- J.L. (1977). "Differential energy-loss cross sections for ionization of atomic hydrogen by 25–200-keV protons," *Phys. Rev. A* **15**, 508–16.
- PEDERSEN, J.O., HVELPLUND, P., PETERSEN, A.G., and FAINSTEIN, P.D. (1990). "Two-centre effects in electron emission from the impact of fast multiply charged projectiles on helium," J. Phys. B. 23, L597-L603.
- PEDERSEN, J.O., HVELPLUND, P., PETERSEN, A.G., and FAINSTEIN, P.D. (1991). "Two-centre effects in ejected-electron spectra from ionization of helium atoms in collisions with fast, fully stripped ions," *J. Phys. B.* **24**, 4001–16.
- Peterson, W.K., Beaty, E.C., and Opal, C.B. (1972). "Measurements of energy and angular distributions of secondary electrons produced in electron-impact ionization of helium," *Phys. Rev. A* 5, 712–23.
- PLATTEN, H. (1986). "Untersuchung der Elektronenemission bei Stössen von C⁶⁺, O⁸⁺ und Ne¹⁰⁺ mit Helium und Argon," Ph.D. Thesis, (Freie Universität, Berlin).
- PLATTEN, H., SCHIWIETZ, G., SCHNEIDER, T., SCHNEIDER, D., ZEITZ, W., MUSIOL, K., ZOUROS, T.J.M., KOWALLIK, R., AND STOLTERFOHT, N. (1987). "Evidence for polarization effects in the observation of directly ionized electrons in bare-ion helium collisions," pages 437–38 in XVth International Conference on the Physics of Electronic and Atomic Collisions, Abstracts, Geddes, J., Gilbody, H.B., Kingston, A.E., Latimer, C.J., and Walters, H.J.R., Eds. (North-Holland, Amsterdam).
- Poll, H.U., Winkler, C., Margreiter, D., Grill, V., and Märk, T.D. (1992). "Discrimination effects for ions with high initial kinetic energy in a Nier-type ion source and partial and total electron ionization cross sections of CF₄," *Int. J. Mass Spectrom. Ion Proc.* **112**, 1–17.
- POOLE, R.T., JENKIN, J.G., LIESEGANG, J., and LECKEY, R.C.G. (1975). "Electronic band structure of the alkali halides. I. Experimental parameters," *Phys. Rev. B* 11, 5179–89.
- QUINN, J.J. (1962). "Range of excited electrons in metals," Phys. Rev. 126, 1453-57.
- RAPP, D. and ENGLANDER-GOLDEN, P. (1965). "Total cross section for ionization and attachment in bases by electron impact," *J. Chem. Phys.* **43**, 1464–79.
- RAPP, D., ENGLANDER-GOLDEN, P., and BRIGLIA, D.D. (1965). "Cross sections for dissociative ionization of molecules by electron impact," *J. Chem. Phys.* 42, 4081–85.
- Reinhold, C.O. and Burgdörfer, J. (1993). "The classical limit of ionization in fast ion-atom collisions," J. Phys. B 26, 3101–22.
- REINHOLD, C.O., SCHULTZ, D.R., and OLSON, R.E. (1990a). "Theoretical description of the binary

- peak in clothed ion-atom collisions," *J. Phys. B* 23, L591–L596.
- REINHOLD, C.O., SCHULTZ, D.R., OLSON, R.E., To-BUREN, L.H., AND DUBOIS, R.D. (1990b). "Electron emission from both target and projectile in C⁺ + He collisions," *J. Phys. B* **23**, L297–L302.
- RESTER, D.H. and DERRICKSON, J.H. (1970). "Electron backscatter measurements for perpendicular incidence at 1.0 MeV bombarding energy," *Nucl. Instrum. Methods* 86, 261–67.
- RICHARD, P., LEE, D. H., ZOUROS, T. J. M., SANDERS, J. M., and SHINPAUGH, J. L. (1990). "Anomalous q-dependence of 0° binary encounter electron production in energetic collisions of F^{q+} (q=3-9) with He and H₂ targets," J. Phys. B 23, L213–L218.
- RIEKE, F.F. and PREPEJCHAL, W. (1972). "Ionization cross sections of gaseous atoms and molecules for high-energy electrons and positrons", *Phys. Rev. A* 6, 1507–19.
- ROPTIN, D. (1975). "Etude expérimentale de l'émission électronique secondaire de l'aluminium and de l'argent," Thesis (University of Nantes, France) pp. 1–97.
- RÖSLER, M. (1994). "Plasmon effects in the particle induced kinetic electron emission from solids," Scan. Micr. 8, 3–22.
- RÖSLER, M. and BRAUER, W. (1988). "Theory of electron emission from solids by proton and electron bombardment," *Phys. Stat. Sol.* (b) 148, 213–26.
- RÖSLER, M. and BRAUER, W. (1991). "Theory of electron emission from nearly-free-electron metals by proton and electron bombardment," pages 1-65 in Particle-Induced Electron Emission I, Vol. 122 of Springer Tracts in Modern Physics (Springer-Verlag, Berlin).
- Rossi, H.H. (1968). "Microscopic energy distributions in irradiated matter," pages 43-92 in *Radiation Dosimetry*, Vol. 1, Attix, F.H., Roesch, W.C., and Tochilin, E., Eds. (Academic Press, New York).
- ROSSI, H.H. and ZAIDER, M. (1992). "Compound dual radiation action," *Radiat. Res.* 132, 178–83.
- ROSSI, H.H. and ZAIDER, M. (1995). Microdosimetry and its Applications (Springer-Verlag, New York).
- ROTHARD, H. (1995). "Swift heavy ion induced electron emission," Scan. Micr. (to be published).
- ROTHARD, H. and BURKHARD, M. (1988), "The influence of solid surfaces on low-energy convoy electron emission," J. Phys. C 21, 5033–39.
- ROTHARD, H., KRONEBERGER, K., SCHOSNIG, M., LORENZEN, P., VEJE, E., KELLER, N., MAIER, R., KEMMLER, J., BIEDERMANN, C., ALBERT, A., HEIL, O., AND GROENEVELD, K.-O. (1990). "Secondary-electron velocity spectra and angular distributions from ions penetrating solids," Nucl. Instrum. Methods B 48, 616–20.
- ROTHARD, H., SCHOU, J., and GROENEVELD, K.-O. (1992). "Projectile- and charge-state- dependent

