Path Integrals in Field Theory: An Introduction

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Book review

Path Integrals in Field Theory: An Introduction
U Mosel
Heidelberg: Springer-Verlag (2003)
213pp, EUR49.95, £38.50, US$64.95 (paperback)
ISBN 3-540-40382-5

In the 1960s Feynman was known to particle physicists as one of the people who solved the major problems of quantum electrodynamics, his contribution famously introducing what are now called Feynman diagrams. To other physicists he gained a reputation as the author of the Feynman Lectures on Physics; in addition some people were aware of his work on the path integral formulation of quantum theory, and a very few knew about his work on gravitation and Yang–Mills theories, which made use of path integral methods. Forty years later the scene is rather different. Many of the problems of high energy physics are solved; and the standard model incorporates Feynman's path integral method as a way of proving the renormalisability of the gauge (Yang–Mills) theories involved. Gravitation is proving a much harder nut to crack, but here also questions of renormalisability are couched in path-integral language. What is more, theoretical studies of condensed matter physics now also appeal to this technique for quantisation, so the path integral method is becoming part of the standard apparatus of theoretical physics. Chapters on it appear in a number of recent books, and a few books have appeared devoted to this topic alone; the book under review is a very recent one.

Path integral techniques have the advantage of enormous conceptual appeal and the great disadvantage of mathematical complexity, this being partly the result of messy integrals but more fundamentally due to the notions of functional differentiation and integration which are involved in the method. All in all this subject is not such an easy ride. Mosel's book, described as an introduction, is aimed at graduate students and research workers in particle physics. It assumes a background knowledge of quantum mechanics, both non-relativistic and relativistic. After three chapters on the path integral formulation of non-relativistic quantum mechanics there are eight chapters on scalar and spinor field theory, followed by three on gauge field theories—quantum electrodynamics and Yang–Mills theories, Faddeev–Popov ghosts and so on.There is no treatment of the quantisation of gravity.Thus in about 200 pages the reader has the chance to learn in some detail about a most important area of modern physics. The subject is tough but the style is clear and pedagogic, results for the most part being derived explicitly. The choice of topics included is main-stream and sensible and one has a clear sense that the author knows where he is going and is a reliable guide. Path Integrals in Field Theory is clearly the work of a man with considerable teaching experience and is recommended as a readable and helpful account of a rather non-trivial subject.

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