Quantum Noise

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Book reviews

Quantum Noise
C W Gardiner and P Zoller
2004 Heidelberg: Springer
449pp EUR89.95 £69.00 US$109.00
(hardback) ISBN 3-540-22301-0

Quantum Noise is advertised as a handbook, and this is indeed how it functions for me these days: it is a book that I keep within hand's reach, ready to be consulted on the proper use of quantum stochastic methods in the course of my research on quantum dots. I should point out that quantum optics, the target field for this book, is not my field by training. So I have much to learn, and find this handbook to be a reliable and helpful guide.

Crispin Gardiner previously wrote the *Handbook of Stochastic Methods* (also published by Springer), which provides an overview of methods in classical statistical physics. *Quantum Noise*, written jointly with Peter Zoller, is the counterpart for quantum statistical physics, and indeed the two books rely on each other by frequent cross referencing.

The fundamental problem addressed by *Quantum Noise* is how the quantum dynamics of an open system can be described statistically by treating the environment as a source of noise. This is a general problem in condensed matter physics (in particular in the context of Josephson junctions) and in quantum optics. The emphasis in this book in on the optical applications (for condensed matter applications one could consult *Quantum Dissipative Systems* by Ulrich Weiss, published by World Scientific).

The optical applications centre around the interaction of light with atoms, where the atoms represent the open system and the light is the noisy environment. A complete description of the production and detection of non-classical states of radiation (such as squeezed states) can be obtained using one of the equivalent quantum stochastic formulations: the quantum Langevin equation for the field operators (in either the Ito or the Stratonovich form), the Master equation for the density matrix, or the stochastic Schrödinger equation for the wave functions. Each formulation is fully developed here (as one would expect from a handbook), with detailed instructions on how to go from one to the other.

The development of the topic is precise and well-organized. The derivations are written out in sufficient detail, without frustrating comments like 'it can be shown that'. The book is not quite self-contained, because it relies on the *Handbook of Stochastic Methods* for some background material (notably the issue of Ito versus Stratonovich). Still, one could very well use this book as a text for a course, supplying the background material to the students in some other form.

Quantum Noise is now in its third edition. The second edition was a major expansion, including applications to laser cooling and quantum information processing. The third edition is a relatively minor upgrade, consisting mainly of pointers to recent literature. If you own the second edition, you might well skip this upgrade. If you do not yet own the book, or are still at edition 1, then I would enthusiastically recommend acquiring this handbook, regardless of whether you work in quantum optics or in another field of quantum physics. As I did, you might well find a new tool to attack your favourite problem.

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Quantum Entanglements: Selected Papers
R Clifton (ed J Butterfield and H Halvorson)
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504pp £50.00 (hardback) ISBN 0-19-927015-5

This book is a sort of tribute to Rob Clifton (1964–2002), Associate Professor of Philosophy and Associate Director of the Center for Philosophy of Science at the University of Pittsburgh, philosopher of physics and editor of the journal *Studies in the History and Philosophy of Modern Physics*, who tragically died of cancer. It contains fourteen papers by Clifton, for the most part written in collaboration with other authors (Jeffrey Bub (2), Sheldon Goldstein, Michael Dickson, Hans Halvorson (6), Adrian Kent (2)), published between 1995 and 2002.

The choice of papers made by the editors is very impressive. They concern the foundations of quantum mechanics and quantum field theory. Among the issues discussed are the modal interpretations of quantum mechanics, the problems of hidden variables theories, non-locality,

Bell's inequality, the Einstein–Podolsky–Rosen paradox, Lorentz invariance, de-coherence, non-contextuality, complementarity, entanglement and quantum information. A consequence of such investigations is that non-separability is a more complex issue than violation of Bell's inequality.

Apart from the perspective one can follow—whether one agrees or not with Clifton—these papers are effective contributions to an understanding of the problems involved in the foundations of quantum mechanics. The most interesting parts, in my opinion, are related to the extension of the discussion of foundational problems to quantum field theory: on the algebraic approach, and on the twin concepts of particle and vacuum. Non-locality appears to be 'worse' in relativistic quantum field theory than in non-relativistic quantum mechanics.

All the papers deal with relevant epistemological and even historical aspects of quantum mechanics interpretations, but all the issues are discussed from a technical, logical and mathematical approach. A complete bibliography of Clifton's papers is given at the end of the volume.

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