- electron yields from ion penetration of solids as a probe of preequilibrium stopping power," *Phys. Rev. A* **45**, 1701–10.
- RUDD, M.E. (1979). "Energy and angular distributions of secondary electrons from 5–100– keV proton collisions with hydrogen and nitrogen molecules," *Phys. Rev. A* **20**, 787–96.
- RUDD, M.E. (1988). "Differential cross sections for secondary electron production by proton impact," *Phys. Rev. A* **38**, 6129–37.
- RUDD, M.E. (1991). "Differential and total cross section for ionization of helium and hydrogen by electrons," *Phys. Rev. A* 44, 1644–52.
- RUDD, M.E. and JORGENSEN, T. Jr. (1963). "Energy and angular distribution of electrons ejected from hydrogen and helium gas by protons," *Phys. Rev.* **131**, 666–75.
- Rudd, M.E. and Gregoire, D. (1969). "Energy distribution of electrons from ionization of helium and hydrogen by proton collisions: Comparison of classical theories and experiment," pages 795–800 in *Physics of One- and Two-Electron Atoms*, Bopp, F. and Kleinpoppen, H., Eds. (North-Holland, Amsterdam).
- RUDD, M.E. and MACEK, J.H. (1972). "Mechanisms of electron production in ion-atom collisions," in *Case Studies in Atomic Physics*, McDowell, M.R.C. and McDaniel, E.W., Eds. 3, 47–136.
- RUDD, M.E. and MADISON, D.H. (1976). "Comparison of experimental and theoretical electron ejection cross sections in helium by proton impact from 5 to 100 keV," *Phys. Rev. A* 14, 128–35.
- Rudd, M.E. and DuBois, R.D. (1977). "Absolute doubly differential cross sections for ejection of secondary electrons from gases by electron impact. I. 100— and 200—eV electrons on helium," *Phys. Rev. A* 16, 26–32.
- RUDD, M.E., JORGENSEN, T. JR., and VOLZ, D.J. (1966a). "Electron energy spectra from Ar⁺—Ar and H⁺—Ar collisions," *Phys. Rev.* **151**, 28–31.
- RUDD, M.E., SAUTTER, C.A., and BAILEY, C.L. (1966b). "Energy and angular distributions of electrons ejected from hydrogen and helium by 100— to 300-keV protons," *Phys. Rev.* 151, 20–27.
- RUDD, M.E., GREGOIRE, D., and CROOKS, J.B. (1971). "Comparison of experimental and theoretical values of cross sections for electron production by proton impact," *Phys. Rev. A* 3, 1635–40.
- RUDD, M.E., TOBUREN, L.H., and STOLTERFOHT, N. (1976). "Differential cross sections for ejection of electrons from helium by protons," At. Data Nucl. Data Tables 18, 413–32.
- RUDD, M.E., TOBUREN, L.H., and STOLTERFOHT, N. (1979). "Differential cross sections for ejection of electrons from argon by protons," At. Data and Nucl. Data Tables 23, 405-442.
- RUDD, M.E., RISLEY, J.S., FRIAR, J., and ROLFES, R.G. (1980). "Angular and energy distribution of elec-

- trons from 15 to 150 keV H^o + He collisions," *Phys. Rev.* A 21, 506–14.
- RUDD, M.E., KIM, Y.-K., MADISON, D.H., and GALLA-GHER, J.W. (1985a). "Electron production in proton collisions: total cross sections," *Rev. Mod. Phys.* 57, 965–94.
- RUDD, M.E., GOFFE, T.V., DUBOIS, R.D., and TOBUREN, L.H. (1985b). "Cross sections for ionization of water vapor by 7–4000 keV protons," *Phys. Rev.* A 31, 492–94.
- Rudd, M.E., Kim, Y.-K., Madison, D.H., and Gay, T.J. (1992). "Electron production in proton collisions with atoms and molecules: Energy distributions," *Rev. Mod. Phys.* **64**, 441–90.
- Rudd, M.E., Hollman, K.W., Lewis, J.K., Johnson, D.L., Porter, R.R., and Fagerquist, E.L. (1993). "Doubly differential electron-production cross sections for 200–1500-eV e⁻ +H₂ collisions," *Phys. Rev. A* 47, 1866–73.
- RUDGE, M.R.H. (1968). "Theory of the ionization of atoms by electron impact," Rev. Mod. Phys. 40, 564-90.
- RUTHERFORD, E. (1911). "The scattering of α and β particles by matter and the structure of the atom," *Phil. Mag.* 21, 669–88.
- Salin, A., (1969). "Ionization of atomic hydrogen by proton impact," J. Phys. B 2, 631-39.
- Salin, A. (1972). "Ionization of helium by proton impact," J. Phys. B 5, 979-86.
- SALZBORN, E. and MÜLLER, A. (1986). "Transfer ionization in collisions of multiply charged ions with atoms," pages 357-402 in *Atomic Processes in Electron-Ion and Ion-Ion Collisions*, F. Brouillard, Ed., NATO Series B, Physics, vol. 145 (Plenum Press, New York).
- SAMUEL, A.H. and MAGEE, J.L. (1953). "Theory of radiation chemistry. II. Track effects in radiolysis of water," *J. Chem. Phys.* 21, 1080–87.
- SANCHE, L. (1990) "Low-energy scattering from molecules on surfaces," J. Phys. B 23, 1597–1624.
- SANCHE, L. (1991). "Primary interactions of low energy electrons in condensed matter," pages 1–42 in *Excess Electrons in Dielectric Media*, Ferradini, C. and Jay-Gerin, J.P., Eds. (CRC Press, Boca Raton, Florida).
- SANCHE, L., MÄRK, T.D., and HATANO, Y. (1995). "Low energy electron interaction with condensed matter," in IAEA-Report: Atomic and Molecular Data for Radiotherapy, TECDOC (International Atomic Energy Agency, Vienna, Austria), in press.
- Sataka, M., Okuno, K., Urakawa J., and Oda, N. (1979a). "Doubly differential cross sections of electron ejection from argon by 5–20 keV H⁺, H₂⁺, and He⁺," pages 620–21 in Abstracts of the XI International Conference on the Physics of Electronic and Atomic Collisions, Takanagi, K. and Oda, N., Eds. (Society of Atomic Collision Research, Japan).
- SATAKA, M., URAKAWA, J., and ODA, N. (1979b).

