Jp.P. Biersac, and U. Littmark, *The Stopping and Range of Ions in Solids*, Pergamon Press 1985, and references therein.

15. D.J. Ficenec *et al.*, Phys. Rev. **D36**, 311 (1987).
16. L.D. Landau, J. Exp. Phys. (USSR) **8**, 201 (1944); See, for instance, K.A. Ispirian, A.T. Margarian, and A.M. Zverev, Nucl. Instr. and Meth. **117**, 125 (1974).
17. K. Hikasa *et al.*, *Review of Particle Properties*, Phys. Rev. **D46** (1992) S1.
18. For unit-charge projectiles, see E.A. Uehling, Ann. Rev. Nucl. Sci. **4**, 315 (1954). For highly charged projectiles, see J.A. Doggett and L.V. Spencer, Phys. Rev. **103**, 1597 (1956). A Lorentz transformation is needed to convert these center-of-mass data to knock-on energy spectra.
19. N.F. Mott and H.S.W. Massey, *The Theory of Atomic Collisions*, Oxford Press, London, 1965.
20. L.V. Spencer "Energy Dissipation by Fast Electrons," Nat'l Bureau of Standards Monograph No. 1 (1959).
21. "Average Energy Required to Produce an Ion Pair," ICRU Report No. 31 (1979).
22. N. Hadley *et al.*, "List of Poisoning Times for Materials," Lawrence Berkeley Lab Report TPC-LBL-79-8 (1981).
23. H.A. Bethe, Phys. Rev. **89**, 1256 (1953). A thorough review of multiple scattering is given by W.T. Scott, Rev. Mod. Phys. **35**, 231 (1963). However, the data of Shen *et al.*, (Phys. Rev. **D20**, 1584 (1979)) show that Bethe's simpler method of including atomic electron effects agrees better with experiment that does Scott's treatment. For a thorough discussion of simple formulae for single scatters and methods of compounding these into multiple-scattering formulae, see W.T. Scott, Rev. Mod. Phys. **35**, 231 (1963). For detailed summaries of formulae for computing single scatters, see J.W. Motz, H. Olsen, and H.W. Koch, Rev. Mod. Phys. **36**, 881 (1964).
24. V.L. Highland, Nucl. Instr. and Meth. **129**, 497 (1975), and Nucl. Instr. and Meth. **161**, 171 (1979).
25. G.R. Lynch and O.I Dahl, Nucl. Instr. and Meth. **B58**, 6 (1991).
26. M. Wong *et al.*, Med. Phys. **17**, 163 (1990).
27. Y.S. Tsai, Rev. Mod. Phys. **46**, 815 (1974).
28. H. Davies, H.A. Bethe, and L.C. Maximon, Phys. Rev. **93**, 788 (1954).
29. O.I. Dahl, private communication.
30. M.J. Berger and S.M. Seltzer, "Tables of Energy Losses and Ranges of Electrons and Positrons," National Aeronautics and Space Administration Report NASA-SP-3012 (Washington DC 1964).
31. We are indebted to H. Hirayama for pointing out both the distinctions among definitions and the appropriateness of the Rossi definition (private communication, 1992; informal KEK note (unpublished)).
32. W.R. Nelson, T.M. Jenkins, R.C. McCall, and J.K. Cobb, Phys. Rev. **149**, 201 (1966).
33. G. Bathow *et al.*, Nucl. Phys. **B20**, 592 (1970).
34. *Experimental Techniques in High Energy Physics*, ed. by T. Ferbel (Addision-Wesley, Menlo Park CA 1987).
35. U. Amaldi, Phys. Scripta **23**, 409 (1981).
36. E. Longo and I. Sestili, Nucl. Instr. and Meth. **128**, 283 (1975).
37. G. Grindhammer *et al.*, in *Proceedings of the Workshop on Calorimetry for the Supercollider*, Tuscaloosa, AL, March 13–17, 1989, edited by R. Donaldson and M.G.D. Gilchriese (World Scientific, Teaneck, NJ, 1989), p. 151.
38. P.H. Barrett, L.M. Bollinger, G. Cocconi, Y. Eisenberg, and K. Greisen, Rev. Mod. Phys. **24**, 133 (1952).
39. W. Lohmann, R. Kopp, and R. Voss, "Energy Loss of Muons in the Energy Range 1–10000 GeV," CERN Report 85–03 (1985).
40. H.A. Bethe and W. Heitler, *Proc. Roy. Soc.* **A146**, 83 (1934); H.A. Bethe, *Proc. Cambridge Phil. Soc.* **30**, 542 (1934).
41. A.A. Petrukhin and V.V. Shestakov, Can. J. Phys. **46**, S377 (1968).
42. V.M. Galitskii and S.R. Kel'ner, Sov. Phys. JETP **25**, 948 (1967).
43. S.R. Kel'ner and Yu.D. Kotov, Sov. J. Nucl. Phys. **7**, 237 (1968). S.R. Kel'ner and Yu.D. Kotov, Can. J. Phys. **46**, S387 (1968).
44. R.P. Kokoulin and A.A. Petrukhin, in *Proceedings of the International Conference on Cosmic Rays*, Hobart, Australia, August 16–25, 1971, Vol. **4**, p. 2436.
45. I.L. Rozental, Sov. Phys. Usp. **11**, 49 (1968).
46. A.G. Wright, J. Phys. **A6**, 79 (1973).
47. L.B. Bezrukov and E.V. Bugaev, Sov. J. Nucl. Phys. **33**, 635 (1981).
48. A. Van Ginneken, Nucl. Instr. and Meth. **A251**, 21 (1986).
49. U. Becker *et al.*, Nucl. Instr. and Meth. **A253**, 15 (1986).
50. J.J. Eastman and S.C. Loken, in *Proceedings of the Workshop on Experiments, Detectors, and Experimental Areas for the Supercollider*, Berkeley, CA, July 7–17, 1987, edited by R. Donaldson and M.G.D. Gilchriese (World Scientific, Singapore, 1988), p. 542.
51. *Methods of Experimental Physics*, L.C.L. Yuan and C.-S. Wu, editors, Academic Press, 1961, Vol. 5A, p. 163.
52. W.W.M. Allison and P.R.S. Wright, "The Physics of Charged Particle Identification: dE/dx, Čerenkov Radiation, and Transition Radiation," p. 371 in *Experimental Techniques in High Energy Physics*, T. Ferbel, editor, (Addison-Wesley 1987).
53. E.R. Hayes, R.A. Schluter, and A. Tamosaitis, "Index and Dispersion of Some Čerenkov Counter Gases," ANL-6916 (1964).
54. T. Ypsilantis, "Particle Identification at Hadron Colliders", CERN-EP/89-150 (1989), or ECFA 89-124, **2** 661 (1989).
55. J.D. Jackson, private communication (1992).