

Contents

1	The Basis of Nanomagnetism	1
1.1	Introduction: The Importance of Nanomagnetism	1
1.2	The Origin of Nanomagnetic Behavior	2
1.2.1	Sample Dimensions and Characteristic Lengths	4
1.2.2	Broken Translation Symmetry	6
1.2.3	Nanomagnetic Samples and Dynamic Behavior	17
1.3	Dimensionality and Critical Behavior	17
	References	22
2	Magnetic Domains	25
2.1	Introduction	25
2.2	Interactions in Magnetic Materials	32
2.2.1	Exchange Interaction	33
2.2.2	Magnetostatic Energy	36
2.2.3	Magnetic Anisotropy	38
2.2.4	Magnetoelastic Energy and Magnetostriction	40
2.3	Elements of Micromagnetism	41
2.3.1	Equation of Motion	46
2.4	Magnetic Domains	48
2.4.1	Domain Wall Width	50
2.4.2	Single-Domain Critical Diameters	56
2.4.3	Domain Wall Motion	58
2.5	Random Anisotropy	65
	References	68
3	Magnetism of Small Particles	71
3.1	Introduction	71
3.2	Particle Size and Magnetic Behavior	75
3.3	Superparamagnetism	82
3.3.1	Superparamagnetism: The Langevin Function	90

3.4	Surface Effects	91
3.5	The Stoner–Wohlfarth Model	94
3.5.1	Inhomogeneous Magnetization Reversal	105
3.5.2	Precessional Magnetization Reversal	108
3.5.3	Current-Induced Magnetization Reversal	111
3.6	Interaction Between Particles	112
	References	121
4	Magnetism of Thin Films and Multilayers	125
4.1	Introduction	125
4.1.1	Thin Films: Planar Systems	126
4.1.2	Thin Films: Laterally Structured Systems	130
4.2	Anisotropy in Thin Films	132
4.3	Domain Walls and Magnetization Reversal in Thin Films	135
4.4	Exchange Bias	138
4.5	Interlayer Exchange Coupling	144
	References	148
5	Magnetotransport and Spin Current Effects	151
5.1	Introduction	151
5.2	Spin Dependent Scattering and Giant Magnetoresistance (GMR)	160
5.2.1	Valet–Fert Model for GMR	167
5.3	Tunnel Magnetoresistance (TMR) and Other Magnetoresistance Effects	169
5.3.1	The Anisotropic Magnetoresistance (AMR)	174
5.4	Current-Induced Domain Wall Motion and Spin Transfer Torque (STT)	176
5.5	Spin Current Effects: Spin Hall Effect, Spin Pumping, and Spin Thermal Effects	181
	References	195
6	Magnetism of Nanodisks, Nanorings, Nanowires, and Nanotubes	201
6.1	Introduction	201
6.2	Nanodisks	202
6.3	Nanorings	210
6.4	Nanowires and Nanotubes	214
	References	226
7	Magnetic Recording	231
7.1	Introduction	231
7.2	Principles of Magnetic Recording	232

7.3 Novel Magnetic Recording Systems	237
7.3.1 Nanodisk and Nanoring Memories	240
7.3.2 Domain Wall and Skyrmion Memories	244
References.	246
Solutions to the Exercises	249
Appendix A: The Hall Effect	257
Appendix B: Elements of Thermoelectricity	261
Appendix C: Units in Magnetism.	265
Appendix D: Physical Constants	269
Glossary	271
Bibliography	277
Material Index.	297
Symbol Index	301
Author Index.	305
Subject Index.	311



<http://www.springer.com/978-3-319-59408-8>

Principles of Nanomagnetism

Guimarães, A.P.

2017, XV, 330 p. 135 illus., 47 illus. in color., Hardcover

ISBN: 978-3-319-59408-8