

CONTENTS

Chapter 1

THE SPIN STRUCTURE OF THE NUCLEON

B.W. Filippone and Xiangdong Ji

1.	Introduction	2
1.1.	A Simple Model for Proton Spin	3
1.2.	Lepton Scattering as a Probe of Spin Structure	4
1.3.	Theoretical Introduction	6
2.	Experimental Overview	10
2.1.	SLAC Experiments	12
2.2.	CERN Experiments	13
2.3.	DESY Experiments	15
2.4.	RHIC Spin Program	16
3.	Total Quark Helicity Distribution	16
3.1.	Virtual Photon Asymmetries	17
3.2.	Extraction of $g_1(x, Q^2)$	19
3.3.	Recent Results for $g_1(x, Q^2)$	21
3.4.	First Moments of $g_1(x, Q^2)$	24
3.5.	Next-to-Leading Order Evolution of $g_1(x, Q^2)$	27
4.	Individual Quark Helicity Distributions	30
4.1.	Semi-Inclusive Polarized Lepton Scattering	32
4.2.	High Energy $\vec{p} - p$ Collisions	36
5.	Gluon Helicity Distribution	37
5.1.	$\Delta G(x)$ from QCD Scale Evolution	38

5.2.	$\Delta G(x)$ from Di-jet Production in $e - p$ Scattering	38
5.3.	$\Delta G(x)$ from Large- p_T Hadron Production in $e - p$ Scattering	42
5.4.	$\Delta G(x)$ from Open-charm (Heavy-quark) Production in $e - p$ Scattering	43
5.5.	$\Delta G(x)$ from Direct Photon Production in $p - p$ Collisions .	45
5.6.	$\Delta G(x)$ from Jet and Hadron Production in $p - p$ Collisions	48
5.7.	Experimental Measurements	48
6.	Transverse Spin Physics	54
6.1.	The $g_2(x, Q^2)$ Structure Function of the Nucleon	54
6.2.	Transversity Distribution	58
6.3.	Single-Spin Asymmetries From Strong Interactions	61
7.	Off-Forward Parton Distributions	64
7.1.	Properties of the Off-Forward Parton Distributions	67
7.2.	Deeply Virtual Exclusive Scattering	70
8.	Related Topics in Spin Structure	73
8.1.	The Drell-Hearn Gerasimov Sum Rule and Its Generalizations	73
8.2.	Spin-Dependent Λ Fragmentation	77
	Conclusions	79
	Acknowledgements	79
	References	80

Chapter 2

LIQUID-GAS PHASE TRANSITION IN NUCLEAR MULTIFRAGMENTATION

S. Das Gupta, A.Z. Mekjian and M.B. Tsang

1.	Introduction	91
2.	Liquid Gas Phase Transition in Nuclear Meanfield Theory	92
3.	Experimental Overview	98
4.	Event Selection	99
4.1.	Central Collisions	99

