

Contents

1. Experimental Evidence of Quarks and Gluons	
By G. Flügge (With 47 Figures)	1
1.1 Introduction	1
1.2 Deep Inelastic Scattering	2
1.2.1 Form Factors and Structure Functions	2
1.2.2 Deep Inelastic Scattering and Bjorken Scaling	4
1.2.3 Parton Scattering and Significance of Bjorken x	5
1.2.4 Deep Inelastic Scattering Experiments	7
1.2.5 Results on the Structure Functions	9
1.2.6 Interpretation of Structure Functions in the Quark-Parton Model	10
1.2.7 Scaling Violation and QCD ¹⁵⁾	14
1.3 Quarks in e^+e^- Annihilation	17
1.3.1 e^+e^- Annihilation into Hadrons in the Quark-Parton Model ..	17
1.3.2 e^+e^- Storage Rings and Detectors	18
1.3.3 Total Hadronic Cross Section	20
1.3.4 Jets in e^+e^- Annihilation	21
1.3.5 Resonances in e^+e^- Annihilation	24
1.3.6 Charm and Carmonium	25
1.3.7 Bottomonium	28
1.3.8 Toponium	29
1.4 Gluons in e^+e^- Annihilation	30
1.4.1 Introduction	30
1.4.2 Decay of Heavy Quarkonia	31
1.4.3 τ Decay Topology	33
1.4.4 QCD in High-Energy Jets	37
1.4.5 Experimental Tests of QCD at High-Energies	40
a) Total Hadronic Cross Section	40
b) Rising Transverse Momentum	41
c) Planar Event Structure	43
d) Three-Jet Events	46
e) Detailed Comparison with QCD	48
f) Determination of α_s	48

1.5 Summary	50
1.5.1 Quarks	50
1.5.2 Gluons	50
References	51
2. The Pauli Principle and QCD for Quarks and Nucleons in Hadrons and Nuclei. By F.E. Close (With 3 Figures)	57
2.1 Introduction	57
2.2 Onium Atoms and Onium Hadrons	57
2.3 QED, QCD; Molecular and Nuclear Forces	60
2.4 "Constituent" Masses for Quarks	61
2.5 Mass Dependence of Potential Energies	64
2.6 Symmetries and Correlations in Baryons	66
2.7 Magnetic Moments: Spin Flavour Correlation	69
2.8 Fermi-Breit Interaction	72
2.9 Spin-Orbit Forces and P-Wave Baryons	74
2.10 What Kills the $\zeta\cdot S$ Contributions?	78
2.11 Conclusions	79
References	80
3. Quantum Chromodynamics at Nuclear Dimensions	
By S.J. Brodsky (With 26 Figures)	81
3.1 Introduction	81
3.2 Basic Features of QCD	82
3.2.1 The QCD Lagrangian	87
3.2.2 QCD Perturbation Theory	88
3.3 Hadronic Wavefunctions in QCD [27]	92
3.4 Measures of Hadronic Wave Functions	99
3.4.1 Form Factors of Composite Systems	99
3.4.2 Form Factors of Mesons	99
3.4.3 The Meson Distribution Amplitude	101
3.4.4 Large Momentum Transfer Exclusive Processes [19]	103
3.4.5 Two-Photon Processes [12]	110
3.5 Deep Inelastic Lepton Scattering	114
3.6 The Phenomenology of Hadronic Wavefunctions	118
3.6.1 Measures of Hadron Wavefunctions	118
3.6.2 Constraints on the Pion and Proton Valence Wavefunction [27]	121
3.6.3 Quark Jet Diffractive Excitation [30]	124
3.6.4 The "Unveiling" of the Hadronic Wavefunction and Intrinsic Charm	125
3.7 The Synthesis of QCD and Nuclear Physics	127

3.7.1	The Deuteron Form Factor and Nuclear States at Short Distances	127
3.7.2	Reduced Form Factors [84]	129
3.7.3	The Nucleon-Nucleon Interaction at Short Distances	130
3.7.4	Continuity of Nuclear Physics and Quantum Chromodynamics ..	133
3.7.5	Structure Functions of Nuclei	134
3.7.6	Nuclei as Probes of Particle Physics Dynamics	136
3.8	Conclusions	137
	References	140
4.	Bag Models and Nuclear Forces. By L. Heller (With 8 Figures)	145
4.1	Introduction to the Lectures	145
4.2	The MIT Bag Model	145
4.2.1	Introduction and Equations	145
4.2.2	Light Quarks vs. Heavy Quarks	150
4.2.3	The Fixed Bag Approximation for Hadrons Composed of Light Quarks (u,d,s)	151
4.2.4	The Born-Oppenheimer Approximation for Hadrons Composed of Heavy Quarks (... b,c,s)	156
4.3	Arguments Against a Quark-Quark Confining Potential	175
4.4	Interaction of Bags	179
	References	182
5.	Quark Matter and Nuclei. By G. Baym (With 5 Figures)	186
5.1	Introduction	186
5.2	Phenomenology of Confinement	186
5.3	Decofinement at High Baryon Density of Temperature	192
5.3.1	Quark Matter	194
5.3.2	Effects of Interactions	196
5.3.3	Deconfinement Transition	199
5.4	Production and Detection of Quark Matter	203
	References	212
6.	How Should or Will QCD Influence Nuclear Physics?	
	By A. Faessler (With 6 Figures)	214
6.1	Introduction	214
6.2	Quantum Chromodynamics and Nuclear Forces	216
6.3	Six and Higher Quark Bags in Nuclei	220
6.4	Static Properties	221
6.5	Conclusions	222
	References	223