

Cambridge University Press

978-0-521-29925-1 - The Investigation of the Physical World

G. Toraldo di Francia

Table of Contents

[More information](#)

Contents

| | |
|---|----------------|
| Preface to the English edition | <i>page</i> ix |
| Preface to the Italian edition | xi |
| 1 The method of physics | |
| 1.1 Introduction | 1 |
| 1.2 What is physics? | 5 |
| 1.3 A first approach to the method | 7 |
| 1.4 The value of the method | 13 |
| 1.5 The operational definition | 16 |
| 1.6 The language of physics | 19 |
| 1.7 Observables or theoretical constructs? | 21 |
| 1.8 How many physical quantities are there? | 25 |
| 1.9 The precision of measurements | 26 |
| 1.10 The limits of the validity of a physical law | 29 |
| 1.11 The procedure of classical physics | 34 |
| 1.12 The mathematical functions used in physics | 38 |
| 1.13 The units of measurement | 43 |
| 1.14 The dimensions of physical quantities | 48 |
| 1.15 Theories, hypotheses, models | 50 |
| 2 The physics of the reversible | |
| 2.1 The divisions of classical physics | 53 |
| 2.2 Velocity and acceleration | 54 |
| 2.3 Curvilinear motion | 58 |
| 2.4 The laws of dynamics | 60 |
| 2.5 Work and energy | 64 |
| 2.6 The invariants | 67 |
| 2.7 Action at a distance | 70 |
| 2.8 Do magnetic charges exist? | 73 |
| 2.9 The field concept | 75 |
| 2.10 Electromagnetism | 79 |
| 2.11 Maxwell's equations | 82 |
| 2.12 The electromagnetic waves | 86 |
| 2.13 The polarization of material media | 88 |
| 2.14 Reflection, refraction, dispersion | 91 |
| 2.15 Lenses and images | 94 |

Cambridge University Press

978-0-521-29925-1 - The Investigation of the Physical World

G. Toraldo di Francia

Table of Contents

[More information](#)

| | | |
|----------|---|-----|
| vi | Contents | |
| | 2.16 The physical theory of vision | 99 |
| | 2.17 How do we really see? | 103 |
| | 2.18 Interference and diffraction | 106 |
| | 2.19 The Galilean relativity | 109 |
| | 2.20 Einstein's relativity | 113 |
| | 2.21 The Lorentz transformation | 116 |
| | 2.22 Length contraction and time dilation | 120 |
| | 2.23 The limiting velocity, the past and the future | 122 |
| | 2.24 The invariance of the laws of physics | 125 |
| | 2.25 Gravitation | 130 |
| | 2.26 General relativity | 132 |
| | 2.27 Consequences of general relativity | 135 |
| | 2.28 Physical theories | 139 |
| | 2.29 The richness of the man–nature relation | 143 |
| 3 | The physics of the irreversible | |
| | 3.1 Reversibility and irreversibility | 152 |
| | 3.2 Temperature and heat | 153 |
| | 3.3 Perfect gases | 155 |
| | 3.4 Heat, work, and internal energy | 157 |
| | 3.5 Specific heats of a gas | 159 |
| | 3.6 The second law of thermodynamics | 162 |
| | 3.7 The entropy | 166 |
| | 3.8 The nonlinear development of classical thermodynamics | 171 |
| | 3.9 The kinetic theory | 175 |
| | 3.10 Probability | 180 |
| | 3.11 Information | 186 |
| | 3.12 Information and probability | 189 |
| | 3.13 The transmission of information | 193 |
| | 3.14 Microstates and macrostates | 197 |
| | 3.15 Statistical irreversibility | 204 |
| | 3.16 Does time have an arrow? | 208 |
| | 3.17 Fluctuations | 214 |
| 4 | Microphysics | |
| | 4.1 The objects of physics | 220 |
| | 4.2 Spectral lines | 225 |
| | 4.3 Electrons | 226 |
| | 4.4 Classical models of the atom | 228 |
| | 4.5 Planck's quanta | 232 |
| | 4.6 Photons | 235 |
| | 4.7 The Bose–Einstein statistics | 238 |
| | 4.8 Bohr's atom | 242 |

Cambridge University Press

978-0-521-29925-1 - The Investigation of the Physical World

G. Toraldo di Francia

Table of Contents

[More information](#)

| Contents | vii |
|--|-----|
| 4.9 Waves and particles | 245 |
| 4.10 The probabilistic interpretation | 249 |
| 4.11 Spin, atoms, and molecules | 252 |
| 4.12 Bosons, fermions, antimatter | 256 |
| 4.13 The uncertainty principle | 260 |
| 4.14 The Hilbert space | 265 |
| 4.15 The formalism of quantum mechanics | 270 |
| 4.16 Revision of the general scheme of physics | 274 |
| 4.17 Difficulties of quantum mechanics | 277 |
| 4.18 Microphysics and reality | 284 |
| 4.19 Determinism and indeterminism | 286 |
| 4.20 Causality | 288 |
| 4.21 The inductive inference | 292 |
| 4.22 Quantum electrodynamics | 299 |
| 4.23 The atomic nucleus | 307 |
| 4.24 The second crisis of classical physics | 312 |
| 4.25 Particles multiply | 315 |
| 4.26 Interactions and conservations | 320 |
| 4.27 Toward the grand unification | 331 |
| 4.28 Materialism and mechanism in contemporary physics | 337 |
| 5 The universe | |
| 5.1 General laws and historical facts | 342 |
| 5.2 Form and movements of the earth | 348 |
| 5.3 The earth's structure | 352 |
| 5.4 The cosmogonic problem | 357 |
| 5.5 The environment and the biosphere | 364 |
| 5.6 The origin and evolution of life | 368 |
| 5.7 Windows on the universe | 377 |
| 5.8 The solar system | 382 |
| 5.9 The origin of the solar system | 394 |
| 5.10 The stars | 397 |
| 5.11 Neutron stars, pulsars, blackholes | 404 |
| 5.12 The galaxies | 409 |
| 5.13 Cosmological hypotheses | 414 |
| 5.14 Life in the universe | 418 |
| Notes | 422 |
| References | 449 |
| Name index | 457 |
| Subject index | 462 |