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# Dedication to Dr. Robert Boyd

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–An NRC Perspective–



Dr. Robert (Bob) K. Boyd is one of Canada's most respected mass spectrometrists. Over the course of his career at the National Research Council (NRC), Bob has made a number of invaluable contributions to the physical, biological and chemical sciences and has become an influential member of the Canadian research and innovation community.

Bob was born on July 19, 1938, in Peebles, Scotland. He attended St. Andrews University where he received both his B.Sc Hons degree in Chemistry and his Ph.D in Physical Chemistry. In 1962, Bob traveled to Ottawa, Ontario, where he landed his first position with the NRC as a Postdoctoral Fellow in the area of photochemistry. Unbeknownst to him, this first position would forecast his future career at the NRC.

Before that would happen, Bob would leave the NRC to gain a wealth of research and teaching experience both in Canada and abroad. Over the next 24 years, he held a number of research and professor positions in England, Wales, Canada and the USA. In 1976, Bob became a Full Professor in the Department of Chemistry and Biochemistry at the University of Guelph.

It was not until 1986, after seven years of teaching, that Bob began his long and significant career with the NRC, first as a Senior Research Officer at the Atlantic Research Laboratory (now the Institute for Marine Biosciences), in Halifax, Nova Scotia. With his already extensive experience in Analytical Chemistry, it was not long before Bob climbed the NRC ladder. Within four years, he became a Principal Research Officer.

Although Bob would stay at the Institute for Marine Biosciences for the remainder of his career, Bob remained active in the local, national and international scientific communities. He became a member of a variety of professional societies, boards and committees involving chemistry, natural sciences and chemical metrology. In 1990,

he began editing for *Rapid Communications in Mass Spectrometry*, before his eventual appointment as Editor-in-Chief in 1997.

I first met Bob in 1996, when he hired me for a two-year appointment as a Research Associate at the Institute for Marine Biosciences. Although he allowed me to develop and conduct my own research program, the interactions with Bob during that time were tremendously important for my future career. After I left the institute, I always stayed in contact with him and, without hesitation, I immediately accepted when Bob offered me the position of principal mass spectrometrists at the institute in 2001.

Although Bob was devoted to the applied and academic sciences, his most significant administrative role was yet to come. In 1998, he was appointed Acting Director General for the Institute for Marine Biosciences. He accepted the position on a short-term basis, knowing it would mean he would have to put a hold on his active participation in science.

During the time he spent as Director General, Bob introduced many important changes to the organizational structure of the institute. For example, he reorganized the management structure and created a Science Advisory Committee. He also established a peer review process for enhanced funding opportunities which helped the institute receive numerous grants for the renewal of research facilities. In addition, Bob played a key role in the Atlantic Initiative, an ongoing multi-phased project focused on the development of life sciences in Nova Scotia. This initiative has supported the acquisition of a significant amount of state-of-the-art equipment for the institute, including several new mass spectrometers.

In 2003, Bob was appointed Researcher Emeritus at NRC's Outstanding Achievement Awards, a title that is intended to mark the career accomplishments of retired employees. The award also expresses the appreciation of the NRC for Bob's willingness to continue to be active in the research activities of the NRC. He currently advises scientists at Ottawa's NRC Institute for National Measurement Standards.

Bob has demonstrated that dedication, creativity and hard work can lead to the highest degree of achievement. His long list of publications (*vide infra*) and accomplishments are a testament to his distinguished career. On a personal level, I am continuously impressed with Bob's unselfishness, motivation and willingness to help in almost any situation. I have always considered Bob a mentor as well as a close personal friend.