- "Measurements of double differential cross sections for electrons ejected from 5–20 keV H⁺, H₂⁺, and He⁺ impacts on argon," *J. Phys. B* **12**, L729–L734.
- Schiwietz, G. (1993). "Electron ejection induced by heavy particles," pages 197–214 in *Ionization of Solids by Heavy Particles*, Baragiola, R., Ed. NATO-ASI series B, Vol. 306 (Plenum Press, New York).
- Schiewietz, G., Schneider, D., Biersack, J.P., Stolterfoht, N., Fink, D., Mattis, A., Skogvall, B., Altevogt, H., Montemayor, V., and Stettner, U. (1988). "Cascade-induced asymmetry in Augerelectron emission following fast ion-solid interactions," *Phys. Rev. Lett.* **61**, 2677–80.
- Schiwietz, G., Bierscak, J.P., Schneider, D., Stolterfoht, N., Fink, D., Montemayor, V.J. and Skogvall, B. (1990). "Investigation of electron emission in collisions of highly charged fast Ne projectiles with carbon-foil targets," *Phys. Rev. B* 41, 6262–71.
- Schneider, D., DeWitt, D., Schlachter, A.S., Olson, R.E., Graham, W.G., Mowat, J.R., DuBois, R.D., Loyd, D.H., Montemayor, V., and Schiwietz, G. (1989). "Strong continuum-continuum couplings in the direct ionization of Ar and He atoms by 6– MeV/u U³⁸⁺ and Th³⁸⁺ projectiles," *Phys. Rev. A* 40, 2971–75.
- Schneider, D., Dewitt, D., Bauer, R.W., Mowat, J.R., Graham, W.G., Schlachter, A.S., Skogvall, B., Fainstein, P. and Rivarola, R.D. (1992). "Absolute doubly differential cross sections for electron emission in collisions of 3.5 MeV/u Fe¹⁷⁺ and Fe²²⁺ ions with He and Ar gas targets," *Phys. Rev. A* 46, 1296–1302.
- Schou, J. (1980). "Transport theory for kinetic emission of secondary electrons from solids," *Phys. Rev.* B 22, 2141–74.
- Schou, J. (1988). "Secondary electron emission from solids by electron and proton bombardment." Scan. Micr. 2, 607–32.
- Schou, J. (1993). "Secondary electron emission from insulators," pages 351–58 in *Ionization of Solids by Heavy Particles*, Baragiola, R., Ed., NATO-ASI, series B, Vol. 306, (Plenum Press, New York).
- Schou, J. (1995). "Electron emission from solids," in *Physical Processes of the Interaction of Fusion Plasmas with Solids*, Hofer, W.O. and Roth, J., Eds. (Academic Press, Cambridge, USA) to be published. (Available as Risø-Report Risø-I-588(EN) (Rev.1), Risø National Laboratory, Risø, Denmark, 1993).
- SCHRAM, B.L., DE HEER, F.J., VAN DER WIEL, M.J., and KISTEMAKER, J. (1965). "Ionization cross sections for electrons (0.6–20 keV) in noble and diatomic gases," *Physica* **31**, 94–112.
- SCHRAM, B.L., MOUSTAFA, H.R., SCHUTTEN, J., and DE HEER, F.J. (1966a). "Ionization cross sections for electrons (100–600 eV) in noble and diatomic gases," *Physica* 32, 734–40.

- SCHRAM, B.L., VAN DER WIEL, M.J., DE HEER, F.J., and MOUSTAFA, H.R. (1966b). "Absolute gross ionization cross sections for electrons (0.6–12 keV) in hydrocarbons," J. Chem. Phys. 44, 49–54.
- SCHRAM, B.L., BOERBOOM, J.H., and KISTEMAKER, J. (1966c). "Partial ionization cross sections of noble gases for electrons with energy 0.5–16 keV," *Physica* 32, 185–96.
- SCHULTZ, D.R. and OLSON, R.E. (1991). "Binary peak enhancement and structure in partially stripped ion-atom collisions," J. Phys. B 24, 3409-32.
- SCHUTTEN, J., DE HEER, F.J., MOUSTAFA, H.R., BORR-BOOM, A.J.H., and KISTEMAKTER, J. (1966) "Gross and partial-ionization cross sections for electrons on water vapor in the energy range 0.1–20 keV," J. Chem. Phys. 44, 3924–28.
- SELLIN, I.A., "Electron capture and loss to continuum," pages 195–221 in *Physics of Electronic and Atomic Collisions*, S. Datz, Ed. (North-Holland, Amsterdam).
- SENGER, B., WITTENDORP, E., and RECHENMANN, R.V. (1978). "δ-ray production along medium energy of particles crossing tissue-like media," pages 361-74 in Vol. 1 of *Proc. 6th Symp. on Microdosimetry*, EUR. 6064, Harwood Acad.
- SENGER, B., WITTENDORP-RECHENMANN, E., and RECHENMANN, R.V. (1982). "Ionization cross-sections in the case of medium and low energy heavy charged particles crossing complex media," *Nucl. Instrum. Methods* **194**, 437–41.
- SETHURAMAN, S.K., REES, J.A., and GIBSON, J.R. (1972). Differential scattering of electrons by helium, Report of the University of Liverpool, Dept. of Electrical Engineering and Electronics (Liverpool, England).
- SEVIER, K.D. (1972). Low Energy Electron Spectrometry. (Wiley-Interscience, New York). See pages 17–32.
- SHAH, M.B., ELLIOTT, D.S., and GILBODY, H.B. (1987). "Pulsed crossed-beam study of the ionisation of atomic hydrogen by electron impact," *J. Phys. B* **20**, 3501–14.
- SHAH, M.B., ELLIOTT, D.S., McCallion, P., and GILBODY, H.B. (1988). "Single and double ionization of helium by electron impact," J. Phys. B 21, 2751–61.
- SHANKER, R., WERNER, U., BILAU-FAUST, R., HIPPLER, R., and WILLE, U. (1989). "Coincidence studies of quasimolecular electron emission in 700-keV Ar²⁺—Kr collisions," *Phys. Rev. A* **40** 2335–39.
- SHIMAMURA, I. (1989). "Cross sections for collisions of electrons with atoms and molecules," Sc. Pap. Inst. Phys. Chem. Research (Jp) 82, 1–51.
- Shimizu, R. and Ichimura, S. (1983). "Direct Monte Carlo simulation of scattering processes of kV electrons in aluminum; Comparison of theoretical N(E) spectra with experiment," Surf. Sci. 133, 250–66.
- SHINGAL, R., CHEN, Z., KARIM, K. R., LIN, C-D., and

