Preface

Preface to the second edition

One of the main goals motivating this new edition was to enhance the elementary material. To this end, in addition to some rewriting and reorganization, several new sections have been added (covering, for example, spin, and conservation laws), resulting in a fairly complete coverage of elementary topics.

A second main goal was to address the key physical issues of stability of atoms and molecules, and mean-field approximations of large particle systems. This is reflected in new chapters covering the existence of atoms and molecules, mean-field theory, and second quantization.

Our final goal was to update the advanced material with a view toward reflecting current developments, and this led to a complete revision and reorganization of the material on the theory of radiation (non-relativistic quantum electrodynamics), as well as the addition of a new chapter.

In this edition we have also added a number of proofs, which were omitted in the previous editions. As a result, this book could be used for senior level undergraduate, as well as graduate, courses in both mathematics and physics departments.

Prerequisites for this book are introductory real analysis (notions of vector space, scalar product, norm, convergence, Fourier transform) and complex analysis, the theory of Lebesgue integration, and elementary differential equations. These topics are typically covered by the third year in mathematics departments. The first and third topics are also familiar to physics undergraduates. However, even in dealing with mathematics students we have found it useful, if not necessary, to review these notions, as needed for the course. Hence, to make the book relatively self-contained, we briefly cover these subjects, with the exception of Lebesgue integration. Those unfamiliar with the latter can think about Lebesgue integrals as if they were Riemann integrals. This said, the pace of the book is not a leisurely one and requires, at least for beginners, some amount of work.

Though, as in the previous two issues of the book, we tried to increase the complexity of the material gradually, we were not always successful, and
first in Chapter 12, and then in Chapter 18, and especially in Chapter 19, there is a leap in the level of sophistication required from the reader. One may say the book proceeds at three levels. The first one, covering Chapters 1-11, is elementary and could be used for senior level undergraduate, as well as graduate, courses in both physics and mathematics departments; the second one, covering Chapters 12 - 17, is intermediate; and the last one, covering Chapters 18 - 22, advanced.

During the last few years since the enlarged second printing of this book, there have appeared four books on Quantum Mechanics directed at mathematicians:


These elegant and valuable texts have considerably different aims and rather limited overlap with the present book. In fact, they complement it nicely.

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Stephen Gustafson

Israel Michael Sigal

**Preface to the enlarged second printing**

For the second printing, we corrected a few misprints and inaccuracies; for some help with this, we are indebted to B. Nachtergaele. We have also added a small amount of new material. In particular, Chapter 11, on perturbation theory via the Feshbach method, is new, as are the short sub-sections 13.1 and 13.2 concerning the Hartree approximation and Bose-Einstein condensation. We also note a change in terminology, from “point” and “continuous” spectrum, to the mathematically more standard “discrete” and “essential” spectrum, starting in Chapter 6.

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From the preface to the first edition

The first fifteen chapters of these lectures (omitting four to six chapters each year) cover a one term course taken by a mixed group of senior undergraduate and junior graduate students specializing either in mathematics or physics. Typically, the mathematics students have some background in advanced analysis, while the physics students have had introductory quantum mechanics. To satisfy such a disparate audience, we decided to select material which is interesting from the viewpoint of modern theoretical physics, and which illustrates an interplay of ideas from various fields of mathematics such as operator theory, probability, differential equations, and differential geometry. Given our time constraint, we have often pursued mathematical content at the expense of rigor. However, wherever we have sacrificed the latter, we have tried to explain whether the result is an established fact, or, mathematically speaking, a conjecture, and in the former case, how a given argument can be made rigorous. The present book retains these features.

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