## R. K. Boyd: List of Publications

1. Boyd RK, Downs GW, Gow JS, Horrex C. Hydrogen iodide as a radical acceptor in the thermal decomposition of gaseous organic iodides. *J. Phys. Chem.* **67**: 719 (1963).
2. Strachan A, Boyd RK, Kutschke KO. Multistage deactivation in the photolysis of hexafluoroacetone. *Can. J. Chem.* **42**: 1345–1354 (1964).
3. Boyd RK, Carter GB, Kutschke KO. Primary processes in the photolysis of hexafluoroacetone in the presence of mercury vapour. *Can. J. Chem.* **46**: 175–190 (1968).
4. Boyd RK, Burns G, Lawrence TR, Lippiatt JH. Dissociation and two-body emission in shock-heated bromine. I. Br<sub>2</sub> in argon. *J. Chem. Phys.* **49**: 3804–3821 (1968).
5. Boyd RK, Brown JD, Burns G, Lippiatt JH. Dissociation and two-body emission in shock-heated bromine. II. Pure Br<sub>2</sub>. *J. Chem. Phys.* **49**: 3822–3827 (1968).
6. Blake JA, Boyd RK, Ip JKK, Burns G. Nonequilibrium effects in recombination-dissociation reactions of halogens from shock wave and flash photolysis data. *Astronautica Acta* **14**: 487–490 (1969).
7. Anderson ML, Boyd RK. Nonequilibrium thermodynamics in chemical kinetics. *Can. J. Chem.* **49**: 1001–1007 (1971).
8. Boyd RK. On the distinction between reaction fluxes and phenomenological rate constants. *Can. J. Chem.* **49**: 1401–1406 (1971).
9. Boyd RK, Burns G. Transient phenomena in the dissociation of diatomic molecules. *Can. J. Chem.* **49**: 3744–3754 (1971).
10. Cock PA, Cottrell CE, Boyd RK. Rates of reaction of nickel(II) with terpyridine in dimethylsulfoxide. *Can. J. Chem.* **50**: 402–411 (1972).
11. Boyd RK. A novel solution to the master equation for chemical reaction. *Can. J. Chem.* **50**: 3104–3108 (1972).
12. Boyd RK. Detailed balance in chemical kinetics as a consequence of microscopic reversibility. *J. Chem. Phys.* **60**: 1214–1222 (1974).
13. Boyd RK. Detailed balance in nonequilibrium theories of chemical kinetics. *J. Chem. Phys.* **61**: 5474–5475 (1974).
14. Boyd RK, Fyfe CA, Wright DA. Potential energy calculations of the rotational barriers in molecular solids. *J. Phys. Chem. Solids* **35**: 1355–1365 (1974).
15. Boyd RK, Burns G, MacDonald RG, Wong WH. Recombination of bromine atoms between 300 and 6000 K: theory and experiment. *Proc. 16th. Int. Symp. Combustion* (Tokyo, 1974), 731–742 (1975).
16. Sanford WE, Boyd RK. Molecular reorientation in crystalline furan and thiophene. *Can. J. Chem.* **54**: 2773–2782 (1976).
17. Boyd RK. Macroscopic and microscopic restrictions on chemical kinetics. *Chem. Rev.* **77**: 93–119 (1977).
18. Boyd RK, Burns G, MacDonald RG. Shock dissociation of bromine in krypton. Modern developments in shock tube research. *Proc. 10th. Int. Shock Tube Symposium* (Kyoto, Japan, 1975), 552–556 (1976).
19. Boyd RK. The linear mixture formula in nonequilibrium theories of chemical kinetics. *Can. J. Chem.* **55**: 802–811 (1977).
20. MacDonald RG, Burns G, Boyd RK. Dissociation rates of bromine in shock waves. *J. Chem. Phys.* **66**: 3598–3608 (1977).
21. Boyd RK, Beynon JH. Scanning of sector mass spectrometers to observe the fragmentations of metastable ions. *Org. Mass Spectrom.* **12**: 163–165 (1977).
22. Boyd RK, Beynon JH. Applications of studies on metastable ions to the determination of enthalpies of gaseous ions. *Int. J. Mass Spectrom Ion Phys.* **23**: 163–188 (1977).
23. Beynon JH, Boyd RK. Unimolecular and collisionally induced ion reactions. *Adv. Mass Spectrom.* **7**: 1115–1156 (1978).
24. Boyd RK. Some common oversimplifications in teaching chemical kinetics. *J. Chem. Educ.* **55**: 84–89 (1978).
25. Sanford WE, Boyd RK, Ripmeester JA. Reorientation of thiophene molecules in a benzene lattice. *Can. J. Chem.* **56**: 714–716 (1978).
26. Sanford WE, Boyd RK, Ripmeester JA. An investigation of molecular reorientation in crystalline pyrazine by pulse NMR and the atom-atom approximation for intermolecular forces. *Mol. Cryst. Liq. Cryst.* **46**: 121–137 (1978).