104

- Bhalla, C. P., (1990). "Charge-state dependence of elastic scattering cross sections at large angles between electrons and multiply charged ions," *J. Phys. B* **23**, L637–L640.
- Shinpaugh, J.L., Wolff, W., Wolf, H.E., Ramm, U., Jagutzki, O., Schmidt-Bocking, H., Wang, J., and Olson, R.E. (1993). "Transition from quantum to quasi-classical behaviour of the binary encounter peak in collisions of 0.6 to 3.6 MeV/u I²³⁺ and Xe²¹⁺ with He and Ar," J. Phys. B **26**, 2869–78.
- SHYN, T.W. (1983). "Doubly differential cross sections of secondary electrons ejected from gases by electron impact: 50–400 on N₂," *Phys. Rev. A* 27, 2388–95.
- SHYN, T.W. (1992). "Doubly differential cross sections of secondary electrons ejected from atomic hydrogen by electron impact," *Phys. Rev. A* 45, 2951–56.
- SHYN, T.W. and SHARP, W.E. (1979a). "Doubly differential cross sections of secondary electrons ejected from gases by electron impact: 50–300 eV on helium," *Phys. Rev. A* 19, 557–67.
- SHYN, T.W. and SHARP, W.E. (1979b). "Doubly differential cross sections of secondary electrons ejected from gases by electron impact: 50–400 eV on CO₂," *Phys. Rev. A* 20, 2322–39.
- SHYN, T.W. and SHARP, W.E. (1991). "Doubly differential cross sections of secondary electrons ejected from molecular oxygen by electron impact," *Phys. Rev. A* **43**, 2300–05.
- SHYN, T.W., SHARP, W.E., and KIM, Y.-K. (1981). "Doubly differential cross sections of secondary electrons ejected from gases by electron impact: 25–250 eV on H₂," *Phys. Rev. A* **24**, 79–88.
- SIGMUND, P. (1975). "Energy loss of charged particles in solids," pages 3-117 in Radiation Damage Processes in Materials, Dupuy, C.H.S., Ed. NATO-ASI. Ser. E8 (Noordhoff Publ., Leiden, The Netherlands).
- SIGMUND, P. (1993). "Particle-induced electron emission: Open questions, pitfalls and a few attempts to answer," pages 59–78 in *Ionization by Heavy Particles*, Baragiola, R., Ed. NATO-ASI series B, Vol. 306, (Plenum Press, New York).
- SIGMUND, P. and TOUGAARD, S. (1981). "Electron emission from solids during ion bombardment," pages 2-37 in *Inelastic Particle-Surface Collisions*, Taglauer, E. and Heiland, W., Eds. (Springer, Berlin-Heidelberg).
- SMITH, P.T. (1930). "The ionization of helium, neon, and argon by electron impact," *Phys. Rev.* 36, 1293–1302.
- Sonntag, B. (1977). "Dielectric and optical properties," pages 1021–1117 in *Rare Gas Solids II*, Klein, M.L. and Venables, J.A., Eds. (Academic Press, London).
- Spekowius, G. and Brehm, B. (1991). "Cross sections and thresholds for electron impact triple and qua-

- druple ionization processes of CO, N₂, and O₂," Chem. Phys. Lett. **187**, 442–46.
- SROUBEK, Z. and FALCONE, G. (1993). "Promotion of electronic levels in bombarded solids," pages 19-25 in *In Ionization of Solids by Heavy Particles*, Baragiola, R., Ed. NATO-ASI series B, Vol. 306, (Plenum Press, New York).
- STEPHAN, K. and MÄRK, T.D. (1984). "Absolute partial electron impact ionization cross sections of Xe from threshold up to 180 eV," J. Chem. Phys. 81, 3116–17.
- STEPHAN, K., HELM, H., and MÄRK, T.D. (1980). "Mass spectrometric determination of partial electron impact ionization cross sections of He, Ne, Ar and Kr from threshold up to 180 eV," J. Chem. Phys. 73, 3763–78.
- STEPHAN, K., DEUTSCH, H., and MÄRK, T.D. (1985). "Absolute partial and total electron impact ionization cross sections for CF_4 from threshold up to 180 eV," J. Chem. Phys. 83, 5712–20.
- STOLTERFOHT, N. (1971a). "Angular and energy distribution of electrons produced by 200–500 keV protons in gases: I. Helium," Z. Phys. 248, 81–91.
- STOLTERFOHT, N. (1971b). "Angular and energy distribution of electrons produced by 200–500 keV protons in gases: I. Nitrogen," Z. Phys. 248, 92–100.
- STOLTERFOHT, N. (1978). "Excitation in energetic ion-atom collisions accompanied by electron emission," pages 155–99 in *Structure and Collisions of Ions and Atoms*, Vol. 5, Sellin, I.A., Ed. (Springer, Berlin).
- STOLTERFOHT, N. (1987). "High resolution Auger spectroscopy in energetic ion atom collisions," *Phys. Rept.* **146**, 315–424.
- STOLTERFOHT, N. (1991). "Dielectronic processes and electron correlation in energetic ion-atom collisions," Nucl. Instrum. Methods B 53, 477-92.
- STOLTERFOHT, N. and SCHNEIDER, D. (1979). "Double differential cross sections for electron emission from Ar by 50- to 500-keV N⁺ and O⁺ impact," *IEEE Trans. Nucl. Science*, Vol. NS-26, No. 1, 1130–32.
- STOLTERFOHT, N., SCHNEIDER, D., BURCH, D., WIE-MANN, H., and RISLEY, J.S. (1974). "Mechanisms for electron production in 30-MeV On+ + O₂ collisions," *Phys. Rev. Lett.* **33**, 59-62.
- STOLTERFOHT, N., SCHNEIDER, D., TANIS, J., ALTEVOGT, H., SALIN, A., FAINSTEIN, P.D., RIVAROLA, R., GRANDIN, J.P., SCHEURER, J.N., ANDRIAMONJE, S., BERTAULT, D., AND CHEMIN, J.F. (1987). "Evidence for two-centre effects in the electron emission from 25 MeV/u Mo⁴⁰⁺ + He: theory and experiment," *Europhys. Lett.* 4, 899–904.
- STREITWOLF, H.W. (1959). "Zur Theorie der Sekundärelektronen-emission von Metallen," Ann. Phys. 7, Folge 3, 183–96.
- SUÁREZ, S., GARIBOTTI, C., MECKBACH, W., and BER-NARDI, G. (1993a). "Experimental evidence of the

