

Contents

Preface	V
The Characters	XIII
The Particles	XIV
Measure for Measure On the Units in Science.....	XVI

I – Rocket Science..... **1**

Auroras An Exciting Glow for Humans and Atoms.....	3
Light Ripples in the Electromagnetic Field.....	7
Invisibility Cloaks Walk Like a Magician.....	11
The Doppler Shift The Stretching of Waves.....	15
Lasers High Quality Light Offering new Possibilities.....	19
Vacuum and Air Pressure Molecules on the Move.....	23
Fluid Flow and Turbulences Nothing You Should Test on a Highway.....	27
Why Does a Plane Fly? How to Guide the Air to Keep You up.....	31
Surface Tension Minimal Surface for Maximum Comfort.....	35
Non-Newtonian Fluid Is It Liquid? Or Is It Solid?.....	39
Rocket Maneuvers Navigating within Nothing.....	43
Kepler’s Laws The Basic Rules for the Movement of Planets.....	47

Conservation Laws Nothing Gets Lost in Nature.....	51
The Voyager Probes Where No One Has Gone Before.....	55
Birth of the Solar System A Star Is Born.....	59
Genesis of the Moon A Mini Big Bang Close to Earth.....	63
Extrasolar Planets Is Anybody out There?.....	67

II – The Cosmos.....71

Spectral Classification A Who Is Who of Stars.....	73
Red Giants and Planetary Nebulae The End of a Main Sequence Star.....	79
Supernovae Going out with a Bang.....	83
White Dwarfs and Type Ia Supernovae Corpses of the Suns and Standard Candles.....	87
Black Holes Once You Go Black, You Never Come Back.....	91
The Big Bang The Horrendous Space Kabloolie.....	97
Timeline of Our Universe From the Big Bang to the Present.....	100
The Cosmic Microwave Background The Oldest Photons in the Universe.....	105
Large Scale Structure of the Universe A Network Made of Stars.....	109
Galaxy Types Looks Is Everything.....	113
Relative Space and Time Why you Can't Make Light Faster by Pushing it.....	117
The Theory of General Relativity Curved Space and Warped Time.....	121
Curved Space Time Getting the Right Angle.....	125

Gravitational Lensing Mirages in the Night Sky.....	129
Dark Matter More than Meets the Eye.....	133
Dark Energy The Revival of Einstein's Biggest Blunder.....	137

III – Quantum Mechanics..... 141

Wave-Particle Duality Is It a Wave or Particle?.....	143
The Double Slit Experiment On the Weirdness of the Quantum World.....	147
Heisenberg Uncertainty You Cannot Have It Both Ways.....	151
Schrödinger's Cat Dead and Alive at the Same Time.....	155
Feynman Paths Reality as the Sum of Possibilities.....	159
Quantum Tunneling Where There Is a Wave Function, There's a Way.....	163
Radioactive Decay About the Life of Nuclei and Their End.....	167
Alpha, Beta and Gamma Rays Radioactive Rays.....	171
Nuclear Fusion Energy Source for Dinosaurs and Future Humans.....	175
Superconductors Super Highways for Electrons.....	179
Superfluidity The Creepy Kind of Fluid.....	183
Spin Particle Dances in Discrete Steps.....	187
Entanglement A Spooky Action at a Distance?.....	191
Quantum Teleportation There and Back Again.....	195
Qubits How to Build a Quantum Computer.....	199

IV – Particle Physics	203
Atoms vs. Elementary Particles Crack and Check, Crack and Check	205
The Neutrino So Light and so Hard to Catch.....	209
Standard Model of Elementary Particles So Far the Best Manual for Our Universe.....	213
Antimatter More Science than Fiction.....	217
Particle Decays The Particles' Short Lives and Interesting Heritages.....	221
Feynman Diagrams Particle Skribblings with a Serious Meaning.....	225
The Strong Interaction Keeping Our Atoms Stable.....	229
The Weak Interaction Weak but with Unique Power.....	233
E=mc² Energy and Mass – Almost the Same.....	237
The Higgs Mechanism Origin of Our Particles' Masses.....	241
The Structure of the Proton Or How to Get Mass without a Higgs.....	245
Particle Accelerators Time Machines and Big Bang Creators.....	249
Particle Detectors Showing the Invisible.....	253
Cosmic Radiation Sent from Unknown Accelerators Far Away from Us.....	257
Neutrino Oscillations Particles Changing Personalities.....	261
Radiation Therapy Particles on a Mission against Evil.....	265

V – Beyond the Boundaries of Our Knowledge	269
Exotic Matter Different from Everything We Know.....	271
Before the Big Bang A Bounce?.....	275
Quantum Gravity Where Is the Quantum Theory of the Fourth Force?.....	279
Black Hole Evaporation Planck Stars Instead of a Singularity?.....	283
Wormholes Shortcuts through Space and Time.....	287
Tachyons Actually Faster than Light.....	291
Warp Drive Surfing on a Space Time Wave.....	295
Supersymmetry A Beautiful Solution to Many Problems.....	299
String Theory A Way to a Theory of Everything™.....	303
Extra Dimensions Tiny Spaces Hiding Out.....	307
Many Worlds The Cat Is Alive in Another Universe.....	311
The End of the Universe And Then?.....	314