Epilogue

The use of low-energy spin-polarized electrons in a beam has highlighted the development of studying electron-electron interactions, electron correlations and the mechanisms of electron emission and electronic properties of surfaces. Most, if not all, of our experimental explorations have been presented in a way which demonstrates the experimental approach of how and why the sequence of steps has been made. We hope readers have been influenced in at least two ways. First, that they have been encouraged to explore quantum phenomena at the fundamental levels of symmetry, of orbital and spin angular momenta in the reaches of expanding space and time, hopefully in their own laboratory. Secondly we hope that readers have increased appreciation of the vast expanse of essential supporting knowledge in books indicated in the Preface. The collaborating theoretical knowledge of many researchers has helped our understanding of the quantum expanse underpinning the experiments and the vast many-body nature of correlation spectroscopy.

Underpinning all aspects of this book and beyond, but particularly with focal points in each word of the title of the book, are the extent of single incident-electron scattering events and two-particle correlation detection. What are the quantum definition and expectation for each observable? It was the choice of instruments, their settings and their use that determined the momentum and time (energy) of detection and hence the particle correlations. All these features are expected to be emphasized, and their limits extended, in future studies. However, observations of two electrons emerging from a surface (and/or its constituent atoms or molecules) under a single electron impact shows they are well correlated.

Those thoughts are evolving with the present interpretations of modern quantum mechanics. For electron scattering by another electron the concept of their spatial and temporal interaction expands because of their Coulomb charge and its range. The concept of non-locality is satisfying measurements and ideas of "quantum entanglement".

If the basic concept of a single atom include an infinity of virtual harmonic oscillators how is the spatial and temporal development and observation of double

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and multiple photon observation explained? How are the ideas developed for single and multiple electron emission from an atom, molecule or surface of a metal, semiconductor or insulator, and perhaps in coincidence with one of more photons? What are the geometric or topological paths for all particles as they follow some 'impact particle perturbed' potential until "free"? What are the smallest spatial and time scales to observe a spin exchange, or a spin-orbit interaction? How do the quantum mechanisms and observable characterizations change from a localized atom to an extended thin film on a magnetic surface?

Nevertheless, within the present experimental limits of some pico- and even atto-seconds with photon assistance, our experiments "observe' that imagined events acquire reality and allow multiple correlations in space and time. It is hoped that readers will question our observations and seek further experimental and theoretical evidence and interpretations and contribute to the knowledge and applications of quantum physics.

The authors: Perth and St. Petersburg. February 2018.

Index

Symbols
(e, 2e) selection rules, 188
(e, 2e) spectroscopy, 1
(p, ep) energy sharing, 213
(p, ep) reaction, 213
(SPe, 2e), 165
(γ, 2e) experiment, 208
(γ, 2e) spectra, 209

A
Accidental coincidences, 219
Adatom–adatom interactions, 134
Adsorbate state, 50
Adsorption of oxygen, 82, 138
Anisotropy of spin-orbit coupling, 121
Antiparallel spins, 186
Arrival time difference, 217
Asymmetric distributions, 34
Asymmetric energy sharing, 77
Asymmetries of the sharing distributions, 122
Asymmetry of elastic scattering, 99
Asymmetry of SPEELS, 140
Asymmetry of the spectral density function, 162
Asymmetry of the Stoner excitations, 141
A two-step model, 44
Au(111) and Cu (111) comparison, 73
Au(111) film on W(110), 125, 128
Au/Fe double-layer, 168
Au/Fe/W(110), 165
Azimuthal angles, 194
Azimuthal dependence, 122
Azimuthal position, 127, 148
Azimuthal rotation, 177

B
Background, 21
Background measurement, 21
Back-reflection, 6
Back-reflection (e,2e) processes, 48
Band structure, 179
Bandgap E_g, 65
Binary collision, 35
Binary electron-electron collision, 161
Binding energy, 46, 60, 135
Binding energy spectrum, 117, 119, 150, 126
Binary interaction, 81
Bloch spectral density function, 162
Bloch spectral functions, 112, 145
Bloch waves, 106
Bound electron, 128
Breaking of symmetry, 147
Broadened diffraction condition, 42
Bulk Bloch waves, 103

C
Central potential, 108
Centre-of-mass frame, 108
Centre of mass wave vector, 37
Circularly polarized light, 26
Co film, 153
Co film on W(110), 155, 160, 161, 163
Co/Ni/W(110), 158
Coincidence, 8
Coincidence spectroscopy, 1
Collective modes, 64
Collision dynamics, 82
Concept of a quasiparticle, 131
Correlated double electron capture, 221

