

## INDEX

- anisotropic ferromagnet, 64–7, 186–98
- anisotropic two-ion coupling, 48, 240–4
- atomic magnetism, 14
- atomic sphere approximation, 19
  
- binary alloys, 247–56
- Bloch’s theorem, 18
- Bogoliubov transformation, 190
- Brillouin function, 15
- broken symmetry, 291
- bunched helix, 52, 82, 239
  
- c*-axis modulated structure, 51
- Callen–Callen theory, 94–101, 203
- canonical bands, 22
- Cartesian strains, 44
- Cerium
  - atomic radius, 37
  - atomic wavefunctions, 11
  - band energies, 34
  - band structure, 27
  - d*-electron occupancy, 38
  - electronic parameters, 26
  - electronic pressure, 36
  - equation of state, 28
  - ionic properties, 13
  - magnetic properties, 57
  - magnetic structure, 61
  - magnetic-ordering temperatures, 57
  - paramagnetic and saturation moments, 57
  - photoemission, 29
  - positron annihilation, 28
  - promotional model, 3, 27
  - Stevens factors, 40
  - structural properties, 17
- CeSn<sub>3</sub> electronic structure, 29
- CeAl<sub>2</sub> Jahn–Teller effect, 339
- Clebsch–Gordan coefficients, 12
- coherent potential approximation, 249–52
- commensurable structures, 52, 82, 84, 115–23, 305–11
- competing interactions, 85–9
- conduction-electron polarization, 50, 258–61
- conduction-electron susceptibility, 47, 262–8
- cone structure, 52, 109, 121, 126, 293–9
- critical phenomena, 93
- crystal field, 39
- crystal-field excitations
  - conduction-electron interactions, 342–5
  - MF-RPA theory, 313–22
  - 1/*Z*-expansion, 324–33
- crystal-field parameters, 41
- Curie constant, 16
- Curie temperature, 56
- Curie’s law, 15
- Curie–Weiss law, 56
- cycloidal structure, 52, 81, 86, 120
  
- de Gennes factor, 2, 58
- Debye–Waller factor, 173
- density-functional theory, 8
- detailed balance, 141
- dhcp structure, 17
- diffusive mode, 146
- dilute alloys, 63
- dipole approximation, 171
- dipole–dipole interaction, 49, 116, 121, 232–6
- domains, 236, 246
- double-zone representation, 184
- Dysprosium
  - atomic radius, 37
  - band energies, 34
  - d*-electron occupancy, 38
  - electronic pressure, 36
  - ionic properties, 13
  - $\mathcal{J}(\mathbf{q})$ , 47
  - magnetic properties, 57

- magnetic structure, 52, 66, 94, 113
- magnetic-ordering temperatures, 57
- magnetoelastic effects, 64
- paramagnetic Curie temperatures, 57
- paramagnetic and saturation moments, 57
- spin waves, 292, 376
- Stevens factors, 40
- structural properties, 17
- two-ion magnetoelastic coupling, 108
- Dy–Y superlattices, 131–3
- elastic constants, 44
- electrical resistivity
  - magnetic-superzone contribution, 281
  - quadrupolar scattering, 279
  - spin-disorder contribution, 278
  - spin-wave scattering, 279
- electronic pressure, 35
- elementary excitation, 146
- Erbium
  - atomic radius, 37
  - band energies, 34
  - crystal-field parameters, 114
  - d*-electron occupancy, 38
  - electronic pressure, 36
  - film, 132
  - ionic properties, 13
  - $\mathcal{J}(\mathbf{q})$ , 47
  - magnetic properties, 57
  - magnetic structure, 52, 94, 119–22
  - magnetic-ordering temperatures, 57
  - magnon–phonon interaction, 299
  - paramagnetic Curie temperatures, 57
  - paramagnetic and saturation moments, 57
  - spin waves
    - $1/J$ -expansion, 209
    - cone structure, 297–300
    - longitudinal structure, 304
  - Stevens factors, 40
  - structural properties, 17
- Er–Y superlattices, 132
- ErFe<sub>2</sub> excitations, 379
- Europium
  - atomic radius, 37
  - ionic properties, 13
  - magnetic properties, 57
  - magnetic structure, 54
  - magnetic-ordering temperature, 57
  - paramagnetic and saturation moments, 57
  - structural properties, 17
- exchange-correlation energy, 9
- fan structure 62, 126–8
- Fermi-surface nesting, 48
- fluctuation–dissipation theorem, 142
- form factor, 171
- Friedel oscillations, 48
- Gadolinium
  - atomic radius, 37
  - band energies, 34
  - d*-electron occupancy, 38
  - electrical resistivity, 284
  - electronic pressure, 36
  - Fermi surface, 32
  - ionic properties, 13
  - $\mathcal{J}(\mathbf{q})$ , 47, 283
  - magnetic properties, 57
  - magnetic structure, 52, 112
  - magnetic-ordering temperature, 57
  - mass-enhancement, 275
  - paramagnetic Curie temperature, 57
  - paramagnetic and saturation moments, 57
  - spin waves, 185
  - Stevens factors, 40
  - structural properties, 17
- Gd–Y alloys, 113
- generalized susceptibility, 136, 144–6, 154–60
- Goldstone mode, 291, 310
- Green function, 147–9
- hcp structure, 17
  - generalized susceptibility, 183

