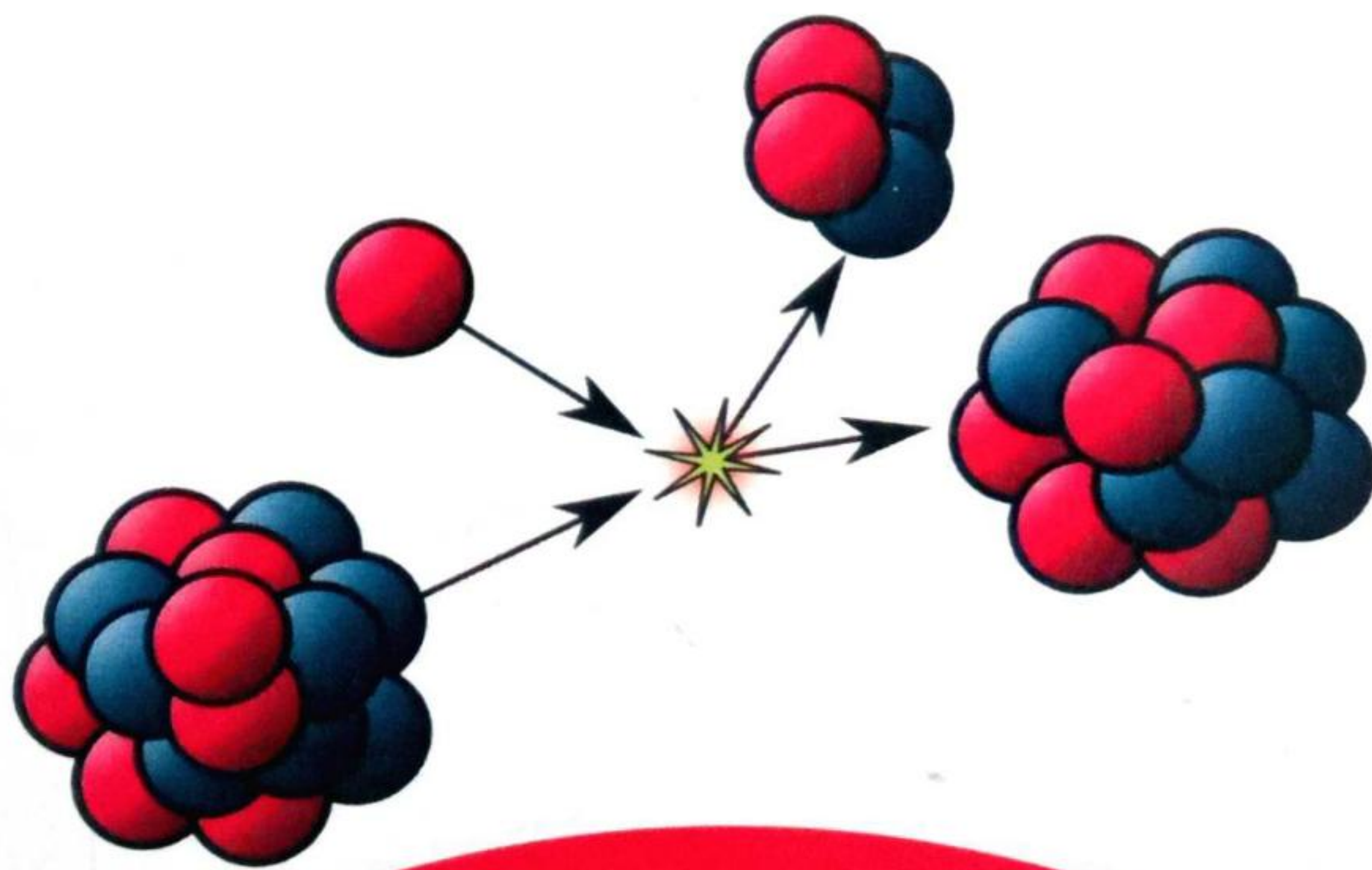


Atomic and Nuclear Physics

Dr. V.W. Kulkarni



Himalaya Publishing House

ISO 9001:2008 CERTIFIED

CONTENTS

1. Charge and Mass of Electron and Positive Ions	1 — 49
1.1 Coulomb's Law — 1.2 Electric Field — 1.3 Electric Potential and Potential Difference — 1.4 Magnetic Field — 1.5 Force on Moving Charge — 1.6 Discovery of the Electron — 1.7 Millikan's Oil Drop Method — 1.8 Deflection of Electron Beam by Magnetic Field — 1.9 Determination of e/m by Thomson's Method — 1.10 Dunnington's Method — 1.11 Classen's Method for e/m — 1.12 Wiechert - Kirchner Method — 1.13 Mass of Electron and Hydrogen Atom — 1.14 Positive Rays — 1.15 Thomson's Positive Rays Analysis — 1.16 Aston's Mass Spectrograph — 1.17 Method of Coincidence — 1.18 Dempster's Mass Spectrograph — 1.19 Bainbridge Mass Spectrograph — 1.20 Bainbridge and Jordan Mass Spectrograph — 1.21 Atomic Mass Unit — 1.22 Composition of Nuclie — 1.23 Isotopes — 1.24 Whole Number Rule — 1.25 Mass Defect and Packing Fraction	
2. Theory of Relativity	50 — 84
2.1 Relative Motion and Frames of Reference — 2.2 The Galilean Transformation — 2.3 The Aether Hypothesis — 2.4 Michelson and Morley Experiment — 2.5 Special Theory of Relativity — 2.6 Lorentz Transformation Equations — 2.7 Minskowski's Four Dimentional Space — 2.8 Length Contraction — 2.9 Time - Dilation — 2.10 Experimental Evidence for Time - Dilation — 2.11 Relativistic Transformation of velocities — 2.12 