S. Samarin et al., *Spin-Polarized Two-Electron Spectroscopy of Surfaces*, Springer Series in Surface Sciences 67, https://doi.org/10.1007/978-3-030-00657-0

Correlated electron, 8
Correlated electron dynamics, 216, 221
Correlated electron pairs, 3, 39, 55, 136
Correlated pair, 19
Correlated pairs distribution, 218
Correlation depletion zone, 180
Correlation energy, 208
Correlation function, 174
Correlation time, 215, 216
Correlation-induced hole, 175
Coulomb interaction, 172
Coulomb potential, 174
Coulomb repulsion, 208
Crystal of LiF, 172
Crystal symmetry, 175
Crystallographic axis, 148
Cs deposition, 26
Cu(001) and Ni (001) comparison, 77
Cu(111) and Cu(001) comparison, 76
Curie temperature, 148, 164

D
De-coherence, 175
De-coherence channel, 177
Decaying plane waves, 103
Degree of polarization, 28, 89, 94, 102, 113, 140, 150
Densities of states, 77
Density functional method, 82
Density matrix, 90, 112
Density of states, 73, 135, 209
Density of the target, 204
Density operator, 112
Depletion zone, 177, 207
Detection solid angles, 115
Dielectric function, 58
Different screening length, 81
Differential cross section, 101
Diffracted beams, 35
Diffracted correlate pairs, 40
Diffraction condition, 39
Diffraction of a quasi-particle, 37
Diffraction of correlated electron pairs, 127, 132
Diffraction of the pairs, 37
Diffraction pattern, 55
Diffraction peaks, 38
Dipole transition amplitude, 207
Dipole–dipole interaction, 120
Dirac equation, 95
Direct ionization, 62
Direct scattering, 142
Direct scattering amplitude, 94
Direction of magnetization, 148
Distinguishable particles, 182
Double electron photoemission, 209
Double ionization energy, 219
Double Photo-Emission (DPE), 203, 208, 209
Double photoemission measurements, 205

E
Earth's magnetic field, 14
Easy magnetization axis, 120
Effective quasiparticle potential, 172
Elastic scattering amplitudes, 105
Electron affinity χ, 65, 67
Electron-electron correlation function, 36, 174
Electron-electron interaction, 55
Electron-electron scattering, 64
Electron ejection, 62
Electron momenta, 175
Electron momentum distribution, 45
Electron pair correlation, 172
Electron-pair current, 54
Electron pair diffraction, 36, 39
Electron pair emission, 51, 113
Electronic correlation, 36, 110, 204
Electronic structure, 72
Electronic structure calculation, 179
Emission features, 58, 59, 62
Energy conservation, 57
Energy loss structures, 58, 60, 62
Energy-momentum space of the valence band, 128, 161
Energy sharing, 23
Energy sharing distribution, 23, 35, 50, 54, 77, 117
Enhances asymmetry, 163
Entanglement, 182
  creation by interaction, 183
  degree, 189
  of the pair, 189
  of the spin states, 95
Escape depth, 174
  of electron pairs, 205
Exact flight distance, 18
Exchange, 87
Exchange induced asymmetry, 144
Exchange-correlation hole, 168, 209
Exchange and correlation, 180
  contribution to exchange-correlation hole, 179
Exchange and Coulomb correlation, 171, 180
Exchange and spin–orbit interactions, 156, 164
Exchange and spin–orbit contributions, 157
Exchange asymmetry, 109
Exchange component of asymmetry, 168
Exchange depletion zone, 180

Exchange effect, 138
Exchange interaction, 59, 102, 109, 156
Exchange process, 142
Exchange scattering, 142
  amplitude, 94
  asymmetry, 113, 144
Excitonic system, 59
Exhibiting ferromagnetic properties, 165
Experimental geometry, 117
External magnetic field, 177
External perturbation, 215

F
Fe films on W(110), 153, 178
Fermi level line, 22, 23, 111
Ferromagnetic materials, 109
Ferromagnetic surface, 30, 109
Ferromagnetic surface systems, 188
Field compensation, 15
Final two-quasiparticle state, 171
First selection rule, 82
Fixed total energies, 128
Flight time, 19
Four Bell two-particle states, 92
Four-component vector, 96

G
GaAs (001) crystal, 69
GaAs crystal, 26
Gd layer on W(110), 71
Good quantum number, 117
Grazing geometry of scattering, 45

H
Helmholtz coils, 14, 15
Hybridization at the interface, 167
Hybridization of *O(2p)* and *W(5d)* states, 138

