

Contents

Preface to the book	xi
Acknowledgements	xiii
1 Fluctuations, renormalization and universality	1
1.1 Fluctuations and universality in condensed matter physics	2
1.2 The universal Prandtl number in two-dimensional hydrodynamics	5
1.3 The universal Poisson ratio in fluctuating polymerized membranes	8
1.4 Defect-mediated phase transitions and hydrodynamic theories	12
1.5 The contents of this book	18
<i>Appendix A Renormalization</i>	21
<i>Appendix B The self-dual point of Ising spins in two dimensions</i>	26
<i>References</i>	28
2 Defect-mediated phase transitions	30
<i>Preface</i>	30
2.1 Introduction	31
2.2 The XY model and superfluidity in two dimensions	41
2.3 Dynamic scaling and third sound in helium films	60
2.4 Statistical mechanics of two-dimensional melting	68
2.5 Melting dynamics	91
2.6 Anisotropic melting	99
2.7 Line singularities in three dimensions	106
<i>References</i>	117
3 Order, frustration and two-dimensional glass	124
<i>Preface</i>	124
3.1 Introduction	126
3.2 Order and frustration in quenched binary arrays	129
3.3 Order and frustration in spaces of incommensurate curvature	136
<i>References</i>	144
	vii

4	The structure and statistical mechanics of three-dimensional glass	146
	<i>Preface</i>	146
	4.1 A physical picture	147
	4.2 The model free energy	154
	<i>References</i>	163
5	The statistical mechanics of crumpled membranes	165
	<i>Preface</i>	165
	5.1 Flat surfaces	166
	5.2 Crumpled membranes	170
	5.3 Normal–normal correlations in liquid membranes	179
	5.4 Tethered surfaces with bending energy	181
	5.5 Defects and hexatic order in membranes	186
	<i>References</i>	191
6	Defects in superfluids, superconductors and membranes	194
	<i>Preface</i>	194
	6.1 Introduction	195
	6.2 Two-dimensional superfluids and superconductors	198
	6.3 Defects in membranes and monolayers	217
	<i>Appendix A Superfluid density and momentum correlations</i>	238
	<i>References</i>	241
7	Vortex-line fluctuations in superconductors from elementary quantum mechanics	245
	<i>Preface</i>	245
	7.1 Introduction	246
	7.2 Correlated pinning and quantum bound states	249
	7.3 Flux melting and the quantum harmonic oscillator	258
	7.4 Vortex entanglement in the liquid phase	261
	<i>Appendix A The transfer-matrix representation of the partition function</i>	266
	<i>Appendix B Vortex probability distributions</i>	267
	<i>References</i>	269
8	Correlations and transport in vortex liquids	271
	<i>Preface</i>	271
	8.1 Introduction	272
	8.2 Statistical mechanics of flexible lines	285

8.3 Correlations in flux liquids with weak disorder	301
8.4 Dynamics near the irreversibility line	311
<i>References</i>	316
9 Statistical mechanics of directed polymers	322
<i>Preface</i>	322
9.1 Introduction	323
9.2 One polymer in a nematic solvent	327
9.3 A model of polymer nematics	332
9.4 Mapping onto boson quantum mechanics	335
9.5 Correlations in polymer nematics with soft broken symmetry	341
9.6 The hydrodynamic treatment of line liquids	344
9.7 Defects in hexagonal columnar crystals	347
<i>References</i>	361
<i>Index</i>	365