

Index

a

accelerator bombardments 298, 299, 338
 accelerator mass spectrometry (AMS)
 31, 32, 778, 779, 780, 815, 820–824
 accelerator-driven transmutation
 technology (ADTT) 570
 accelerators, production of 314–322
 actinides 764, 768, 864, 868
 properties of 551, 652
 and transactinides 547, 649
 activation analysis 302, 313, 589, 738,
 793, 794, 796, 797, 798, 800,
 802–805, 811, 838, 839, 921
 adsorption–desorption process 692
 adsorption–desorption sequence 679
 advanced X-ray techniques 882
 aerosols 289, 325, 673–675, 678, 698,
 785, 803, 858, 859, 860, 874, 877,
 925, 932
 alpha-decay energies 125–127
 alternating-gradient synchrotrons 600
 aluminosilicate colloids 863
 angular correlations 180–183, 341, 349,
 350, 351, 353, 388, 412, 418, 514
 angular momentum 85, 96, 112, 119, 130
 cut-off parameter 392
 eigenfunctions 372
 aquatic sediments 868
 artificial elements 35
 artificial radionuclides 265, 842, 855, 877
³⁹Ar 768–769, 780, 787, 823
 asymmetry energy 44, 46
 atomic transitions 811

atomic nucleus 4
 atomic processes 2–4
 Auger electron spectroscopy (AES) 814
 Automated Rapid Chemistry Apparatus
 (ARCA) 680–683, 696, 698–700,
 702

b

backscattering 4, 212, 213, 214, 233, 245,
 255, 337, 809, 813, 814, 887, 895
 barrier–transmission process 423
¹⁰Be 28, 37, 780, 803, 823
 beam geometry 921
 beam intensity and fluxes 304–306
 Berkeley Gas-Filled Separator (BGS)
 633, 639, 674, 686
 beta decay
 Cabibbo–Kobayashi–Maskawa Matrix
 163–168
 electron capture-to-positron ratios
 156–157
 fundamental processes 146–156
 nuclear matrix elements 157–160
 parity non-conservation 160–168
 vector bosons 162–163
 beta radiation 210–215
 Bethe–Bloch formula 207
 binomial distribution 272–276, 892
 biochemical methods 311, 845, 849
 biogenic emissions 778
 biosphere 1, 567, 569, 768, 778, 844, 855,
 856, 868, 873–878, 891, 935
 Blair model predictions 379

- blank-free technique 803
- Bohr model 389
- boiling-water reactors (BWRs) 535, 548, 550, 557, 558
- boreholes 809
- BOREXINO detector 761
- boron-neutron-capture-therapy (BNCT) 916–921
- bosons 11, 15–17, 19, 90, 108, 109, 162, 163, 165, 739
- Bragg's rule 208
- branching decay 196–197

- C**
- Cabibbo theory 165
- carriers, role of 287–289
- catcher-foil techniques 330
- Cerenkov detectors 756
- Cerenkov radiation 214, 759
- charged particles 2, 7, 20, 142, 203–210, 212, 214, 235, 239, 246, 255, 259, 263, 304, 321, 338, 366, 407, 412, 740, 744, 745, 756, 765, 793, 797, 800, 801, 804, 811, 911
- charged-particle accelerators
 - cyclotrons 596–598
 - direct voltage accelerators 591–594
 - linear accelerators 594–596
 - photon sources 605
 - radioactive beams 601
- chemical bonds 67, 228, 489, 490, 492–495, 497, 502, 506, 511, 652, 667, 850
 - half-lives, dependence of 512–513
 - Mössbauer spectrometry 522–527
 - radiation emission 514–522
 - spin and orbital angular momentum 511
- chemical information 518, 521, 522
- chemisorption 290, 291, 865
- chemotherapy 920
- Chernobyl disaster 554–560
- chromatographic methods 288, 294, 508, 672
- chromatographic separation techniques 325
- ¹⁴C-labeled organic compounds 311, 845
- ³⁶Cl 310, 768–769, 780, 823
- classical mechanics 11
- classical saddle point model 824, 825
- clay minerals 325, 859–861, 866, 867
- Clebsch–Gordon coefficient 176
- cluster radioactivity 8, 127–128, 262
- coarse particles 861, 862, 868
- coated particles 546, 547
- Cockcroft–Walton machines 587
- coincidence techniques 340
- cold-fusion reactions 625–632, 640, 641, 646
- collisions 83
 - deep inelastic collisions 435–464
 - head-on collisions 419
 - kinematics 362
- colloids 296
 - aluminosilicate colloids 863
 - radiocolloids 294–297
- combined-function magnets 600
- combustible solid radioactive waste 932
- comparative half-lives 152
- compound-nucleus fission 394, 430
- compound-nucleus model 384–400, 415
- compound-nucleus reactions 383–418
- consolidated rocks 866, 867
- controlled thermonuclear reactors (CTRs) 577–579
- conversion factor 537, 538
- coolants 547, 551, 552
- coprecipitation 291–293, 323, 337, 564, 569, 614, 795, 809, 865, 868, 882
- Coriolis forces 97, 112
- corrosion products 567
- cosmic radiation 8, 25, 28, 37, 231, 259, 262, 520, 619, 652, 738, 765–769, 824, 859, 925
- cosmic rays
 - in meteorites 768–769
 - radionuclides 767–768
- cosmochemistry 1, 735–769, 775, 803, 818, 824

