Preface

The aim of this book is to elucidate the origin and nature of dissipative forces and to present a detailed account of various attempts to study the phenomena of dissipation in classical mechanics and in quantum theory. From the early days of the old quantum theory it was realized that the quantization of the velocity-dependent dissipative forces are problematic, partly because of the inconsistencies in the mathematical formulation and partly due to the problem of interpretation. Recent works on the quantum theory of measurement, the theory of collision of heavy ions and the macroscopic quantum tunneling has necessitated a more critical examination of the nature of the frictional forces and their derivations from conservative many-body systems. In this book we discuss the basic concepts of these forces without discussing any particular application. There are monographs available dealing with these applications. For instance *Quantum Theory of Dissipative Systems* (Second Edition), by U. Weiss (World Scientific, 1999) gives an excellent account of the role of dissipative forces in condensed matter physics.

The scope of this book is also limited to the discussion of regular motions since the very important subject of chaotic dissipative motion deserves a completely different approach. Furthermore the emphasis of the present work is on the solvable models where the ideas of symmetries and the conservation laws, the way that the time asymmetry arises in the equations of motion, and the classical-quantum correspondence can be discussed without the ambiguity which is often associated with approximate solutions.

This text is divided into three parts. In the first part we present a detailed coverage of the classical dissipative systems using the canonical formalism. This includes a description of the inverse problem of analytical dynamics, i.e. determination of Lagrangians and Hamiltonians from the equations of motion specifically for the cases involving dissipative forces. Important theoretical concepts such as the Noether theorem and the minimal coupling rule in the presence of frictional forces are presented and applied to simple examples. In addition to the phenomenological frictional forces, a large part is devoted to the problem of derivation of frictional forces from solvable many-body problems. Chapters 2 through 11 cover the classical description of the subject.

In the second part of the book, Chapters 12-17 lays the groundwork for the problem of quantization of classical systems with phenomenological velocity-dependent forces. Various attempts to find a consistent theory satisfying the basic postulates of quantum theory, and their successes and failures are examined. This is followed by a more basic approach in which we try to derive a wave equation for the motion of the damped system, again from a closed many-body system.

Finally in the third part of the book, Chapters 17-18, we discuss a number of problems where the starting point is quantum mechanical, but only in some cases we can associate a classically damped system to these quantal problems.

In selecting references I have tried to cite a number of interesting albeit forgotten works. Unfortunately the task of achieving a complete list of important contributions is an impossible one. I apologize to the authors of the papers that I have overlooked or have failed to give the proper credit to. In writing this monograph I have benefited greatly from the help of my colleagues and my former students. I should thank my wife for sympathetic understanding of the ups and downs of writing a book.

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