

Index

- absorption edges 33, 50, 68
acceleration form (of dipole matrix element) 323–4
alignment 91–4, 357–62
 angle-dependent tensor 168–72, 356, 360–1
 parameter 91–4, 200, 357–60
 tensor 91, 93, 168–72, 356
analyser (of electrons): *see* electron spectrometer
angular correlation (of electrons) 9, 258, 314
angular correlation patterns 158, 164–5, 168–72, 254–5, 354–7, 360–3, 402–3
angular distribution: *see* angular correlation patterns; Auger electrons; photoelectrons
angular momentum transfer 326–7
anisotropy parameter 20
 see Auger electrons (angular distribution parameter); photoelectrons (angular distribution parameter)
aufbau principle 4, 217
Auger decay/electrons 73–94, 185–97, 199–200, 206, 239–47, 247–56, 331–40
 angular correlation patterns 158, 164–5, 168–72, 254–5, 354–7, 360–3, 402–3
 angular distribution form 20, 41, 90, 364–6
 angular distribution parameter 91, 205–7, 352–7, 357–60
 connection of ang. distrib. parameter to alignment parameter 91, 357–60
 decay parameter 91, 169, 356
 diagram lines (main lines) 14, 18, 59–60, 76, 332, 334
 double Auger 60, 76
 energy 18
 intensity 88–90, 393–4
 involved (participator) transitions 77, 191–2
 main (diagram) lines 14, 18, 59–60, 76, 332, 334
 operator 14, 79, 335–6, 345
 participator (involved) transitions, 77, 191–2
 radiative Auger 58
 resonance Auger 77, 190–5, 333
 satellites 60, 75–7
 spectator Auger 77, 189–95, 333
 valence multiplet Auger 267
 virtual Auger 211, 219
 yield (of Auger electrons) 60, 89–90
 see postcollision interaction
autoionization 14, 18, 75
 see Auger decay (participator/spectator); resonances
atom–photon interaction 318–21
atomic units 273–4
attenuation factors (solid-angle effects) 40, 180–4, 255, 401–3
bandpass (of monochromator) 23, 32, 56, 66, 391
beta parameter (in photoionization) 20
 see Auger electrons (angular distribution); photoelectrons (angular distribution)
Beutler–Fano line shape 56, 191
brightness (of electron beam) 389–90
brilliance (of synchrotron radiation) 26
Brillouin theorem 210, 214
boundary condition (for electron emission), 163, 284–9
bunches (in a storage ring) 23, 29, 97, 251, 262, 264–6, 375
channelplate: *see* electron detector
channels (of photoionization) 49, 166, 197, 228, 326–9
channeltron: *see* electron detector
Chevron mounting (of channelplates) 118–22
CI: *see* configuration interaction
circular dichroism 156
Clebsch–Gordan coefficients 290–3
CMA: *see* cylindrical mirror analyser
coefficients of fractional parentage 294–6
coincidences (electron–electron) 154–84, 247–56, 262–6, 391–9
 correlation time 173
 energy resolution 177, 394–9
 false and true 172–5, 178, 251, 252–3
 intensity 252–3, 394–9, 402–3
 optimization 178–80, 396
 resolution time 175
 resolving time 173, 178, 180–1
 solid-angle effects 182–4, 255, 401–3
 source strength 177, 179–80
 source volume 176, 180
 true and false 172–5, 178, 251, 252–3
coincidences (electron–ion) 130–1
collapse (of wavefunctions) 194, 217–18
complete experiments 197, 202, 228, 247, 255
configuration (of electrons) 5–6
 standard order 290, 335
configuration interaction (CI) 10–13, 15–16, 306–12, 313–17
 see correlation (of electrons); CSCI (continuum state configuration interaction); ISCI (initial state

- configuration interaction); FISI (final ionic state configuration interaction); FSCI (final state configuration interaction); wavefunctions (correlated)
- contact potential 151, 241–2
- convolution (of energy distribution functions) 62–4, 391–401
- for Auger electron observation 89, 394