- cosmogenic radionuclides 775, 776–781, 855
- Coulomb barrier 60, 81, 110, 119, 362, 366, 394, 407, 433, 435, 437, 447, 456, 461, 463, 465, 466, 472, 618, 745, 753, 800
- Coulomb effects 380
- Coulomb energy 44, 46, 78, 81, 132, 134, 398
- Coulomb energy difference 78, 81
- Coulomb excitation 110–116, 174, 340, 345, 349, 419, 420, 422
- Coulomb potential 75, 86, 87, 92, 95, 123, 125, 130, 366
- Coulomb repulsion 44, 134, 142, 222, 362, 813
- Coulomb scattering amplitude 60
- Coulomb trajectories 364–367, 467
- coupled-channels effect 468, 469
- cryo on-line detector (COLD) 712, 715–717, 720
- cryo-online multidetector for physics and chemistry of the transactinoides (COMPACT) 704–710, 718–720
- Curie, Marie 24, 35, 323, 767, 837
- Curie, Pierre 24, 35, 323, 619
- cyclotron resonance frequency 597
- cyclotrons 315, 596–600, 811, 842
- d**
- dark matter 766
- dating
 - cosmogenic radionuclides 776–781
 - daughter nuclides 775
 - fission tracks 788–789
 - natural decay series 783–786
 - radioactive decay 775
 - radioactive disequilibria 788
 - radioactive equilibria 775
 - stable isotopes 786–787
 - terrestrial mother/daughter nuclide pairs 781–783
- de Broglie wavelength 13–14, 37, 77, 123, 367
- decay constant 10, 120–124, 130, 149, 151, 172, 174, 177, 187, 190, 196, 305, 317, 338, 512, 513, 519, 535, 617, 787, 789, 804, 874, 875
- decay modes 72
 - alpha decay
 - alpha-decay energies 125–127
 - Gamow factor 122
 - hindrance factors 124–125
 - quantum-mechanical theory 120
 - beta decay 146–168
 - cluster radioactivity 127–128
 - nuclear instability and nuclear spectroscopy 119
 - proton radioactivity 129–131
 - spontaneous fission 132–146
- β -decay reactions 638, 756
- deep-blue Cerenkov radiation 214
- detectors
 - choice of 251–253
 - contamination monitors 265
 - film badges 264
 - gas-filled detectors 235–242
 - pocket ionization chambers 264
 - portable counters and survey meters 264
 - scintillation detectors 242–245
 - semiconductor detectors 245–251
 - thermoluminescence dosimeters 264
 - track detectors 260–263
 - whole-body counters 265
- deuterons 222, 314, 315, 318, 407, 586, 587, 597, 616, 617, 619, 739, 798
- dielectric track detectors 262
- direct voltage accelerators 591–594
- disposal facility phases 933
- disproportionation 879, 883–885
- dissipation fluctuation theorem 426
- Doppler broadening effects 348
- Doppler effect 173, 523
- Doppler shift methods 173, 339
- dosimetry
 - radiation doses and dose rates 909–910
 - radiation weighting factors 910–911

- double-humped fission barrier 136–138, 143
- double-humped mass distribution 418
- double-sided position-sensitive Si detector (DSSD) 650
- double-sided silicon strip detector (DSSSD) 345
- dye lasers 818, 829, 830
- e**
- earth
 - evolution of 743–744
- Einstein, Albert 11, 18, 41, 70, 621, 659, 751, 766, 817, 824
- elastic scattering 59, 60, 114, 220, 221, 223, 225, 313, 340, 364, 371–383, 388, 401, 419, 420, 423, 424, 430, 474, 761, 762, 809, 811, 813
- electric quadrupole moments
 - higher static electric and magnetic moments 70
 - non-spherical charge distribution 69–70
- electrodeposition 300, 337, 338, 566, 567, 698
- electromagnetic transitions 139, 141, 168–183
 - angular correlations 180–183
 - internal conversion 168
 - internal conversion coefficients 176–180
 - multipole order and selection rules 169–171
 - transition probabilities 171–176
- electron configurations 615, 652, 655, 660, 668–670, 688
- elementary particles 17, 18, 70, 164, 226–228, 262, 763
- elements, natural abundance 38, 41, 615, 735–738, 824
- α -emitting radionuclides 749, 849
- energy dispersive X-ray spectrometry (EDS) 303
- energy production 42, 531–536, 548, 560, 562, 580, 587, 742, 747
- β -delayed neutrons 535
- features 531–536
- fissile nuclides 531
- neutron losses 534
- operational conditions 533
- energy straggling 209
- energy-dependent thermal neutron flux 307
- epithermal neutrons 260, 308–309, 313, 533, 797, 804
- epithermal neutrons and resonances 308–309
- equilibrium isotope effect 297, 736
- evaporated films 299
- excess reactivity 534, 554, 561
- exchange reactions 297–298, 506, 518, 578, 672, 693, 694, 736–737, 808, 845, 849–850
- exothermic reaction 294, 701
- experimental storage ring (ESR) 51, 54, 55, 131, 347, 601, 603, 776
- extended X-ray absorption fine structure (EXAFS) 572, 605, 882–883, 887–888, 892, 895
- f**
- FAIR 390, 409, 601–604, 634, 800, 882
- fast fission factor 532
- fast neutrons 222, 259, 264, 312, 313, 404, 534, 536, 562, 579, 580, 589
- fast pneumatic transport systems 310
- Fermi Gamma-ray Space Telescope 753
- Fermi gas model 83, 84–86
- Fermi matrix element 159
- fermions 15–17, 108, 163, 164
- film badges 264
- finite nuclei 82
- first-order perturbation theory 110, 466
- fission 404
 - fragment angular distributions 394
 - neutrons 312, 412, 532, 534, 535, 551, 664
 - probabilities 394, 460, 643, 644
- fixed-frequency cyclotrons 598