4.2. Peripheral Collisions 102

5. Evidence for Nuclear Expansion 102

6. Space-Time Determination 105

7. Temperature Measurements 109

7.1. Kinetic Temperatures 109

7.2. Excited State Temperature 110

7.3. Isotope Temperature 110

7.4. Effect of Sequential Decays 111

7.5. Cross-Comparisons Between Thermometers 113

7.6. Summary of Temperature Measurements 115

8. Excitation Energy Determination 115

9. Signals for Liquid-Gas Phase Transition 118

9.1. Rise and Fall of IMF 118

9.2. Critical Exponents 119

9.3. Nuclear Caloric Curve 120

9.4. Isospin Fractionation 123

10. A Class of Statistical Models 126

11. A Thermodynamic Model 128

12. Generalisation to a More Realistic Model 138

13. A Brief Review of the SMM Model 142

14. The Microcanonical Approach 142

15. The Percolation Model 144

16. The Lattice Gas Model(LGM) 146

17. Phase Transition in LGM 149

18. Isospin Dependent LGM Including Coulomb Interaction 152

19. Calculations With Isospin Dependent LGM 153

20. Fragment Yields from a Model of Nucleation 156

21. Isospin Fractionation in Meanfield Theory 157

22. Dynamical Models for Fragmentation 158

23. Outlook 161

Acknowledgements 161

References 162

Chapter 3

HIGH SPIN PROPERTIES OF ATOMIC NUCLEI

D. Ward and P. Fallon

1.	Introduction	168
1.1.	Nuclear Structure at High Angular Momentum	168
1.2.	Basic Ideas	169
1.3.	Electromagnetic Decays	173
1.4.	Organisation of the review	173
2.	The Development of Large Arrays for Gamma-Ray Spectroscopy .	175
2.1.	Early Ideas-Selectivity, Sensitivity and Population Mechanisms	175
2.2.	Second and Third Generation Arrays	180
2.3.	Close-packed Composite-Detectors	186
2.4.	Segmented Detectors	189
2.5.	Ancillary Detectors	190
3.	Rotations, Particle Alignments and the Nuclear Shape	194
3.1.	Introduction	194
3.2.	Triaxial Shapes	197
3.3.	High-K States	205
3.4.	Rotational Bands Built on Vibrational Intrinsic States	208
4.	Superdeformation	218
4.1.	The Existence and Stability of Superdeformed Nuclei	219
4.2.	Rotations of Superdeformed Nuclei	229
5.	Limits to Nuclear Rotations	242
5.1.	Termination of Rotational Bands	242
5.2.	Rotations and Pairing Correlations	244
5.3.	Rotations in $N = Z$ Nuclei	249
5.4.	Shears Bands	252
6.	Studies of the Quasi-Continuous Radiation	256
6.1.	Introduction	256
6.2.	The Nuclear Inertia at the Highest Angular Momentum . . .	274
	Acknowledgements	282
	References	282

Chapter 4

THE DEUTERON: STRUCTURE AND FORM FACTORS

M. Garçon and J.W. Van Orden

1.	A Historical Introduction	294
1.1.	Discovery of the Deuteron	294
1.2.	Early Theories	295
1.3.	Spin	296
1.4.	Connection with OPE	297
2.	The Non-Relativistic Two-Nucleon Bound State	297
2.1.	The Potential Model of the Deuteron	297
2.2.	The Deuteron Wave Function	298
3.	Static and Low Energy Properties	301
3.1.	Deuteron Static Properties (Experiment)	302
3.2.	Low Energy np Scattering Parameters	304
3.3.	Static Properties and the NN Potential	305
4.	Elastic Electron-Deuteron Scattering	305
4.1.	Deuteron electromagnetic form factors	305
4.2.	Observables	307
4.3.	Review of elastic ed data	311
4.4.	Empirical features of form factors	316
5.	Theoretical Issues	319
5.1.	Deuteron Elastic Form Factors in the Simple Potential Model	319
5.2.	Limitations of the simple potential model	322
5.3.	Construction of Relativistic Models	324
5.4.	v/c expansions	327
5.5.	Relativistic Constraint Dynamics	330
5.6.	Field Theoretical Models	332
5.7.	Deuteron models with nucleon isobar contributions	348
5.8.	Quarks and gluons	350
5.9.	Further Comparison Between Models and Data	353
6.	The Nucleon Momentum Distribution in the Deuteron	358
6.1.	$d(e, e'p)n$ Measurements at High Missing Momenta	358
6.2.	$d(e, e')$ measurements and y-scaling	359

6.3. Hadronic deuteron break-up at high energy	360
7. The Deuteron as a Source of “Free” Neutrons	361
8. Prospects for the Future	361
Acknowledgements	364
Appendix	365
A.1. Beyond One Photon Exchange at High Q^2 ?	365
A.2. Polarized Deuteron Targets — Polarimeters	365
A.3. Nucleon Electromagnetic Form Factors	369
References	372
<i>Index</i>	379