- asymmetry of the soft electron peak in ion-atom ionization," *Phys. Rev. Lett.* **70**, 418–21.
- Suárez, S., Garibotti, C., Bernardi, G., Focke, P., and Meckbach, W. (1993b). "Ne ionization induced by the impact of 106-keV/u H⁺ and ³He²⁺: Twocenter effects on the soft-electron emission," *Phys. Rev. A* 48, 4339–49.
- Suárez, S., Garibotti, C., Meckbach, W., and Ber-Nardi, G. (1993c). "Experimental evidence of the asymmetry of the soft electron peak in ion-atom ionization," *Phys. Rev. Lett.* **70**, 418–21.
- Syage, J.A. (1988). "Measurements of electronimpact ionization and dissociation cross sections in a crossed electron-supersonic molecular beam," *Chem. Phys. Lett.* **143**, 19–25.
- Syage, J.A. (1991). "Electron impact cross sections for multiple ionization of Ar: detector gain effects revealed," J. Phys. B 24, L527–L532.
- Syage, J.A. (1992). "Electron-impact cross sections for multiple ionization of Kr and Xe," *Phys. Rev. A* **46**, 5666–79.
- Tahira, S. and Oda, N. (1973). "Calculation of double differential cross sections for ionizing collisions of electrons with helium by Born approximation and binary encounter theory," J. Phys. Soc. Japan 35, 582–91.
- TARNOVSKY, V. and BECKER, K. (1992). "The electronimpact ionization of Ar and Kr revisited: a critical analysis of double-to-single ionization cross section ratio measurements using the fast atom-beam technique, "Z. Phys. D 22, 603–10.
- TARNOVSKY, V. and BECKER, K. (1993). "Electronimpact ionization of atoms, molecules and transient species: Current status and perspectives for the future," pages 234–48 in *Physics of Electronic* and Atomic Collisions XVIII International Conference (Aarhus University, Denmark).
- TATE, J.T. and SMITH, P.T. (1932). "The efficiencies of ionization and ionization potentials of various gases under electron impact," *Phys. Rev.* **39**, 270–77.
- TAWARA, H. and KATO, T. (1987). "Total and partial ionization cross sections of atoms and ions by electron impact," *Atomic Data Nucl. Data Tables* **36**, 167–353.
- TAWARA, H., HARRISON, H.G., and DE HEER, F.J. (1973). "X-ray emission cross sections and fluorescence yields for light atoms and molecules by electron impact," *Physica* **63**, 351–67.
- TAWARA, H., ITIKAWA, Y., NISHIMURA, H., and YOSHINO, M. (1990). "Cross sections and related data for electron collisions with hydrogen molecules and molecular ions," J. Phys. Chem. Ref. Data 19, 617–36.
- Thomas, L.H. (1927). "The effect of the orbital velocity of the electrons in heavy atoms on their stopping of α -particles," *Proc. Cambr. Phil. Soc.* **23**, 713–16.
- THOMSON, J.J. (1912). "Ionization by moving electrified particles," *Phil. Mag.* 23, 449-57.

- TILININ, I.S. (1982). "Reflection of fast electrons normally incident on a surface," Sov. Phys. JETP 55, 751-58.
- TISONE, G.C. (1972a). "Low-resolution study of the inelastic continuum of N₂," J. Chem. Phys. **56**, 108–12.
- TISONE, G.C. (1972b). "Energy-loss cross sections for 500 eV electrons in the continuum of O₂ and CO," *J. Chem. Phys.* **57**, 3686–89.
- TOBUREN, L.H. (1971). "Distributions in energy and angle of electrons ejected from molecular nitrogen by 0.3–1.7 MeV protons," *Phys. Rev. A* 3, 216–28.
- TOBUREN, L.H. (1974). "Distribution in energy and angle of electrons ejected from xenon by 0.3- to 2.0-MeV protons," *Phys. Rev.* 9, 2505–17.
- TOBUREN, L.H. (1979a). "Secondary electron emission in collisions of 1.2 MeV C⁺ ions with He, Ne, Ar, and CH₄" pages 630–31 in Abstracts of XI International Conference on the Physics of Electronic and Atomic Collisions, Takayanagi, K. and Oda, N., Eds. (The Society for Atomic Collision Research, Japan).
- Toburen, L.H. (1979b). "Differential cross sections for electron emission in heavy ion-atom collisions," pages 1056-61 in Proceedings of the Fifth Conf. on the Use of Small Accelerators, IEEE Trans. Nucl. Science NS-26.
- Toburen, L.H. (1982). "Continuum electron emission in heavy-ion collisions," pages 53–82 in *Nuclear Methods 2; High-Energy Ion-Atom Collisions*, Berenyi, D. and Hock, G., Eds. (Elsevier, New York).
- TOBUREN, L.H. (1990). "Angular distributions of electrons emitted from gases and thin foils during light ion bombardment," Scan. Micros. Suppl. 4, 239-56.
- Toburen, L.H. (1991). "Atomic and molecular physics in the gas phase," pages 51–94 in *Physical and Chemical Mechanisms in Molecular Radiation Biology*, Glass, W.A. and Varma, M.N., Eds. (Plenum Press, New York).
- TOBUREN, L.H. and WILSON, W.E. (1972). "Distributions in energy and angle of electrons ejected from molecular hydrogen by 0.3–1.5 MeV protons," *Phys. Rev. A* 5, 247–56.
- Toburen, L.H. and Wilson, W.E. (1975). "Time-of-flight measurements of low-energy electron energy distributions from ion-atom collisions," *Rev. Sci. Instr.* **46**, 851–54.
- TOBUREN, L.H. and WILSON, W.E. (1977a). "Ionization of noble gases by equal velocity He⁺, He⁺⁺, and H⁺ ions" pages 1006–07 in Abstracts of X International Conference on the Physics of Electronic and Atomic Collisions (Commissariat à l'Energie Atomique, Paris).
- Toburen, L.H. and Wilson, W.E. (1977b). "Energy and angular distributions of electrons ejected from water vapor by 0.3–1.5 MeV protons," *J. Chem. Phys.* **66**, 5202–13.
- TOBUREN, L.H. and WILSON, W.E. (1977c). "Energy

