

# Contents

Preface	vii
1. An Assortment of Well-Established Concepts	1
1.1 Symmetry-Breaking .....	1
1.2 Critical Phenomena and Scaling .....	9
1.3 Multicriticality .....	16
1.4 Multicriticality in an Open System of Two-Mode Lasers .....	24
2. Quantum Phase Transition: Transverse Ising Model and Other Systems	29
2.1 Introductory Remarks .....	29
2.2 The Mean Field Theory of TIM .....	32
2.3 The Quantum Magnet $\text{LiHo}_x\text{Y}_{1-x}\text{F}_4$ .....	36
2.4 Quantum Statistical Mechanics .....	41
3. Glass Transitions	47
3.1 Preamble – Magnetic Glass, Quantum Glass, Spin Glass, Proton Glass and Structural Glass .....	47
3.2 Magnetic Glass: $\text{LiHo}_x\text{Y}_{1-x}\text{F}_4$ .....	48
3.3 Quantum Glass: $\text{LiHo}_x\text{Y}_{1-x}\text{F}_4$ in a Transverse Field .....	57
3.4 Spin Glasses .....	59
3.5 Proton Glasses .....	62
3.6 Structural Glasses .....	64
4. Relaxation Effects	69
4.1 Introductory Remarks .....	69
4.2 Single Spin Kinetics in Equilibrium .....	71
4.3 Non-Equilibrium Response of a Single Spin .....	78
4.4 Effects of Interaction on Relaxation .....	83

5. Memory in Nanomagnets	95
5.1 Introduction to the Physics of Single Domain Nanomagnetic Particles .....	95
5.2 Rotational Brownian Motion, the Kramers Problems and Susceptibility .....	106
5.3 Experiments: Stern-Gerlach and Mössbauer Spectroscopy .....	117
6. Dissipative Quantum Systems	139
6.1 Introduction .....	139
6.2 Nonequilibrium Statistical Mechanics .....	142
6.3 Spin-Boson Hamiltonian .....	148
6.4 Dissipative Diamagnetism .....	157
6.5 Spin Tunneling and Coherence-Decoherence Phenomenon .....	169
References	179
Index	189