

<<力学>>

图书基本信息

书名：<<力学>>

13位ISBN编号：9787510004490

10位ISBN编号：7510004497

出版时间：2009-5

出版时间：世界图书出版公司

作者：弗洛里舍克

页数：547

版权说明：本站所提供下载的PDF图书仅提供预览和简介，请支持正版图书。

更多资源请访问：<http://www.tushu007.com>

## 前言

Purpose and Emphasis. Mechanics not only is the oldest branch of physics but was and still is the basis for all of theoretical physics. Quantum mechanics can hardly be understood, perhaps cannot even be formulated, without a good knowledge of general mechanics. Field theories such as electrodynamics borrow their formal framework and many of their building principles from mechanics. In short, throughout the many modern developments of physics where one frequently turns back to the principles of classical mechanics its model character is felt. For this reason it is not surprising that the presentation of mechanics reflects to some extent the development of modern physics and that today this classical branch of theoretical physics is taught rather differently than at the time of Arnold Sommerfeld, in the 1920s, or even in the 1950s, when more emphasis was put on the theory and the applications of partial-differential equations. Today, symmetries and invariance principles, the structure of the space-time continuum, and the geometrical structure of mechanics play an important role. The beginner should realize that mechanics is not primarily the art of describing block-and-tackles, collisions of billiard balls, constrained motions of the cylinder in a washing machine, or bicycle riding. However fascinating such systems may be, mechanics is primarily the field where one learns to develop general principles from which equations of motion may be derived, to understand the importance of symmetries for the dynamics, and, last but not least, to get some practice in using theoretical tools and concepts that are essential for all branches of physics. Besides its role as a basis for much of theoretical physics and as a training ground for physical concepts, mechanics is a fascinating field in itself. It is not easy to master, for the beginner, because it has many different facets and its structure is less homogeneous than, say, that of electrodynamics. On a first assault one usually does not fully realize both its charm and its difficulty. Indeed, on returning to various aspects of mechanics, in the course of one's studies, one will be surprised to discover again and again that it has new facets and new secrets. And finally, one should be aware of the fact that mechanics is not a closed subject, lost forever in the archives of the nineteenth century. As the reader will realize in Chap. 6, if he or she has not realized it already, mechanics is an exciting field of research with many important questions of qualitative dynamics remaining unanswered.

<<力学>>

内容概要

Purpose and Emphasis. Mechanics not only is the oldest branch of physics but was and still is the basis for all of theoretical physics. Quantum mechanics can hardly be understood, perhaps cannot even be formulated, without a good knowl- edge of general mechanics.

