

Contents

Abstract	1
Kurzfassung	3
1 Introduction	7
1.1 Magnetization dynamics	7
1.1.1 Magnetism in technology	7
1.1.2 Magnetic switching	8
1.1.3 New methods	9
1.2 Magnetooptics	11
1.2.1 Experiments	11
1.2.2 Angular momentum	13
1.2.3 Nonthermal switching	13
1.3 Quantum Computing	15
1.3.1 What is quantum computing?	15
1.3.2 Qubits	16
1.3.3 Manipulating qubits	18
2 The Inverse Faraday Effect	23
2.1 The Faraday effect	23
2.2 Energy considerations	24
2.3 The effective Hamiltonian formulation	27
2.4 The ultrafast inverse Faraday effect	32
3 Conservation of Angular Momentum: Small Systems	35
3.1 Introduction	35
3.2 Angular momentum of light	36
3.3 Effective magnetic field	38
3.4 Demonstration using hydrogen atom	39
4 Conservation of Angular Momentum: Extended Systems	43
4.1 Description of the problem	44
4.2 Orbital angular momentum of light	45
4.3 Propagation of light	48
4.4 Change of polarization	54
4.5 The second interface	55

4.5.1	First reflection	55
4.5.2	Loss of angular momentum	57
4.5.3	Multiple reflection	58
5	The Difficulty of Measurement	63
5.1	Measuring ultrafast magnetization dynamics	63
5.2	Orthoferrites	64
5.3	Faraday rotation in a birefringent weak ferromagnet	65
5.4	Limiting cases	68
5.4.1	Zero birefringence	68
5.4.2	Large birefringence, small θ	69
5.5	Numerical exploration of nonperturbative regions	72
5.6	Summary	73
6	Interaction of a Quantum System with a Heat Bath	77
6.1	Dephasing and dissipation	77
6.2	The generalized master equation	78
6.3	Solving the master equation	81
6.3.1	Numerical integration	82
6.3.2	Laplace transformation	86
7	Dephasing of Quantum Dots: Coulomb Interaction with a Gate	91
7.1	Overview	91
7.2	Dephasing of spin qubits	92
7.2.1	Structure of qubit	92
7.2.2	Coulomb interaction with the gate	95
7.2.3	Response function of the gate	98
7.2.4	Laplace transform of $I^>(t)$	100
7.2.5	Results	101
7.3	Dephasing of charge qubits	104
7.3.1	Difference between charge and spin qubits	104
7.3.2	Results	106
8	Concluding Remarks	111
A	Propagation and Polarization of Electromagnetic Waves	113
A.1	Monochromatic plane waves	113
A.2	Polarization of plane waves	114
	Bibliography	126
	List of Publications	127
	Acknowledgments	129
	Curriculum Vitae	131