27. Ripmeester JA, Wright DA, Fyfe CA, Boyd RK. Molecular motion and phase transitions in the solid hexafluorobenzene-benzene complex by NMR and heat capacity measurements. *J. Chem. Soc. Faraday Trans. II* **74**: 1164–1178 (1978).
28. Boyd RK, Fyfe CA. Comment on “An error in the calculation of the rotational barrier in molecular crystals”. *J. Phys. Chem. Solids* **39**: 693–694 (1978).
29. Boyd RK, Burns G. Dissociation-recombination reactions of halogens: current status. *J. Phys. Chem.* **83**: 88–92 (1979).
30. Ripmeester JA, Boyd RK. Molecular reorientation in solid sym-triazine. *Can. J. Chem.* **57**: 128–130 (1979).
31. Ripmeester JA, Boyd RK. Molecular reorientation in p-fluoranyl as studied by <sup>19</sup>F NMR and potential profile calculations. *J. Chem. Phys.* **71**: 5167–5170 (1979).
32. Boyd RK, Comper J, Ferguson G. Entropy changes and structural implications for crystalline phases of pyrazine. *Can. J. Chem.* **57**: 3056–3060 (1979).
33. Tang SY, McGowan JC, Singh M, Galatsis P, Ellis BE, Boyd RK, Brown SA. Mass spectrometry of some methoxy-furanocoumarins. *Can. J. Chem.* **57**: 1995–2003 (1979).
34. Harris D, McKinnon HS, Boyd RK. The origins of the base peak in the EI spectrum of limonene. *Org. Mass Spectrom.* **14**: 265–272 (1979).
35. Shushan B, Safe S, Boyd RK. Mass spectrometry of polycyclic aromatic hydrocarbons by linked-scan studies of metastable ions. *Anal. Chem.* **51**: 156–158 (1979).
36. Tulp MTM, Safe S, Boyd RK. Fragmentation pathways in electron-impact mass spectra of methoxyhalobiphenyls. *Biomed. Mass Spectrom.* **7**: 109–114 (1980).
37. Shushan B, Boyd RK. Unimolecular and collision-induced fragmentations of molecular ions of polycyclic aromatic hydrocarbons. *Org. Mass Spectrom.* **15**: 445–453 (1980).
38. Sanford WE, Kupferschmidt GJ, Fyfe CA, Boyd RK, Ripmeester JA. The dynamic structure of acenaphthalene in the solid state: pulse NMR measurements. *Can. J. Chem.* **58**: 906–912 (1980).
39. Shushan B, Boyd RK. Modulated-field linked-scan studies of metastable ions. *Int. J. Mass Spectrom. Ion Phys.* **34**: 37–62 (1980).
40. Boyd RK, Shushan B. Derivation of scan laws for detection of consecutive ion fragmentations in conventional double focussing mass spectrometers. *Int. J. Mass Spectrom. Ion Phys.* **37**: 355–368 (1981).
41. Shushan B, Boyd RK. Further experiments concerning an ambiguous assignment of a metastable peak to a sequential process in 3-chlorophenol. *Int. J. Mass Spectrom. Ion Phys.* **37**: 369–378 (1981).
42. Shushan B, Bunce NJ, Boyd RK, Corke CT. Mass spectrometric analysis of chlorinated biphenyls using metastable ions. *Biomed. Mass Spectrom.* **8**: 225–230 (1981).
43. Shushan B, Boyd RK. Scans for preselected neutral fragmentation loss in double focussing mass spectrometry. *Anal. Chem.* **53**: 421–427 (1981).
44. Boyd RK, Burns G. Dissociation-recombination reactions of homopolar diatomic molecules. In *Shock Waves in Chemistry*, Lifshitz A (ed). Marcel Dekker: New York, 131–181 (1981).
45. Boyd RK, Porter CJ, Beynon JH. A new linked scan for reversed geometry mass spectrometers. *Org. Mass Spectrom.* **16**: 490–494 (1981).
46. Safe S, Boyd RK. Applications of mass spectrometry in pesticide analysis. In *Pesticide Analysis*, Das KG (ed). Marcel Dekker: New York, 329–368 (1981).
47. Boyd RK, Porter CJ, Beynon JH. Linked scan laws to detect fragmentations in the second field-free region of double focussing mass spectrometers. *Int. J. Mass Spectrom. Ion Phys.* **44**: 199–214 (1982).
48. Boyd RK. Scanning techniques for MS/MS experiments in double focussing mass spectrometers. *Spectrosc. Int. J.* **1**: 169–200 (1982).
49. Boyd RK, Shushan B. Correlations between spectroscopic properties of neutral precursors and fragmentation rates of metastable molecular ions of aromatic molecules. *Can. J. Chem.* **60**: 2484–2499 (1982).