- flux densities 309, 312, 315, 384, 548, 587, 749, 796, 797
- force carriers 10, 16, 19–20
- forward-scattering geometry 812
- Fourier transform–ion cyclotron resonance (FT-ICR) technique 53, 54
- fractional crystallization 24, 323
- fragment separator (FRS) 54, 346, 602, 603
- Fraunhofer diffraction 380, 381
- frequency-modulated (FM) cyclotrons 599
- Fresnel diffraction 381
- fuel elements
 - ceramic fuels UO₂ and UC 545
 - fabrication of 544
 - fuel rods 544
 - metallurgical properties 544
 - recrystallization 545
- Fukushima Accidents 554–560, 858
- fundamental forces 10–13, 15
- fusion probability 426, 427, 429, 640
- fusion reaction rate parameter 577
- g**
- galactic cosmic-ray (GCR) fluence 550, 768, 769
- galactose elimination capacity (GEC) 918, 920
- gamma radiation 215–221
- gamma-ray burst (GRB) 752, 753
- Gamow factor 122, 130, 745
- Gamow peak 746
- Gamow–Teller matrix element 159, 160
- GANEX (grouped actinides extraction) process 573
- gas chromatography (GC) 253, 325, 502, 508, 674–690, 693, 704, 850
- gas-filled detectors
 - Geiger–Müller Counters 241
 - ionization chambers 238–239
 - proportional counters 239–241
- gas-filled separators 331, 332, 335, 342
- Gaussian distribution 209, 277, 278, 396, 409, 423, 424, 439, 449, 454
- Ge detector 111, 244, 247, 248, 250, 252–254, 258, 305, 341, 628, 650, 803, 811
- Geiger–Müller counters 235, 238, 240–243, 251, 257, 264, 269, 675
- generalized hydrodynamical model 114
- generator-produced radionuclides 849
- geosphere 577, 735, 844, 855–900, 935
- giant dipole resonance (GDR) 354, 403
- giant resonances 110–116, 174, 383
- Goshal experiments 389
- gyromagnetic ratio 67
- h**
- hadrons 15, 17, 20, 60, 163–165, 478, 480
- half-lives determination 338–340
- halo nuclei 64, 349, 353, 354
- harmonic oscillator 50, 53, 60, 61, 88–90, 98, 136, 138, 446
- Hartree–Fock calculations 95, 668
- Hartree–Fock procedure 86, 88, 93
- head-on collisions 76, 419, 480
- heavy-ion fusion reactions 420–429, 514, 640
- heavy-ion-induced fusion 579
- Heisenberg uncertainty principle 14–15, 19, 149, 221, 385, 522
- helium burning 747–748
- heterogeneous exchange 808, 850, 867, 868
- heterogeneous exchange reactions 808, 850
- Higgs boson 16, 17
- high level radioactive waste (HLRW) 879, 934
- high neutron flux densities 309, 548, 749
- high-energy reactions 383, 414–418, 769
- high-energy storage ring (HESR) 602–604
- high-energy synchrotron (SPS) 479, 480, 600
- High-Flux Beam Reactor (HFBR) 589

- High-Flux Isotope Reactor (HFIR) 589, 638
- high-repetition-rate laser system 818
- high-spin states 110–116
- high-temperature gas-cooled reactors (HTGRs) 546, 548, 551
- Highest Occupied Molecular Orbital (HOMO) 706
- hindrance factors 124–125, 127, 134, 637
- hot atoms 489, 503, 508
- hot reactions 490, 500, 502
- hot-atom chemistry 489
- Hubble time 738
- hydrogen burning 149, 746–747, 749, 754, 769
- i**
- in-beam γ -ray spectroscopy 340
- independent particle model 83
- inelastic scattering 225, 313, 340, 383, 419, 423, 424, 430, 474, 811
- infinite nuclear matter 82, 83
- infinitely dilute resonance integrals 308
- inorganic ion exchangers 325
- interacting boson approximation (IBA) 108–110, 642
- internal conversion coefficients 176–180, 341
- internal radiation sources 837, 842, 912–915
- International Atomic Energy Agency (IAEA) 412, 501, 555, 821, 929, 930
- International Commission on Radiological Protection (ICRP) 910, 925, 926, 928, 933, 935, 936
- International Thermonuclear Reactor Experiment 577
- interstellar matter 765–769
- ion beams 51, 346, 601–604, 632, 673, 703, 705, 811–815
- ion-exchange procedures 325
- ionization chambers 236, 238–239, 245, 251, 259, 260, 264, 449, 622, 821, 823
- ionization potential 49, 207, 226, 518, 521, 659, 660, 661, 668, 708, 817, 819, 824–830
- ionizing radiation 8, 9, 201, 202, 235, 239, 246, 281, 415, 490, 909
- isobaric contaminations 821
- isochron 54, 598, 782, 783, 787
- isochronous mass spectrometry (IMS) 54, 55
- isothermal chromatography (IC) 675, 678, 704
- isothermal gas chromatography (IGC) 8, 168, 176, 177, 179, 675, 677, 678, 691, 694, 704, 706, 718
- experiments 677
- isotopes 30, 36
- effects 297, 521, 735, 736
- exchange equilibria 735
- exchange method 807, 808
- isotope dilution analysis (IDA) 805–807
- isotope ratio (IR) 31, 576, 735–738, 776, 779, 782, 783, 785, 787, 789, 805, 815, 822
- isotopic exchange 297, 298, 322, 794, 850
- isotopic radionuclides 844
- j**
- Joachimsthal uranium 32
- Joint European Torus (JET) 577
- k**
- Kamiokande 743, 757–760
- KamLAND 760, 762
- kilonova GW170817 753
- kilonovae 752
- kinetic energy 12–14, 77–78, 208–209, 226, 342, 347–348, 384–385, 410–412, 431–433, 489, 493–495, 503–504, 522–524, 829, 882
- kinetic isotope effects 521, 736
- Knight shift 515, 517
- knockout reactions 225, 349, 352

