

Contents

1	Generic Aspects of Skyrmion Lattices in Chiral Magnets	1
	Andreas Bauer and Christian Pfleiderer	
1.1	Introduction and Outline	1
1.2	Skyrmion Lattice in Cubic Chiral Magnets	2
1.3	Theoretical Description	6
1.4	Magnetic Phase Diagrams	8
	1.4.1 Phase Transitions in the Susceptibility and Specific Heat	9
	1.4.2 Magnetic Phase Diagrams for Different Materials	13
1.5	Emergent Electrodynamics	17
1.6	Conclusions and Outlook	19
	References.	22
2	Topological Skyrmion Dynamics in Chiral Magnets	29
	Markus Garst	
2.1	Introduction	29
2.2	Effective Theory of Cubic Chiral Magnets	32
2.3	Skyrmion Excitation of the Field-Polarized Phase	34
	2.3.1 Magnon Spectrum in the Presence of a Skyrmion	36
	2.3.2 Magnon Skew and Rainbow Scattering	38
	2.3.3 Spin-Magnus Force and Magnon Pressure	39
2.4	Skyrmion Crystal	41
	2.4.1 Excitations of the Skyrmion Crystal	43
2.5	Spin-Transfer Torques on the Skyrmion Crystal	44
	2.5.1 Gradient in the Effective Spin-Transfer Torques	45
2.6	Emergent Electrodynamics in Metallic Chiral Magnets	46
	2.6.1 Topological Hall Effect	47
	2.6.2 Skyrmion-Flow Hall Effect.	49
	2.6.3 Emergent Magnetic Monopoles.	49
2.7	Discussion	50
	References.	51

3	Current-Driven Dynamics of Skyrmions	55
	Masahito Mochizuki	
3.1	Introduction	55
3.2	Electric-Current Driven Dynamics of Skyrmions in Non-confined System	61
3.3	Electric-Current Driven Dynamics of Skyrmions in Confined Geometries	68
3.4	Magnon-Current Driven Dynamics of Skyrmions	73
3.5	Concluding Remarks	77
	References.	78
4	Functional Topologies in (Multi-) Ferroics: The Ferroelastic Template	83
	E.K.H. Salje, O. Aktas and X. Ding	
4.1	Introduction	83
4.2	Wall Intersections with the Surface	85
4.3	Bending of Domain Walls, Needle Domains and 90° Junctions	86
4.4	Adaptive Structure	90
4.5	Wall Functionalities	92
4.6	Vortices in Domain Walls	94
4.7	Bloch Lines and Vortex Points	96
4.8	Conclusion.	97
	References.	98
5	Charged Domain Walls in Ferroelectrics	103
	Tomas Sluka, Petr Bednyakov, Petr Yudin, Arnaud Crassous and Alexander Tagantsev	
5.1	Introduction	103
5.2	Classification of Charged Domain Walls	105
	5.2.1 Depolarizing Electric Field.	110
	5.2.2 Charged Domain Walls in Improper and Hybrid Improper Ferroelectrics	112
	5.2.3 Charged Domain Walls in Weak Ferroelectrics	112
5.3	Charged Domain Wall Screening	113
	5.3.1 Electron-Hole Screening in the Thermodynamic Equilibrium	114
	5.3.2 Combined Free Carrier and Defect Screening in the Thermodynamic Equilibrium	123
5.4	Charged Domain Wall Formation: Factors Controlling the Formation Energy	125
	5.4.1 Electrically Isolated Ferroelectric: Bipolar Electron-Hole Screening.	125
	5.4.2 Electrically Isolated Ferroelectric: Unipolar Screening.	126