50. Curtis JM, Boyd RK, Shushan B, Morgan TG, Beynon JH. Experimental investigation of the molecular ions of the xylenes. *Org. Mass Spectrom.* **19**: 207–216 (1983).
51. Comper J, Quesnel A, Fyfe CA, Boyd RK. Experimental study of the structure I clathrate-hydrate of trimethylene oxide by adiabatic calorimetry. *Can. J. Chem.* **61**: 92–96 (1983).
52. Kingston EE, Brenton AG, Boyd RK, Beynon JH. Angle-resolved mass spectrometry. *Int. J. Mass Spectrom. Ion Phys.* **47**: 117–120 (1983).
53. Boyd RK. Thermal shift corrections to appearance energies of fragment ions. *Int. J. Mass Spectrom. Ion Phys.* **55**: 55–67 (1983/84).
54. Curtis JM, Boyd RK. Measurement of low kinetic energy loss in collision experiments using a conventional double focussing mass spectrometer. *Int. J. Mass Spectrom. Ion Phys.* **57**: 19–26 (1984).
55. Boyd RK, Kingston EE, Brenton AG, Beynon JH. Angle dependence of ion kinetic energy spectra obtained using mass spectrometers. I. Theoretical consequences of conservation laws for collisions. *Proc. Roy. Soc. (Lond.) A* **392**: 59–88 (1984).
56. Boyd RK, Kingston EE, Brenton AG, Beynon JH. Angle dependence of ion kinetic energy spectra obtained using mass spectrometers. II. Experimental considerations and preliminary results on non-fragmenting systems. *Proc. Roy. Soc. (Lond.) A* **392**: 89–106 (1984).
57. Curtis JM, Boyd RK. Ion kinetic energy spectroscopy of the doubly charged ion of carbon monoxide. *J. Chem. Phys.* **80**: 1150–1161 (1984).
58. Wetmore RW, LeRoy RJ, Boyd RK. Theoretical investigation of the  $\text{CH}^{2+}$  dication. *Chem. Phys.* **89**: 329–336 (1984).
59. Wetmore RW, LeRoy RJ, Boyd RK. A theoretical investigation of the dication  $\text{CO}^{2+}$ . *J. Phys. Chem.* **88**: 6318–6328 (1984).
60. Curtis JM, Boyd RK. Predissociation processes in  $\text{N}_2^{2+}$ ,  $\text{O}_2^{2+}$  and  $\text{NO}^{2+}$  studied by ion kinetic energy spectroscopy. *J. Chem. Phys.* **81**: 2991–3001 (1984).
61. Curtis JM, Boyd RK. Translational spectroscopy of carbon ions. *Int. J. Mass Spectrom. Ion Phys.* **57**: 27–37 (1984).
62. Baudais FL, Dynes JJ, Boyd RK. Inter-ring dihedral angles in polychlorinated biphenyls from photoelectron spectroscopy. *Can. J. Chem.* **63**: 1292–1299 (1985).
63. Singh S, Boyd RK, Harris FM, Beynon JH. Collision-induced reactions of the triply-charged triatomic ion  $\text{CS}_2^{3+}$ . *Int. J. Mass Spectrom. Ion Processes* **66**: 167–183 (1985).
64. Boyd RK, Singh S, Beynon JH. Delayed predissociation and collision-induced processes of the ammonia dication. *Chem. Phys.* **100**: 297–314 (1985).
65. Singh S, Boyd RK, Harris FM, Beynon JH. Charge-stripping and delayed autoionisation in doubly-charged ions of the noble gases. *Proc. Roy. Soc. (Lond.) A* **402**: 373–400 (1985).
66. Boyd RK, Bott PA, Beynon JH, Harvan DJ, Hass JR. Collision-induced dissociations of ions from zero to 4 keV translational energy in a single apparatus. *Int. J. Mass Spectrom. Ion Processes* **66**: 253–270 (1985).
67. Boyd RK, Harris FM, Beynon JH. Calibration of energy deposition in collision-induced dissociations of the butylbenzene molecular ion. *Int. J. Mass Spectrom. Ion Processes* **66**: 185–194 (1985).
68. Singh S, Harris FM, Boyd RK, Beynon JH. The variation of translational energy release in collision-induced dissociations of polyatomic ions with initial kinetic energy and with observation angle. I. Theoretical considerations. *Int. J. Mass Spectrom. Ion Processes* **66**: 131–149 (1985).
69. Boyd RK, Harvan DJ, Hass JR. Ion current surfaces for a tandem double-focussing mass spectrometer with a floatable gas collision cell. *Int. J. Mass Spectrom. Ion Processes* **65**: 273–286 (1985).
70. Guilhaus M, Boyd RK, Brenton AG, Beynon JH. Advantages of a second electric sector on a double-focussing mass spectrometer of reversed configuration. *Int. J. Mass Spectrom. Ion Processes* **67**: 209–227 (1985).
71. Singh S, Boyd RK, Harris FM, Beynon JH. The variation of translational energy release in collision-induced dissociations of polyatomic ions. II. Experimental investigations. *Int. J. Mass Spectrom. Ion Processes* **66**: 151–166 (1985).