## 书籍目录

1. Elementary Newtonian Mechanics

1.1 Newton's Laws ( 1687 ) and Their Interpretation

1.2 Uniform Rectilinear Motion and Inertial Systems

1.3 Inertial Frames in Relative Motion

1.4 Momentum and Force

1.5 Typical Forces. A Remark About Units

1.6 Space, Time, and Forces

1.7 The Two-Body System with Internal Forces

1.7.1 Center-of-Mass and Relative Motion

1.7.2 Example: The Gravitational Force Between Two Celestial Bodies ( Kepler's Problem )

1.7.3 Center-of-Mass and Relative Momentum in the Two-Body System

1.8 Systems of Finitely Many Particles

1.9 The Principle of Center-of-Mass Motion

1.10 The Principle of Angular-Momentum Conservation

1.11 The Principle of Energy Conservation

1.12 The Closed n-Particle System

1.13 Galilei Transformations

1.14 Space and Time with Galilei Invariance

1.15 Conservative Force Fields

1.16 One-Dimensional Motion of a Point Particle

1.17 Examples of Motion in One Dimension

1.17.1 The Harmonic Oscillator

1.17.2 The Planar Mathematical Pendulum

1.18 Phase Space for the n-Particle System ( in  $R^3$  )

1.19 Existence and Uniqueness of the Solutions of  $\dot{x}=F(x, t)$

1.20 Physical Consequences of the Existence and Uniqueness Theorem

1.21 Linear Systems

1.21.1 Linear, Homogeneous Systems

1.21.2 Linear, Inhomogeneous Systems

1.22 Integrating One-Dimensional Equations of Motion

1.23 Example: The Planar Pendulum for Arbitrary Deviations from the Vertical

1.24 Example: The Two-Body System with a Central Force

1.25 Rotating Reference Systems: Coriolis and Centrifugal Forces

1.26 Examples of Rotating Reference Systems

1.27 Scattering of Two Particles that Interact via a Central Force

1.28 Two-Particle Scattering with a Central Force: Dynamics

1.29 Example: Coulomb Scattering of Two Particles with Equal Mass and Charge

1.30 Mechanical Bodies of Finite Extension

1.31 Time Averages and the Virial Theorem

Appendix: Practical Examples

2. The Principles of Canonical Mechanics

2.1 Constraints and Generalized Coordinates

2.1.1 Definition of Constraints

2.1.2 Generalized Coordinates

2.2 D'Alembert's Principle

2.2.1 Definition of Virtual Displacements

2.2.2 The Static Case

2.2.3 The Dynamical Case

2.3 Lagrange's Equations

2.4 Examples of the Use of Lagrange's Equations

2.5 A Digression on Variational Principles

2.6 Hamilton's Variational Principle ( 1834 )

2.7 The Euler-Lagrange Equations

2.8 Further Examples of the Use of Lagrange's Equations

2.9 A Remark About Nonuniqueness of the Lagrangian Function

2.10 Gauge Transformations of the Lagrangian Function

2.11 Admissible Transformations of the Generalized Coordinates

2.12 The Hamiltonian Function and Its Relation to the Lagrangian Function

2.13 The Legendre Transformation for the Case of One Variable

2.14 The Legendre Transformation for the Case of Several Variables

2.15 Canonical Systems

2.16 Examples of Canonical Systems

2.17 The Variational Principle Applied to the Hamiltonian Function

2.18 Symmetries and Conservation Laws

2.19 Noether's Theorem

2.20 The Generator for Infinitesimal Rotations About an Axis

2.21 More About the Rotation Group

2.22 Infinitesimal Rotations and Their Generators

2.23 Canonical Transformations

2.24 Examples of Canonical Transformations

2.25 The Structure of the Canonical Equations

2.26 Example: Linear Autonomous Systems in One Dimension

2.27 Canonical Transformations in Compact Notation

2.28 On the Symplectic Structure of Phase Space

2.29 Liouville's Theorem

2.29.1 The Local Form

2.29.2 The Global Form

2.30 Examples for the Use of Liouville's Theorem

2.31 Poisson Brackets

2.32 Properties of Poisson Brackets

2.33 Infinitesimal Canonical Transformations

2.34 Integrals of the Motion

2.35 The Hamilton-Jacobi Differential Equation

2.36 Examples for the Use of the Hamilton-Jacobi Equation

2.37 The Hamilton-Jacobi Equation and Integrable Systems

2.37.1 Local Rectification of Hamiltonian Systems

2.37.2 Integrable Systems

2.37.3 Angle and Action Variables

2.38 Perturbing Quasiperiodic Hamiltonian Systems

2.39 Autonomous, Nondegenerate Hamiltonian Systems in the Neighborhood of Integrable Systems

2.40 Examples. The Averaging Principle

2.40.1 The Anharmonic Oscillator

2.40.2 Averaging of Perturbations

2.41 Generalized Theorem of Noether

Appendix: Practical Examples

3. The Mechanics of Rigid Bodies

3.1 Definition of Rigid Body

3.2 Infinitesimal Displacement of a Rigid Body

3.3 Kinetic Energy and the Inertia Tensor

