

Contents

1	Introduction	1
	References	4
2	Sub-Nucleonic Structure and the Modern Picture of Isotopes	7
2.1	History and Overview	7
2.2	The Structure of Atomic Nucleus	10
2.3	Big Bang and Stellar Nucleosynthesis: Origin of Elements	34
2.4	Isotope Effect in Nuclear Physics	39
2.5	The Origin of the Mass	42
2.6	New Physics Beyond the Standard Model	45
	References	47
3	Early Spectroscopic Studies of Isotopes	53
3.1	Some General Remarks	53
3.2	Motion of the Nucleus: Atomic Isotope Shift	56
3.3	Separation of Mass- and Field-Shift Contributions	58
3.3.1	Mass Isotope Shift	59
3.3.2	Field Isotope Shift	61
3.4	Vibrations in a Diatomic Molecule	62
3.4.1	Raman and IR Spectra of Molecules	66
3.4.2	Isotope Shift in Molecular Frequencies	68
3.5	“Mass-Independent” Isotope Effect	73
3.6	Laser Isotope Separation	77
	References	82
4	Isotopes in Solids	87
4.1	Elementary Excitations in <i>Isotope-Mixed Crystals</i>	87
4.2	Electronic Band Structure	89
4.2.1	Phonons	96
4.2.2	Electronic Excitations	104

4.3	Phonon Spectra of Solids: Indicator of their Isotope Purity.	112
4.3.1	Thermal Conductivity	112
4.3.2	Isotope-Induced-Disorder Raman Scattering	117
4.4	Effects of Isotope Randomness on Electronic Properties and Exciton Transitions	122
4.5	Zero-Point Field Energy	129
4.5.1	Zero-Phonon Vibration Energy in Solids	129
4.5.2	Origin of Zero-Point Field Energy	135
4.5.3	Inertia and Gravitation in the Zero-Point Field Model	139
4.5.4	Vacuum Energy Extraction	141
	References	142
5	Effects Related to Isotopic Disorder in Solids	151
5.1	Introduction	151
5.2	Self-Diffusion Process	157
5.2.1	SIMS Technique	160
5.2.2	Self-Diffusion of Li and H in LiH Crystals	162
5.2.3	Self-Diffusion in Si and Ge	166
5.3	Isotope Dependence of Thermal Expansion Coefficient	173
5.3.1	Thermal Expansion Coefficient.	175
5.3.2	Isotope Influence on the Linear Thermal Expansion Coefficient	182
5.4	Heat Capacity and Debye Temperature	184
5.4.1	The Lattice Theory of Heat Capacity	184
5.4.2	Different Method of θ_D Determination	188
5.5	Effect of the Isotopic Composition of a Crystal Lattice on the Specific Heat	188
5.6	Dependence of the Lattice Constant on Isotopic Composition and Temperature.	191
5.6.1	Background	191
5.6.2	Lithium Hydride	193
5.6.3	Germanium and Silicon	195
5.6.4	Diamond	196
5.6.5	Compound Semiconductors: GaAs, ZnSe.	199
	References	201
6	Traditional Application of Stable and Radioactive Isotopes	207
6.1	Background	207
6.2	The NTD Process: A New Reactor Technology	208
6.3	Experimental Results	213
6.3.1	Ge.	213
6.3.2	Metal-Insulator Transition	218
6.3.3	Neutral-Impurities Scattering	222
6.3.4	Si	228

6.3.5	Other Compounds	235
6.4	Optical Fibre.	238
6.4.1	Optical Communication	238
6.4.2	Nuclear Technology in Fibre Preparation.	240
6.5	Radioactive Isotopes	242
6.5.1	Human Health	243
6.5.2	Geochronology	245
6.5.3	Solid-State Physics	251
6.6	Low-Dimensional Devices	259
6.6.1	Introduction	259
6.6.2	Resonant Tunnelling Diodes.	260
6.6.3	Field Effect Transistors	262
6.6.4	Single-Electron-Transistor	262
6.7	Solid-State Lasers	264
6.7.1	Background	264
6.7.2	Isotope-Mixed Bulk Lasers.	268
6.7.3	Light-Emitting Diodes and Lasers of Low-Dimensional Structures.	270
6.7.4	Quantum Well Photodetectors	274
	References	275
	Index	285



<http://www.springer.com/978-3-642-28722-0>

Isotopes in Condensed Matter

G. Plekhanov, V.

2013, XIV, 290 p., Hardcover

ISBN: 978-3-642-28722-0