

# Table of Contents

Table of Contents, v  
Preface, xiii  
List of Contributors, xv

## Volume 1

- Absorption Coefficient, 1  
Accelerators, Linear, 2  
Accelerators, Potential-Drop Linear, 10  
Acoustical Measurements, 21  
Acoustics, 29  
Acoustics, Architectural, 32  
Acoustics, Linear and Nonlinear, 35  
Acoustics, Physiological, 50  
Acoustoelectric Effect, 54  
Adsorption, 57  
Aerosols, 61  
Allotropy and Polymorphism, 63  
Alloys, 65  
Alpha Decay, 67  
Ampère's Law, 71  
Anelasticity, 72  
Angular Correlation of Nuclear  
Radiation, 76  
Antimatter, 81  
Arcs and Sparks, 84  
Astronomy, High-Energy Neutrino, 89  
Astronomy, Optical, 100  
Astronomy, Radio, 103  
Astronomy, X-Ray, 110  
Astrophysics, 122  
Atmospheric Physics, 126  
Atomic Spectroscopy, 130  
Atomic Structure Calculations, Electronic  
Correlation, 138  
Atomic Structure Calculations, One-Electron  
Models, 141  
Atomic Structure Calculations, Relativistic  
Atoms, 149  
Atomic Trapping and Cooling, 157  
Atoms, 161  
Auger Effect, 169  
Aurora, 173  
Balmer Formula, 177  
Baryons, 179  
Beams, Atomic and Molecular, 182  
Beta Decay, 186  
Betatron, 190  
Bethe–Salpeter Equation, 192  
Binding Energy, 197  
Biophysics, 198  
Black Holes, 203  
Blackbody Radiation, 208  
Bohr Theory of Atomic Structure, 212  
Bose–Einstein Condensation, 218  
Bose–Einstein Statistics, 221  
Boundary Layers, 223  
Bremsstrahlung, 226  
Brillouin Scattering, 230  
Brownian Motion, 233  
Calorimetry, 235  
Capillary Flow, 238  
Carnot Cycle, 241  
Casimir Effect, 244  
Catalysis, 246  
Catastrophe Theory, 250  
Cellular Automata, 258  
Center-of-Mass System, 262  
Ceramics, 263  
Čerenkov Radiation, 267  
Channeling, 268  
Chaos, 272  
Charge-Density Waves, 277  
Charged-Particle Optics, 281  
Charged-Particle Spectroscopy, 286  
Chemical Bonding, 295  
Chemiluminescence, 304  
Circuits, Integrated, 306

- Clocks, Atomic and Molecular, 310  
Cloud and Bubble Chambers, 312  
Cold Atoms and Molecules, 316  
Collisions, Atomic and Molecular, 317  
Color Centers, 332  
Combustion and Flames, 349  
Complementarity, 354  
Complex Systems, 356  
Compton Effect, 359  
Conduction, 362  
Conservation Laws, 364  
Constants, Fundamental, 371  
Coriolis Acceleration, 393  
Corona Discharge, 394  
Cosmic Rays, Astrophysical Effects, 397  
Cosmic Rays, Solar System Effects, 410  
Cosmic Strings, 418  
Cosmology, 421  
Counting Tubes, 428  
CPT Theorem, 438  
Critical Points, 441  
Cryogenics, 444  
Crystal and Ligand Fields, 447  
Crystal Binding, 449  
Crystal Defects, 451  
Crystal Growth, 455  
Crystal Symmetry, 458  
Crystallography, X-Ray, 474  
Currents in Particle Theory, 487  
Cyclotron, 490  
Cyclotron Resonance, 497  
Deformation of Crystalline Materials, 499  
de Haas–van Alphen Effect, 502  
Demineralization, 507  
Diamagnetism and Superconductivity, 508  
Dielectric Properties, 512  
Diffraction, 516  
Diffusion, 526  
Dispersion Theory, 528  
Doppler Effect, 532  
Dynamic Critical Phenomena, 534  
Dynamics, Analytical, 535  
Eigenfunctions, 547  
Elasticity, 548  
Electric Charge, 553  
Electric Moments, 554  
Electrochemical Conversion and Storage, 557  
Electrochemistry, 563  
Electrodynamics, Classical, 567  
Electroluminescence, 574  
Electromagnetic Interaction, 579  
Electromagnetic Radiation, 583  
Electromagnets, 589  
Electron, 591  
Electron and Ion Beams, Intense, 595  
Electron and Ion Impact Phenomena, 600  
Electron Beam Technology, 605  
Electron Bombardment of Atoms and Molecules, 611  
Electron Diffraction, 616  
Electron Energy States in Solids and Liquids, 621  
Electron–Hole Droplets in Semiconductors, 631  
Electron Microscopy, 635  
Electron Spin Resonance, 637  
Electron Tubes, 644  
Electronics, 651  
Electronic Noses, 659  
Electrophoresis, 663  
Electrophotography, 665  
Electrostatics, 669  
Elementary Particles in Physics, 671  
Elements, 713  
Ellipsometry, 718  
Energy and Work, 720  
Entropy, 723  
Equations of State, 725  
Ergodic Theory, 728  
Error Analysis, 730  
Excitons, 734  
Far-Infrared Spectra, 737  
Faraday Effect, 741  
Faraday's Law of Electromagnetic Induction, 742  
Fatigue, 744  
Fermi–Dirac Statistics, 746  
Fermi Surface, 748  
Ferrimagnetism, 753