72. Boyd RK. General principles of analytical mass spectrometry. In *Mass Spectrometric Analysis of Pesticides and Pollutants*, Karasek FW, Safe S, Hutzinger O (eds). Plenum Press: New York, 1–19 (1985).
73. Fung D, Safe S, Boyd RK, Chittim B. GC/MS analysis of specific isomers of polychlorodibenzofurans. *Biomed. Mass Spectrom.* **12**: 247–253 (1985).
74. Waddell DS, Boyd RK, Brenton AG, Beynon JH. Experimental and theoretical investigations of angular distributions of fragments from dissociations of polyatomic ions. *Int. J. Mass Spectrom. Ion Processes* **68**: 71–90 (1986).
75. Boyd RK, Bott PA, Harvan DJ, Hass JR. A method for computer-based time-to-mass conversion of fragment-ion spectra for tandem double focussing mass spectrometers. *Int. J. Mass Spectrom. Ion Processes* **69**: 251–263 (1986).
76. Harrison AG, Mercer RS, Reiner EJ, Young AB, Boyd RK, March RE, Porter CJ. A hybrid BEQQ mass spectrometer for studies in gaseous ion chemistry. *Int. J. Mass Spectrom. Ion Processes* **74**: 13–31 (1986).
77. Jonathan P, Boyd RK, Brenton AG, Beynon JH. Interference peaks in translational energy loss spectra: an example in the spectrum of  $\text{NO}^{2+}$ . *Int. J. Mass Spectrom. Ion Processes* **68**: 91–97 (1986).
78. Wetmore RW, Boyd RK. A theoretical investigation of the dication of molecular nitrogen. *J. Phys. Chem.* **90**: 5540–5551 (1986).
79. Wetmore RW, Boyd RK. A theoretical and experimental investigation of the molecular dication of nitric oxide. *J. Phys. Chem.* **90**: 6091–6101 (1986).
80. Jonathan P, Boyd RK, Brenton AG, Beynon JH. Diatomic dications containing one inert gas atom. *Chem. Phys.* **110**: 239–246 (1986).
81. Beynon JH, Boyd RK, Brenton AG. Charge permutation reactions. *Adv. Mass Spectrom.* **10**: 437–469 (1986).
82. Jonathan P, Boyd RK, Brenton AG, Beynon JH. Characterisation of cluster ions formed from inert gas atoms plus small molecules and radicals. *Int. J. Mass Spectrom. Ion Processes* **71**: 257–282 (1986).
83. Singh S, Boyd RK, Harris FM, Beynon JH. Collisional and unimolecular ionisation of monatomic halogen cations. *Int. J. Mass Spectrom. Ion Processes* **68**: 183–201 (1986).
84. Waddell DS, Sim PG, Boyd RK. Electron capture negative ion mass spectrometry of the chlorobenzenes. *Rapid Commun. Mass Spectrom.* **1**: 106–107 (1987).
85. Jonathan P, Brenton AG, Beynon JH, Boyd RK. Diatomic dications of noble gas chlorides. *Int. J. Mass Spectrom. Ion Processes* **76**: 319–324 (1987).
86. Curtis JM, Brenton AG, Beynon JH, Boyd RK. Translational energy spectroscopy of long-lived dications of methyl iodide. *Chem. Phys.* **116**: 325–339 (1987).
87. Curtis JM, Brenton AG, Boyd RK. Charge-separation reactions of the  $\text{CF}^{2+}$  and  $\text{CCl}^{2+}$  dications. *Chem. Phys.* **116**: 241–248 (1987).
88. Boyd RK, Bott PA, Beer BA, Harvan DJ, Hass JR. Computer-based mass measurement of fragment ion spectra from tandem magnetic sector mass spectrometers with a floated collision cell. *Anal. Chem.* **59**: 189–193 (1987).
89. Boyd RK. Scan laws for tandem mass spectrometry using a floated gas collision cell. *Int. J. Mass Spectrom. Ion Processes* **75**: 243–264 (1987).
90. Beynon JH, Brenton AG, Boyd RK. Some applications of collision spectroscopy of gas phase ions. *J. Chem. Soc. Farad. Trans. II* **83**: 37–47 (1987).
91. Curtis JM, Brenton AG, Beynon JH, Boyd RK. Comparison of three experimental techniques using collision-induced dissociation in determination of isomeric ion structures: the example  $\text{C}_5\text{H}_8^+$ . *Org. Mass Spectrom.* **22**: 779–789 (1987).
92. Waddell DS, Boyd RK, McKinnon HS, Safe L, Safe S, Chittim BG. tetrachlorodibenzofurans - gas chromatographic and mass spectrometric characteristics. *Chemosphere* **16**: 1655–1660 (1987).
93. Sim PG, Boyd RK, Gershey RM, Guevremont R, Jamieson WD. A comparison of chromatographic and chromatographic/mass spectrometric techniques for the determination of polycyclic aromatic hydrocarbons in marine sediments. *Biomed. Environ. Mass Spectrom.* **14**: 375–382 (1987).
94. Chittim B, Safe S, Waddell DS, McKinnon HS, Boyd RK. Gas chromatography/mass spectrometry characteristics of