- heat capacity
  - conduction electrons, 273, 347
  - spin waves, 274
- Heisenberg ferromagnet
  - linear response, 149–54
  - MF-RPA theory, 160–2
  - neutron-scattering cross-section, 178
  - spin waves in hcp structure, 185
- helical structure, 51, 79, 286–93
- helifan structure, 126–30
- high-temperature susceptibility, 71–4
- Holmium
  - anisotropic two-ion coupling, 307
  - atomic radius, 37
  - band energies, 34
  - crystal-field parameters, 114
  - d*-electron occupancy, 38
  - dipole–dipole interaction, 307
  - electrical resistivity, 282
  - electronic pressure, 36
  - film, 131
  - ionic properties, 13
  - $\mathcal{J}(\mathbf{q})$ , 47, 115, 235
  - magnetic properties, 57
  - magnetic structure, 52, 114–9, 126–30
  - magnetic-ordering temperatures, 57
  - magnetization, 53, 125–30
  - paramagnetic Curie temperatures, 57
  - paramagnetic and saturation moments, 57
  - spin waves
    - bunched helix, 306
    - spin-slip structures, 308
  - Stevens factors, 40
  - structural properties, 17
  - two-ion coupling, 235
- Ho<sub>90</sub>Tb<sub>10</sub> spin waves, 239
- HoCo<sub>2</sub> excitations, 379
- Holstein–Primakoff transformation, 187
- Hund’s rules, 13
- hybridization, 25
- hyperfine interaction, 50, 349–52
- indirect exchange, 45, 256–64
- Kohn anomalies, 48
- Korringa law, 346
- Kramers’ theorem, 60, 314
- Kramers–Kronig relation, 137
- Kubo formula, 139
- Lanthanum
  - atomic radius, 37
  - band energies, 34
  - d*-electron occupancy, 38
  - electronic pressure, 36
  - ionic properties, 13
  - structural properties, 17
- Landau expansion, 78
- Landé *g*-factor, 15
- lattice clamping, 66, 109
- Lindhard function, 264
- LMTO method, 19
- longitudinal ordering, 83–5
- longitudinal-wave structure, 51, 123, 124, 300–4
- Lutetium
  - atomic radius, 37
  - band energies, 34
  - d*-electron occupancy, 38
  - electronic pressure, 36
  - Fermi surface, 33
  - ionic properties, 13
  - structural properties, 17
- magnetic anisotropy
  - axial, 53, 86, 102
  - energy, 58
  - hexagonal, 52, 81, 86, 102, 107
  - macroscopic, 62
  - magnetoelastic contribution, 106–11
  - microscopic and macroscopic, 101–6
  - and susceptibility, 103
- magnetic Bragg scattering, 176
- magnetic exciton–phonon coupling, 335–40
- magnetic structures
  - anisotropic ferromagnet, 64–7
  - bunched helix, 52, 82
  - commensurable, 52, 82, 84, 115–23
  - cone, 52, 109, 121, 126