## *Table of Contents*

- Ferroelasticity, 761
- Ferroelectricity, 763
- Ferromagnetism, 768
- Feynman Diagrams, 777
- Fiber Optics, 779
- Field Emission, 782
- Field-Ion Microscopy, 785
- Field Theory, Axiomatic, 791
- Field Theory, Classical, 797
- Field Theory, Unified, 803
- Fields, 805
- Fine and Hyperfine Spectra and Interactions, 807
- Fluctuation Phenomena, 813
- Fluid Physics, 819
- Formation of Stars and Planets, 835
- Fourier Transforms, 840
- Fractals, 847
- Franck–Condon Principle, 850
- Fraunhofer Lines, 851
- Free Energy, 853
- Friction, 854
- Fullerenes, 858
- Galaxies, 863
- Galvanomagnetic and Related Effects, 866
- Gamma Decay, 871
- Gamma-Ray Spectrometers, 875
- Gauge Theories, 877
- Gauss's Law, 882
- Geochronology, 884
- Geomagnetism, 888
- Geometric Quantum Phase, 891
- Geophysics, 893
- Glass, 902
- Glassy Metals, 904
- Grand Unified Theories, 909
- Gratings, Diffraction, 916
- Gravitation, 918
- Gravitational Lenses, 931
- Gravitational Waves, 934
- Gravity, Earth's, 937
- Group Theory in Physics, 941
- Gyromagnetic Ratio, 952
- H** Theorem, 955
- Hadrons, 956
- Hadron Colliders at High Energy, 958
- Hall Effect, 965
- Hall Effect, Quantum, 969
- Hamiltonian Function, 972
- Heat, 975
- Heat Capacity, 976
- Heat Engines, 978
- Heat Transfer, 982
- Heavy-Fermion Materials, 988
- Helium, Liquid, 992
- Helium, Solid, 1001
- Hidden Variables, 1010
- High-Field Atomic States, 1013
- High Temperature, 1015
- History of Physics, 1024
- Holography, 1044
- Hot Atom Chemistry, 1052
- Hot Cells and Remote Handling Equipment, 1054
- Hubble Effect, 1057
- Hydrodynamics, 1060
- Hydrogen Bond, 1065
- Hypernuclear Physics and Hypernuclear Interactions, 1072
- Hyperons, 1076
- Hysteresis, 1078
- Ice, 1081
- Inclusive Reactions, 1087
- Inertial Fusion, 1090
- Infrared Spectroscopy, 1096
- Insulators, 1102
- Interatomic and Intermolecular Forces, 1106
- Interferometers and Interferometry, 1110
- Intermediate Valence Compounds, 1114
- Internal Friction in Crystals, 1120
- Interstellar Medium, 1123
- Invariance Principles, 1127
- Inversion and Internal Rotation, 1132
- Ionization, 1139
- Ionosphere, 1143
- Ising Model, 1145
- Isobaric Analog States, 1147
- Isomeric Nuclei, 1150
- Isospin, 1155
- Isotope Effects, 1160

