Preface

This book is based on notes handed out to students at Imperial College who attended my undergraduate lecture course on quantum theory during the years 1989 to 1994. All students in the Physics Department take at least two courses in quantum theory: one in their first year, and one in their second. My course was part of the third year theoretical physics option. Thus, in preparing the notes, I could assume a genuine interest in mathematical approaches to physics, plus a moderate knowledge of basic wave mechanics, and a small exposure to the ideas of electron spin and the Pauli spin matrices.

The aim of my lectures was to build on this background to provide an introduction to the structural foundations of modern quantum theory. The scope is deliberately limited to the non-relativistic regime of physics, but the text includes discussions of many of the basic conceptual problems that arise in this context. The main mathematical tool is the theory of operators on vector spaces, and this is developed from scratch, albeit without becoming too entangled in mathematical detail. For example, although I mention infinite-dimensional spaces, no effort is made to describe the necessary analysis in any rigorous way. This is not because I doubt the importance of these matters, but too many mathematical subtleties can distract attention from the fundamental issues.

On the other hand, these notes are not intended to be a textbook on the philosophical foundations of quantum theory. Several comprehensive works of this type have appeared recently, and I am not trying to rival them. Nor do I have any personal axe to grind concerning interpretational issues in quantum theory (other, perhaps, than prejudices stemming from my interest in quantum gravity): the course was intended to provide an introduction to some of the issues in a reasonably balanced, but brief,

way. Indeed, although a number of explanatory paragraphs have been added to the material from which I spoke, I have deliberately kept to the abbreviated style of the original lecture notes: the course was only twenty-five lectures long (I do talk rather quickly!), and this is reflected in the length of the book. I have included the problems and worked answers that were handed out to the students to assist them in mastering the basic mathematical tools of vector-space theory. This is an important part of the overall development of the work and a self-study student should benefit from looking at them seriously.

I would like to express my thanks to all those students who attended my course and drew my attention to various errors and confusions in the earlier versions of the notes. I am particularly grateful to Steve Weinstein for his extensive and penetrating remarks on the conceptual aspects of quantum theory and the way they are treated here.

Finally, I would like to dedicate this work with great affection to my wife Valerie, and to my daughters Nicola and Louise. For many years they have had to cope with the stress of being married to, respectively fathered by, a theoretical physicist. Their collective survival skills are most impressive.

Chris Isham

Imperial College, March 1995