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In the past 10 to 15 years, the quantum leap in understanding of nonlinear dynamics has radically changed the frame of reference of physicists contemplating such systems. This book treats classical and quantum mechanics using an approach as introduced by nonlinear Hamiltonian dynamics and path integral methods.

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The two formulations of classical mechanics, Lagrangian and Hamiltonian, lead to two expressions of quantum mechanics, the path integral and canonical, respectively. After an introduction to the principles of these two theories, subjects related to calculations of molecular dynamics are discussed.

In the past 10 to 15 years, the quantum leap in understanding of nonlinear dynamics has radically changed the frame of reference of physicists contemplating such systems. This book treats classical and quantum mechanics using an approach as introduced by nonlinear Hamiltonian dynamics and path integral methods. It is written for graduate students who want to become familiar with the more advancedcomputational strategies in classical and quantum dynamics. Therefore, worked examples comprise a large part of the text. While the first half of the book lays the groundwork for a standard course, the second half, with its detailed treatment of the time-dependent oscillator, classical and quantum Chern-Simons mechanics, the Maslov anomaly and the Berry phase, willacquaint the reader with modern topological methods that have not as yet found their way into the textbook literature.

Describes the chaos apparent in simple mechanical systems with the goal of elucidating the connections between classical and quantum mechanics. It develops the relevant ideas of the last two decades via geometric intuition rather than algebraic manipulation. The historical and cultural background against which these scientific developments have occurred is depicted, and realistic examples are discussed in detail. This book enables entry-level graduate students to tackle fresh problems in this rich field.

This book investigates two possibilities for describing classical-mechanical physical systems along with their Hamiltonian dynamics in the framework of quantum mechanics.The first possibility consists in exploiting the geometrical properties of the set of quantum pure states of "microsystems" and of the Lie groups characterizing the specific classical system. The second approach is to consider quantal systems of a large number of interacting subsystems - i.e. macrosystems, so as to study the quantum mechanics of an infinite number of degrees of freedom and to look for the behaviour of their collective variables. The final chapter contains some solvable models of "quantum measurement" describing dynamical transitions from "microsystems" to "macrosystems".

This book is a collection of problems that are intended to aid students in graduate and undergraduate courses in Classical and Quantum Physics. It is also intended to be a study aid for students that are preparing for the PhD qualifying exam. Many of the included problems are of a type that could be on a qualifying exam. Others are meant to elucidate important concepts. Unlike other compilations of problems, the detailed solutions are often accompanied by discussions that reach beyond the specific problem.The solution of the problem is only the beginning of the learning process--it is by manipulation of the solution and changing of the parameters that a great deal of insight can be gleaned. The authors refer to this technique as "massaging the problem," and it is an approach that the authors feel increases the pedagogical value of any problem.

The short Heroic Age of physics that started in 1925 was one of the rare occasions when a deep consideration of the question: What does physics really say? was necessary in carrying out numerical calculations. In many parts of microphysics the calculations have now become relatively straightforward if not easy, but most physicists seem to agree that some questions of principle remain to be resolved, even if they do not think it is very important to do so. This situation has affected the way people think and write about quantum mechanics, a gingerly approach to fundamentals and a tendency to emphasize what fifty years ago was new in the new theory at the expense of continuity with what came before it. Nowadays those who look into the subject are more likely to be struck by unexpected similarities between quantum and classical mechanics than by dramatic contrasts they had been led to expect. It is often said that the hardest part of understanding quantum mechanics is to understand that there is nothing to understand; all the same, to think quantum mechanically it helps to have firm mental connections with classical physics and to know exactly what these connections do and do not imply. This book originated more than a decade ago as informal lecture notes [OP, prepared for use in a course taught from time to time to advanced undergraduates at Williams College.