 - for photoelectron Auger electron coincidences 394–9
 - for photoelectron observation 64, 67, 393–4
 - for two Gaussian functions 399–400
 - for two Lorentzian functions 400
- Cooper–Zare model (of photoionization) 329–31
- Coster–Kronig decay/electron 62, 73, 334
- virtual 219
- correlation (of electrons) 9, 212
- angular correlation, 9, 258, 314
 - correlated motion 9–13, 14, 162–4, 212–15, 313–17
 - correlation factor (in double photoionization) 163
 - diagrammatical representations 207–12
 - interchannel correlation 211, 329
 - intrachannel correlation 208
 - radial correlation 9, 258, 260, 315
 - see* configuration interaction (CI)
- counting rate
- of Auger line 89
 - in coincidence measurements 176–7, 252–3, 394–9
 - of photoline 67, 69
 - losses (in counting rate) 126–7, 144–9
- coupling schemes
- intermediate: in Auger decay 85–6, 310–12; in photoionization 198, 326–9
 - jjJ* case 7, 52–3, 197–8, 328–30
 - LSJ* case (Russell–Saunders coupling) 6–7, 198, 331
- cross section (of photoionization)
- differential (double ionization) 154–72, 247–56, 260–1, 401–3
 - differential (single ionization) 20, 41–5, 47–52, 325–6, 327–31, 350–2
 - partial (double ionization) 68, 256–7, 261–2, 269
 - partial (single ionization) 16–18, 41–5, 51–3, 67–8, 70, 326–31
 - total ionization 67–8, 205
- CSCI continuum state configuration interaction 16, 211
- cut-off effects in
- electron spectrometry 115
 - light reflectivity 31–3
- cylindrical mirror analyser (CMA) 42–5, 98–9
- characteristic features 99–113
 - optical properties 99–104, 378–86
 - timing properties 180–2
 - see* electron spectrometers
- decay (of a state) 56–8
- see* transition rate
- density matrices 340–1
- density of final states 82, 289, 325–6
- determinantal (Slater) wavefunction 4–5, 78–80, 290–8
- diagonalization 220–4, 308–10, 310–12
- diagrammatic representation of photon–atom interaction and electron correlation 207–13, 219
- dipole approximation (electric) 321–6
- dipole moment 13
 - dipole operator 13, 46, 322–4
 - matrix element 49–51; 328–9;
 - acceleration/length/velocity forms 162, 210, 323–5; radial matrix element 50, 69–70, 199
 - non-dipole effects 321
- Dirac–Fock approach 12, 90, 209, 298
- see* Hartree–Fock approach
- dispersion (energy, in electron spectrometers) 104–5, 385–6
- corrected area 65, 67, 89, 106–7, 112, 115, 394
 - slit/plane (of spectrometer) 99, 101–2, 104–6, 123
- dispersive element (of electron spectrometers) 97–9
- disturbances in electron spectrometry
- Doppler broadening 151–2
 - by electric fields 150–1
 - by magnetic fields 149–50, 403–6
 - by scattering 144–9
 - see* postcollision interaction
- Doppler broadening (in electron spectrometry) 151–2
- double ionization *see* photoionization (direct/two-step)
- dynamical aspects/parameters 1, 13–16, 41, 50–2, 54, 156–7, 167–8, 169–72, 247, 259, 342–3, 350
- EDC energy distribution curves 113, 187, 378
- efficiency
- of electron detector 39, 127–31
 - of electron spectrometer 129–31
 - matrices 341
 - of monochromator 32
 - tensors 341, 346
- electric field in
- atom–photon interaction 318–20: *see* polarization of light/synchrotron radiation
 - electron spectrometers 98–101, 150, 379–81
 - lenses 386–7
- electron correlations: *see* configuration interaction; correlation (of electrons)
- electron detector (channeltron/channelplate) 117–27
- detection efficiency 39, 127–31
 - ion feedback 120–2
 - position-sensitive detectors 102, 122–7, 186, 378
 - saturation 121–2
 - secondary electrons 118, 127–9
- electron spectrometers 21, 97–9

- electrostatic analysers