- purified synthetic isomers of tetrachlorodibenzofuran. *Biomed. Environ. Mass Spectrom.* **14**: 457–464 (1987).
95. Harvan DJ, Wilson WE, Hass JR, Hamm C, Boyd RK, Yajima H, Klapper DG. Fast-atom bombardment/tandem mass spectrometry of physalaemin-like peptides. *Biomed. Environ. Mass Spectrom.* **14**: 281–287 (1987).
  96. Boyd RK, deFreitas AJ, Hope J, McCulloch AW, McInnes AG, Rogerson A, Walter JA. Glycerol 1,2-cyclic phosphate in centric diatoms. *J. Biol. Chem.* **262**: 12406–12408 (1987).
  97. Boyd RK, deFreitas AJ, McCulloch AW, McInnes AG, Walter JA. Confirmation of glycerol 1,2-cyclic phosphate as a metabolite in centric diatoms by tandem mass spectrometry. *Rapid Commun. Mass Spectrom.* **1**: 96–98 (1987).
  98. Sim PG, Jamieson WD, Boyd RK. Selective detection of aromatic hydrocarbons involving half-masses. *Org. Mass Spectrom.* **23**: 469–482 (1988).
  99. Waddell DS, Bunce NJ, Boyd RK. Preionisation effects in the mass spectrometry of some azoxybenzenes. *Rapid Commun. Mass Spectrom.* **1**: 28–29 (1987).
  100. Guevremont R, Boyd RK. Operation of a tandem hybrid mass spectrometer of BEqQ configuration in scan modes using uncoupled analysers. *Int. J. Mass Spectrom. Ion Processes* **84**: 47–67 (1988).
  101. Brenton AG, Hamdan M, Guilhaus M, Fournier PG, Boyd RK. Observation of rotational predissociation in  $^{20}\text{NeH}^+$ ,  $^{22}\text{NeH}^+$ ,  $^{20}\text{NeD}^+$ ,  $^{40}\text{ArH}^+$  and  $\text{D}_2^+$  formed from various precursors. *Int. J. Mass Spectrom. Ion Processes* **86**: 401–423 (1988).
  102. Alexander AJ, Thibault P, Guevremont R, Boyd RK. An example of intense artifact peaks in mass analysed ion kinetic energy (MIKE) spectra and their elucidation using an instrument of BEqQ configuration. *Rapid Commun. Mass Spectrom.* **2**: 79–82 (1988).
  103. Guevremont R, Boyd RK. Are Derrick shifts real? An investigation by tandem mass spectrometry. *Rapid Commun. Mass Spectrom.* **2**: 1–5 (1988).
  104. Alexander AJ, Boyd RK. Experimental investigations of factors controlling the collision induced dissociation spectra of peptide ions in a tandem hybrid mass spectrometer. 1. Leucine enkephalin. *Int. J. Mass Spectrom. Ion Processes* **90**: 211–240 (1989).
  105. Alexander AJ, Thibault P, Boyd RK. Collision induced dissociations of peptide ions. II. Remote charge site fragmentations in a tandem hybrid mass spectrometer. *Rapid Commun. Mass Spectrom.* **3**: 30–34 (1989).
  106. Boyd RK, Dyer EW, Guevremont R. A practical approach to linked E-Q scans over a wide mass range: partially linked scans with E-modulation. *Int. J. Mass Spectrom. Ion Processes* **88**: 147–160 (1989).
  107. Alexander AJ, Dyer EW, Boyd RK. Transmission characteristics of an RF-only quadrupole gas collision cell at high axial energies in a hybrid tandem mass spectrometer. *Rapid Commun. Mass Spectrom.* **3**: 364–372 (1989).
  108. Sim PG, Jamieson WD, Boyd RK. Collision induced fragmentation reactions of doubly-charged ions of polycyclic aromatic hydrocarbons. *Org. Mass Spectrom.* **24**: 327–337 (1989).
  109. Waddell DS, Boyd RK. Dissociative electron capture collisions of the diatomic dications  $\text{CO}^{2+}$  and  $\text{NO}^{2+}$  with inert gas targets. *Int. J. Mass Spectrom. Ion Processes* **93**: 337–358 (1989).
  110. Wright JLC, Boyd RK, deFreitas ASW, Falk M, Foxall RA, Jamieson WD, Laycock MV, McCulloch AW, McInnes AG, Odense P, Pathak V, Quilliam MA, Ragan M, Sim PG, Thibault P, Walter JA, Gilgan M, Richard D, Dewar D. Identification of domoic acid, a neuroexcitatory amino acid, in toxic mussels from eastern P.E.I. *Can. J. Chem.* **67**: 481–490 (1989).
  111. Thibault P, Quilliam MA, Jamieson WD, Boyd RK. Mass spectrometry of domoic acid, a marine neurotoxin. *Biomed. Environ. Mass Spectrom.* **18**: 373–386 (1989).
  112. McCulloch AW, Boyd RK, deFreitas ASW, Foxall RA, Jamieson WD, Laycock MV, Quilliam MA, Wright JLC. Zinc from oyster tissue as a causative factor in mouse deaths in the official bioassay procedure for paralytic shellfish poison (PSP). *J. AOAC* **72**: 384–386 (1989).
  113. Alexander AJ, Thibault P, Boyd RK. Collision induced dissociation of  $\text{Cs}_4\text{I}_3^+$ : an example of superelastic collisions? *Rapid Commun. Mass Spectrom.* **3**: 267–272 (1989).
