

# Preface

There are two complementary methods, broadly speaking, used by authors to communicate physics. In the first of these, the “formal method,” the manipulatory skills relating to the subject matter of interest are emphasized. It is tacitly assumed that a mastery of the techniques required to solve the standard problems will lead automatically and rapidly to an understanding of the physical meanings of the techniques and their products. In the second, the “conceptual method,” physical meanings are investigated carefully with little attention to technique. Once the basic concepts are clearly understood, or so it is assumed, manipulative skills will take care of themselves. Graduates of the formal method calculate easily (at least on textbook problems) but often they know not what they compute. The conceptual method, on the other hand, produces philosophical wranglers who can tear subtle ideas to shreds but who are unable, perhaps, to draw a fresh conclusion from even the most fruitful stock of ideas.

This book, as its title intimates, makes use of the conceptual method and shares in the weaknesses and, hopefully, also in some of the strengths of that method. The book is not (and this negation deserves

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emphasis) a text designed to teach the theory of quantum mechanics; at the end of the book we shall be only at the edges of the formal structure and explicit content of the theory. It is not possible to learn from this book how to solve even the simplest of the problems of quantum mechanics.

But considerable care and attention is given in what follows to an analysis of the physical meaning and conceptual consequences of the Heisenberg principle (Chapters 4, 5, and 6) and, in particular, to a close examination of the incompatibility of pairs of observables. In Chapters 7 and 8, the effects of the concept of incompatibility on the meanings of "measurement," "property," "state," "indeterminism," etc. are studied. An important step beyond what may reasonably be inferred from the Heisenberg principle is taken in Chapter 9, where the existence and great significance of "probability amplitudes" are discussed. But we refrain even after this fairly considerable preparation from going on to the implicitly promised land. The structure of quantum mechanics is not formulated here and its explicit content for classical observables is not given. To repeat what has already been emphasized, this book is not intended as an exposition of quantum mechanical theory.

To whom and for what, then, is the book of value? Two distinct groups may profit from it. Students who have been exposed to highly formal expositions and are only too painfully aware that they know not what they compute may find answers to some of their questions in the following pages. And those blocked from the normal paths which lead to the quantum mechanics by lack of mathematical skills may be able to get here at least a partial understanding of some of the significant ideas of a most important and fascinating theory.

This book is a revised and expanded version of the monograph I wrote while a member of the Conference on the New Instructional Materials in Physics. The Conference was held at Seattle in the summer of 1965 under the auspices of The Commission on College Physics and the University of Washington. The materials produced at the Conference were subsequently given limited publication by the University of Washington Press. I am indebted to The Commission on College Physics and the University of Washington Press for permission to make use of portions of the monograph in the preparation of this book.

It is a pleasure to acknowledge my extensive debts to Professor

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Walter C. Michels. It was at his suggestion that I undertook to revise and expand my monograph for publication in the Momentum Series. I owe him thanks also for his careful and able editing of my manuscript.

I can best remember again the many who helped me at the Seattle Conference by quoting the last paragraph of the preface to my monograph. "I wish to thank Walter C. Michels and Ernest Henley for their helpful comments and criticisms. I am grateful also to Jack Ludwig and Ralph Caplan for showing me that it is easier to read English than Academese; the numerous changes they suggested greatly improved the style of the monograph. My thanks are due also to the officers of The Commission on College Physics and the University of Washington for their support and assistance during the pleasant, stimulating and productive months of the 'Writing Conference.'"

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