 acceptance 37–9, 108–12: *see* coincidences
 (effective energy resolution, resolving
 time, source volume): *see* luminosity (of
 electron spectrometers)
 characteristic features 99–117
 dispersion corrected area 65, 67, 89, 112,
 115, 394
 dispersion slit/plane 101–3, 104–8, 111–12,
 123
 energy dispersion 104–5, 385–6: *see*
 dispersion corrected area
 focussing order 102–3, 382–5
 optical properties of CMA 99–104, 378–86
 spectrometer factor 39, 101, 241, 380
 spectrometer function 40, 62, 66, 106–7,
 108–12, 243, 391–2
 spectrometer resolution 40, 104–8, 112,
 114–15
 spectrometer transmission 37–9, 66, 108–13,
 129–31, 392: *see* luminosity
 spectrometer voltage 39, 100–1
see cylindrical mirror analyser
 (CMA)
see luminosity (of electron spectrometers)
see operation modes
- electron spectrometry 17, 18, 21, 37–45, 113–17
see electron spectrometers
- electrons
 active 49, 83, 160, 330
 equivalent 78, 290, 294–6
 passive 47–58, 83, 160–1, 330: *see* relaxation
 (relaxed orbitals)
- emittance (of beams) 388
- energy
 binding energy 17, 212–13
 dispersion 97, 104, 123, 385: *see* dispersion
 corrected area
 electron pair energy 298–301
 of emitted electrons 17–18: *see* contact
 potential
 excess energy (in double ionization) 17, 155,
 164, 259–60
 pass energy (of analyser) 39–40, 115–17,
 176–7, 180, 393–9
 in PCI 240, 334
 Euler angles 258, 284, 346–7, 402
- excitation (by photons) 13–14, 187–90, 190–5
 Fano line shape 56, 191
see Auger electrons (satellites); photoelectrons
 (satellites)
- Fano effect (in spin-polarized electrons) 236
 Fano line shape 56, 191
 Fano–Racah algebra 340–57
 Fermi's golden rule 82, 320
 FISI (final ionic state configuration
 interaction) 16, 213–14, 217–19, 220–8
 fluorescence (radiative) decay 16, 58–62, 88
 fluorescence yield 60
 Förster probe 404–6
- frozen orbitals/structure 47, 83, 161, 214, 221,
 303, 335
see relaxation (relaxed orbitals)
- FSCI final state configuration interaction 16,
 210, 217, 227
see CSCI (continuum state configuration
 interaction)
- gas beam (formation) 406–14
 flow 407–10
 mean-free-path 408–9
 metal vapour 202–3
 pressure versus density 147, 407
 target 37, 144, 249, 411–14
- Gaussian function 62, 64, 163, 399–400
 Gaussian relation (in optics) 135
- geometry/geometrical aspects 37, 41–5, 51–2,
 155–8, 164–5, 167, 247, 342–3, 350
- Hamilton matrix 220–1, 307, 309
 diagonalization 306, 308–10, 310–12
 eigenvalues, eigenvectors 221–4, 308–10,
 310–12
 graphical solution 221–2
see configuration interaction
- Hamilton operator (of atom) 3–4
 with electromagnetic field 319
- Hartree–Fock (HF) approach 7, 298–305
 Brillouin theorem 210
 HF equations for: helium 302–4; neon 305
 HF potential (helium) 302–4
 Koopman theorem 303
 Lagrange parameter 301–2, 305
 multiconfiguration HF 213
 state-dependent HF 207
 time-dependent HF 209
- Heisenberg uncertainty principle 58
- helicity (states of light) 371–4
see polarization of light/synchrotron radiation
- Helmholtz–Lagrange relation 134–5, 388
- Herman–Skillman potential 207
- Hylleraas function 8–9
 compared to CI 12–13, 315–17
- hyperspherical coordinates 163, 257–9
- imaging (of charged particles) using
 electron spectrometers 99–104, 378–86
 lenses 132–6, 388–90
 position-sensitive detection 123
- independent particles (single-particle model) 7,
 198, 200, 207, 298, 329–31
- intensity
 borrowing model 215, 224
 in coincidence experiments 172–7, 252–3,
 394–9
 of photons 23–6, 31–2, 319
 of registered electrons: *see* line intensity: *see*
 convolution (of energy distribution