- and angular distributions of electrons ejected in the ionization of SF_6 and TeF_6 by fast protons," *J. Chem. Phys.* **67**, 4212–21.
- Toburen, L.H. and Wilson, W.E. (1979). "Differential cross sections for ionization of argon by 0.3–2-MeV He²⁺ and He⁺ ions," *Phys. Rev. A* **19**, 2214–24.
- Toburen, L.H., Manson, S.T., and Kim, Y.-K. (1978). "Energy distributions of secondary electrons. III. Projectile energy dependence for ionization of He, Ne, and Ar by protons," *Phys. Rev. A* 17, 148–59.
- TOBUREN, L.H., WILSON, W.E., and POPOWICH, R.J. (1980). "Secondary electron emission from ionization of water vapor by 0.3 to 2 MeV He⁺ and He²⁺ ions," *Radiat. Res.* **82**, 27–44.
- Toburen, L.H., Metting, N.F., Braby, L.A., Kraft, G., Scholz, M., Kraske, F., Schmidt-Böcking, H., Dörner, R., and Seip, R. (1990a). "Radial distributions of energy deposited along charged particle tracks," *Radiat. Prot. Dosim.* 31, 199–203.
- TOBUREN, L.H., DUBOIS, R.D., REINHOLD, C.O., SCH-ULTZ, D.R., AND OLSON, R.E. (1990b). "Experimental and theoretical study of the electron spectra in 66.7–350-keV/u C⁺ + He collisions," *Phys. Rev. A* 42, 5338–42.
- TÖGLHOFER, K., AUMAYR, F., KURZ, H., WINTER, H., SCHEIER, P., and MÄRK, T.D. (1993a). "Nearthreshold electron emission from slow cluster impact on clean gold," *Europhys. Lett.* **22**, 597–602.
- TÖGLHOFER, K., AUMAYR, F., KURZ, H., WINTER, H.P., SCHEIER, P., and MÄRK, T.D. (1993b). "Nearthreshold electron emission from impact of slow van der Waals clusters and fullerene ions on clean gold," J. Chem. Phys. 99, 8254–61.
- TOKORO, N. and ODA, N. (1985). "Energy and angular distributions of ejected electrons for hydrogen-cluster-ion (H_n^+ , D_n^+ , n=1-3) impacts on helium in the intermediate energy region," J. Phys. B 18, 1771–80.
- TOKORO, N., TAKENOUCHI, S., URAKAWA, J., and ODA, N. (1982). "Angular distribution of ejected electrons from 20 keV He⁺ impact on He," *J. Phys. B* **15.** 3737–43.
- Ton-That, D. and Flannery, M.R. (1977). "Cross section for ionization of metastable rare gas atoms (Ne*, Ar*, Kr*, Xe*) and of metastable N₂*, CO* molecules by electron impact," *Phys. Rev. A* 15, 517–26.
- TRABOLD, H., SIGAUD, G.M., JAKUBAβA-AMUNDSEN, D.H., KUZEL, M., HEIL, O., and GROENEVELD, K-O. (1992). "Electron capture and loss to continuum from 200 keV/u H^o and He^o projectiles colliding with He and Ar targets," Phys. Rev. A 46, 1270-78.
- Trautmann, D., Rösel, F., and Baur, G. (1985). "Fast evaluation of the relativistic ionization form factor: coordinate space formulation," *J. Phys. B.* **18**, 1167–80.
- Tung, C.J. and Ritchie, R.H. (1977). "Electron slowing-down spectra in aluminum metals," *Phys. Rev.* B 16, 4302–13.

- Tung, C.J., Ashley, J.C., and Ritchie, R.H. (1979). "Electron inelastic mean free paths and energy losses in solids: Electron gas statistical model," *Surf. Sci.* 81, 427–39.
- URAKAWA, J., TOKORO, N., and ODA, N. (1981). "Differential cross sections for ejection of electrons and dissociative ionization cross sections for 5–20 keV H₂⁺ and H₃⁺ impacts on helium," J. Phys. B **14**, L431–L435.
- VALKEALAHTI, S. (1987). "Monte Carlo and molecular dynamics simulations of near-surface phenomena," pages 1–98 in *Res. Rep.* (Department of Physics, University of Jyväskylä, Finland) 3/1987.
- Valkealahti, S. and Nieminen, R.M. (1984). "Monte Carlo calculations of keV electron and positron slowing down in solids. II," *Appl. Phys. A* **35**, 51–59.
- Valkealahti, S., Schou, J., Sørensen, H., and Nieminen, R. (1988). "Ranges and stopping power of keV electrons in the solid hydrogens," *Nucl. Instrum. Methods B* **34**, 321–31.
- Valkealahti, S., Schou, J., and Nieminen, R. (1989). "Energy deposition of keV electrons in light elements," J. Appl. Phys. 65, 2258-66.
- VARGA, P., HOFER, W., and WINTER, H. (1981). "Apparent cross sections for metastable ion production by electron impact," *J. Phys. B* 14, 1341–51.
- VARMA, M.N., BAUM, J.W., and KUEHNER, A.V. (1975). "Energy deposition by heavy ions in a 'tissue equivalent' gas," *Radiat. Res.* **62**, 1–11.
- VARMA, M.N., BAUM, J.W., and KLIAUGA, P. (1978). "Microdosimetric results obtained by proportional counter and ionization chamber methods: A comparison," pages 227–37 in *Proceedings of the 6th Symposium on Microdosimetry*, Booz, J. and Ebert, H.G., Eds. (Harwood Academic Publishers Ltd, Brussels).
- VARMA, M.N. and CHATTERJEE, A., EDS. (1994). Computational Approaches in Molecular Radiation Biology. Monte Carlo Methods (Plenum Press, New York).
- VESTAL, M. (1965). "Theoretical studies on the unimolecular reactions of polyatomic molecular ions. I. propane," J. Chem. Phys. 43, 1356–69.
- VRIENS, L. (1966). "Binary-encounter electron-atom collision theory," *Phys. Rev.* **141**, 88–141.
- VRIENS, L. (1967). "Binary-encounter proton-atom collision theory," *Proc. Phys. Soc. London* **90**, 935–45.
- VRIENS, L. (1969). "Binary encounter and classical collision theories, pages 335–98 in *Case Studies in Atomic Collision Physics I*, McDaniel, E.W. and McDowell, M.R.C., Eds. (North-Holland Publ., Amsterdam).
- VROOM, D.A. and COMEAUX, A.R. (1971). "Energy and angular distributions of secondary electrons released from nitrogen and argon by fast electrons," pages 878–79 in *Electronic and Atomic Collisions*, Abstracts of Papers of the VIIth International Con-