Isotope Separation, 1163  
 Isotopes, 1176  
 Jahn–Teller Effect, 1197  
 Josephson Effects, 1198  
 Kepler's Laws, 1205  
 Kerr Effect, Electro-Optical, 1208  
 Kerr Effect, Magneto-Optical, 1209  
 Kinematics and Kinetics, 1212  
 Kinetic Theory, 1218  
 Kinetics, Chemical, 1226  
 Klystrons and Traveling-Wave Tubes, 1228  
 Kondo Effect, 1232  
 Laser Spectroscopy, 1239  
 Laser Cooling, 1246  
 Lasers, 1254  
 Lattice Dynamics, 1284

Lattice Gauge Theory, 1294  
 Leptons, 1297  
 Levitation, Electromagnetic, 1299  
 Lie Groups, 1308  
 Light, 1310  
 Light Scattering, 1316  
 Light-Sensitive Materials, 1319  
 Lightning, 1321  
 Liquid Crystals, 1325  
 Liquid Metals, 1334  
 Liquid Structure, 1338  
 Lorentz Transformations, 1344  
 Low-Energy Electron Diffraction  
 (LEED), 1345  
 Luminescence (Fluorescence and  
 Phosphorescence), 1349

## **Volume 2**

Mach's Principle, 1355  
 Magnetic Circular Dichroism, 1356  
 Magnetic Cooling, 1359  
 Magnetic Domains and Bubbles, 1366  
 Magnetic Fields, High, 1372  
 Magnetic Materials, 1379  
 Magnetic Moments, 1385  
 Magnetic Monopoles, 1389  
 Magnetic Ordering in Solids, 1392  
 Magnetoacoustic Effect, 1396  
 Magnetoelastic Phenomena, 1398  
 Magneto hydrodynamics, 1401  
 Magnetoresistance, 1412  
 Magnetosphere, 1415  
 Magnetostriction, 1421  
 Magnets (Permanent) and  
 Magnetostatics, 1425  
 Many-Body Theory, 1428  
 Masers, 1440  
 Mass, 1447  
 Mass Spectroscopy, 1448  
 Matrices, 1454  
 Maxwell–Boltzmann Statistics, 1463  
 Maxwell's Equations, 1464  
 Mechanical Properties of Matter, 1467

Mesons, 1473  
 Mesoscopic Physics, 1474  
 Metal–Insulator Transitions, 1477  
 Metallurgy, 1482  
 Metals, 1485  
 Meteorology, 1486  
 Metrology, 1490  
 Michelson–Morley Experiment, 1493  
 Microscopy, Optical, 1496  
 Microwave Spectroscopy, 1508  
 Microwaves and Microwave Circuitry, 1512  
 Milky Way, 1520  
 Molecular Spectroscopy, 1522  
 Molecular Structure Calculations, 1600  
 Molecules, 1615  
 Molten Salts, 1622  
 Moment of Inertia, 1626  
 Momentum, 1633  
 Monte Carlo Techniques, 1635  
 Mossbauer Effect, 1642  
 Multipole Fields, 1659  
 Muonic, Mesonic, and Other Exotic  
 Atoms, 1662  
 Muonium, 1667  
 Musical Instruments, 1671