  114. Yost RA, Boyd RK. Tandem mass spectrometry: quadrupole and hybrid instruments. *Methods Enzymol.* **193**: 154–200 (1990).
  115. Alexander AJ, Thibault P, Boyd RK. Collision induced dissociation versus target gas excitation: a reinvestigation of kinetic energy loss accompanying activation of chlorophyll-a ions. *J. Am. Chem. Soc.* **112**: 2484–2491 (1990).
  116. Alexander AJ, Thibault P, Boyd RK, Curtis JM, Rinehart KL. Collision induced dissociation of peptide ions. III. Comparison of results obtained using sector-quadrupole hybrids with those from tandem double-focussing instruments. *Int. J. Mass Spectrom. Ion Processes* **98**: 107–134 (1990).
  117. Perrault H, Ramaley L, Benoit FM, Sim PG, Boyd RK. Fragmentation reactions of doubly charged ions of nitrogenous heterocyclic aromatic compounds. *J. Phys. Chem.* **95**: 4989–4998 (1991).
  118. Anacleto JF, Ramaley L, Boyd RK, Pleasance S, Quilliam MA, Sim PG, Benoit FM. Analysis of polycyclic aromatic compounds by supercritical fluid chromatography-mass spectrometry using atmospheric pressure chemical ionization. *Rapid Commun. Mass Spectrom.* **5**: 149–155 (1991).
  119. Sim PG, Boyd RK, Jamieson WD. Novel mass spectrometric techniques for more reliable determination of PAH. In *Polynuclear Aromatic Hydrocarbons: Measurement, Means, and Metabolism*, Proc. PAH Symposium, Gaithersburg, MD, Oct. 1987, Cooke M, Loening K, Merritt J (eds). Battelle Press: Columbus, OH, 847–855 (1991).
  120. Pleasance S, Thibault P, Sim PG, Boyd RK. Caesium iodide clusters as mass calibrants in ionspray mass spectrometry. *Rapid Commun. Mass Spectrom.* **5**: 307–308 (1991).
  121. Sim PG, Boyd RK. Calibration and mass measurement in negative ion fast atom bombardment mass spectrometry. *Rapid Commun. Mass Spectrom.* **5**: 538–542 (1991).
  122. Boyd RK, Embree DJ, MacAlees AJ, Taylor A. Liquid-assisted secondary ion mass spectrometry of  $\eta^5$ - $(\text{C}_5\text{Me}_4\text{R})\text{Rh}(\text{SCN})_2(\text{RNC})$  ( $\text{R} = \text{Me}, \text{Et}$ ) complexes of isocyanides. *Can. J. Chem.* **69**: 257–263 (1991).
  123. Boyd RK, MacAlees AJ, Taylor A, Walter JA. Isolation of new isocyanide metabolites of *Trichoderma hamatum*. *J. Chem. Soc., Perkin Trans. I* 1461–1465 (1991).
  124. Thibault P, Pleasance S, Laycock MV, MacKay RM, Boyd RK. Characterization of a mixture of lobster digestive proteinases by ionspray mass spectrometry and tryptic mapping with LC/MS and LC/MS/MS. *Int. J. Mass Spectrom. Ion Processes* **111**: 317–353 (1991).
  125. Thibault P, Faubert D, Karunanithy S, Boyd RK. Isolation, mass spectrometric characterization, and protein phosphatase inhibition characteristics, of cyclic peptide analogues of gramicidin-S from *Bacillus brevis* (Nagano strain). *Biol. Mass Spectrom.* **21**: 367–379 (1992).
  126. Tang X-J, Thibault P, Boyd RK. Characterization of the tyrocidine and gramicidin fractions of the tyrothricin complex from *Bacillus brevis* using liquid chromatography and mass spectrometry. *Int. J. Mass Spectrom. Ion Processes* **122**: 153–179 (1992).
  127. Pleasance S, Kelly J, LeBlanc MD, Quilliam MA, Boyd RK, Kitts DK, McErlane K, Bailey MR, North DH. Determination of erythromycin A by liquid chromatography with ionspray tandem mass spectrometry with application to salmon tissue. *Biol. Mass Spectrom.* **21**: 675–687 (1992).
  128. Anacleto JF, Pleasance S, Boyd RK. Calibration of ionspray mass spectra using cluster ions. *Org. Mass Spectrom.* **27**: 660–666 (1992).
  129. Anacleto JF, Perreault H, Boyd RK, Pleasance S, Quilliam MA, Sim PG, Howard JB, Makarovskiy Y, Lafleur AL.  $\text{C}_{60}$  and  $\text{C}_{70}$  fullerene isomers generated in flames; detection and verification by LC-MS analyses. *Rapid Commun. Mass Spectrom.* **6**: 214–220 (1992).
  130. Anacleto JF, Boyd RK, Pleasance S, Quilliam MA, Howard JB, Lafleur AL, Makarovskiy Y. Analysis of minor constituents in fullerene soots by LC-MS using a heated nebuliser interface with atmospheric pressure chemical ionisation. *Can. J. Chem.* **70**: 2558–2568 (1992).
  131. Perreault H, Ramaley L, Benoit FM, Sim PG, Boyd RK. Fragmentation reactions of molecular dications of aromatic heterocyclic fused-ring compounds containing more than one nitrogen atom. *Org. Mass Spectrom.* **27**: 89–96 (1992).



