

Contents

| | |
|--|----|
| Introduction | 1 |
| 1. The Interaction Between the Nucleus and an External Probe | 3 |
| 1.1 Nuclear Probes | 3 |
| 1.2 Electromagnetic and Weak Interactions of Nuclei | 3 |
| 1.3 Excitation Operators and Nuclear Structure | 8 |
| 1.4 Classification of Giant Multipoles and Nuclear Models | 12 |
| 2. Dipole and Multipole Giant Resonances in Electron Scattering | 20 |
| 2.1 Kinematics and Cross Section | 20 |
| 2.2 Giant Dipole Excitation in Even-Even Nuclei | 22 |
| 2.3 Higher-Multipole Giant Resonances in Electron Scattering; Sum Rules | 25 |
| 3. Giant Resonances in Muon Capture | 37 |
| 3.1 Giant Dipole Excitations | 38 |
| 3.2 Muon Capture in $N > Z$ Nuclei | 39 |
| 3.3 Improvement of the Closure Approximation | 41 |
| 3.4 Shell-Model Calculations | 42 |
| 4. Resonance Excitation by Neutrinos | 44 |
| 4.1 Charged and Neutral Current Interactions | 44 |
| 4.2 Neutrino Cross Sections | 46 |
| 4.3 Collective Nuclear Excitations Described by the Goldhaber-Teller Model | 49 |
| 4.4 Sum Rules for Forward Neutrino-Induced Reactions | 52 |
| 4.5 Helm Model and Shell-Model Calculations | 54 |
| 5. Photoproduction and Radiative Capture of Pions | 63 |
| 5.1 Giant Resonance Excitation in Reactions Involving Pions | 63 |
| 5.2 Radiative Pion Capture | 65 |
| 5.3 Pion Photoproduction | 68 |

| | |
|--|-----|
| 6. Higher-Multipole Giant Resonance Excitation by Hadrons | 82 |
| 6.1 Hadron Probes and Nuclear Structure | 82 |
| 6.2 (p,p') Reactions | 83 |
| 6.3 (α,α') Reactions | 86 |
| 6.4 (π,π') Reactions | 88 |
| Appendix A: Nonrelativistic Sum Rules in Nuclear Physics | 92 |
| Appendix B: Exchange Effects and SU4 Invariance in Electromagnetic and Weak Transitions | 96 |
| 1. Introduction | 96 |
| 2. SU4 and Current Algebra | 97 |
| 3. Muon Capture in Scalar Supermultiplets | 100 |
| 4. Discussion of SU4 Breaking Effects | 102 |
| References | 105 |
| Subject Index | 111 |