l

Laser-Induced Breakdown Detection
 (LIBD) instrument 880, 881, 886,
 887, 889–891, 895

labeled compounds 189, 296, 297,
 506–508, 806, 821, 837, 839, 841,
 843–850

labeled organic molecules 837

lanthanides 332, 538, 561, 566, 570, 571,
 572, 574, 576, 577, 614, 615, 652,
 654, 655, 657–662, 664, 666, 674,
 681, 682, 688, 698, 828, 860, 863,
 865, 867, 868, 869

lanthanum fluoride 619

Large Area Neutron Detector (LAND)
 259, 347–349, 351, 353, 476, 601,
 934

laser-induced fusion 579

laser-induced photoacoustic spectroscopy
 (LIPAS) 881, 882, 886

lattice defects and deformations 553

Lawson criterion 578

Lawson limit 577

limits of detection (LOD) 803, 815, 817

linear accelerators 594–596, 800

linear energy transfer (LET) 202, 262,
 415, 910, 911, 915–917, 923

liquid scintillation counting (LSC) 244,
 245, 686, 687, 885, 899

liquid-drop model 46, 48, 49, 106, 125,
 129, 132–134, 136, 139, 140, 142,
 143, 174, 397, 398, 399, 412, 413,
 431, 632, 645

lithium aluminum hydride 847

long-lived fission products 561, 568, 860

Lorentz transformation 12

lunar samples 738, 768, 803

m

Mössbauer spectrometry 422, 522

macroscopic–microscopic model
 106–108, 633, 642, 646, 649

magnetic dipole moments
 gyromagnetic ratio 67

nuclear magnetic resonance technique
 (NMR) 68

main-sequence stars 742

mass number 8, 28–30, 36–37, 39–43,
 46–48, 145–146, 407–409, 432–433,
 454–456, 491–492, 494, 632,
 639–641, 749–752

