



# CONTENTS

## *Chapter 1*

### **STRONG INTERACTIONS IN $\Lambda$ -HYPERNUCLEI**

#### **A. Gal**

1. Introduction . . . . .	1
2. $\Lambda N$ Interaction and $\Lambda$ -Nucleus Properties . . . . .	6
2.1. $\Lambda p$ Cross Sections and $\Lambda N$ Potential . . . . .	7
2.2. Meson-Theoretic Models for the $\Lambda N$ Interaction . . . . .	11
2.3. The $\Sigma$ Channel in Hypernuclei and Three-Body $\Lambda NN$ Forces	15
2.4. Charge Symmetry Breaking of $\Lambda N$ Interactions . . . . .	19
3. The Well Depth $D_\Lambda$ for $\Lambda$ in Nuclear Matter . . . . .	23
4. Binding Energies of Hypernuclear Systems . . . . .	31
4.1. General Methods of Calculation . . . . .	32
4.2. $s$ -Shell Hypernuclei . . . . .	38
4.3. $p$ -Shell Hypernuclei . . . . .	57
5. Hypernuclear Excitations . . . . .	81
5.1. Excited Hypernuclear States in the $p$ Shell . . . . .	84
5.2. Strangeness Exchange Reactions . . . . .	95
6. Conclusions . . . . .	114
References . . . . .	116

## *Chapter 2*

### **OFF-SHELL BEHAVIOR OF THE NUCLEON-NUCLEON INTERACTION**

**M. K. Srivastava and D. W. L. Sprung**

1. Introduction . . . . .	121
1.1. Outline . . . . .	121
1.2. Present Status of Off-Shell Behavior . . . . .	122

2.	The Two-Body Scattering Problem . . . . .	127
2.1.	Off-Shell Continuation of the Schrödinger Equation . . . . .	128
2.2.	Partial Wave Decomposition . . . . .	129
2.3.	Off-Shell Generalization of the Jost Function . . . . .	131
2.4.	The Reaction Matrix . . . . .	132
2.5.	Separable Potentials . . . . .	135
2.6.	Restrictions on the Off-Shell $T$ -Matrix Elements . . . . .	136
3.	Phase Shift Equivalent Potentials . . . . .	141
3.1.	Isometric Point Transformation . . . . .	143
3.2.	Unitary Transformations . . . . .	144
3.3.	Fiedeldey's Procedure . . . . .	145
3.4.	Fuda's Method . . . . .	145
3.5.	Method of Srivastava and Sprung . . . . .	146
3.6.	Coulomb–Nuclear Interference . . . . .	147
4.	Avoiding Potentials as Far as Possible . . . . .	148
4.1.	Method of Baranger <i>et al.</i> . . . . .	148
4.2.	Method of Picker <i>et al.</i> . . . . .	150
4.3.	Dispersion-Theoretic Approach . . . . .	150
5.	Separable Approximations to the $T$ -Matrix . . . . .	151
5.1.	Weinberg's Expansion . . . . .	153
5.2.	Unitary Pole Expansion . . . . .	154
5.3.	Unitary Pole Approximation . . . . .	155
5.4.	Approximation of Bhatia and Walker . . . . .	156
5.5.	Separable Approximation of Ernst <i>et al.</i> . . . . .	157
5.6.	Kowalski–Noyes Approximation . . . . .	159
5.7.	Other Approximations . . . . .	160
5.8.	Comparison of Various Approximations . . . . .	161
6.	Approximate Methods of Avoiding Potentials . . . . .	163
7.	Power Series Expansions of the $K$ -Matrix . . . . .	165
7.1.	Fuda's Expansion . . . . .	166
7.2.	Expansion of Redish <i>et al.</i> . . . . .	166
8.	General Features of Off-Shell $K$ -Matrix Elements . . . . .	168
8.1.	Low-Energy Behavior . . . . .	168
8.2.	Behavior for $p \sim 4 \text{ fm}^{-1}$ . . . . .	170
8.3.	General Behavior and Comments . . . . .	171
8.4.	Interplay between On-Shell and Off-Shell Matrix Elements	172
9.	Methods for Calculating the $T$ - or $K$ -Matrix . . . . .	172
9.1.	Method for Separable Potentials . . . . .	173
9.2.	Method for Hard Core Potentials . . . . .	175

9.3. Boundary Condition Model of Nuclear Forces . . . . .	178
9.4. Matrix Inversion Method . . . . .	180
9.5. Evaluation . . . . .	185
10. Many-Body Calculations . . . . .	186
10.1. Variations in the High-Energy Phase Shifts . . . . .	187
10.2. Off-Shell Variation . . . . .	188
11. Summary and Comments . . . . .	207
References . . . . .	209

*Chapter 3*

## **THEORETICAL AND EXPERIMENTAL DETERMINATION OF NUCLEAR CHARGE DISTRIBUTIONS**

**J. L. Friar and J. W. Negele**

1. Introduction and Definition of the Problem . . . . .	219
1.1. Outline . . . . .	219
1.2. The Static Coulomb Interaction . . . . .	221
1.3. Corrections to the Static Coulomb Interaction . . . . .	222
2. Direct Comparison of Theoretical Charge Densities with Experiment . . . . .	264
2.1. Theories of the Ground-State Density Distribution . . . . .	265
2.2. Physical Origin of Salient Features of Density Distributions	281
2.3. Comparison with Experimental Results . . . . .	290
3. Specification of the Information Actually Determined by Available Data . . . . .	302
3.1. Determination of Constraints Imposed by Experimental Data . . . . .	303
3.2. Determination of Densities, Errors, and Error Correlations in Coordinate Space . . . . .	316
4. Results from Analyses of Data . . . . .	331
4.1. Pseudodata . . . . .	332
4.2. $^{12}\text{C}$ Results . . . . .	341
4.3. $^{208}\text{Pb}$ Results . . . . .	353
5. Discussion and Conclusions . . . . .	367
References . . . . .	370
<i>Index</i> . . . . .	377