- cycloid, 52, 81, 86, 120
  - fan, 62, 126–8
  - helix, 51, 79
  - helifan, 126–30
  - longitudinal wave, 51, 123, 124
  - multiply periodic, 89–94, 124
  - spin slips, 53, 117
  - square wave, 52, 84, 123
  - superlattices, 130–3
  - tilted helix, 52, 81, 87
  - magnetic superzones, 59, 281
  - magneto-acoustic waves, 222, 338
  - magnetoelastic coupling, 43
    - two-ion, 108, 122
  - magnetostriction, 43
    - ferromagnet, 106
    - periodic structures, 109–11
  - magnon–phonon interaction, 219–31
    - selection rules, 228
  - magnon–phonon scattering, 229
  - mass-enhancement of conduction electrons
    - crystal-field excitations, 347
    - spin waves, 270–5
  - mean-field theory 55, 74–9, 116
  - multilayers, 130–3
  - multiply periodic structures, 89–94, 124
- Neodymium
- atomic radius, 37
  - band energies, 34
  - crystal-field excitations, 376
  - d*-electron occupancy, 38
  - electronic pressure, 36
  - form factor, 172
  - ionic properties, 13
  - magnetic properties, 57
  - magnetic structure, 61, 89–94, 124, 130
  - magnetic-ordering temperatures, 57
  - paramagnetic and saturation moments, 57
  - Stevens factors, 40
  - structural properties, 17
- Néel temperature, 57
- neutron-scattering cross-section
- anisotropic ferromagnet, 194
  - binary alloys, 249, 251
  - cone structure, 295
  - helical structure, 290
  - longitudinal structure, 303
  - magnon–phonon modes, 227
  - singlet–singlet system, 315
- non-local susceptibility, 70
- paramagnetic Curie temperature, 56–7, 63, 73
- phason, 291, 310, 367
- Promethium
- atomic radius, 37
  - band energies, 34
  - d*-electron occupancy, 38
  - electronic pressure, 36
  - ionic properties, 13
  - magnetic properties, 57
  - paramagnetic and saturation moments, 57
  - Stevens factors, 40
  - structural properties, 17
- positron annihilation, 32
- potential function, 22
- Praseodymium
- anisotropic two-ion coupling, 361
  - atomic radius, 37
  - band energies, 34
  - band structure, 29
  - crystal-field excitations
    - conduction-electron scattering, 345
    - cubic sites, 321, 364
    - hexagonal sites 319, 361–4
    - lifetimes, 332
    - magnetic-field dependence, 361–4
    - neutron-scattering spectrum, 179
    - ordered structure, 365–9
    - temperature dependence, 323
  - crystal-field levels, 43, 317, 359
  - d*-electron occupancy, 38
  - de Haas–van Alphen effect, 30
  - diffusive response, 354, 367
  - elastic constants, 338
  - electrical resistivity, 355
  - electronic pressure, 36
  - electronic-nuclear ordering, 351–4

