of modern research in this area. Gardiner's book is written in a more leisurely fashion, covers more ground, and provides more introductory material.

One of the most useful chapters in this book is on the Ito calculus and stochastic differential equations. The subject is covered with great clarity, including a valuable discussion of multivariate systems, and the relation between stochastic differential equations and the Fokker–Planck equation. A particularly nice feature of the exposition relates to the conversion from Cartesian to polar coordinates of a pair of Ornstein–Uhlenbeck processes, a device used to describe optical fields. A detailed account is given of the Fokker–Planck equation, including the subject of Feller's enumeration of possible boundaries, which is not often met outside of mathematical texts. First passage time problems are covered, as is the relation between forward and backward equations. A somewhat more advanced topic is that of the consequences of detailed balance on solutions to the Fokker–Planck equation.

A topic not found in many other texts is that of approximation methods for diffusion processes. In his chapter on this subject Gardiner

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discusses perturbation theories for systems in which the noise is small in some sense, and the method of adiabatic elimination in which fast variables can be eliminated systematically from a multiscale system. Here one might wish to see a more detailed account of the recent work of Matkowsky and Schuss, as well as that of Suzuki. The chapter on master equations includes, in addition to more conventional topics, van Kampen's system size expansion of the master equation, as well as Gardiner and Chaturvedi's elegant Poisson representation which allows one to generate Fokker–Planck equations equivalent to certain classes of master equations.

Remaining chapters include ones on spatially distributed systems, metastability and related escape problems, and quantum Markov processes. That on metastability does not get into some of the more intricate calculations seen lately in physics journals. It does however get into the commoner methods of attacking questions of bistability and metastability, including a clear and useful introduction to Kramer's ideas and generalizations thereof. The final chapter concerns ideas that have found wide use in the analysis of laser systems.

There are topics that one might want to see discussed at greater length in this book—branching processes and random walks being two such topics —but one must always allow the authors' preferences some play. The material contained in this text is generally very well presented and there are few misprints.

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