

Contents

Preface:

The Training of an Elementary Particle Phenomenologist vii

List of Figures xxi

0.	A Pictorial Journey through the Landscape of α -Quantized Elementary Particle Lifetimes and Masses	1
0.1	The Experimental Journey	1
0.2	Global Lifetime α -Quantization	2
0.3	Unpaired-Quark Lifetime Hyperfine (HF) Structure	6
0.4	The α^4 “Lifetime Desert” between Unpaired and Paired Quark Decays	12
0.5	Two α^{-1} Mass Leaps: The $m_b = 70$ MeV and $m_f = 105$ MeV Basis States	15
0.6	The Spin-1/2 Standard Model $q \equiv (u, d), s, c, b$ “Muon” Constituent Quarks	22
0.7	The Spin-0 Generic “Pion” Constituent Quarks	34
0.8	The Relativistically Spinning Sphere and the $m_f/m_b = 3/2$ Mass Ratio	39
0.9	The M^X Threshold-State Particle Excitation Mechanism	41
0.10	An α^{-2} Mass Leap: The $q^\alpha = 43,182$ MeV Basis Set for the W, Z Gauge Bosons and Top Quark t	48
0.11	Mathological Studies of Elementary Particle Spectroscopy	59

1.	Lifetime and Mass α -Quantization: Physics Beyond the Paradigm	63
1.1	The Missing Elementary Particle Ground State and Its Mass Generator	63
1.2	The Particle Mass Mystery: Physics from the Higgs Down or the Bottom Up?	65
1.3	The Double Mystery of the Fine Structure Constant $\alpha = e^2/\hbar c$	69
1.4	The Dichotomy of Leptons and Hadrons: Interactive Charges and Passive Masses	72
1.5	Experiment, Phenomenology, Theory: The Three Steps to Success	76
1.6	The Review of Particle Physics (RPP) Elementary Particle Data Base	78
1.7	The Linkage Between Particle Lifetimes/Widths (Stability) and Particle Masses (Structure)	81
1.8	The Numerical Challenge of the Proton-to-Electron Mass Ratio	83
2.	The Phenomenology of α -Quantized Particle Lifetimes and Mass-Widths	87
2.1	The Zeptosecond Boundary between Threshold-State and Excited-State Lifetimes	87
2.2	The Nonstrange π^+ , π^- , π^0 , η , η' PS Meson Quintet: The “Crown Jewels” of Lifetime α -Quantization	93
2.3	The Strange K^+ , K^- , K_L^0 , K_S^0 Meson Quartet: α -Scaling and Factor-of-2 Hyperfine (HF) Structure	100
2.4	The PS Meson Lifetime Nonet: Physics Outside of the Standard Model	103
2.5	Hyperfine (HF) Factor-of-2 and Factor-of-3 Lifetime Structure	105
2.6	The α -Quantization of the 36 Long-Lived Threshold-State Particle Lifetimes	113
2.7	The s , c , b Quark Group Structure in α -Quantized Particle Lifetimes	124
2.8	Factor of α^4 Lifetime Ratios between Unpaired and Paired Quark Decays	126
2.9	The b -Quark and c -Quark Factor-of-3 Lifetime Flavor Structure	135