 functions)
- ionization: *see* photoionization; scattering losses
 (in electron spectrometry)
- ISCI (initial state configuration interaction)
 10–12, 16, 210, 212–13, 217, 225–6

- j*-symbols 291, 297
- Koopman theorem 393
- Lambert cosine law (in optics) 390
- Legendre polynomials 280
- length form (of dipole matrix element) 162, 210, 323–5
- lenses (electrostatic) 131–43, 386–8
 equation of motion (within a lens) 387
 fundamental lens equation 133–5, 387
 Helmholtz–Lagrange relation 135–6, 388–90:
see Liouville theorem
 magnifications 135–6
 paraxial rays 132, 387
 potentials and energies 132, 135, 387
 zoom lens 136
- level width 56–62
 of neon (1s) 65, 89–90, 152
- lifetime 57–8, 334
- line intensity (of registered electrons) 39, 40–1, 43–5, 54
 of Auger electrons 88–90, 393–4
 of photoelectrons 65–9, 393–4
see dispersion corrected area
- line position
 of Auger electrons 18, 87, 150–1
 of photoelectrons 17, 52–4, 150–1
see postcollision interaction
- line shape 56, 62–4
 Beutler–Fano line shape 56, 191
 Gaussian function 62, 64, 163, 399–400
 Lorentzian function 57–8, 64, 338, 400–1
 Voigt profile 62–3
see convolution (of energy distribution functions); postcollision interaction
- line width 54–6, 87–8
- Liouville theorem 26, 115, 388–90
- Lorentzian function 57–8, 64, 338, 400–1
- luminosity (of electron spectrometers) 37–8, 66, 110–12, 389–90
see transmission (of electron spectrometers)
- main lines: *see* Auger electrons; photoelectrons
- magic angle 43
- magnetic field
 as dispersive element 97–8
 earth field disturbance 115–16, 149–50
 earth field shielding 403–6
 mu-metal 403
- many-body problem/effects 11, 16, 54, 154, 324
see configuration interaction; correlation (of electrons); MBPT, RPA, RRPA
- matrix element
 Coulomb matrix element 83, 299–300, 345:
see Auger decay operator
 dipole matrix element 48–51, 321, 323–4, 328–9, 344–5: *see* dipole approximation
 overlap matrix element/integral 47–8, 50, 83, 161, 194, 214, 279, 336
 reaction matrix element 344
 reduced matrix element 343, 345
 of rotations 284, 342–3, 346–7
 of transitions 340–1
 of virtual transitions 211, 212, 219
- MBPT (many-body perturbation theory) 90, 205, 208, 210
- mean-free-path (of gases) 408–9
- metal vapour 202–3
- mixing of wavefunctions: *see* configuration interaction
- monochromatization (of synchrotron radiation)/monochromators 29–37
 bandpass 23, 32–3, 66, 391
 cut-off (in reflectivity) 31–2
 higher orders 33, 241–2
 monochromator function 66, 391
 polarization 34–7
 reflection grating 29–30
 stray light 33
 toroidal grating 30–1
- Mott scattering/detector 201, 230–4
- MQDT (multichannel quantum defect theory) 238–9
- multiplicity (of terms) 6
- non-dipole effects 321
- non-radiative decay 14, 16
see Auger decay; autoionization
- one-step process (photon-induced Auger decay) 191, 331–7
see two-step process
- on-the-energy shell 47, 82, 155, 325, 337, 392
- operation modes (of electron spectrometers) 113–17, 187
 CFS (constant-final-state) mode 117, 187
 CIS (constant-ionic-state) mode 116, 187
 dithering mode 131
 EDC energy distribution curves 113–16, 187, 378
 modes derived from complete mapping 187
 PES (photoelectron spectroscopy) mode 113
- operator
 for Auger electron emission 14, 79, 335–6, 345
 for photoionization 13, 46, 318–21, 321–5, 343–5
 for shake processes 192, 336
 step down/up operators 296–7
 tensor operators 343–5
- orientation 91–4, 358
- oscillator strength 13
- parity 6–7, 93
- Pauli principle 4, 78
- Pauli spin matrices 369, 373
- Pauli spinors 8, 278, 284, 313, 369–71