mass spectrographs 51

mass spectrometers 51

mass spectrometry (MS)
 accelerator 31, 32, 778, 779, 780, 815,
 820–824

isochronous 54, 55

radioisotope 815–830

secondary-ion 814

thermal ionization 31–32, 815

Mattauch–Herzog mass spectrograph 51

Maxwell–Boltzmann distribution 392,
 745

Mendelevium 621, 622

methyl isobutyl ketone (MIBK) 324, 695

microorganisms 849, 862, 865, 866, 868,
 869, 873, 874, 876, 921, 922

Mikheyev–Smirnov–Wolfenstein effect
 758

minimum ionizing particles 208

minimum potential energy (MPE)
 concept 410, 432, 451

mixed irradiation field 921

moderators 308, 532, 536, 547–554

molecular isobars 821

molecular plating (MP) 300–303

monoenergetic neutrinos 754, 755

monoenergetic photons 605

monoenergetic protons 8

Monte Carlo code MCNP5 921

Monte Carlo methods 394, 417

Monte Carlo simulations 350, 675, 676,
 679, 695, 708, 709, 713, 920

muon spin depolarization 521

muonium formation 522

n

nanoelectrospray mass spectrometry
 technique (ESI-MS) 882

- natural radionuclides 28, 838, 842, 855, 861, 877
- natural reactors 576–577, 789, 861
- neutrino mass 18, 761, 762–765
- neutron activation analysis (NAA) 302, 738, 793, 796–799, 804
- neutron flux(es) 260, 298, 303, 306–309, 310, 312–315, 535, 548, 550, 561, 570, 576, 580, 585, 587, 588, 589, 617, 638, 743, 749, 750, 787, 789, 796–798, 809, 918, 919, 921, 923
- neutron-induced fission 225, 259, 404, 406, 407, 410, 411, 418, 570, 610, 703, 705, 738, 788, 789
- neutrons 315, 454, 553, 809
 - interactions 225
 - scattering 164, 374, 587
 - sources 143, 548, 585–587, 798, 809
- Nilsson model 100–103, 106
- non-combustible solid radioactive waste 932
- non-isotopic radionuclides 844
- nuclear β decay 7, 10, 167, 168
- Nuclear Angular Momenta 64–66, 180
- nuclear decay 2, 3, 6–10, 36, 42, 119, 269, 274, 711, 713
- nuclear electromagnetic decay 8
- Nuclear Explosives 579–580
- nuclear forces
 - charge Independence and Isospin 78–82
 - and chemical forces 77
 - collective motion 95–100
 - Fermi gas model 84–86
 - macroscopic–microscopic model 106–108
 - Nilsson model 100–104
 - nuclear potential 78
 - pairing force and quasi-particles 104–105
 - polarized projectiles and targets 75
 - potential energy function 75
 - quantum chromodynamics (QCD) 76
 - Shell Model 86–95
- nuclear fuel and fuel cycles
 - binding energies, and fission cross-sections 536
 - data on 537
 - fission barrier 536
 - fuel elements 538
 - high-temperature reactors 538
 - uranium and plutonium 537
- nuclear instability 119
- nuclear isomers 513
- nuclear magnetic resonance (NMR)
 - technique 67, 68, 346, 511, 512
- nuclear matrix elements 153, 157–160
- nuclear physics techniques 384
- nuclear radiation
 - absolute disintegration rates 255–258
 - activity and counting rate 231–235
 - beta radiation 210–215
 - coincidence and anticoincidence circuits 258
 - gamma radiation 215–221
 - gas-filled detectors 235–242
 - heavy charged particles 203–210
 - low-level counting 258–259
 - neutron detection and measurement 259–260
 - properties 201–203
 - scintillation detectors 242–245
 - semiconductor detectors 245–251
 - spectrometry 253–255
- nuclear radii
 - angular distribution of electrons 61
 - charge distributions 62
 - elastic scattering 59
 - form factor 61
 - quarterpoint 60
 - volume or field shift (FS) 63
 - Woods–Saxon potential 60
- nuclear reaction
 - chemical reactions and nuclear reactions 361
 - collision kinematics 362–364
 - compound-nucleus model 384–400
 - Coulomb trajectories 364–367
 - deep inelastic collisions

- angular distribution 437
 - bombarding-energy dependence 451–454
 - charge drift and diffusion 447
 - charge equilibration 445
 - complex reactions 469–475
 - diffusion-model predictions 461–464
 - isotope distributions 449–451, 454–459
 - quantal fluctuations 446
 - shell-corrected liquid-drop binding energies 444
 - simple (quasi-elastic) reactions 464–469
 - target–projectile combinations 438
 - total kinetic energy loss (TKEL) 438
 - $^{238}\text{U} + ^{238}\text{U}$ reaction 447–449
 - $^{238}\text{U} + ^{248}\text{Cm}$ reaction 459–461
 - direct reactions 401–403
 - elastic scattering 371–378
 - elastic scattering and reaction cross-section 378–381
 - fission 404–414
 - heavy-ion fusion reactions 420–429
 - high-energy reactions 414–418
 - investigation of 384
 - optical model 381–383
 - photonuclear reactions 403–404
 - precompound decay 400–401
 - quasi-fission 429–435
 - relativistic heavy-ion collisions 475–480
 - nuclear reactors 760, 860
 - low neutron absorption 553
 - production in 309–314
 - nuclear spectroscopy 81, 119, 180, 340, 347, 422, 705
 - nuclear structure
 - interacting boson approximation (IBA) 108–110
 - nuclear transmutations
 - excitation effects 495–499
 - gases and liquids 499–502
 - recoil effects 490–495
 - recoil labeling and self-labeling 506–508
 - solids 502–505
 - Szilard–Chalmers Reactions 506
 - nuclear weapons 312, 531, 564, 579, 580, 613, 860, 931
 - nuclei synthesis 748
 - nucleons 2
 - nucleon–nucleon potentials 83, 93
 - nucleon–nucleon scattering 75, 78, 383
 - nucleus-nucleus system 465
 - nuclides 37
 - daughter nuclides 775
 - fissile nuclides 531
- O**
- Octupole vibrations 99, 423
 - off-gas system 932
 - on-line detection technique (IVO) 680, 715
 - on-line elemental analysis 811
 - on-line laser spectroscopy 62
 - one-body dissipation 431, 443, 472
 - optical model 381–383, 385, 386, 391, 468
 - optical oscillator (OPO) system 829
 - orbital angular momentum 3, 11, 50, 64, 88, 102, 125, 152, 160, 401, 402, 435, 468, 511
 - oscillator frequency 598, 599
- P**
- ^{32}P 151, 153, 189, 210, 288, 323, 780, 839, 842, 849
 - pairing energy 44, 45, 119, 129, 393, 404
 - parity 71
 - parity non-conservation 160–168
 - statistics and 70–71
 - particle-induced X-ray emission (PIXE) 255, 811–813
 - α -particle spectrometry 919
 - passivated implanted planar silicon (PIPS) detector 678, 697, 702, 715, 829, 830