The Relativistic Mass — 2.13 Mass Energy Equivalence — 2.14 Total Energy and Rest Energy — 2.15 The Hamiltonian for a free particle — 2.16 Lorentz Transformation of Energy and Momentum — 2.17 Particles if Zero Rest Mass — 2.18 Simultaneity of Events — 2.19 The Ultimate Speed — 2.20 The General Theory of Relativity	
3. Quantum Theory	83 — 114
3.1 Emission of Thermal Radiation — 3.2 Wien's Law — 3.3 Rayleigh - Jeans Formula — 3.4 Plank's Quantum Theory — 3.5 Quantum Theory of Radiation — 3.6 Photoelectric Effect — 3.7 Richardson and Compton Experiment — 3.8 Faikure of Classical Theory — 3.9 Einstein's Theory of Photoelectric Effect — 3.10 Millikan's Experiments — 3.11 Photo-cells — 3.12 Photomultiplier Tube — 3.13 Photo-voltaic cell — 3.14 Photoconductive cell — 3.15 Work Function and Threshold Wavelength	
4. Atomic Models and Atomic Spectra	115 — 156
4.1 Thomson Model — 4.2 Rutherford's Experiments — 4.3 Rutherford's Theory — 4.4 Experimental Verification — 4.5 Size of the Nucleus — 4.6 Difficulties with Rutherford's Model — 4.7 Hydrogen Spectrum — 4.8 Atom as a Source of Spectrum — 4.9 Bohr's Postulates — 4.10 Radii of Bohr's Orbits — 4.11 Energy of the Orbit — 4.12 Emission of Spectra — 4.13 Correction for Finite Nuclear Mass — 4.14 Spectra of Ionised Helium — 4.15 Isotope of Hydrogen — 4.16 Shortcomings of Bohr's Theory — 4.17 Excitation and	

Ionisation Potential — 4.18 Frank and Hearts Experiment — 4.19 Fine Structure and Sommerfeld Theory

