

# Contents

<b>Acknowledgement</b>	<b>i</b>
<b>Abstract</b>	<b>iii</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Exotic magnetism in itinerant magnets . . . . .	1
1.1.1 Experimental examples . . . . .	1
1.1.2 Mechanisms of exotic spin textures . . . . .	4
1.1.3 Kondo lattice model and effective interactions . . . . .	5
1.1.4 Theoretical examples . . . . .	8
1.2 Electronic properties induced by exotic magnetism . . . . .	9
1.2.1 Spin Berry phase . . . . .	9
1.2.2 Experimental examples . . . . .	11
1.2.3 Theoretical examples . . . . .	13
1.3 Purpose of this thesis . . . . .	15
1.4 Organization of this thesis . . . . .	16
<b>2 Model and method</b>	<b>17</b>
2.1 Model . . . . .	17
2.1.1 Kondo lattice model . . . . .	17
2.1.2 Relation to the Hubbard model . . . . .	18
2.2 Simulation method . . . . .	19
2.2.1 Partition function . . . . .	19
2.2.2 Kernel polynomial method . . . . .	20
2.2.3 Langevin dynamics . . . . .	23
2.2.4 Automatic differentiation . . . . .	25
2.3 Benchmark . . . . .	26
2.4 Diagonalization method . . . . .	27
<b>3 Noncoplanar vortex crystal with a scalar chiral stripe</b>	<b>30</b>
3.1 Introduction to this chapter . . . . .	30
3.2 Bare susceptibility and Fermi surface . . . . .	31
3.3 Simulation results . . . . .	31
3.4 Perturbative argument . . . . .	38
3.4.1 Fourth-order perturbation . . . . .	40

3.4.2	Perturbation in a local reference frame . . . . .	43
3.4.3	Gap opening on the Fermi surface . . . . .	47
3.5	Variational calculations . . . . .	49
3.6	Electronic properties . . . . .	51
3.7	Results on a triangular lattice . . . . .	52
3.8	Summary of this chapter . . . . .	54
<b>4</b>	<b>Zero-field skyrmion crystal with a high topological number</b>	<b>55</b>
4.1	Introduction to this chapter . . . . .	55
4.2	Symmetry consideration and numerical details . . . . .	57
4.3	Zero-field skyrmion crystals with topological number two . . . . .	60
4.4	Skyrmion crystal and noncoplanar state in applied magnetic field . . . . .	62
4.5	Successive topological transitions . . . . .	63
4.6	Energetics of skyrmion crystals . . . . .	63
4.7	Electronic properties . . . . .	65
4.8	Controllability of skyrmion size . . . . .	67
4.9	Summary of this chapter . . . . .	67
<b>5</b>	<b>Domain formation</b>	<b>71</b>
5.1	Introduction to this chapter . . . . .	71
5.2	Model and numerical details . . . . .	72
5.3	Simulation results . . . . .	73
5.3.1	Collinear Néel state . . . . .	73
5.3.2	Coplanar 120° state . . . . .	74
5.3.3	Nonoplanar triple- $Q$ states . . . . .	74
5.4	Directional preference of domain walls . . . . .	77
5.5	Summary of this chapter . . . . .	78
<b>6</b>	<b>General phase diagram</b>	<b>84</b>
<b>7</b>	<b>Summary</b>	<b>88</b>