- Radiation Belts, 2174  
Radiation Chemistry, 2177  
Radiation Damage in Solids, 2181  
Radiation Detection, 2187  
Radiation Interaction with Matter, 2192  
Radioactivity, 2196  
Radiochemistry, 2200  
Radiological Physics, 2205  
Radiometry, 2217  
Raman Spectroscopy, 2221  
Rare Earths, 2227  
Rare Gases and Rare-Gas Compounds, 2231  
Rayleigh Scattering, 2235  
Reflection, 2236  
Reflection High-Energy Electron Diffraction (RHEED), 2240  
Refraction, 2241  
Regge Poles, 2247  
Relativity, General, 2249  
Relativity, Special Theory, 2257  
Relaxation Phenomena, 2274  
Renormalization, 2278  
Resistance, 2283  
Resonance Phenomena, 2285  
Resonances, Giant, 2291  
Rheology, 2298  
Rotation and Angular Momentum, 2310  
S-Matrix Theory, 2333  
Scanning Tunneling Microscopy, 2337  
Scattering Theory, 2339  
Schrodinger Equation, 2347  
Scintillation and Čerenkov Counters, 2348  
Second Sound, 2353  
Secondary Electron Emission, 2354  
Sedimentation and Centrifugation, 2357  
Seismology, 2361  
Semiconductor Radiation Detectors, 2369  
Semiconductors. Amorphous, 2377  
Semiconductors, Crystalline, 2393  
Servomechanism, 2410  
Shock Waves and Detonations, 2411  
Soil Physics, 2418  
Solar Energy, 2421  
Solar Neutrinos, 2442  
Solar System, 2451  
Solar Wind, 2456  
Solid-State Physics, 2459  
Solid-State Switching, 2472  
Solitons, 2483  
Sound, Underwater, 2485  
Space Science and Technology, 2488  
Spacetime, 2494  
Spectrophotometry, 2500  
Spin, 2502  
Statics, 2509  
Statistical Mechanics, 2511  
Statistics, 2519  
Stellar Energy Sources and Evolution, 2524  
Stochastic Processes, 2531  
String Theory, 2539  
Strong Interactions, 2551  
Sum Rules, 2556  
Sun, 2560  
Superconducting Materials, 2565  
Superconductive Devices, 2571  
Superconductivity Theory, 2580  
Superheavy Elements, 2591  
Supersymmetry and Supergravity, 2598  
Surface Tension, 2605  
Surface Waves on Fluids, 2607  
Surfaces and Interfaces, 2609  
SU(3) and Symmetry Groups, 2613  
Symbols, Units, and Nomenclature, 2619  
Symmetry Breaking, Spontaneous, 2642  
Synchrotron, 2650  
Synchrotron Radiation, 2659  
Tachyons, 2667  
Temperature, 2668  
Thermal Analysis, 2671  
Thermal Expansion, 2674  
Thermionic Emission, 2678  
Thermodynamic Data, 2682  
Thermodynamics, Equilibrium, 2684  
Thermodynamics, Nonequilibrium, 2689  
Thermoelectric Effects, 2701  
Thermoluminescence, 2705  
Thermometry, 2720  
Thin Films, 2727  
Three-Body Problem, Gravitational, 2734

Three-Body Problem, Quantum Mechanical, 2737	Uncertainty Principle, 2829
Time, 2741	Universe, 2832
Transducers, 2744	Vacuums and Vacuum Technology, 2837
Transistors, 2746	Vapor Pressure, 2846
Transition Elements, 2756	Vector and Tensor Analysis, 2848
Transmission Lines and Antennas, 2760	Vibrations, Mechanical, 2854
Transport Properties, 2766	Viscosity, 2856
Transport Theory, 2771	Visible and Ultraviolet Spectroscopy, 2860
Transuranium Elements, 2774	Vision and Color, 2866
Tribology, 2780	Vortices, 2884
Tunneling, 2783	Water, 2891
Turbulence, 2789	Waves, 2893
Twin Paradox, 2796	Weak Interactions, 2900
Ultracold Quantum Gases, 2799	Weak Neutral Currents, 2908
Ultrahigh-pressure Techniques, 2803	Whiskers, 2913
Ultrashort Optical Pulses, 2816	Work Function, 2914
Ultrasonic Biophysics, 2820	X-Ray Spectra and X-Ray Spectroscopy, 2917
Ultrasonics, 2822	Zeeman and Stark Effects, 2927