

Contents

1. <i>Introduction</i>	
By U. Gonser (With 1 Figure)	1
References	3
2. <i>A Solution of the Phase Problem in the Structure Determination of Biological Macromolecules</i>	
By R.L. Mössbauer, F. Parak, and W. Hoppe (With 12 Figures)	5
2.1 Introductory Comments	5
2.2 The Phase Problem in the Structure Analysis of Macromolecules and Its Experimental Solutions	7
2.2.1 Basic Aspects	7
2.2.2 General Features of Phase Determinations by Means of Gamma-Resonance Scattering	12
2.2.3 Resonance Scattering of Gamma Radiation	13
2.3 Experimental Details	19
2.3.1 The Gamma-Ray Source	19
2.3.2 The Lamb-Mössbauer Factor of a Protein Crystal	21
2.3.3 Phase Determination on a Myoglobin Crystal	22
2.4 Future Prospects	24
2.4.1 The Investigation of Bacterial Catalase	24
2.4.2 Two-Dimensional Position-Sensitive Proportional Counters ..	26
References	29
3. <i>The Gravitational Red-Shift</i>	
By R.V. Pound (With 3 Figures)	31
3.1 Mössbauer's Discovery	31
3.1.1 The Principle of Equivalence and the Red Shift	31
3.1.2 Astronomical Studies	32
3.1.3 Application of the Mössbauer Effect	33
3.2 Modulation Technique to Detect Small Shifts	35
3.2.1 The Enclosed Tower of the Jefferson Physical Laboratory ...	37
3.2.2 The Effect of Temperature	39
3.2.3 The Monitor Channel and Source Unit	39
3.2.4 The Main Absorber	41

3.3	Data Taking and Results	43
3.3.1	Systematic Errors	44
3.4	Other Recent Red-Shift Experiments	44
3.4.1	Future Possibilities	45
	References	46
4.	<i>Trends in the Development of the Gamma Laser</i>	
	By V.I. Goldanskii, R.N. Kuzmin, and V.A. Namiot (With 4 Figures)	49
4.1	Formulation of the Problem	50
4.2	General Considerations	52
4.3	Gamma Laser Using Long-Lived Isomers	55
4.4	Gamma Laser with Pulsed Pumping	59
4.5	On the Kinetics of Amplification of Emission in the Gamma Laser ..	64
4.6	Resonators	66
4.7	Short Wave Radiation from Moving Charged Particles	68
4.8	Non-Mössbauer Gamma Lasers	71
4.9	Main Trends in the Near Future	73
4.10	Possible Applications of Gamma Lasers	76
	References	77
5.	<i>Nuclear Resonance Experiments Using Synchrotron Sources</i>	
	By R.L. Cohen (With 7 Figures)	81
5.1	Overview	81
5.2	Single Nucleus Excitations	83
5.2.1	Mössbauer Effect	83
5.2.2	Nuclear Excitation Without the Mössbauer Effect	87
5.2.3	Experimental Results	88
5.3	Nuclear Bragg Scattering	91
5.3.1	Proposed Experiments	91
5.3.2	Experimental Problems	94
5.3.3	Grazing Incidence Reflecting Films — A New Development	96
5.3.4	Conclusions	97
	References	97
6.	<i>Resonance γ-Ray Polarimetry</i>	
	By U. Gonser and H. Fischer (With 19 Figures)	99
6.1	Intensity and Polarization of Radiation in Mössbauer Transitions .	100
6.1.1	Description of Polarization in Terms of Density Matrices ..	101
6.1.2	Calculations of Density Matrices for the Hyperfine Lines ..	104
6.1.3	Transmission of γ Rays in Resonantly Absorbing Materials ..	107
6.2	Hyperfine Interactions in ^{57}Fe	110
6.2.1	Magnetic Dipole Interaction	112
6.2.2	Electric Quadrupole Interaction	116

6.3	Polarized γ Rays	118
6.3.1	Magnetized Ferromagnetic Sources	118
6.3.2	Quadrupole Split Sources	118
6.3.3	Filter Techniques	119
6.4	Polarimetry	119
6.4.1	Circularly Polarized γ Rays	120
6.4.2	Linearly Polarized γ Rays (Magnetic Hyperfine Interaction).	122
6.4.3	Linearly Polarized γ Rays (Quadrupole Interaction)	123
6.4.4	Special Applications (Amorphous Metals)	125
6.5	γ -Ray Rotation Polarimeter	127
6.6	Birefringence Polarimetry	129
6.6.1	Mössbauer Faraday Effect	129
6.6.2	"Optical" Rotation	134
	References	135

7. *Iron-Ion Implantation*

Studied by Conversion-Electron Mössbauer Spectroscopy

By B.D. Sawicka and J.A. Sawicki (With 19 Figures)	139
7.1 Implantation of Iron Ions	140
7.1.1 Stopping and Range of Ions	140
7.1.2 Implanted Materials	142
7.1.3 Mössbauer Study of Iron Implanted Materials	144
7.1.4 Technique of ⁵⁷ Fe Implantation	144
7.2 Conversion-Electron Mössbauer Spectroscopy	145
7.2.1 The Method	145
7.2.2 CEMS of ⁵⁷ Fe Implants	146
7.2.3 Experimental Technique	148
7.3 Studies of Iron Implanted in Various Hosts	150
7.3.1 Aluminum	151
7.3.2 Other Metals	154
7.3.3 Silicon, Germanium and Diamond	156
7.3.4 Chemical Compounds	161
7.4 Remarks	162
References	163

8. *Selected "Exotic" Applications*

By R.S. Preston and U. Gonser	167
8.1 Tests of Relativity	167
8.1.1 Special Relativity	167
8.1.2 Special Relativity or General Relativity?	169
8.1.3 General Relativity	171

8.2	Detection and Measurement of Small Motions of Macroscopic Objects.	173
8.3	Modulation of Gamma-Ray Quanta	174
8.4	Atmospheric Aerosols	177
8.5	Archaeology and Art	178
8.5.1	Pottery	178
8.5.2	Fine Art	179
8.6	Medicine and Biology	180
	References	182
9.	<i>The Discovery of the Magnetic Hyperfine Interaction in the Mössbauer Effect of ^{57}Fe</i>	
	By S.S. Hanna (With 2 Figures)	185
	References	190
	<i>Subject Index</i>	191