

Contents

1	Introduction	7
2	Synchrotron Radiation	9
2.1	Basic Features	9
2.2	Insertion Devices	11
2.3	Properties of Synchrotron Radiation	13
3	Nuclear Resonant Scattering	15
3.1	Fundamentals	15
3.1.1	The ^{57}Fe Nucleus	15
3.1.2	Mössbauer Spectroscopy	16
3.1.3	Excitation with Conventional Sources	17
3.2	Nuclear Forward Scattering	19
3.2.1	Mathematical Treatment	20
3.2.2	Speed-up of the Exponential Decay	22
3.2.3	Quantum Beats	24
3.2.4	Coherence	26
3.2.5	Examples	28
3.2.6	Measurement of Isomer Shifts	30
3.3	Nuclear Inelastic Scattering	31
3.3.1	Basic Features	31
3.3.2	Data Evaluation	33

4	Experimental Details	39
4.1	Nuclear Resonance Beamline at ESRF	39
4.1.1	High-Resolution Monochromator	41
4.1.2	Fast Detectors	41
4.1.3	Focusing Elements	42
4.2	High-Pressure Technique for NFS	44
4.3	High-Pressure Technique for NIS	46
5	NFS in RFe₂ Laves Phases	51
5.1	Structure and Magnetism of RFe ₂ Laves Phases	51
5.1.1	Crystal Structure	51
5.1.2	Magnetism in R-Fe Compounds	53
5.1.3	Magnetic Phase Diagram	55
5.2	Special Features of NFS Spectra	60
5.2.1	Texture Effects	60
5.2.2	Complex Hyperfine Interactions / External Field	61
5.2.3	Thickness Distributions	63
5.3	Results	65
5.3.1	YFe ₂	65
5.3.2	GdFe ₂	69
5.3.3	TiFe ₂	73
5.3.4	ScFe ₂	73
5.3.5	Measurement of Isomer Shifts	77
5.4	Discussion	80
5.4.1	Volume Dependence of Magnetic Ordering Temperatures T_m	82
5.4.2	Intersublattice Coupling Under Pressure	86

6	Lattice Dynamics in Iron Under Pressure	89
6.1	Iron Under Pressure	89
6.2	Lattice Dynamics	90
6.2.1	Debye Model	92
6.2.2	Grüneisen Parameter	93
6.2.3	Elastic Coefficients and Aggregate Velocities	94
6.3	Nuclear Inelastic Scattering in Iron	97
6.3.1	NIS Spectra	97
6.3.2	Extracted Phonon DOS	99
6.3.3	Derived Properties	100
6.4	Discussion	110
6.4.1	Grüneisen Parameter	110
6.4.2	Aggregate Velocities and Shear Modulus	111
6.4.3	The α - ϵ Phase Transition	113
7	Summary	115