- Pauli exclusion principle 50, 71, 104, 418
 Pauli principle 15, 65, 79, 83, 84, 87, 108
 Penning trap 51–53, 345
 periodic table of elements 35–36
 perturbation theory 95, 110, 466, 688
 photoionization thresholds 824
 photomultipliers (PMTs) 760, 761
 photon activation 793, 797, 802
 photon sources 605
 photonuclear reactions 221, 403–404, 753
 plutonium 619
 cycle 565
 hydroxide 818
 pocket ionization chambers 264
 Poisson distribution 275–277, 281, 285
 polyelectrolytes 864
 polyether-etherketone (PEEK) 301
 polynuclear hydroxo complexes 861, 863
 porous catalysts 812
 positron emission tomography (PET)
 314, 315, 318, 322, 356, 837, 842, 844
 positrons 25, 162, 201, 213, 226, 227, 250, 490, 494, 515, 518, 519, 521, 600, 605, 758, 842, 910
 potential energy surface (PES) 413–415, 426, 427, 441, 443–445, 467, 469, 470, 472, 474, 647
 power reactors 309, 548, 549, 551, 613, 760
 p-process 750, 753
 precipitation 24, 288, 291, 292, 293, 323, 337, 542, 544, 568, 569, 614, 615, 620, 807–809, 863, 865, 868, 879, 899
 precipitation reactions 288, 865
 precompound decay 383, 389, 400–401
 pressurized-water reactor (PWR) 536, 545, 547, 548, 551, 571
 primordial matter 739
 primordial radionuclides 39, 855
 probability and probability distributions 271–277
 probability density function 283
 promethium 35, 609, 613–616
 prompt gamma activation analysis 589, 798
 proportional counters 237–242, 246, 251, 252, 257, 260, 265, 779, 932
 proto-neutron star 752
 proton emission 131, 394
 proton radioactivity 8, 129–131, 183
 proton synchrotron (PS) 479, 600
 proton-induced gamma emission (PIGME) 811
 proton–neutron model 37, 38
 Pulsed research reactors 312
 PUREX process 564, 565, 568, 570, 571, 663
- q**
 quadrupole moment 69–70, 75, 95, 96, 111, 139, 140, 142, 174–176, 345, 514, 515, 524
 quantum chromodynamics (QCD) 76, 478
 quantum electrodynamics (QED) 18, 511, 688
 quantum fluctuations 739
 quantum-mechanical sharp-cutoff model 378
 quasi-deuteron mechanism 404
 quasi-elastic collisions 449, 450, 453
 quasi-elastic transfer reactions (QE) 419, 420, 427, 429
 quasi-fission (QF) reaction 427
 quasi-particle random-phase approximation (QRPA) 356
- r**
 radiation
 absorption and scattering 809–810
 cell, effects in
 boron-neutron-capture-therapy (BNCT) 916–921
 external radiation sources 911–912
 humans, animals, and plants, effects in 921–925

- in X-ray Fluorescence Analysis (XFA) 810–811
- internal radiation sources 912–915
- non-occupational radiation exposure 925
- protection and monitoring 932
- special regulations 928–932
- β radiation 202, 210–212, 214–216, 233–234, 238, 240, 242, 244–245, 249, 251, 253, 261, 264, 337, 709, 803, 809, 923, 929
- β^- radiation 193, 202, 233–234, 553, 785, 795, 809
- radiation-induced exchange 850
- radiation-induced labeling (self-labeling) 845, 850
- radiation-induced reactions 506, 508, 765
- β radiation materials 202
- radiative capture 225, 309, 748
- radio-active waste 933–936
- radioactive beams 37, 51, 54, 346–347, 349, 601–602
- radioactive contamination 263, 265, 325, 821, 930
- radioactive decay 6, 489, 738
 - branching decay 196–197
 - half-lives of mother nuclide 194–196
 - law and energy of 187–189
 - mother nuclide decays 194
 - radioactive equilibria 189–191
 - secular radioactive equilibrium 191–193
 - successive transformations 197–199
 - transient radioactive equilibrium 193–194
- radioactive decay modes 7, 132
- radioactive disequilibria 776, 788
- radioactive disintegrations 272, 274
- radioactive equilibria 189–191, 775, 788
- radioactive equilibrium 190–195, 197–199, 542, 775, 783, 785, 793–794
- radioactive substances 189
 - nuclear forensics 30–33
 - uranium and thorium 26
- radioactive waste
 - chemical decontamination 568
 - corrosion products 567
 - EURO-GANEX process 575, 576
 - extraction cycles 569
 - GANEX second cycle concept 574
 - liquid wastes 568
 - off-gas and coolant 568
 - off-gas passes scrubbers 569
 - PUREX process 568
 - thermal neutron-induced fission 570
- radioactivity
 - cluster radioactivity 127–128
 - discovery of 23–25
 - proton radioactivity 129–131
 - sources of 855–858
- radioanalysis
 - activation analysis 793, 802–805
 - applications of 793
 - charged particles 800
 - detection limits of 794
 - in life science 838–840
 - inherent radioactivity 794–796
 - isotope dilution analysis (IDA) 805–807
 - neutron activation analysis (NAA) 796–799
 - photons 800–802
 - radiometric analysis 807–808
- radiochemical detectors 755–756, 760
- radiochemical techniques 330, 449
- radiocolloids 761, 765, 861, 865
 - radionuclide or the labeled compound 296
 - tracer techniques 297–298
- radioecology 838, 873, 876
- radioelements 36
 - actinides
 - properties of 652–667
 - and transactinides 649–652
 - artificial radioelements 610, 611
 - cross-sections 640–644
 - natural radioelements 610
 - superheavy elements 645–649