- ference on the Physics of Electronic and Atomic Collisions, Branscomb, L.M., Ehrhardt, H., Geballe, R. de Heer, F.J., Fedorenko, N.V., Kistemaker, J., Barat, M., Nikitin, E.E., and Smith, A.C.H., Eds. (North-Holland, Amsterdam).
- VROOM, D.A. and PALMER, R.L. (1977). "Measurement of energy distributions of secondary electrons ejected from water vapor by fast electrons," *J. Chem. Phys.* **66**, 3720–23.
- WALIGORSKI, M.P.R., HAMM, R.N., and KATZ, R. (1986).
 "The radial distribution of dose around the path of a heavy ion in liquid water," Nucl. Tracks Radiat.
 Meas. 11, 309–19.
- WANG, J., REINHOLD, C.O., and BURGDÖRFER, J. (1992). "Electron-electron interaction and two- center effects in projectile ionization at backward emission angles," *Phys. Rev. A* **45**, 4507–18.
- WANG, J., OLSON, R.E., WOLF, H., SHINPAUGH, J., WOLFF, W., and SCHMIDT-BÖCKING, H. (1993). "Dependence of binary encounter electron production on the charge state of the recoil ion," *J. Phys. B* **26**, L457–L463.
- WARTERS, R.L., HOFER, K.G., HARRIS, C.R., and SMITH, J.M. (1977). "Radionuclide toxicity in cultured mammalian cells: elucidation of the primary site of damage," Current Topics in Radiation Research Quarterly 12, 389–407.
- WENDT, H.H. and KARSTENSEN, F. (1984). "Absolute cross sections for excited Ba III states produced by single-electron impact from Ba I," *Phys. Rev.A* 29, 562–66.
- WETZEL, R.C., BAIOCCHI, F.A., HAYES, T.R., and FRE-UND, R.S. (1987). "Absolute cross section for electron-impact ionization of the rare-gas atoms by the fast-neutral-beam method," *Phys. Rev. A* **35**, 559–77.
- WILLIAMS, E.J. (1927). "The passage of α -rays and β -rays through matter," *Nature* **119**, 489–90.
- WILSON, W.E. (1972). "Stopping power partition and mean energy loss for energetic protons in hydrogen," *Radiat. Res.* **49**, 36–50.
- WILSON, W.E. (1994). "The stochastics of the positive ion penumbra," *Radiat. Res.* **140**, 375–81.
- WILSON, W.E. and TOBUREN, L.H. (1973). "Electron emission in H₂⁺—H₂ collisions from 0.6 to 1.5 MeV," *Phys. Rev. A* **7**, 1535–44.
- WILSON, W.E. and TOBUREN, L.H. (1975). "Electron emission from proton-hydrocarbon-molecule collisions at 0.3–2.0 MeV," *Phys. Rev. A* 11, 1303–08.
- WILSON, W.E. and PARETZKE, H.G. (1980). "Calculation of ionization frequency distributions in small sites," *Radiat. Res.* **81**, 326–35.
- WILSON, W.E. and PARETZKE, H.G. (1981). "Calculations of distributions of energy imparted and ionization by fast protons in nanometer sites," *Radiat. Res.* 87, 521–37.

- WILSON, W.E., MILLER, J.H., TOBUREN, L.H., and MANSON, S.T. (1984). "Differential cross sections for ionization of methane, ammonia, and water vapor by high velocity ions," J. Chem. Phys. 80, 5631–38.
- WILSON, W.E., METTING, N.F., and PARETZKE, H.G. (1988). "Microdosimetric aspects of 0.3- to 20-MeV proton tracks," *Radiat. Res.* **115**, 389–402.
- Woerlee, P.H., Gordeev, Yu.S., de Waard, H., and Saris, F.W. (1981). "The production of continuous electron spectra in collisions of heavy ions and atoms. B: Direct coupling with the continuum," J. Phys. B 14, 527–39.
- WOLF, H.E., OLSON, R.E., BECHTHOLD, U., and SCHMIDT-BÖCKING, H. (1993a). "Pronounced small-angle diffraction in the binary encounter peak in collisions of Au¹¹⁺ with H₂," J. Phys. B **26**, L65–L71.
- Wolf, H., Wolff, W., Shinpaugh, J.L., and Schmidt-B Öcking, H. (1993b). "Diffraction effects in binary encounter electron projection from collisions of partially stripped ions," *Nucl. Instrum. Methods B* **79**, 64–66.
- Wolff, W., Shinpaugh, J.L., Wolf, H.E., Olson, R.E., Wang, J., Lencinas, S., Piscevic, D., Herrmann, R., and Schmidt-Bocking, H. (1992). "Diffraction in the binary encounter electron peak observed in collisions of 0.6 MeV/u I⁷⁺, I²³⁺, and Au¹¹⁺ projectiles with He and Ar," J. Phys. B **25**, 3683–91.
- WRIGHT, H.A., MAGEE, J.L., HAMM, R.N., CHATTERJEE, A. TURNER, J.E., and CLOTTS, C.E. (1985). "Calculations of physical and chemical reactions produced in irradiated water containing DNA," *Radiat. Prot. Dosim.* 13, 1–4.
- Yarlagadda, B.S., Robinson, J.E., and Brandt, W. (1978). "Effective-charge theory and the electronic stopping power of solids," *Phys. Rev. B* 17, 3173–80.
- Younger, S.M. (1985). "Quantum theoretical methods for calculating ionization cross sections," pages 1–23 in *Electron Impact Ionization*, Märk, T.D. and Dunn, G.H., Eds. (Springer, Vienna, Austria).
- Younger, S.M. and Märk, T.D. (1985). "Semiempirical and semi-classical approximations for electron ionization", pages 24–41 in *Electron Im*pact Ionization, Märk, T.D. and Dunn, G.H., Eds. (Springer, Vienna, Austria).
- Zaider, M. (1991). "Charged particle transport in the condensed phase," pages 137–59 in *Physical and Chemical Mechanisms in Molecular Radiation Biology*, Glass, W.A. and Varma, M.N., Eds. (Plenum Press, New York).
- ZIEGLER, D.L., NEWMAN, J.H., SMITH, K.A., and STEBBINGS, R.F. (1982). "Double ionization of atomic oxygen by electron impact," *Planet. Space Sci.* **30**, 451–56.

