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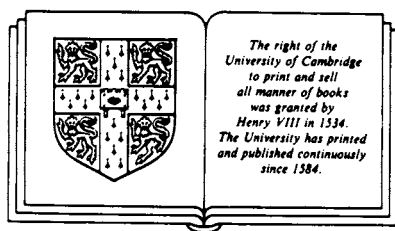
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# *The philosophy of quantum mechanics*

*An interactive interpretation*

*Richard Healey*



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*For Jean*

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## *Preface*

In this book I present a new interpretation of the theory of nonrelativistic quantum mechanics. In this interpretation, measurement in quantum mechanics corresponds to a physical interaction internal to a compound quantum system, which correlates the dynamical states of measured system and (quantum mechanical) apparatus system; whereas the quantum state provides (via the Born rules) a summary of numerical information concerning probabilistic dispositions realized in such interactions. The distinction between dynamical and quantum states is maintained to be the key to the dissolution of the measurement problem. The further idea that the dynamical state of a compound quantum system is not always determined by those of its components then permits a novel understanding of EPR-type correlations as manifested in experiments such as those of Aspect, Grangier, and Roger (1982a) and Aspect, Dalibard, and Roger (1982b).

This book is a monograph: Our present understanding of quantum mechanics does not suffice for the composition of a treatise. It arose when the continual frustration of my attempts to understand quantum mechanics in accordance with any existing interpretation forced me to try something new. I have no illusions that this monograph finally renders quantum mechanics transparent and manifestly free of all conceptual problems. But I do believe that new ideas are urgently needed if we are to approach this happy state; and that there is a good chance that the particular combination of ideas contained in the present interpretation represents significant progress toward this goal. Consequently, I have written



mostly in a spirit of advocacy for the interpretation presented here, developing the view so that its advantages are emphasized. But I have also tried to clearly acknowledge difficulties, particularly in the concluding chapter. I hope that some reader will be motivated by the promise of the view to develop or modify the interpretation so as to overcome such difficulties.

After an introductory chapter which explains and motivates the attempt to provide a new interpretation of quantum mechanics, Chapter 1 outlines the central ideas of the new interpretation. The detailed presentation begins in Chapter 2, where the character of dynamical states is investigated in some depth. Chapter 3 analyzes quantum measurement and preparation interactions, explains the role of the quantum state, and discusses the interpretation and origin of the Born probability rules of quantum mechanics. Chapter 4 gives technical details of the application of the present interpretation of quantum mechanics to coupled systems of the type studied by EPR, Bell, and Aspect, and Chapter 5 explores metaphysical aspects and implications of this application concerning holism and causal explanation. In Chapter 6 I explicitly compare the interpretation to certain other interpretations which were influential in its development: The present interpretation represents an evolution from earlier views, not a radical break with them. I conclude in Chapter 7 by discussing a number of problems still to be faced by the interpretation presented here. A few proofs whose presentation in the text would have interrupted the exposition have been relegated to an appendix.

I first began the work which resulted in this monograph in the winter of 1984 while I was a visiting fellow of the Center for Philosophy of Science at the University of Pittsburgh. I wish to thank the National Endowment for the Humanities, whose award made this visit financially possible, and the Center and its Director Nicholas Rescher and secretary Linda Butera, whose generous hospitality, both then and later (dur-

ing the academic year 1987–8), provided me with ideal working conditions in a friendly and stimulating intellectual community. After my return to Los Angeles, continued work on the project during the period 1985 through 1987 was facilitated by the NSF. Consequently, this monograph is, in part, based upon work supported by the National Science Foundation under Grant no. SES8512026: It does not, of course, reflect the views of that organization. I am grateful to the NSF for their support. I have had the benefit of presenting various earlier versions of parts of this work before a number of audiences, including the philosophy of physics mini-conference at Stanford University organized by Nancy Cartwright in February 1985; the philosophy departments of Cornell University, the University of California, Santa Barbara, Arizona State University, Rice University, Columbia University, Amherst College, the University of Western Ontario, Pittsburgh University, and the University of California, Davis; and the Joint US–USSR colloquium on the foundations of quantum mechanics at Easton, Maryland, organized by Jeffrey Bub in September 1988. I wish to single out the Relativity Group at the University of Chicago for special mention. Under the active leadership of Robert Geroch, participants at a talk I gave there in April 1984 not only reacted in a constructive and open-minded way to thoughts which at that stage were considerably less than half-baked, but also took pleasure in resolving technical questions in a matter of minutes, a positive answer to which at that time was crucial to the continued development of my interpretation.

I have a number of individuals to thank for constructive criticisms of my work during this period, including David Albert, Geoffrey Hellman, David Malament, Hilary Putnam, Abner Shimony, Allen Stairs, and Roberto Torretti. I am grateful to Howard Stein and Al Janis, both of whom read a penultimate draft of the first five chapters of the manuscript with exceptional speed, care, and thoughtfulness, and offered advice which I have usually taken (and ignored at my peril!).

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Earlier in the project, conversations with both Al and Tony Martin were crucial in determining the direction of my thinking; although I am confident that neither of them would endorse the present interpretation, and certainly neither of them can be held responsible for the consequences of their interventions.

My greatest debt is to my family, and especially to my wife, Jean Hampton. As a colleague she has provided constant encouragement and wise philosophical counsel while I have been working on this project. As a friend she has been a source of emotional support during some difficult times. But the countless sacrifices she has made on my behalf, of career opportunities as well as of her own precious time, far exceed those appropriate to any colleague or friend: They constitute a debt which I can never hope to repay, but can only wonder at.

*Davis, California*  
*January 1989*