132. Tang X-J, Boyd RK. An investigation of fragmentation mechanisms of doubly-protonated tryptic peptides. *Rapid Commun. Mass Spectrom.* **6**: 651–657 (1992).
133. Orlando R, Boyd RK. Detection of fragment ions produced by collisional activation of multiply charged ions in a floated collision cell. *Org. Mass Spectrom.* **27**: 151–155 (1992).
134. Morris M, Thibault P, Boyd RK. Low-energy ion-molecule collision products with ammonia. *Rapid Commun. Mass Spectrom.* **7**: 1136–1140 (1993).
135. Thibault P, Alexander AJ, Boyd RK. High energy collisional activation studied via angle-resolved translational energy spectra of survivor ions. *J. Am. Soc. Mass Spectrom.* **4**: 835–844 (1993).
136. Thibault P, Alexander AJ, Boyd RK, Tomer KB. Delayed dissociation spectra of survivor ions from high energy collisional activation. *J. Am. Soc. Mass Spectrom.* **4**: 845–854 (1993).
137. Tang X-J, Thibault P, Boyd RK. Fragmentation reactions of multiply protonated peptides and implications for sequencing by tandem mass spectrometry with low-energy collisions. *Anal. Chem.* **65**: 2824–2834 (1993).
138. Curtis JM, Boyd RK. Does the mercurous diatomic dication exist in the gas phase? A search by mass spectrometry. *Rapid Commun. Mass Spectrom.* **7**: 409–411 (1993).
139. Tang X-J, Thibault P, Boyd RK. Fragmentation reactions of singly- and doubly-charged alkali ion-peptide complexes: a reaction specific to C-terminal arginine residues. *Org. Mass Spectrom.* **28**: 1047–1052 (1993).
140. Anacleto JF, Boyd RK, Quilliam MA. High performance liquid chromatographic-mass spectrometric detection of giant fullerenes. *J. High Res. Chromatogr.* **16**: 85–89 (1993).
141. Anacleto JF, Quilliam MA, Boyd RK, Howard JB, Lafleur AL, Makarovskiy Y. Charge-transfer ionspray LC-MS analyses of fullerenes and related compounds from flame-generated materials. *Rapid Commun. Mass Spectrom.* **7**: 229–234 (1993).
142. Boyd RK. Quantitative trace analysis by combined chromatography and mass spectrometry using external and internal standards. *Rapid Commun. Mass Spectrom.* **7**: 257–271 (1993).
143. Burlingame AL, Boyd RK, Gaskell SJ. Mass spectrometry (biennial review). *Anal. Chem.* **66**: 634R–683R (1994).
144. Tang X-J, Boyd RK. Rearrangements of doubly-charged acylium ions from lysyl and ornithyl peptides. *Rapid Commun. Mass Spectrom.* **8**: 678–686 (1994).
145. Morris M, Thibault P, Boyd RK. Characterization of a high pressure quadrupole collision cell for low-energy-collision-induced dissociation. *J. Am. Soc. Mass Spectrom.* **5**: 1042–1063 (1994).
146. Quilliam MA, Hardstaff WR, Anacleto JF, LeBlanc MD, Stergiopoulos V, Dick KL, Bowser M, Curtis JM, Embree DJ, Sim PG, Boyd RK. Preparation and certification of solutions of perdeuterated polycyclic aromatic hydrocarbons intended for use as surrogate internal standards. *Fresenius J. Anal. Chem.* **350**: 109–118 (1994).
147. Anacleto JF, Ramaley L, Benoit FM, Boyd RK, Quilliam MA. Comparison of liquid chromatography-mass spectrometry interfaces for the analysis of polycyclic aromatic compounds. *Anal. Chem.* **67**: 4145–4254 (1995).
148. Boyd RK. Linked scan techniques for MS/MS experiments using tandem-in-space mass spectrometers. *Mass Spectrom. Rev.* **13**: 359–410 (1995).
149. Thomas D, Morris M, Curtis JM, Boyd RK. Fragmentation mechanisms of protonated actinomycins and their use in structural determination of unknown analogues. *J. Mass Spectrom.* **30**: 1111–1125 (1995).
150. Whalen K, Grossert JS, Boyd RK. Ion fragmentation reactions observed in a high-pressure quadrupole collision cell. *Rapid Commun. Mass Spectrom.* **9**: 1366–1375 (1995).
151. Boyd RK, Henion JD, Alexander M, Budde WL, Gilbert JD, Musser SM, Palmer C, Zurek EK. Mass spectrometry and good laboratory practices: a workshop report. *J. Am. Soc. Mass Spectrom.* **7**: 211–218 (1996).
152. Sim PG, Perreault H, Benoit FM, Ramaley L, Crain SM, McCully GK, Thomas D, Boyd RK. The use of copper immobilized on silica for compound class fractionation of polycyclic aromatic compounds in environmental samples. *Polycyclic Aromat. Compd.* **8**: 105–116 (1996).
153. Boyd RK, Crain SM, Curtis JM, LeBlanc MD, Macdonald J, McCully GM, Sim PG, Thomas D. Certification of marine sediment reference materials for PAHs. *Polycyclic Aromat. Compd.* **9**: 217–224 (1996).
154. Burlingame AL, Boyd RK, Gaskell SJ. Mass spectrometry (biennial review). *Anal. Chem.* **68**: 599R–651R (1996).
155. Mansoori BA, Volmer DA, Boyd RK. Wrong-way-round electrospray ionisation of amino acids. *Rapid Commun. Mass Spectrom.* **11**: 1120–1130 (1997).
156. Curtis JM, Boyd RK. Dissociative electron attachment negative ion mass spectrometry: a chlorine-specific detector. *Int. J. Mass Spectrom. Ion Processes* **165/166**: 623–637 (1997).
157. Baldwin R, Bethem RA, Boyd RK, Budde WL, Cairns T, Gibbons RD, Henion JD, Kaiser MA, Lewis DL, Matusik JE, Sphon JA, Stephany RW, Trubey RK. Limits to confirmation, quantitation and detection. *J. Am. Soc. Mass Spectrom.* **8**: 1180–1190 (1997).
158. Whalen K, Grossert JS, Curtis JM, Boyd RK. Mixed-site vs. charge-site-remote fragmentations of long-chain quaternary ammonium ions. *Int. J. Mass Spectrom. Ion Processes* **160**: 223–240 (1997).
159. Milley JE, Boyd RK, Curtis JM, Musial C, Uthe JF. Dichloromyristic acid, a major component of organochlorine load in lobster digestive gland identified by mass spectrometry. *Environ. Sci. Technol.* **31**: 535–541 (1997).
160. Mansoori BA, Dyer EW, Lock CM, Bateman KP, Boyd RK, Thomson BA. Analytical performance of a high-pressure RF-only quadrupole collision cell with an axial field applied using conical rods. *J. Am. Soc. Mass Spectrom.* **9**: 775–788 (1998).
161. Bethem RA, Boyd RK. Mass spectrometry in trace analysis. *J. Am. Soc. Mass Spectrom.* **9**: 643–648 (1998).
162. Burlingame AL, Boyd RK, Gaskell SJ. Mass spectrometry (biennial review). *Anal. Chem.* **70**: 647R–716R (1998).
163. Seto C, Grossert JS, Waddell DS, Curtis JM, Boyd RK. Studies of mixed-site and charge-site-remote fragmentations of quaternary ammonium ions. II. Effects of chain length. *Int. J. Mass Spectrom. Ion Processes* **188**: 27–38 (1999).
164. Seto C, Grossert JS, Waddell DS, Curtis JM, Boyd RK. Effects of ionization mode on charge-site-remote and related fragmentation reactions of long-chain quaternary ammonium ions. *J. Am. Soc. Mass Spectrom.* **12**: 571–579 (2001).
165. Pinto DM, Boyd RK, Volmer DA. Ultra-high resolution for mass spectrometric analysis of complex and low-abundance mixtures: the emergence of FTICR-MS as an essential analytical tool. *Anal. Bioanal. Chem.* **373**: 378–389 (2002).