- radioelements (*contd.*)
 - technetium and promethium 613–616
 - transactinides
 - applied methods and elution sequences 691
 - experimental results 690–721
 - methods of investigation 670–690
 - transuranic elements
 - ⁴⁸Ca-induced fusion reactions 632–638
 - cold-fusion reactions 625–632
 - curium 619
 - hot-fusion reactions 622–625
 - methods of 616
 - neutron irradiation 616
 - plutonium 619
- radiographic imaging (RI) 304
- radioimmunoassay 839
- radioisotope mass spectrometry
 - accelerator mass spectrometry (AMS) 820–824
 - ionization potentials, measurements of 824–830
 - resonance ionization mass spectrometry (RIMS) 815–820
- radiometric analysis 807
- radiometric titration 794, 807–808
- radionuclide generators 312, 317, 326–329, 342, 566, 837, 842, 849
- radionuclide neutron sources 585
- radionuclides 841–843, 876
 - accelerators, production of 314–322
 - application of 838
 - beam intensity and fluxes 304–306
 - in-beam nuclear reaction studies 342–356
 - in biosphere 873–878
 - decay-scheme studies 340–342
 - in ecological studies 838
 - α -emitting radionuclides 849
 - epithermal neutrons and resonances 308–309
 - generator-produced radionuclides 849
 - geosphere 858–861
 - half-lives determination 338–340
 - Homologs Th(IV) and Zr(IV) 888
 - of iodine 748, 848
 - microamounts of 290–294
 - nuclear medicine 841–843
 - nuclear reactors, production in 309–314
 - physical half-lives and effective half-lives 913
 - and radioelements 915
 - radionuclide generators 326–329
 - reaction rates in thermal reactors 309
 - reaction with water 861–865
 - recoil, uses of 329–337
 - sample preparation 337–338
 - separation techniques 322–326
 - short-lived radionuclides and carriers 287–289
 - single-photon emission computed tomography (SPECT) 843
 - solid components, of geosphere 865–873
 - specific activity of 289–290
 - thermal neutrons 306–308
 - time-resolved laser-induced fluorescence 895–899
- radioreagent methods 807
- radiorelease methods 807
- radiotherapy 314, 842, 921, 925
- radiotracer techniques 808, 838, 840, 841
- RADRES method 660, 830
- range straggling 208–209
- γ -rays 704, 802
 - photon 201, 203, 213–215, 219–220, 227, 258, 315, 491–494, 498, 522–524, 527, 797
 - spectroscopy 303, 305, 340, 446, 449, 589, 698, 699
- reactivity 321, 503, 519–520, 534, 548, 550, 552–554, 557, 560–561, 714, 720
- reactor-produced radionuclides 313, 316
- recoil labeling 506–508, 845, 847–848, 850
- recoil technique 338, 621–623

- recoil transfer chamber (RTC) 674, 703, 705, 708, 710, 720
- red giants 642, 742–743, 748–749
- reduced transition probability 111, 173, 176
- relativistic mechanics 11–13
- reprocessing
 - disintegration rate 562
 - dry reprocessing procedures 566
 - fission products 561
 - gaseous or volatile fission products 564
 - head-end process 564
 - long-lived fission products 561
 - solvent extraction 565
 - U–Pu fuel cycle 564
- reprocessing plants 567–568, 570, 779, 858, 860
- research reactors 148, 298, 309, 312, 537, 544, 548, 587–589, 794
- resonance absorption 168, 504, 523–524, 534, 809
- resonance integrals 308–309, 313
- resonance ionization laser ion source (RILIS) 345
- resonance ionization mass spectrometry (RIMS) 31–32, 659, 815–820
- resonance scattering 376, 388
- resorption 874, 875, 877, 878
- retention 490, 498, 503–505, 507, 673, 677–678, 696, 719, 720, 874, 891
- reusable imaging plates (IPs) 304
- reverse isotope dilution 806
- thermonuclear reactors 579
- rotating liquid-drop model (RLDM) 398–400, 426, 458
- Rutherford backscattering (RBS)
 - experiment 813, 814
- Rutherford, Ernest 4–5
- S**
- SANEX (Selective ActiNide EXtraction)
 - process 570–572
- scanning electron microscopy (SEM) 303, 880, 889
- scattering process 61, 369, 371–372, 382
- Schrödinger equation 50, 86, 88, 102, 121, 374, 377, 424
- scintillation detectors 242–245, 252–254, 258–259, 265, 760, 803, 844
- secondary-ion mass spectrometry (SIMS) 814
- secular radioactive equilibrium 191–194, 542
- sedimentation 788, 868
- self-absorption 233–234, 244, 251–252, 255, 337
- self-consistent mean-field approaches 47, 646
- self-scattering 337
- self-shielding 298
- self-supporting foils 300
- semiconductor detectors 174, 245–251, 253, 255, 258–260, 282, 338, 342, 344, 803, 811, 813, 815, 823, 882
- semileptonic processes 163–164
- shell effects 106, 126, 134, 140, 146, 332, 352, 407, 414–415, 445, 457, 463, 632, 642, 751
- short-lived elementary particle 226–228
- short-lived radionuclides 287–289, 312, 326–327, 550, 568, 793, 837, 843, 875, 932
- ³²Si 8, 127, 768, 780, 823
- single-photon emission computed tomography (SPECT) 322, 327, 837, 843
- Slope anomalies 468
- smooth-cutoff model 379–380
- solar neutrino 18, 149, 754–762
- solid-state nuclear track detectors (SSNTDs) 128
- solvent extraction 251, 288, 293, 323–324, 564, 565, 570, 573, 576, 700, 807, 882, 885
- Sommerfeld parameter 110, 364–365, 437
- specific activity model 877
- spectroscopic test 24
- spin-dipole resonance 64