5.4.3	Electrically Isolated Ferroelectric: Screening with Photon Generated Carriers.	126
5.4.4	Electrically Isolated Ferroelectric: Mixed Electron/ion Screening.	127
5.4.5	Screening of sCDW with Charge Provided from External Source.	128
5.5	Charged Domain Wall Engineering.	129
5.6	Charged Domain Wall Conductivity.	131
	References.	137
6	Extended Defects in Nano-Ferroelectrics: Vertex and Vortex Domains, Faceting, and Cylinder Stress.	139
	James F. Scott	
6.1	Introduction.	139
6.2	Definitions: Vertex, Vortex, and Kosterlitz-Thouless Melting.	140
6.3	Basic Theory: Landau-Lifshitz-Kittel as Extended by (a) Lukyanchuk; (b) Catalan, Schilling, Scott et al.	141
6.4	Statics.	142
6.5	More statics.	143
	6.5.1 Hoop Stress.	143
	6.5.2 KAI Theory.	144
	6.5.3 Faceting.	146
	6.5.4 Toroidal Domains (Ginzburg, Kopaev, et al.; Fiebig).	149
6.6	Dynamics:	150
	6.6.1 Comparison with Magnetic Domains.	150
	6.6.2 Domain Wall Creep.	150
	6.6.3 Pinning.	152
	6.6.4 Pyroelectric Effects.	154
	6.6.5 Domains Within Domains—Multiferroics.	154
6.7	Transport.	154
6.8	Domain Wall Oscillation.	155
6.9	Summary.	156
	References.	156
7	Ferroelectric Domain Walls and their Intersections in Phase-Field Simulations.	161
	J. Hlinka, V. Stepkova, P. Marton and P. Ondrejovic	
7.1	Introduction.	161
7.2	Bloch Versus Ising Versus Néel-like Domain Wall.	163
7.3	Bloch-Ising Phase Transition.	165
7.4	Predictive Value of Phase-Field Simulations.	167
7.5	180-Degree Domain Walls with Different Crystallographic Orientation.	168
7.6	Electrically Neutral Ferroelastic Walls.	171

7.7	Domain Wall Intersections	173
7.8	Polarization Switching Mediated by Bloch Wall	177
7.9	Conclusions	179
	References.	179
8	Topological Defects in Ferroic Materials	181
	Anna N. Morozovska, Eugene A. Eliseev and Sergei V. Kalinin	
8.1	Introduction	181
8.2	Thermodynamic Approach	183
8.3	Domain Wall Vectorial Structure, Energy and Static Conductivity in Multiaxial Ferroelectrics	185
8.4	Spatially-Modulated Structures Induced in the Vicinity of Topological Defects by Flexo-Antiferrodistortive Coupling in Ferroics	190
8.5	Summary	194
	References.	194
9	Topological Defects in Nanostructures—Chiral Domain Walls and Skyrmions	199
	Benjamin Krüger and Mathias Kläui	
9.1	Introduction to Topological Spin Structures in Confined Geometries.	199
9.2	Topological Defects in Nanowires—Domain Walls	202
9.3	Using Magnetic Domain Walls in Devices	204
	9.3.1 Operations for a Devices Based on Current Induced DW Motion in Wires	204
9.4	Topological Defects in Discs—Skyrmions	213
	References.	217
10	Magnetic Solitons in Superlattices	219
	Amalio Fernández-Pacheco, Rhodri Mansell, JiHyun Lee, Dishant Mahendru, Alexander Welbourne, Shin-Liang Chin, Reinoud Lavrijsen, Dorothee Petit and Russell P. Cowburn	
10.1	Introduction	219
10.2	Magnetic Solitons in Superlattices.	220
10.3	Soliton Injection Using the Surface Spin-Flop Transition	222
10.4	CoFeB/Ru Ferrimagnetic Superlattices.	225
10.5	General Diagram for Injection and Propagation of Solitons in Ferrimagnetic Superlattices.	229
10.6	Experimental Realization for the Injection and Propagation of Solitons in CoFeB/Ru Ferrimagnetic Superlattices.	232
10.7	Influence of the Anisotropy/Coupling Ratio and Number of Layers for Soliton Propagation	233
10.8	Conclusions and Outlook.	235
	References.	236
	Index	239



<http://www.springer.com/978-3-319-25299-5>

Topological Structures in Ferroic Materials

Domain Walls, Vortices and Skyrmions

Seidel, J. (Ed.)

2016, XII, 241 p. 121 illus., 75 illus. in color., Hardcover

ISBN: 978-3-319-25299-5