

Table of Contents

1. Brief Summary of Experimental Techniques Required for Working with Polarized Slow Neutrons	1
1.1 Generation and Analysis of Polarized Slow Neutron Beams	1
1.1.1 Behavior of Neutron Spins in Magnetic Fields	1
1.1.2 Schematic Diagram of a System for Generating and Analyzing Polarized Neutrons	3
1.1.3 Measurement of Beam Polarization	4
1.2 Experimental Methods for Studying Polarized Slow Neutron Beams	5
1.2.1 Collimators, Filters, Detectors	5
1.2.2 Adiabatic Spin Rotation	7
1.2.3 Spin Flippers	8
1.3 New Methods of Generating Polarized Slow Neutron Beams	13
1.3.1 Sources of Polarized Cold Neutrons	14
1.3.2 Neutron Guides	14
1.3.3 Polarizing Neutron Guides	16
1.3.4 Multilayer Polarizing Monochromators	20
1.3.5 Polarizing Supermirrors	21
1.3.6 Systems Generating Polarized Neutron Beams	21
2. Precession of Magnetic Moments of Polarized Neutrons in a Magnetic Field	23
2.1 Fundamentals of the Magnetic Resonance Depolarization Technique	24
2.2 Measurements of the Neutron Magnetic Moment	25
2.2.1 Survey of Experiments	25
2.2.2 The Magnetic Resonance Neutron Spectrometer at Grenoble	26
2.2.3 The Value of the Neutron Magnetic Moment	27
2.2.4 The Sign of the Neutron Magnetic Moment	27
2.2.5 Comparison with the Theory	27
2.3 Search for the Electric Dipole Moment of the Neutron	28
2.3.1 Fundamentals of the Method	28
2.3.2 The Experiment on Measuring the Electric Dipole Moment of the Neutron	29

2.3.3	The Result of Searching for the Electric Dipole Moment of the Neutron	34
2.3.4	Other Experimental Methods in the Search for the Electric Dipole Moment of the Neutron	35
2.3.5	Comparison with the Theory	36
3.	Interaction of Polarized Neutrons with Polarized Nuclei	37
3.1	Fundamentals of the Method	37
3.2	Survey of Experiments	39
3.3	Nuclear Precession of Neutrons	42
4.	Anisotropy of Gamma Rays Emitted by Polarized Nuclei After Polarized Neutron Capture	44
4.1	Fundamentals of the Experimental Method	44
4.2	Survey of Experiments	47
4.3	Coherent Interference of Spin States	49
5.	Circular Polarization of Gamma Rays Emitted by Nuclei After Polarized Neutrons Capture	50
5.1	Fundamentals of the Experimental Method	50
5.2	Survey of Experiments	52
6.	Quantum-Mechanical Symmetry Properties and Polarized Neutrons	55
6.1	Quantum-Mechanical Conservation Laws	55
6.2	Violation of P, C, and CP Parities in the Weak Interaction	57
6.3	The Role of Polarized Neutrons in the Investigation of Quantum-Mechanical Symmetry Properties	58
6.4	Some Aspects of the Weak Interaction Theory	58
6.5	The Structure of the Nucleon-Nucleon Weak Interaction	60
6.6	Enhancement Mechanisms of the Nucleon-Nucleon Weak Interaction	61
7.	Decay of Polarized Neutrons	64
7.1	Fundamentals of the Experimental Method	64
7.2	Spatial Parity Violation	65
7.2.1	Experiment	65
7.2.2	Results	67
7.3	Investigation of Invariance Under Time Reversal	68
7.3.1	Experiment	68
7.3.2	Results	70

8. Anisotropy of Gamma Rays Emitted by Nuclei After Polarized Neutron Capture	71
8.1 Fundamentals of the Experimental Method	72
8.1.1 Estimate of the Expected Enhancement of P-Odd Effects	72
8.1.2 Angular Distribution of Gamma Quanta Emitted by Nuclei After the Capture of Polarized Thermal Neutrons	72
8.2 Experimental Investigation of Spatial Parity Violation in Nuclear Interactions	74
8.2.1 Choice of Nuclei	74
8.2.2 Specifics of the Reactions $^{113}\text{Cd}(\vec{n}, \gamma_0)$ and $^{117}\text{Sn}(\vec{n}, \gamma_0)$	74
8.2.3 First Attempt at Detecting a P-Odd Effect in (n, γ) Reactions	75
8.2.4 Experimental Discovery of the Effect	76
8.2.5 Other Experiments on the Analysis of P-Odd Effects in the $^{113}\text{Cd}(n, \gamma)^{114}\text{Cd}$ Reaction	78
8.2.6 A Study of the P-Odd Effect in the Reaction $^{117}\text{Sn}(\vec{n}, \gamma_0)^{118}\text{Sn}$	79
8.2.7 An Attempt to Study P-Odd Effects in Light Nuclei	80
8.2.8 Analysis of P-Odd Effects in the Integral Spectrum of Gamma Quanta	81
8.2.9 Results of Studying the Anisotropy of Gamma Radiation Emitted by Nuclei After Polarized Neutron Capture	81
8.3 Experimental Investigation of Time Reversal Invariance in Nuclear Interactions	83
8.3.1 Introductory Remarks	83
8.3.2 Fundamentals of the Method	83
8.3.3 Experiments	85
8.3.4 Measurement Results for Angular Correlations of Gamma Quanta Emitted by Nuclei After Polarized Neutron Capture	87
9. Anisotropy of Beta Particles Emitted by Nuclei After Polarized Neutron Capture	89
9.1 Fundamentals of the Experimental Method	89
9.1.1 Polarization of Nuclei	89
9.1.2 Angular Anisotropy of the Beta Emission	91
9.1.3 Experimentally Measured Asymmetry of the Beta Emission	91
9.1.4 Nuclear Magnetic Resonance of Polarized Beta-Radioactive Nuclei and the Measurement of Nuclear Magnetic Moments	93

9.1.5 Measurements of Quadrupole Moments of Nuclei	93
9.2 Survey of Experiments	94
9.3 Summary of Experimental Data	97
10. Anisotropy of Alpha Particles and Other Light Nuclei Emitted After Polarized Neutron Capture	98
10.1 Fundamentals of the Experimental Method	99
10.2 Survey of Experiments	100
10.2.1 Selection of Nuclei	100
10.2.2 Requirements for the Detector Unit of the Apparatus ...	101
10.2.3 Experimental Systems	101
10.3 Summary of Results	105
11. Anisotropy of the Angular Distribution of Fragments After Fission of Heavy Nuclei by Polarized Neutrons	106
11.1 Survey of Experiments	107
11.1.1 Specific Features of Fission Reactions	107
11.1.2 Discovery of P-Odd Asymmetry in the Emission of Fission Fragments	107
11.1.3 An Analysis of the Asymmetry Coefficient as a Function of Fragment Mass and Neutron Energy	109
11.1.4 Asymmetry in Fission Neutron Emission	111
11.2 Summary of Experimental Data	112
11.3 Investigation of P-Even Angular Correlations	112
11.4 Attempt at a Theoretical Interpretation	114
12. Spatial Parity Violation Effects in Neutron Optics	117
12.1 Fundamentals of the Experimental Method	118
12.2 Survey of Experiments	121
12.2.1 Neutron Spin Rotation	121
12.2.2 Transmission of Longitudinally Polarized Neutrons	123
12.3 Summary of Experimental Data	126
References	129
Subject Index.....	137