- Praseodymium (*cont.*)  
 Fermi surface, 29  
 form factor, 172  
 induced magnetic ordering, 352–60  
 ionic properties, 13  
 magnetic exciton–phonon interaction, 362  
 magnetic-field dependence  
 crystal-field excitations, 362  
 magnetic moment, 360  
 magnetic impurities, 356  
 magnetic properties, 57  
 magnetic structure, 60, 89–93, 359  
 magnetic susceptibility, 60  
 magnetic-ordering temperature, 57, 352, 357  
 magneto-acoustic waves, 338  
 magnetoelastic effects, 334–9  
 mass-enhancement, 348  
 nuclear heat capacity, 353  
 nuclear-magnetic resonance, 351  
 paramagnetic and saturation moments, 57  
 quasielastic peak, 354  
 Stevens factors, 40  
 structural properties, 17  
 two-ion coupling, 49, 361  
 uniaxial pressure, 357–9  
 $\text{Pr}_{95}\text{Er}_5$  excitations, 254, 256  
 $\text{Pr}_{97.5}\text{Nd}_{2.5}$  structure and excitations, 356
- Racah operators, 40  
 random-phase approximation, 151–62  
 relativistic effects, 11  
 response functions, 135, 137–42  
 Russell–Saunders coupling, 12
- scattering function, 140  
 scattering vector, 165  
 singlet–doublet system, 318  
 singlet–singlet system, 314–17  
 singlet–triplet system, 320
- Samarium  
 atomic radius, 37  
 band energies, 34
- d*-electron occupancy, 38  
 electronic pressure, 36  
 form factor, 172  
 ionic properties, 13  
 magnetic properties, 57  
 magnetic structure, 61  
 magnetic-ordering temperatures, 57  
 paramagnetic and saturation moments, 57  
 Stevens factors, 40  
 structural properties, 17  
 structure, 17  
 Van Vleck paramagnetism, 16  
 soft-mode transition, 307, 316  
 spectral weight function, 148
- spin waves  
 anisotropic ferromagnet, 186–98  
 commensurable structures, 305–11  
 conduction-electron scattering, 268  
 cone structure, 293–99  
 dipole–dipole coupling, 236  
 elliptical polarization, 203  
 energy gap, 186–205  
 frozen-lattice effect, 214  
 magnetoelastic contribution, 211–9  
 relation to susceptibility, 198–205  
 helical structure, 286–293  
 incommensurable structures, 286–305  
 longitudinally polarized structure, 300–4  
 spin-slip structures, 308  
 square-wave structure, 310  
 two-ion anisotropy, 243–7
- spin-wave theory and corrections, 206–11  
 spin–orbit coupling, 13  
 spin-slip structure, 53, 117, 308  
 square-wave structure, 52, 84, 123, 310  
 standard model, 3  
 standard-basis operators, 156  
 Stevens factors, 40  
 Stevens operators, 41  
 temperature dependence, 94–101, 202–4, 212

- structure factor, 178
- superlattices, 130–3
  
- Terbium
  - anisotropy parameters, 216–8
  - atomic radius, 37
  - band energies, 34
  - critical behaviour, 224, 342
  - critical field, 65
  - $d$ -electron occupancy, 38
  - electrical resistivity, 279, 282
  - electronic pressure, 36
  - Fermi surface, 33
  - ionic properties, 13
  - $\mathcal{J}(\mathbf{q})$ , 47, 293
  - magnetic anisotropy, 98–100
  - magnetic properties, 57
  - magnetic structure, 52, 66, 113
  - magnetic-ordering temperatures, 57
  - magneto-acoustic waves, 223, 238
  - magnetoelastic effects, 64
  - magnetostriction, 66
  - magnon–phonon interaction, 228
  - paramagnetic Curie temperatures, 57
  - paramagnetic and saturation moments, 57
  - spin waves
    - binary alloys, 253–5
    - dipolar effects, 238
    - dispersion relations, 197
    - energy gap, 216
    - helical structure, 292
    - lifetimes, 269
    - temperature dependence, 206
    - $1/J$ -expansion, 208
  - Stevens factors, 40
  - structural properties, 17
  - two-ion anisotropy, 218, 244–6
  - two-ion magnetoelastic coupling, 108
- Tb<sub>0.5</sub>Dy<sub>0.5</sub> structures, 114
- tilted helix, 52, 81, 87, 292
- Thulium
  - atomic radius, 37
  - atomic wavefunctions, 11
  - band energies, 34
  - crystal-field excitations, 311
  - crystal-field parameters, 114
  - $d$ -electron occupancy, 38
  - electronic pressure, 36
  - ionic properties, 13
  - $\mathcal{J}(\mathbf{q})$ , 47
  - magnetic properties, 57
  - magnetic structure, 52, 123
  - magnetic-ordering temperatures, 57
  - paramagnetic Curie temperatures, 57
  - paramagnetic and saturation moments, 57
  - spin waves, 310
  - Stevens factors, 40
  - structural properties, 17
- TmZn quadrupolar ordering, 341
- transverse ordering, 79–3
- triple-axis spectrometer, 165
  
- Van Hove scattering function, 174
- Van Vleck paramagnetism, 16, 76
- virtual crystal approximation, 248
  
- Wortis expansion, 152
  
- Y alloys, 113, 379
- Y positron annihilation, 32
- Y–Dy superlattices, 131–3
- Y–Er superlattices, 132
- Ytterbium
  - atomic radius, 37
  - ionic properties, 13
  - Stevens factors, 40
  - structural properties, 17
  
- Zener power-law, 58, 96, 203