5. X-Rays

157 — 194

5.1 Discovery of X-Rays — 5.2 Rontgen Gas Filled Tube — 5.3 Coolidge X-Ray Tube — 5.4 Properties of X-Rays — 5.5 Applications of X-Rays — 5.6 Diffraction of X-Rays — 5.7 Bragg's Law — 5.8 Bragg's X-Ray Spectrometer — 5.9 Wavelength of X-Rays — 5.10 Refraction of X-Rays — 5.11 Measurement of X-Rays Wavelength by Ruled Grating — 5.12 X-Rays Spectra — 5.13 Continuous X-Ray Spectra — 5.14 Origin of Continuous Spectrum — 5.15 X-Rays Characteristic Spectrum — 5.16 Origin of Characteristic X-Rays — 5.17 X-Rays Energy Level Diagrams — 5.18 Absorption of X-Rays — 5.19 Scattering of X-Rays, Compton Effect — 5.20 Compton Recoil Electrons

6. Natural Radioactivity

195 — 223

6.1 Discovery of Radioactivity — 6.2 Properties of Radioactive Radiations — 6.3 Radioactive Transformations — 6.4 Nuclear Symbols and Equations — 6.5 Radioactive Series — 6.6 Isotopes, Isomers and Isobars — 6.7 Equations of Radioactive Decay — 6.8 The Half - Life — 6.9 Mean Life — 6.10 Growth and Decay of Parent and Daughter Elements — 6.11 Transient Equilibrium — 6.12 Secular Equilibrium — 6.13 Radioactive Carbon Dating — 6.14 Age of the Earth — 6.15 Units of Radioactivity — 6.16 Radiation Damage — 6.17 Applications of Radioactivity.

7. Matter Waves

224 — 251

7.1 De Broglie's Hypothesis — 7.2 Group Velocity and Phase Velocity — 7.3 The De Broglie Wavelength — 7.4 Davisson and Germer Experiment — 7.5 Experiments of G.P. Thomson — 7.6 Heisenberg's Uncertainty Principle — 7.7 Illustrations of Uncertainty Principle — 7.8 Refraction of Electron Beam — 7.9 Electron Lens — 7.10 Magnetic Lens — 7.11 Electron Microscope — 7.12 Applications of Electron Microscope

8. Fundamentals of Quantum Mechanics

252 — 289

8.1 Wave Function — 8.2 Schrodinger's Equation : Time Dependent Form — 8.3 Probability Current — 8.4 Expectation Values — 8.5 Operators in Quantum Mechanics — 8.6 Schrodinger's Equation : Steady State Form — 8.7 Eigen Values and Eigen Functions — 8.8 Infinite Square Well — 8.9 Rectangular Box — 8.10 Square well with Finite Sides — 8.11 Potential Wall of Finite Height — 8.12 Barrier Penetration — 8.13 Harmonic Oscillator — 8.14 Radiation and Absorption

9. Hydrogen Atom

290 — 313

9.1 Schrodinger's Equation for Hydrogen Atom — 9.2 Polar Form — 9.3 Separation of Variables — 9.4 Solution for ϕ — 9.5 Solution for θ — 9.6 Spherical Harmonics — 9.7 Solution for Radial Equation — 9.8 Quantum Numbers and Eigen Values — 9.9 Polar Diagrams of Probability Density — 9.10 Angular Momentum Operator — 9.11 Angular Momentum of One Electron Atom

10. Atomic Spectra

314 — 335

10.1 Angular Momentum Vector — 10.2 Angular Momentum of Orbital Electron — 10.3 Electron Spin — 10.4 Total Angular Momentum — 10.4 Stern and Gerlach Experiment — 10.5 Total Angular Momentum — 10.6 Pauli's Exclusion Principle — 10.7 Shells and Sub - Shells — 10.8 Electronic Structure and Periodic Table — 10.9 L - S Coupling — 10.10 J - J Coupling — 10.11 Spectral Notation — 10.12 Alkali Spectra — 10.13 Spectra of Two Electron Atom — 10.14 Terms of Electrons with any number of Electrons — 10.15 Equivalent Terms — 10.16 Zeeman Effect — 10.17 The Lande g - Factor — 10.18 Larmor Precession — 10.19 Quantum Mechanical Explanation of Zeeman Effect — 10.20 Anomalous Zeeman Effect