This book describes, by using elementary techniques, how some geometrical structures widely used today in many areas of physics, like symplectic, Poisson, Lagrangian, Hermitian, etc., emerge from dynamics. It is assumed that what can be accessed in actual experiences when studying a given system is just its dynamical behavior that is described by using a family of variables ("observables" of the system). The book departs from the principle that ''dynamics is first'' and then tries to answer in what sense the sole dynamics determines the geometrical structures that have proved so useful to describe the dynamics in so many important instances. In this vein it is shown that most of the geometrical structures that are used in the standard presentations of classical dynamics (Jacobi, Poisson, symplectic, Hamiltonian, Lagrangian) are determined, though in general not uniquely, by the dynamics alone. The same program is accomplished for the geometrical structures relevant to describe quantum dynamics. Finally, it is shown that further properties that allow the explicit description of the dynamics of certain dynamical systems, like integrability and super integrability, are deeply related to the previous development and will be covered in the last part of the book. The mathematical framework used to present the previous program is kept to an elementary level throughout the text, indicating where more advanced notions will be needed to proceed further. A family of relevant examples is discussed at length and the necessary ideas from geometry are elaborated along the text. However no effort is made to present an ''all-inclusive'' introduction to differential geometry as many other books already exist on the market doing exactly that. However, the development of the previous program, considered as the posing and solution of a generalized inverse problem for geometry, leads to new ways of thinking and relating some of the most conspicuous geometrical structures appearing in Mathematical and Theoretical Physics.

This thesis presents several important aspects of the plasma dynamics in extremely high intensity electromagnetic fields when quantum electrodynamics effects have to be taken into account. This work is of utmost importance for the forthcoming generation of multipetawatt laser facilities where this physics will be tested. The first part consists of an introduction that extends from classical and quantum electrodynamics in strong fields to the kinetic description of plasmas in the interaction with such fields. This can be considered as an advanced tutorial which would be extremely useful to researchers and students new to the field. The second part describes original contributions on the analysis of the signatures of classical and quantum radiation reaction on the distribution function of the charged particles and of the photon spectrum, and leads to significant advances on this topic. These results are then extended to the analysis of the so-called QED cascades which are of central importance for a better understanding of some astrophysical phenomena and basic physics problems. Finally, the book discusses future directions for the high intensity laser-plasma interaction community. The results presented in this thesis are expected to become more and more relevant as the new multipetawatt facilities become operative.

As a limit theory of quantum mechanics, classical dynamics comprises a large variety of phenomena, from computable (integrable) to chaotic (mixing) behavior. This book presents the KAM (Kolmogorov-Arnold-Moser) theory and asymptotic completeness in classical scattering. Including a wealth of fascinating examples in physics, it offers not only an excellent selection of basic topics, but also an introduction to a number of current areas of research in the field of classical mechanics. Thanks to the didactic structure and concise appendices, the presentation is self-contained and requires only knowledge of the basic courses in mathematics. The book addresses the needs of graduate and senior undergraduate students in mathematics and physics, and of researchers interested in approaching classical mechanics from a modern point of view.

The field of nonlinear dynamics and chaos has grown very much over the last few decades and is becoming more and more relevant in different disciplines. This book presents a clear and concise introduction to the field of nonlinear dynamics and chaos, suitable for graduate students in mathematics, physics, chemistry, engineering, and in natural sciences in general. It provides a thorough and modern introduction to the concepts of Hamiltonian dynamical systems' theory combining in a comprehensive way classical and quantum mechanical description. It covers a wide range of topics usually not found in similar books. Motivations of the respective subjects and a clear presentation eases the understanding. The book is based on lectures on classical and quantum chaos held by the author at Heidelberg University. It contains exercises and worked examples, which makes it ideal for an introductory course for students as well as for researchers starting to work in the field.

This textbook provides an introduction to classical mechanics at a level intermediate between the typical undergraduate and advanced graduate level. This text describes the background and tools for use in the fields of modern physics, such as quantum mechanics, astrophysics, particle physics, and relativity. Students who have had basic undergraduate classical mechanics or who have a good understanding of the mathematical methods of physics will benefit from this book.