<<引力的量子效应导论>>

图书基本信息

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前言

This book is an expanded and reorganized version of the lecture notes for a course taught at the Ludwig-Maximilians University, Munich, in the spring semester of 2003. The course is an elementary introduction to the basic concepts of quantum field theory in classical backgrounds. A certain level of familiarity with general relativity and quantum mechanics is required, although .many of the necessary concepts are introduced in the text.The audience consisted of advanced undergraduates and beginning graduate students. There were 11 three-hour lectures. Each lecture was accompanied by exercises that were an integral part of the exposition and encapsulated longer but straightforward calculations or illustrative numerical results. Detailed solutions were given for all the exercises. Exercises marked by an asterisk （*） are more difficult or cumbersome.The book covers limited but essential material: quantization of free scalar fields; driven and time-dependent harmonic oscillators; mode expansions and Bogolyubov transformations; particle creation by classical backgrounds; quantum scalar fields in de Sitter spacetime and the growth of fluctuations; the Unruh effect;Hawking radiation; the Casimir effect; quantization by path integrals; the energy-momentum tensor for fields; effective action and backreaction; regularization of functional determinants using zeta functions and heat kernels. Topics such as quantization of higher-spin fields or interacting fields in curved spacetime, direct renormalization of the energy-momentum tensor, and the theory of cosmological perturbations are left out.The emphasis of this course is primarily on concepts rather than on compu-tational results. Most of the required calculations have been simplified to the barest possible minimum that still contains all relevant physics. For instance,only free scalar fields are considered for quantization; background spacetimes are always chosen to be conformally flat; the Casimir effect, the Unmh effect,and the Hawking radiation are computed for massless scalar fields in suitable 1 + 1-dimensional spacetimes. Thus a fairly modest computational effort suffices to explain important conceptual issues such as the nature of vacuum and parti-cles in curved spacetimes, thermal effects of gravitation, and backreaction. This should prepare students for more advanced and technically demanding treatments suggested below.The authors are grateful to Josef GalBner and Matthew Parry for discussions and valuable comments on the manuscript. Special thanks are due to Alex Vikman who worked through the text and prompted important revisions, and to Andrei Barvinsky for his assistance in improving the presentation in the last chapter.The entire book was typeset with the excellent LyX and TEX document prepa-ration system on computers running Debian GNU/Linux. We wish to express our gratitude to the creators and maintainers of this outstanding free software.Suggested literatureThe following books offer a more extensive coverage of the subject and can be studied as a continuation of this introductory course.N. D. BIRRELL and P. C. W. DAVIES, Quantum Fields in Curved Space （Cambridge University Press, 1982）.S. A. FULLING, Aspects of Quantum Field Theory in Curved Space-Time （Cambridge University Press, 1989）.

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内容概要

本书系统地介绍了引力中的量子场论方法，适合用作理论天体物理，宇宙学，粒子物理和超弦理论等专业的本科生和研究生教材。
本书首先介绍了量子场论中的一般概念，重点讲解了利用量子场论方法研究引力，同时还介绍了基本且必要的不断扩张宇宙中的场量子化和膨胀时空中的量子涨落。
此外，本书还详细讨论了Casimir效应，Unruh效应和霍金效应，并介绍了计算外部重力场中量子系统的反向反应的有效作用量。
作者从最初的基本原理出发，经过演绎得出最终结果，并对最终结果做详细的解释，帮助读者对该领域建立完整的物理图像。
本书内容全面，讲解深刻，附有习题及其答案。
阅读本书只需要基本的广义相对论知识。
前言；(第一部分)正则量子化和粒子产生：概述：量子场；回顾：经典和量子理论；受迫谐振子；从谐振子到场；回顾：经典场；扩张宇宙中的量子场；Sitter宇宙中的量子场；Unruh效应；Hawking效应，黑洞热力学；Casimir效应；（第二部分）路径积分和真空极化：路径积分；有效作用量；热核计算；从有效作用量导出的结论；附录1：数学补充；附录2：反向反应的有效作用量推导；附录3：模展开要点；附录4：习题答案；索引。
　　读者对象：理论天体物理，宇宙学，粒子物理和超弦理论等专业的高年级本科生、研究生和相关领域的科研人员。

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