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3	Report of Committee on Standardization of X-ray Mag
4	surements, Radiology 22, 289 (1934). Recommendations of the International Committee for Radiological Main P. II. International Committee for Radiology 22, 289 (1934).
5	diological Units, Radiology 23, 580 (1934). Recommendations of the International Committee for Ra-
	diological Units, Radiology 29 , 634 (1937).
6	Recommendations of the International Commission on Radiological Protection and of the International Com-
	mission on Radiological Units. National Burgan of
	Standards Handbook 47 (U.S. Government Printing
7	Office, Washington, D.C., 1951).
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8	Radiological Units, Radiology 62, 106 (1954).
Ü	Report of the International Commission on Radiological
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	Units and Measurements (ICRU) 1959, National Bu-
	reau of Standards Handbook 78 (U.S. Government
	Printing Office, Washington, D.C., 1961).
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	dards Handbook 84 (U.S. Government Printing Office
10d	Washington, D.C., 1962).
200	Clinical Dosimetry, National Bureau of Standards Hand-
	book 87 (U.S. Government Printing Office, Washington, D.C., 1968).
10e	Radiobiological Dosimetry, National Bureau of Standards
	Handbook 88 (U.S. Government Printing Office, Washington, D.C., 1963).
11	Radiation Quantities and Units (Table 1)
	Radiation Quantities and Units (International Commission on Radiation Units and Management Williams)
,	sion on Radiation Units and Measurements, Washington, D.C., 1968).
	1011, 2.0., 1000/.

- 19 Radiation Quantities and Units (International Commission on Radiation Units and Measurements, Washington, D.C., 1971).
- 19S Dose Equivalent [Supplement to ICRU Report 19] (International Commission on Radiation Units and Measurements, Washington, D.C., 1973).
- 21 Radiation Dosimetry: Electrons with Initial Energies Between 1 and 50 MeV (International Commission on Radiation Units and Measurements, Washington, D.C., 1972).
- 29 Dose Specification for Reporting External Beam Therapy with Photons and Electrons (International Commission on Radiation Units and Measurements, Washington, D.C., 1978)

^{*}References given are in English. Some of the Reports were also published in other languages.

Index

Autoionization, 16-17, 41 Attachment, 16 Auger emission, 41, 56, 77, 83 Average energy of ejected electrons, 82 Backscattered electrons, 64-65, 76 Bethe approximation, 10, 39, 49 Table of constants, 10 Binary encounter, 39 Approximation, 7-8, 39, 44-47, 68-69 Binary-encounter Bethe (BEB) method, 12, 17, 20-21, 34-36 Binary-encounter dipole (BED) method, 12, 17, 20-21, 34-36 Peak, 6, 14, 40 Binding energies, table, 8 Born approximation, 8, 39 Coulomb Born, 8 Distorted-wave Born, 8 Plane-wave Born, 8-10, 39, 46-47, 55 Charge-state effects, 69 Classical-trajectory Monte Carlo (CTMC) method, 13, 47 Clusters, 27-31 Condensed matter targets, 64-79, 83 Conduction band, 70 Consistency requirements, 13-14, 21 Continuum dipole oscillator strengths, 34-35 Continuum-distorted-wave eikonal-initial-state (CDW-EIS) method, 6, 8, 12-13, 40, 47, 55 Coster-Kronig transition, 41 Cross section, Counting, 2 Definitions, 2 Differential, 2, 30-38

Doubly differential (DDCS), 2, 5–6, 30–38, 41–43, 46, 55–57, 59, 73, 75, 77–78
Energy loss, 14
K-shell, 16, 20, 56

K-shell, 16, 20, 56 Møller, 15

Mott, 7, 15

Partial, 2, 17–19, 22–30

Recommended values, 22, 27, 53-54

Singly differential (SDCS), 2, 30–38, 41–43, 45, 47, 53–54, 59, 68, 71–74, 77 Total ionization (TICS), 2, 12, 20–23, 36, 41–42, 52, 54

Delta rays, 1

Dielectric response theory, 66–68 Dielectronic process, 41, 48

Dissociation, 2, 3

Deutsch-Märk (DM) method, 18–21

DNA, 81–83, 86

Doubly differential cross section-mixed treatment (DDCS-MT), 47 Dressed projectiles, 12, 39, 49, 56-60

Diffraction effects, 49

Effective charge, 58-60

Electron capture to the continuum (ECC), 12, 40

Electron collisions, 16–38

Electron ejection from the surface, 70

Electron energy analysis, 31–32

Electron loss from the projectile, 57–58

Electron promotion, 41

Electron transfer, 2-3

Empirical or semi-empirical formulas

Lotz, 19

Jain-Khare, 21

Energy analysis, 31-32

Energy loss of the projectile, 14

Energy per ion pair, 87-88

Excitation, 2-3, 14

Experimental data available, 37–38, 53–54, 60–63

Experimental methods

Condensed matter targets, 64-66

Electron impact, 18-19, 22-25, 30-32

Ion impact, 42-44

Mass spectrometer, 23-25

Glossary, ix

Gryzinski equation, 19, 39

Guide for users, 3-4

Hansen-Kocbach-Stolterfoht (HKS) model, 40, 51-52

Heavy ion and neutral collisions, 54-63

Ionization, 2-3

Autoionization, 16-17

Clusters, 27-31

Dissociative ionization, 16

Experimental data available, 37-38, 53-54

Mechanisms, 16, 39-42

Multiple ionization, 3, 16-17, 41-42

Applications in radiological science, 2, 80-88

Transfer ionization, 41

Jain-Khare method, 21, 25, 33

Kim model, 50-51

Kinetic energies of orbital electrons, 7-8

Table, 8

Linear energy transfer (LET), 80, 82, 85-87

Mean free paths, 84

Mechanisms of ionization, 16, 39-42

Median energy of ejected electrons, 82

 $Microdosimetry,\,80,\,85$

Migration of electrons to the surface, 69

Miller model, 49

Moments of energy loss, 88

Mott cross section, 7

Notation, 2

Occupation numbers, table, 8

Plasmon effects, 67-68, 71-73, 83

Platzman plot, 10-12, 35

Primary electrons, 5

Projectile emission, 42, 57-58

Proportional counters, 80-81

Proton collisions, 52-54

Purpose and scope, 1

Radiation biology, 86

Radiation chemistry, 85–86

Relativistic corrections, 14-15

Rudd model, 49-50

Rutherford equation, 6-7

Saddle-point electron emission, 40 Screening effects, 48–49, 57

Semi-classical method, 47 Single-center electron emission, 39 Solid targets, 64–79 Stopping power, 1, 68–69, 71, 80, 86–88 String-of-beads model of a track, 85

Theoretical methods, 5-15, 18-21, 44-52

Tracks, 80
Radial distribution of energy deposition, 81–82
Simulation of, 80–83
Two-center electron emission, 39–40, 55

Valence band, 70

W-values, 80, 87–88 Wilson-Paretzke tract simulation code, 82, 85

Zero-center electron emission, 39