Preface

Four previous editions of this book were published in 1989, 1992, 1999, and 2001. They were preceded by a German version (Zeh 1984) that was based on lectures I had given at the University of Heidelberg.

My interest in this subject arose originally from the endeavor to better understand all aspects of irreversibility that might be relevant for the statistical nature and interpretation of quantum theory. The quantum measurement process is often claimed to represent an 'amplification' of microscopic properties to the macroscopic scale in close analogy to the origin of classical fluctuations, which may lead to the local onset of a phase transition, for example. This claim can hardly be upheld under the assumption of universal unitary dynamics, as is well known from the example of Schrödinger's cat. However, the classical theory of statistical mechanics offers many problems and misinterpretations of its own, which are in turn related to the oft-debated retardation of radiation, irreversible black holes with their thermodynamical aspects, and – last but not least – the expansion of the Universe. So the subject offered a great and exciting 'interdisciplinary' challenge. My interest was also stimulated by Paul Davies' (1977) book that I used successfully for my early lectures. Quantum gravity, that for consistency has to be taken into account in cosmology, even requires a complete revision of the concept of time, which leads to entirely novel and fundamental questions of interpretation (Sect. 6.2).

Many of these interesting fields and applications have seen considerable progress since the last edition came out. So, while all chapters have again been thoroughly revised for this fifth edition in order to take these developments into account, changes concentrate on Sects. 2.3 (Radiation Damping), 4.3 (Decoherence), 4.6 (Interpretations of Quantum Theory), 5.3 (Expansion of the Universe) and Chap. 6 (Quantum Cosmology). There are new Sects. 3.5 (on Cosmic Probabilities and History) and 4.3.3 (on Quantum Computers), while Sect. 5.3 has been subdivided and extended. In general, I have tried to remove 'vague' statements, or to make them more precise – although this was not always possible because of the complexity or even speculative nature of some fields. As in previous editions, the focus of the book is on questions

of interpretation and relations between different fields – not on technical formalisms and empirically unfounded or predominantly mathematical ideas and concepts.

Many friends and colleagues helped me with their advice on various subjects during the preparation of all previous editions. I cannot here repeat all their names (I hope they are all duly mentioned in the corresponding previous prefaces), but I wish to thank here my former collaborators Erich Joos and Claus Kiefer for their enduring support to all editions. Special thanks this time go to Angela Lahee for her encouragement to prepare a fifth edition (the first one for the Springer Frontiers Collection), and to Stephen Lyle for editing it (although he is not responsible for any errors I may have introduced with numerous last-minute corrections).

I intend to post corrections or revisions to some sections of the book at my website www.time-direction.de whenever it should turn out to be appropriate.

Heidelberg, *H.D. Zeh*
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