11. Molecular Spectra

356 — 382

11.1 Types of Molecular Spectra — 11.2 Pure Rotational Spectra — 11.3 Vibrational - Spectra — 11.4 Vibration - Rotation Spectra — 11.5 Electronic Bands — 11.6 Frank - Condon Principle — 11.7 Rotational Fine Structure — 11.8 Fortrat Diagram — 11.9 Raman Effect — 11.10 Experimental Raman Effect Setup — 11.11 Theoretical Explanation of Raman Effect — 11.12 Applications of Raman Effect

12. Statistical Physics

383 — 430

12.1 Thermodynamics and Statistical Methods — 12.2 Distribution Function — 12.3 Concept of the Phase Space — 12.4 Density of States — 12.5 Most Probable Distribution — 12.6 Maxwell - Boltzman Statistics — 12.7 Evaluation of Constants — 12.8 The Partition Function — 12.9 Factorisation of the Partition Function — 12.10 Translational Partition Function — 12.11 The Equipartition Theorem — 12.12 Limitations of M - B Statistics — 12.13 Quantum Statistics — 12.14 Bose - Einstein Statistics — 12.15 Black Body Radiation — 12.16 Fermi - Dirac Statistics — 12.17 Comparison of Three Statistical Distributions — 12.18 Phonons — 12.19 Specific Heat of Gases and Solids — 12.20 Classical Theory of Specific Heat of Solids — 12.21 Einstein's Theory of Specific Heat — 12.22 Debye Model — 12.23 Debye Approximation — 12.24 The Free Electron Model — 12.25 The Particle in a Box — 12.26 Fermi Energy — 12.27 Electronic Specific Heat

13. Crystal Structure

431 — 470

13.1 Crystal Lattice — 13.2 Crystal Translation Vectors — 13.3 Primary Cell — 13.4 Symmetry Elements and Symmetry Operation — 13.5 Symmetry planes and Reflection — 13.6 Rotations — 13.7 Improper Rotations — 13.8 Point groups and Space Groups — 13.9 Binding in Solids — 13.10 Ionic Crystals — 13.11 Total Lattice Energy — 13.12 Covalent Crystals — 13.13 The Metallic Crystals — 13.14 Miller Indices — 13.15 Relation between Interplanar Spacing and Lattice Spacing — 13.16 Plane Systems in Cubic Crystals — 13.17 Laue Spot Method — 13.18 Bragg Reflection — 13.19 Bragg Spectrometer — 13.20 Rotating Crystal Method — 13.21 Powder Crystal Method

14. Solid State Physics

471 — 522

14.1 Hall Effect — 14.2 Electrons in Periodic Lattice — 14.3 Effective Mass — 14.4 Brillouin Zones — 14.5 Fermi Surface — 14.6 Density of States — 14.7 Occupation of Bands by Electrons — 14.8 Filled bands and Holes — 14.9 Intrinsic Semiconductors — 14.10 Position of Fermi Level in Intrinsic Semiconductor — 14.11 Extrinsic Semiconductors — 14.12 Position of Fermi Level in Extrinsic Semiconductor — 14.13 The P - N Junction — 14.14 The P - N Junction Rectifiers — 14.15 Metal - Metal Junctions — 14.16 Metal Semiconductor Contact — 14.17 Junction Transistor — 14.18 Superconductivity — 14.19 Electrical Conductivity — 14.20 — Theory of Superconductivity — 14.19 Electron Pair Formation — 14.22 Behaviour of a Superconductor in External Electric Field — 14.23 Luminescence

15. Detectors of Nuclear Radiations

523 - 548

15.1 Classification of Detectors — 15.2 The Wilson Cloud Chamber — 15.3 The Automatic Cloud Chamber — 15.4 Diffusion Cloud Chamber — 15.5 Bubble Chamber — 15.7 Ionisation Chamber — 15.8 The Proportional Counter — 15.9 The Geiger Muller Counter — 15.10 Coincidence and Anti - Coincidence Counters — 15.11 Photographic Emulsion — 15.12 Photomultiplier

16. Accelerator of Charged Particles

523 — 548

16.1 Introduction — 16.2 Cockcroft and Walton Accelerator — 16.3 Van De Graff Accelerator — 16.4 Linear Resonance Accelerator — 16.5 Cyclotron — 16.6 Synchro - Cyclotron — 16.7 Electron Synchrotron — 16.8 Proton Synchrotron — 16.9 The Microtron — 16.10 Alternating Gradient Strong Focusing — 16.12 Indian Accelerators