- phases (phase shifts) in the wavefunction of the emitted electron 286–8
 incoming spherical wave boundary condition 285
 long/short range potential contributions 49, 288
 phase differences 52, 69–70, 198, 202, 208, 329

- photoelectrons 14, 46–72, 197–215,
215–28, 228–39, 239–47, 247–56, 256–69,
326–31
- angular distribution form 20, 40–5, 364–6
- angular distribution parameter 20, 52, 69–72,
205–6, 215, 225, 326–31
- energy 17
- intensities 65–9, 393–4
- main lines 14, 17, 53–4, 67–8, 332
- operator for photoionization 13, 46, 318–21,
343–5: *see* dipole approximation
- photolines 53: *see* photoelectrons (main lines,
satellites)
- satellites (continuous) 14, 17, 68, 77
- satellites (discrete) 14, 17, 68, 77, 191–3,
195–7, 203–5, 215–28
- satellites (resonantly enhanced) 192
- satellites (shadow) 224, 226
- see* cross section (of photoionization); direct
double photoionization; photon operator;
spin polarization of electrons; threshold
electrons
- photoionization 13–14, 16–21, 68, 318–26
- direct double ionization 14, 154–6, 158–65,
257–69, 333, 391–2, 397
- single ionization *see* photoelectrons
- two-step (indirect, sequential) double
ionization 14, 154–6, 166–72, 199, 267,
331–2, 337–40, 391–3: *see* Auger
electrons; *see* postcollision interaction
- photon/flux/number 23–6, 31–2, 319
- photon operator 13, 46, 318–21, 321–5, 343–5
see dipole approximation
- Poisson distribution/statistics 126, 127, 174–5
- polarization of electrons 20, 228–39, 367–71
- Mott detector/scattering 201, 230–4
- spin polarization parameters 201, 229–30,
235–7
- polarization of ions 16, 91–4
see alignment
see orientation
- polarization of light/synchrotron radiation 27–9,
371–4
- electric field vector 19–20, 318–19, 322–3,
372
- helicity (states of light) 371–4
- mixed/pure state 27–9, 34–7
- optical/helicity definition 27–8, 371–2, 374
- polarization ellipse 28, 34, 41–2, 366
see Stokes parameters
- position sensitive detectors (of electrons) 102,
122–7, 186, 378
- postcollision interaction (PCI) 56, 75, 152–4,
195–7, 239–47, 336
- energy shift 153, 196, 245–6
- link of processes 195–7
- retarded/sudden PCI 153, 239, 245–7
- Poynting vector 319
- pressure
see gas target
see scattering losses
- principal planes (in lenses) 133
- principal ray/trajectories (in electron
spectrometers) 100–1, 382
- quasimagic angle 45
- radiation parameters 346–7
- radiative (fluorescence) decay 16, 58–62, 88
- recoil ion momentum spectroscopy 17, 98
- recoupling coefficients 297
- relaxation (relaxed orbitals) 16, 161, 192, 213
see collapse of wavefunctions; shake process
- resistive strip anode 125
- resonances 190–5, 332–3
- Beutler–Fano line shape 56, 191
- giant (shape) resonances 212
- resonantly enhanced satellites 192
see Auger (resonance), autoionization;
excitation (by photons)
- resonant Raman Auger 88, 191
- rotations/rotation matrix elements 284, 342–3,
346–7
- RPA (random phase approximation) *see* RRPA
- RRPA (relativistic random phase
approximation) 205–7, 208–12, 237,
325
- Russell–Saunders coupling 6–7, 198, 331
see coupling schemes
- satellites
see Auger electrons
see photoelectrons
- scattering
amplitudes (in photoionization) 327
relation to dipole matrix elements 328
- losses (in electron spectrometry) 144–9
- Mott scattering/detector 201, 230–4
- Schrödinger equation 3, 286, 303, 306–8, 319
- selection rules for
Auger decay 79, 345
- photoionization 48–50, 345
- shake processes 192
- shadow satellites 224, 226
- shake processes 152, 189, 192, 213, 336
see relaxation (relaxed orbitals)