I
Incident positron, 211
Independent neutralization steps, 220
Induce a magnetic moment, 167
Induced magnetic moment of Au, 168
Inelastic scattering, 30
Initial two-quasiparticle state, 171
Intensities of elastic maxima, 98
Interchange of the outgoing electrons, 138
Interface anisotropy, 120
Intraband transitions, 58
Iron film on W(110), 148

K
K_x-distributions, 131
Kinetic energies of electrons, 208

L
Larger orbital momentum, 128
Larger spin orbit asymmetry, 128
Large-Z materials, 116
Left-right symmetry, 99, 122
LiF and Ag on Si(001) crystal, 72
Lippmann-Schwinger equation, 172
Local Density Approximation (LDA), 170

M
Magnetic anisotropies of Fe/W and Fe/Mo, 120, 121
Magnetic asymmetry, 145
Magnetic circular dichroism, 165
Magnetization, 148
Magnetization direction, 111
Magnetoelastic effect, 121
Majority and minority electrons, 142, 145
Majority states, 142
Majority type, 180
Many-body system, 110
Maximal entanglement, 187
Measured asymmetry, 99, 113
Mechanism of the pairs' generation, 217
MgO crystal, 71
Micro-Channel Plates (MCPs), 11
Minority bands, 145
Minority states, 142
Mirror symmetry plane, 32
Mo 4d electrons, 121
Model metal films, 120
Model of the (e,2e) reaction, 103
Modification of the valence states, 138
Momentum components, 48
Momentum conservation law, 47, 161
Momentum density spectroscopy, 6
Momentum distribution, 48
Momentum exchange, 37
Momentum of the centre of mass, 204
Momentum sharing distribution, 42
Momentum transfer, 60
Momentum uncertainty, 48
Momentum-space pair correlation, 172
Multi-particle interaction, 81
Multi-step collisions, 31, 117
Multi-step contribution, 156
Multi-step scattering, 8, 35, 135

N
Negative affinity, 24
Negative electron affinity, 65
Neutralization rates, 220
Ni buffer layer, 161, 163
Nonlocal quantum correlations, 184

Nonmagnetic systems, 188
Normal and off-normal incidence, 32, 161
Normal incidence, 42, 119
Normalisation, 21

O
Occupied electronic states, 176
Occupied two-electron states, 211
Off-normal incidence, 20, 32, 80, 118, 119, 132, 213
One step events, 208
One-electron spectroscopy (EELS), 66
One-electron states, 104
Orbital angular momentum, 97, 131
Order–disorder transitions, 134
Oxidized tungsten, 135
Oxygen adsorption, 46, 49
on W(110), 133
Oxygen covered W(100) surface, 46, 138
Oxygen layer, 136
Oxygen-tungsten interaction, 134

P
Pair correlation function, 170
Pair diffraction, 39, 54
Parallel to the surface component, 80
Pauli exclusion principle, 107, 168
Pauli spin matrix, 88
Penetration depth, 43
Photoelectron spectroscopy, 157
Plasma frequency, 59
Plasmon and the phonon fields, 36
Plasmon decay, 57
Plasmon energies, 59
Plasmon excitation, 56
Plasmon-assisted channel, 62
Plasmon-assisted secondary electron emission, 62
Poisson statistics, 2
Polarization of a state, 92
Polarization vector, 28, 92, 111, 204
Polarization vector components, 93
Polarized electron beam, 111, 204
Polarizer, 27
Position of the valence electron, 179
Position sensitive detector, 12, 20
Positron scattering, 211
Positron–electron pair, 213
Preferred direction of magnetization, 158
Probability of excitation of surface and bulk states, 125
Probing depth, 43
Projection of the polarization vector, 93
Propensity rule, 207
Proximity effect, 165
Pulsing unit, 10
Pure spin state, 89

Q
Quantum correlations, 183, 189
Quantum information processing, 177

R
Reciprocal lattice vector, 42
Reduced charge density, 170
Reflection (2.2b) geometries, 6
Reflection coefficient, 194
Relativistic LEED state, 103
Remanent magnetization, 149, 164
Repulsive Coulomb interaction, 168
Residual magnetic field, 11
Role of d-states, 116

S
Sample magnetization, 140
Sample's magnetic asymmetry, 144
Scattered electron polarization, 190
Scattering amplitude, 92
Scattering angle, 93
Scattering dynamics, 117
Scattering from ferromagnetic, 139
Scattering plane, 48, 204
Screened Coulomb interaction, 171
Screened Coulomb potential, 37
Screening length, 80
Screening potentials, 81
Second selection rule, 83
Selected Azimuthal orientations, 196
Selection rule, 194, 204
Sequential and simultaneous, 215
Shape of the surface barrier, 137
Sharing distributions, 119
Sherman function, 102
Shockley surface states, 76, 125
Shockley-type surface states, 73
Sign of asymmetry, 130
Signature of entanglement., 189
Simultaneous excitation of two electrons, 205
Single crystal target, 135
Single domain, 149
Single-electron spectroscopy, 162
Single excitation, 220
Single- and multi-step scattering, 30
Single-particle excitation, 62
Single photoemission, 208
of a quasiparticle, 204
Single-photon absorption, 203
Single Slater determinant, 183