17. Radioactive Decay

583 - 626

17.1 Determination of q/M of alpha particles — 17.2 Range of alpha particles — 17.3 Geiger Nuttal Method for weak source — 17.4 Alpha Particle Disintegration — 17.5 Alpha Decay — 17.6 Specific Charge of Beta Particles — 17.7 Bucherer's Method — 17.8 Beta Ray Spectrometer — 17.9 Origin of Beta Ray Spectra — 17.10 Fermi Theory of Beta Decay — 17.11 Evidence for the Neutrino — 17.12 Absorption of gamma rays by matter — 17.13 Interaction of gamma rays with matter — 17.14 Wavelength measurement of gamma rays — 17.15 Secondary Electron Method — 17.16 Nuclear Energy Levels — 17.17 Internal Conversion — 17.18 Resonance Absorption of Gamma Rays — 17.19 Mossbauer Effect — 17.20 Applications of Mossbauer Effect

18. Atomic Disintegration

627 — 660

18.1 Discovery of the Position — 18.2 Disintegration of Nuclie by α - particles — 18.3 The Neutron — 18.4 Mass of the Neutron — 18.5 Basic Properties of Neutron — 18.6 Magnetic Moment of Neutrons — 18.7 Artificial or Induced Radioactivity — 18.8 Cockcroft - Walton Experiment — 18.9 Conservation Laws in Nuclear reactions — 18.10 Compound Nucleus — 18.11 Disintegration by Protob Bombardment — 18.12 Disintegration by Dueteron Bombard-

ment — 18.13 Disintegration by α - particle Bombardment — 18.14 Disintegration by Neutron Bombardment — 18.15 Radiative capture of α - particles — 18.16 Nuclear Isomerism — 18.17 The Production of Radioactive Isotopes — 18.18 Applications of Radioisotopes

19. The Nucleus **661 — 690**

19.1 Binding Energy — 19.2 Average Binding Energy — 19.3 Short Range of Nuclear Forces — 19.4 Nuclear Size — 19.5 Nuclear Forces — 19.6 Yukawa's Theory — 19.7 Nuclear Stability — 19.8 Nuclear Spin — 19.9 — Nuclear Magnetic Moment — 19.10 Nuclear Magnetic Resonance — 19.11 Rabi's Method — 19.12 Nuclear Potential Well — 19.13 Liquid Drop Model — 19.14 Collective Nuclear Model — 19.15 Nuclear Shell Model

20. Nuclear Fission And Fusion **691 — 737**

20.1 Nuclear Fission — 20.2 Liquid Drop Model applied to Fission — 20.3 Bohr and Wheeler Theory of Nuclear Fission — 20.4 Energy released in Fission — 20.5 Fission Products — 20.6 Release of Neutrons in Fission — 20.7 Transuranic Elements — 20.8 Nuclear Cross Section — 20.9 Fission Chain Reaction — 20.10 Fission Bomb — 20.11 Moderators — 20.12 — Nuclear Reactors — 20.13 Pile Reactor — 20.14 Research Reactor — 20.15 Breeder Reactors — 20.16 Power Reactors — 20.17 Boiling Water Reactor — 20.18 Nuclear Fusion — 20.19 The Source of Stellar Energy — 20.20 Controlled Thermonuclear Fusion — 20.21 Fusion Reactors

21. Cosmic Rays and Particle Physics **738 — 766**

21.1 Early Experiments — 21.2 Absorption of Cosmic Rays by Matter — 21.3 Altitude Effect — 21.4 Latitude Effect — 21.5 Geomagnetic Effect — 21.6 The East-West Directional Effect — 21.7 Mature of Cosmic Rays — 21.8 Origin of Cosmic Rays — 21.9 Electron Showers and Bursts — 21.10 Particle Interaction — 21.11 Antimatter — 21.12 The Elementary Particles — 21.13 Subatomic Conservation Laws — 21.14 Conservation of Parity