- shell model 4, 7, 316
- collapse (of wavefunctions) 194, 217–18
- Sherman function 230, 233–4
- single-particle model (independent particles) 7,
198, 200, 207, 298, 329–31
- Slater Coulomb integrals 84, 300
- Slater wavefunctions 4–5, 78–80, 290–8
- source volume/size 38–9, 66, 103, 104–6, 110–11
- in coincidence experiments 176, 180
- solid angle 38, 108–9
- effects of large solid angles 40, 182–4, 255,
401–3
- Sommerfeld factor 163
- spectrometer
charged particle imaging 123
- time-of-flight (TOF) spectrometer 97, 375–8
see electron spectrometers
- spectroscopic factor 214, 223

- spherical Bessel function 281, 286
spherical harmonics 279
 bipolar spherical harmonics 156
spin (of electron) 3–4, 5, 367–8
 spinor function 8, 278, 284, 313, 369–71
 see polarization of electrons
spin (of photon) 371
 helicity (states of light) 371–4
state
 in configuration interaction 10–12, 306–8
 intermediate state 334
 of light 27, 366–7, 371–4
 metastable state 56
 multipoles: *see* statistical tensors
 out-state of emitted electron 285
 stationary state (of atom) 3, 6, 306–8
statistical tensors 92, 156, 169, 341–57
 comparison to tensor operators 343
 coupling examples 348–50
 of final products (efficiency tensors) 341, 345–7
 of incident light 156, 348
 of initial state 348
step down/up operators 296–7
Stokes parameters of light 27–9, 34–7, 348, 373–4
 in electron spectrometry 41–2, 365–6
 in electron–electron coincidences 155, 156
Stokes parameters of electron detector 229–30, 347
storage ring (for electrons) 22
structure (of atoms) 3–13
superposition (of configurations) 10
synchrotron radiation 21–9
 see bunches; monochromators
target density *see* gas target
tensor operator (irreducible) 343
threshold photoelectrons 142–3, 256–7, 262–6
TOF (time-of-flight) electron spectrometry 97, 265–6, 375–8
 see ZEKE
transition rate 56–8, 340–2, 345–6
 in Auger decay (neon) 77–87, 89–90
 in photoionization 325
 for two-electron emission 332–40
 using density matrices 341
 using statistical tensors 342, 345–6
 virtual transitions 211, 212, 219
transmission (of electron spectrometer) 37–9, 66, 108–113
 cut-off 115
 measurement of transmission (and detector efficiency) 129–31
 transmission function 104–5, 110–12, 392
 see: electron spectrometers (spectrometer function); luminosity
triple-differential cross section 155
two-electron processes 14
two-step processes 14, 154–6, 166–72, 199, 267, 331–2, 337–40, 391–3
 see one-step process
undulator 22, 24–6, 33
vacuum ultraviolet radiation 21–2
velocity form (of dipole matrix element) 162, 210, 323–5
virtual transitions/excitations 211, 212, 219
Voigt profile 62–3
Wannier theory 257–62
 exponent 164, 260
 point/ridge 259, 261
 threshold law (in double ionization) 257, 259
wavefunctions
 basic functions 10–13, 306–8, 308–10: *see* argon satellites 216–24; configuration interaction (CI); correlation (of electrons); magnesium satellites 213–15
 correlated wavefunctions of helium: (CI) 10–13, 313–15, 317; (Hylleraas) 8–9, 12–13, 315–17
 dimensions of wavefunctions 289–90
 discrete hydrogenic wavefunctions 278–80
 of emitted electrons 284–9: incoming spherical wave boundary condition 285–8; normalization 288–9
 plane wave 280–4
 Slater wavefunctions 4–5, 78–80, 290–8
wavepacket 280–1, 284–5
width of
 lines 54–6, 87–8
 levels 56–62
wiggler 22, 24
Wigner coefficients 291, 297
 see Clebsch-Gordan coefficients
Wigner–Eckart theorem 343–5
X-rays 22, 33, 52–4, 60
yield (Auger/fluorescence) 16, 60–2, 89–90
ZEKE (zero-kinetic energy) spectroscopy 262, 264–6, 375