2.10	Flavor Substitutions and $c > b > s$ Flavor Dominance in Unpaired-Quark Decays	138
2.11	The Historical Emergence of α -Quantized Elementary Particle Lifetimes	141
3.	The Phenomenology of Reciprocal α^{-1} and α^{-2} Particle Mass Quantization	153
3.1	What Are the Elementary Particle Lepton and Hadron “Ground States”?	153
3.2	The Correlation between Particle Mass-Widths and Particle Masses	160
3.3	Electrons, Muons and Pions: The “Rosetta Stones” of α -Quantized Masses	163
3.4	The First-Order $m_b = 70$ MeV Boson and $m_f = 105$ MeV Fermion “ α -Leap” Masses	169
3.5	Symmetric ($M_\pi, M_\phi, M_{\mu\mu}$) and Asymmetric ($M_K, \bar{M}_K, M_\mu, \bar{M}_\mu$) “Platform” States	173
3.6	The Spin and Flavor Hierarchy of the M^X Platform Excitations	177
3.7	The M_π (π, η, η') Boson M^X Tower: The “Crown Jewels” of α -Quantized Masses	180
3.8	The $M_{\mu\mu}$ ($\mu\bar{\mu}, p\bar{p}, \tau\bar{\tau}$) Fermion M^X Tower	186
3.9	The “Supersymmetric” 420 MeV Excitation Quantum $X = 3m_b\bar{m}_b = 2m_f\bar{m}_f$	192
3.10	The Strange M_K (K, \bar{K}) Boson M^X Excitations and the $\eta' = K\bar{K}$ Bound State	195
3.11	The Strange M_μ (s, \bar{s}) Fermion M^X Excitations: s and \bar{s} Quarks	201
3.12	The Strange $M_\phi(\phi)$ Vector Boson M^X Excitation: The $\phi = s\bar{s}$ Bound State	205
3.13	The Fundamental “ M_X Octet” of Threshold-State Particles	209
3.14	Isotopic Spin Mass Splittings and Charge-Independent (CI) Particle Masses	211
3.15	Hadronic Binding Energy (HBE) Systematics	214
3.16	Almost-Parameter-Free M^X Octet Mass Calculations	221
3.17	The M_ϕ ($\phi, J/\psi, \Upsilon$) = ($s\bar{s}, c\bar{c}, b\bar{b}$) Vector Meson M^T Mass-Tripling Tower	226

3.18	Charge Exchange (CX) and Fragmentation (CF) Excitations and Proton Stability	233
3.19	Excitation Doubling and the W and Z Vector Mesons . .	237
3.20	The Second-Order α^{-2} Fermion Mass Leap to the W and Z Bosons and Top Quark t	242
3.21	The PS Lifetime and Mass Nonet: Physics Outside of the Standard Model	251
3.22	Examples of Reciprocal α -Quantized Lifetimes and Masses	254
3.23	The q, s, c, b Quark Benchmark Test: Calculate 16 Unpaired-Quark Ground States	259
3.24	The Short-Lived Excited-State Masses: Evidence from Excitation Clusters	269
3.25	Muon (Fermion) Masses and Quarks; Pion (Boson) Masses and Generic Quarks; Superheavy Muon α -Quark Masses	276
3.26	Evidence for the $s^* = 595$ MeV Strange Quark Excited State	285
3.27	The Universal 35 MeV Mass Grid	291
3.28	Mass Freedom in Quantum Chromodynamics (QCD) . . .	294
4.	The Mathology of the Elementary Particle: The Relativistically Spinning Sphere	299
4.1	Introduction to Mathology	299
4.2	The Most Accurate Example of Mathology: Quantum Electrodynamics (QED)	301
4.3	The Mechanical Mathology of Relativistically Spinning Spherical Masses	302
4.4	The Spectroscopic Mathology of the Electron: A Classical Representation Does Exist	308
4.5	The Vanishing Electric Quadrupole Moment of the Electron	310
4.6	The Physical Basis for the Anomalous Magnetic Moment of the Electron: The Answer to Richard Feynman's Challenge for a First-Order Model	313
4.7	The Relativistic Transformation Properties of the Mathological Electron: Correct Transformations Occur only at the Rotational Relativistic Limit	317

5.	The Mathology of Particle Waves: The Particle–Hole Pair	323
5.1	The Mathology of the Electron Phase Wave	323
5.2	The Mathology of Particle–Hole Pairs: Zeron and Photons	328
5.3	The Mathology of QED Renormalization: Bare Masses as “Hole” States	341
5.4	Vacuum-State Zero-Point Fluctuations as Energy-Conserving Particle–Hole Pairs	346
6.	The Mathology of the Fine Structure Constant $\alpha = e^2/\hbar c$	349
6.1	The Mystery of the Numerical Value $\alpha \cong 1/137$	349
6.2	The Phase Transitions $\alpha_{1,2,3,4} \equiv \alpha_e, \alpha_\mu, \alpha_q, \alpha_\gamma$ of the Mass Generator α	352
6.3	Three Configurations of the Multiform Electric Charge e	357
7.	Ramifications	361
7.1	Cosmological Masses	361
7.2	The “Mechanical” Mass of the Elementary Particle	363
7.3	Three Deficiencies in the Standard Model Treatment of Particle Masses	365
<i>Postscript:</i>		
	<i>The Saga of the $m_b = 70$ MeV and $m_f = 105$ MeV Mass Quanta</i>	371
<i>Appendices</i>		385
<i>Acknowledgments</i>		413
<i>References</i>		415
<i>Index</i>		421