
Contents

1	Introduction and Motivation	1
	References	4
2	Quark Flavor Interaction	5
2.1	Chiral Symmetry	5
2.2	Dynamical Breaking of Chiral Symmetry	6
2.3	The Nambu–Jona–Lasinio Model	8
2.4	Gradient Expansion	15
2.5	PCAC	19
2.6	Relation to Instanton Effects	21
2.7	Final Note on Chiral Quark Models	24
	References	24
3	Self-consistent Soliton	27
3.1	Static Energy Functional	27
3.2	Method	31
3.3	Soliton Solutions in NJL-Type Models	35
3.3.1	Pseudoscalar Fields	35
3.3.2	Vector and Axial-Vector Fields	38
3.3.3	Remark on the ω Field	39
3.3.4	Comments on Scalar Fields	40
	References	41
4	The Skyrme Model	43
4.1	Large- N_C Considerations	43
4.2	Baryons in Large- N_C QCD	47
4.3	A Simple Soliton	51
4.4	Skyrme Model Soliton	53
4.5	Equations of Motion and Wess–Zumino Term	55
4.6	Topological Structures	58

4.7	Vector Interactions	60
	References	64
5	Soliton Quantization in Flavor SU(2)	65
5.1	Collective Coordinates	65
5.2	Quantization of the $SU(N)$ Rigid Top	67
5.3	Nucleon and Δ States	71
5.4	Nucleon Static Properties	73
5.5	Quantization in Vector Meson Models	79
5.6	Quantization in Chiral Quark Models	81
	References	83
6	Soliton Quantization in Flavor SU(3)	85
6.1	Baryon States in the Non-relativistic Quark Model	85
6.2	Quantization of the Soliton in the Flavor Symmetric Case	86
6.3	Flavor Symmetry Breaking	92
6.4	Diagonalization with Flavor Symmetry Breaking	96
6.5	Beyond the Classical Hedgehog Solution	98
6.6	Bound State Approach	100
6.7	Baryons with a Heavy Valence Quark	105
6.8	Brief Summary on Soliton Quantization	110
	References	111
7	Baryon Properties	113
7.1	Electromagnetic Properties	114
7.2	Relativistic Corrections	119
7.3	Axial Charges and Hyperon Decays	120
7.4	Proton Spin Puzzle	125
7.5	Strangeness in the Nucleon	129
7.6	Neutron–Proton Mass Difference	131
7.7	Nucleon Structure Functions	134
	References	143
8	Meson–Baryon Scattering in Chiral Soliton Models	147
8.1	Adiabatic Approximation	148
8.2	S-Wave Scattering	153
8.3	P-Wave Scattering and the Yukawa Problem	156
8.4	Photoproduction	160
8.5	Non-harmonic Excitations	167
8.6	Estimate of Quantum Corrections in Soliton Models	171
	References	178

9 Exotic Baryons	181
9.1 Exotic Flavor Structure and Spectrum	182
9.2 Spectrum and Mixing Mechanisms	185
9.3 The Myth of the Narrow Pentaquark	190
9.4 Rigid Rotator at Arbitrary N_C	193
9.5 Solution to the Yukawa Problem	197
9.6 Skyrme Model Results for the Pentaquark Width	203
References	204
10 Multi-baryon Systems in the Skyrme Model	207
10.1 Static Configurations with $B \geq 2$	207
10.2 Product Ansatz	211
10.3 Nucleon–Nucleon Potential	212
10.4 Towards Dense Matter	217
10.5 An Application to Heavy Ion Collisions	220
10.6 The H-dibaryon	225
References	229
Epilogue	231
A: Chiral Properties of Quark Bilinears	233
Reference	235
B: Functional Techniques	237
C: Baryon Current and Wess–Zumino Term	243
C.1 Gradient Expansion of the Fermion Determinant with a Baryon Source	243
C.2 Gauging the Wess–Zumino Term	246
C.3 Wess–Zumino Term in the Bound State Approach	249
C.4 π^0 Decay	250
References	252
D: $SU(3)$ Euler Angles	253
References	258
E: Matrix Elements of Momentum Eigenstates	259
E.1 Momentum Eigenstates from Collective Coordinates	259
E.2 Relativistic Recoil Corrections	261
References	263
Recoupling Coefficients in Adiabatic Scattering	265
F.1 Adiabatic Recoupling Coefficients	265
F.2 Jost Function for Intrinsic Fluctuations	267
References	270
Index	271