- spin-orbit splitting 90–92, 351–352, 649, 657
- spontaneous fission 8, 39, 108, 119, 126, 132–146, 262, 404, 407–408, 425, 579, 585, 623, 645, 652, 780, 789, 798
- sputter-induced photon spectrometry (SIPS) 814
- sputtering process 822
- stable isotopes 41, 49, 51, 189, 289–290, 355, 409, 609–610, 736, 739, 786–787, 805, 844, 874, 876, 892
- standard solar model 754, 756–757, 760–761
- stars
 - evolution of 741–743
 - main-sequence stars 642, 742
 - proto-neutron star 652, 752
- statistical equilibrium 390, 400
- statistical inference 277
- statistical methods, radioactivity measurements
 - experimental applications 278–280
 - probability and probability distributions 271–277
 - pulse-height distributions 280–282
 - random variables 269–271
- steady-state machines 578
- Steinwedel–Jensen model 445
- stripping process 822–823
- stripping reaction 401, 466
- substoichiometric isolation 840
- substoichiometric principle 806–807, 838–840
- Super-Kamiokande detector 759
- supernova explosions 638–639, 743–744, 749, 752, 767
- surface barrier (SSB) detectors 249–250, 252, 255
- surface energy 44, 46, 132, 134, 295, 398, 428
- surface ionization method 828
- swimming-pool reactor 552, 588
- synchrocyclotrons 596, 598–600
- synchrotron oscillations 599
- synchrotrons 54, 346, 479, 578, 598–601, 603, 605, 882
- Szilard–Chalmers reactions 311, 493, 502, 506–507
- t**
- Target Preparation 298–304, 338
- technetium 35, 609, 613–616, 705
- thenoyltrifluoroacetone (TTA) 663, 697, 795
- thermal ionization mass spectrometry (TIMS) 31–32, 815
- thermal neutron fluxes 306, 589
- thermal neutrons 222, 225, 259–260, 264, 306–311, 313, 404–405, 407–411, 493, 531–533, 536, 538–540, 580, 587, 589, 619, 789, 796–798, 800, 803–804, 809, 917
- thermal positronium 520
- thermal utilization 532
- thermochromatographic in-situ volatilization 715
- thermochromatography (TC) 289, 325, 675, 680, 694, 704, 706, 709, 712, 715, 717, 849
- thermoluminescence detectors (TLD) 919, 921
- thermoluminescence dosimeters 264
- thermonuclear reaction rates 744–746
- Thomas–Reiche–Kuhn (TRK) sum rule 115–116, 355–356
- threshold monitor foils 306
- time-of-flight (ToF) mass spectrometers 51, 818, 882, 892
- time-resolved laser-induced fluorescence 895–899
- time-resolved laser-induced fluorescence spectroscopy (TRLFS) 883, 896, 898–899
- total center-of-mass kinetic energy (TKE) 429, 431–432, 435, 439
- total kinetic energy loss (TKEL) 364, 437–443, 452, 474–475, 477
- tracer techniques 297–298, 808–809, 838, 840

- track detectors
 bubble chamber 263
 cloud chambers 263
 dielectric track detectors 262
 photographic emulsions and
 autoradiography 260–262
 spark chambers 263
- TransActinide Separator and Chemistry
 Apparatus (TASCA) 300, 302,
 304, 333, 335–336, 339, 633, 635,
 641, 674, 703, 717–721
- transient radioactive equilibrium
 193–194
- β transitions 153, 155, 258, 341
- γ transitions 94, 120, 168, 171, 175, 182,
 341–342, 384, 522, 913
- transition probabilities 70, 72, 111, 113,
 115, 152, 165, 170–176
- transmission coefficient 121, 370, 373,
 397, 642
- tributylphosphate (TBP)/cyclohexane
 565, 698
- tri-isooctyl amine (TIOA) 695
- trim coils 598
- triple product 577
- tritium 311
 atoms 507, 776
 method 777
- two-photon annihilation 518
- two-quantum annihilation 515
- U**
- ultracold neutrons (UCNs) 167,
 222–223, 550
- unconsolidated rocks 866–867
- Universe 1, 19, 479, 601, 645, 738–741,
 766–767, 786
- uranium and compounds
 chemical procedures 542
 electromagnetic separators 543
 gas diffusion 543
 radiation hazards 541
 selective extraction procedures 542
- uranium cycle 565
- uranium isotope ratios 31
- V**
- vacuum evaporation 299
- van de Graaff generators 591–593, 798,
 800, 811
- van der Waals forces 83
- van der Waals repulsion 83
- velocity distribution 226, 307, 477, 577,
 595, 745
- volume energy 44, 46
- W**
- white dwarfs 742–743
- Wien filters 331, 342
- Woods–Saxon potential 60–61, 88, 102,
 124, 382, 413
- X**
- X-ray Fluorescence Analysis (XFA) 255,
 810–811