3.4 Properties of the Inertia Tensor

3.5 Steiner's Theorem

3.6 Examples of the Use of Steiner's Theorem

3.7 Angular Momentum of a Rigid Body

3.8 Force-Free Motion of Rigid Bodies

3.9 Another Parametrization of Rotations: The Euler Angles

3.10 Definition of Eulerian Angles

3.11 Equations of Motion of Rigid Bodies

3.12 Euler's Equations of Motion

3.13 Euler's Equations Applied to a Force-Free Top

3.14 The Motion of a Free Top and Geometric

Constructions  
 3.15 The Rigid Body in the Framework of Canonical Mechanics  
 3.16 Example: The Symmetric Children's Top in a Gravitational Field  
 3.17 More About the Spinning Top  
 3.18 Spherical Top with Friction: The "Tippe Top"  
 3.18.1 Conservation Law and Energy Considerations  
 3.18.2 Equations of Motion and Solutions with Constant Energy  
 Appendix : Practical Examples  
 4. Relativistic Mechanics  
 4.1 Failures of Nonrelativistic Mechanics  
 4.2 Constancy of the Speed of Light  
 4.3 The Lorentz Transformations  
 4.4 Analysis of Lorentz and Poincaré Transformations  
 4.4.1 Rotations and Special Lorentz Transformations ( " Boosts " )  
 4.4.2 Interpretation of Special Lorentz Transformations  
 4.5 Decomposition of Lorentz Transformations into their Components  
 4.5.1 Proposition on Orthochronous Proper Lorentz Transformations  
 4.5.2 Corollary of the Decomposition Theorem and Some Consequences  
 4.6 Addition of Relativistic Velocities  
 4.7 Galilean and Lorentzian Space-Time Manifolds  
 4.8 Orbital Curves and Proper Time  
 4.9 Relativistic Dynamics  
 4.9.1 Newton's Equation  
 4.9.2 The Energy-Momentum Vector  
 4.9.3 The Lorentz Force  
 4.10 Time Dilatation and Length Contraction  
 4.11 More About the Motion of Free Particles  
 4.12 The Conformal Group  
 5. Geometric Aspects of Mechanics  
 5.1 Manifolds of Generalized Coordinates  
 5.2 Differentiable Manifolds  
 5.2.1 The Euclidean Space  $R^n$   
 5.2.2 Smooth or Differentiable Manifolds  
 5.2.3 Examples of Smooth Manifolds  
 5.3 Geometrical Objects on Manifolds  
 5.3.1 Functions and Curves on Manifolds  
 5.3.2 Tangent Vectors on a Smooth Manifold  
 5.3.3 The Tangent Bundle of a Manifold  
 5.3.4 Vector Fields on Smooth Manifolds  
 5.3.5 Exterior Forms  
 5.4 Calculus on Manifolds  
 5.4.1 Differentiable Mappings of Manifolds  
 5.4.2 Integral Curves of Vector Fields  
 Stability and Chaos  
 Exercises  
 Solution of Exercises  
 Author Index  
 Subject Index

## 章节摘录

By assumption the transformation matrix is not singular; cf. ( 2.34 ) . This proves the proposition.

Another way of stating this result is this: the variational derivatives are covariant under diffeomorphic transformations of the generalized coordinates. It is not correct, therefore, to state that the Lagrangian function is "T - U". Although this is a natural form, in those cases where kinetic and potential energies are defined it is certainly not the only one that describes a given problem. In general,  $L$  is a function of  $q$  and  $q'$ , as well as of time  $t$ , and no more. How to construct a Lagrangian function is more a question of the symmetries and invariances of the physical system one wishes to describe. There may well be cases where there is no kinetic energy or no potential energy, in the usual sense, but where a Lagrangian can be found, up to gauge transformations ( 2.33 ) , which gives the correct equations of motion. This is true, in particular, in applying the variational principle of Hamilton to theories in which fields take over the role of dynamical variables. For such theories, the notion of kinetic and potential parts in the Lagrangian must be generalized anyway, if they are defined at all. The proposition proved above tells us that with any set of generalized coordinates there is an infinity of other, equivalent sets of variables. Which set is chosen in practice depends on the peculiarities of the system under consideration. For example, a clever choice will be one where as many integrals of the motion as possible will be manifest. We shall say more about this as well as about the geometric meaning of this multiplicity later. For the moment we note that the transformations must be diffeomorphisms. In transforming to new coordinates we wish to conserve the number of degrees of freedom as well as the differential structure of the system. Only then can the physics be independent of the special choice of variables. ....

版权说明

本站所提供下载的PDF图书仅提供预览和简介，请支持正版图书。

更多资源请访问:<http://www.tushu007.com>