

Contents

1	Motivation and Overview	1
1.1	Superconductivity	1
1.2	Scope of This Thesis	3
	References	5
2	Iron-Based Superconductors	9
2.1	Basic Properties	10
2.1.1	Structure and Magnetic Structure	10
2.1.2	Electronic Structure	14
2.2	Phase Diagrams	15
2.2.1	Spin Density Wave	17
2.2.2	Superconductivity and Fermi Surface Nesting	19
2.2.3	Coexisting and Competing Orders	21
	References	23
3	Neutron Scattering	29
3.1	Historical Overview	29
3.2	Principles	30
3.2.1	Cross Section	31
3.2.2	Nuclear Scattering	33
3.2.3	Magnetic Interactions and Elastic Magnetic Scattering	34
3.2.4	Coherent Inelastic Magnetic Scattering	36
3.2.5	Dynamic Structure Factor $S(\mathbf{Q}, \omega)$ and Generalized Susceptibility $\chi''(\mathbf{Q}, \omega)$	37
3.3	Neutron Scattering Spectrometry	38
3.3.1	Triple-Axis Spectrometry	38
3.3.2	Time-of-Flight Spectrometry	42
	References	49

4	Phase Diagram and Avoided Quantum Criticality in $\text{BaFe}_{2-x}\text{Ni}_x\text{As}_2$	51
4.1	Background and Motivation	51
4.2	Sample Preparation	53
4.3	Structural and Magnetic Phase Transitions and Magnetoelastic Coupling	55
4.4	Avoided Quantum Criticality	62
	References	64
5	Short-Range Cluster Spin Glass Near Optimal Superconductivity in $\text{BaFe}_{2-x}\text{Ni}_x\text{As}_2$	67
5.1	Incommensurate Magnetic Order in $\text{BaFe}_{2-x}\text{Ni}_x\text{As}_2$ ($T = \text{Co, Ni}$)	67
5.2	Slow Dynamics of Spin Glass State	68
5.3	Experimental Results and Discussions	70
	References	78
6	Nematic Spin Correlations in Detwinned $\text{BaFe}_{2-x}\text{Ni}_x\text{As}_2$	81
6.1	Nematic in Iron Pnictides	81
6.2	Experimental Methods	85
6.3	Nematic Spin Correlations in the Tetragonal State of $\text{BaFe}_{2-x}\text{Ni}_x\text{As}_2$	87
	References	97
7	Magnetic Excitations in Overdoped $\text{BaFe}_{2-x}\text{Ni}_x\text{As}_2$	101
7.1	Scientific Background	101
7.1.1	Spin Resonance and Superconductivity	101
7.1.2	Ubiquitous High Energy Magnetic Excitations	103
7.1.3	Magnetic Excitations in Doped BaFe_2As_2	103
7.1.4	Calculation of Local Susceptibility	105
7.2	Results and Discussions	106
7.2.1	Spin Resonance in Overdoped $\text{BaFe}_{2-x}\text{Ni}_x\text{As}_2$	106
7.2.2	Evolution of Magnetic Excitations in Heavily Overdoped $\text{BaFe}_{2-x}\text{Ni}_x\text{As}_2$ ($x=0.3$)	109
7.3	Summary	116
	References	116
8	Summary and Outlook	119

Phase Diagram and Magnetic Excitations of
BaFe_{2-x}Ni_xAs₂: A Neutron Scattering Study

Lu, X.

2017, XII, 120 p. 55 illus., Hardcover

ISBN: 978-981-10-4997-2