Single-step process, 30
Single-step electron-electron collision, 177
Single step two-electron collisions, 117
Singlet and triplet channels, 132
Singlet channel, 83
Singlet state, 108
Six-dimensional array, 17, 18
Slater determinants, 183
Spectral density function, 113
Spin and orbital momentum, 95
Spin asymmetry, 107, 111, 113
  of the sharing distribution, 128
Spin-density matrix, 90, 91
Spin-dependent cross section, 82
Spin-dependent electron scattering, 88
Spin-dependent interactions, 3
Spin detector, 194
Spin-down polarization, 98
Spin entanglement, 196
Spin-entangled state, 184
Spin-filter effect, 137
Spin-flip amplitude, 101
Spin-integrated density of states, 155
Spin-orbit and exchange contributions, 152
Spin-orbit asymmetry, 102, 128
Spin-orbit contribution, 151
Spin-Orbit Coupling (SOC), 106, 107, 120
Spin-orbit effect, 95
Spin-Orbit Interaction (SOI), 87, 97, 102, 113, 116
Spin-orbit symmetry, 136
Spin-polarised (e,2e) spectroscopy, 107
Spin-polarised LEED, 106
Spin-polarized electron, 24, 87
Spin-polarized incident electrons, 112
Spin polarization, 112
  of the emitted electrons, 193
Spin-polarizing mirror, 193
Spin Reorientation Transition (SRT), 120
Spin-resolved densities of states, 141, 142
Spin-resolved sharing distributions, 142
Spins orientation, 194
Spin-up incident beam polarization, 98
Stable ferromagnetic surface, 168
Stoner density of states, 161
Stoner excitation, 140, 149
Stoner excitation asymmetry, 109, 149, 150, 160
Strain in the film, 121
Strained GaAs, 25
Strong quantum correlation, 191
Sufficient condition for entanglement, 194
Superlattice of oxygen, 50
Surface and bulk anisotropy, 120
Surface barrier, 137
Surface Brillouin zone, 114
Surface potential barrier, 138
Surface sensitivity, 43, 44, 46
Surface states, 46
Surface-parallel momentum, 103
Symmetric experimental conditions, 114
Symmetrised wavefunction, 108
Symmetry of the energy sharing distributions, 79
Symmetry property, 107
System responds, 216

T
Tail of accidental coincidences, 2
Thomas-Fermi screening, 82
Three-electron Auger decay, 221
Time correlated electron pairs, 1
Time difference, 2
Time evolution, 215
Time resolution, 9
Time-correlated electrons, 170
Time-difference distribution, 3
Time-Of-Flight (TOF), 1, 12
Time-reversed LEED states, 103
Time-to-Amplitude Converter (TAC), 10
Top most atomic layer, 142
Total Current Spectroscopy (TCS), 66
Total energy distribution, 50, 117
Total momentum, 131
Total momentum of the pair, 40, 118
Totally entangled pairs, 189
Total polarisation, 90
Total spin of the pair, 131
Total wave vector of the pair, 39
Transition amplitude, 37, 52
Transversely polarized electron, 28
Triplet channel, 145
Triplet cross-section, 40, 83, 132
Triplet state, 109
True coincidences, 2
True secondary electrons, 127
Two-dimensional distribution of correlated electron pairs, 128
Two-dimensional energy distribution, 60, 218
Two-electron correlation spectroscopy, 3
Two-electron Green function, 185
Two-electron interaction potential, 185
Two-electron spectroscopy (e,2e), 66
Two-fold symmetry, 122, 124
Two neutralization steps, 220
Two opposite magnetizations, 150
Two-particle/density matrix, 173
Two-step model, 46

U
Ultimate polarization, 25
Up-down spin-asymmetry, 109

V
Vacuum level, 22
Valence band Δ, 65
Valence band width, 67
Valence electron momentum, 156
Valence electron state, 112
Von Neumann entropy, 183, 193

W
W 5d electrons, 121
W(100) surface, 132
W(110), 148
W(110)/O system, 135
W(5d)-O(2p) hybridized orbitals, 135
Wave function, 100
Wave function symmetry, 109
Wave vector of the pair, 35
Width of the diffraction peaks, 39
Work function of the surface, 205

X
Xc hole, 170, 174, 177, 180