

# **JOHN CHRISTOPHER HARDY**, Ph.D., F.R.S.C.

*Distinguished Professor Emeritus  
Cyclotron Institute  
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Curriculum Vitae

## **PROFESSIONAL HISTORY**

- 1965-67 Postdoctoral Research Fellow, Nuclear Structure Laboratory, Oxford University, England
- 1967-70 Miller Research Fellow, then Staff Physicist, Lawrence Berkeley Laboratory, California, USA
- 1970-74 Associate Research Officer, AECL, Chalk River Nuclear Laboratories (CRNL), Ontario, Canada
- 1974-83 Senior Research Officer, CRNL
- 1976-77 Scientific Associate, CERN, Geneva (sabbatical leave from CRNL)
- 1983-86 Head, Nuclear Physics Branch, CRNL
- 1986-97 Director, TASCC (Tandem Accelerator Superconducting Cyclotron) Division, CRNL
- 1987-97 Chair, National Board of Directors, Deep River Science Academy
- 1997-2006 Professor, Physics Department, Texas A&M University
- 1997-2018 Faculty Researcher and Group Leader, Cyclotron Institute, Texas A&M University
- 2006-2018 Distinguished Professor, Physics Department, Texas A&M University
- 2015-2018 R and M Schilling Chair Professor in Physics & Astronomy, Texas A&M University
- 2018- Distinguished Professor Emeritus, Physics & Astronomy Dept., Texas A&M University

## **EDUCATION**

- 1961 B.Sc. (Honours Mathematics and Physics), McGill University, Montreal
- 1963 M.Sc. (Nuclear Physics), McGill University, Montreal
- 1965 Ph.D. (Nuclear Physics), McGill University, Montreal  
*Dissertation title: The  $A=4k + 1$  Sequence of Delayed Proton Precursors*  
*Supervisor: R.E. Bell FRS, FRSC*

## **HONOURS, AWARDS, ETC.**

- 1963-65 National Research Council Studentship (McGill)
- 1965 D.W. Ambridge Prize (Outstanding McGill graduand with science Ph.D.)
- 1965-67 National Research Council Postdoctorate Overseas Fellowship (Oxford)
- 1967-69 Miller Fellowship for Basic Research (University of California, Berkeley)
- 1976 Herzberg Medal, Canadian Association of Physicists
- 1976-77 CERN Research Associateship

1979	Fellowship, Royal Society of Canada
1981	Rutherford Medal in Physics, Royal Society of Canada
1983	Fellowship, American Physical Society
1992-95	Vice President, Academy of Science, Royal Society of Canada
2002-04	Member, Executive Council, Nuclear Physics Division, American Physical Society
2006	Tom W Bonner Prize, American Physical Society
2006	Distinguished Achievement Award in Research, Association of Former Students, Texas A&M University
2006	Appointed Distinguished Professor by Texas A&M University
2009-14	Divisional Associate Editor, Physical Review Letters
2014-17	Member, DOE/NSF Nuclear Science Advisory Committee
2016	Named "Outstanding Referee" for their journals by the American Physical Society
2017	Paper published in 2009 named one of "40 Years of Research Milestones" by DOE

### ASSOCIATIONS

Fellow, Royal Society of Canada  
Member, Canadian Association of Physicists  
Fellow, American Physical Society

### RESEARCH FUNDING AT TAMU

- 1) DOE      Between 1998 and my retirement in 2018, my research was partially funded through the Cyclotron Group Grant, "Cyclotron Based Nuclear Science," of which I was a co-PI. In 20 years my assigned share of that grant has totaled \$7,351,819
- 2) Welch    Between 1998 and my retirement in 2018, my research was also funded through three-year Welch Foundation grants "Nuclear Decay Studies," which were regularly renewed throughout the subsequent 20 years: total amount \$1,079,000.
- 3) BNL      Beginning in 2006, I secured annual contracts, renewed each year, from the National Nuclear Data Center at Brookhaven National Laboratory for data evaluation; this work was executed by a research scientist under my supervision. In 2016 I convinced DOE to transfer the funding for this effort to the Cyclotron Group Grant. During the 11 years these contracts were in force, they totaled \$594,950.

### TEACHING RECORD AT TAMU

- 1) Physics 218    5 semesters (~600 students total)
- 2) Physics 208    33 semesters (~4000 students total)  
Student evaluations always in the 4.50/5.00 range
- 3) Undergraduate Research supervision  
REU student (NSF funded) each summer for 13 years, 2005-2017
- 4) Graduate students supervised  
Russel Neilson M.Sc. 2002 (seconded from University of Auckland, NZ)  
Hyo In Park Ph.D. 2011  
John Goodwin Ph.D. 2012  
Miguel Bencomo Ph.D. 2018

## **PARTIAL RECORD OF SERVICE TO TAMU**

- 1) Reactor Safety Board (University Committee) Member 2003-2015; chair 2015-2017
- 2) College Promotion & Tenure Committee 2012-2015
- 3) Department Promotion, Tenure & Appointments Committee 2011-2013
- 4) Department Qualifying Exams Committee Member 1999-2001; chair 2002-2004
- 5) Department Performance Evaluation Committee Member 1998-2000, 2004; chair 2001, 2005-2006
- 6) Department Advisory Committee 1997-1999, 2008-2009
- 7) TAMU representative on JSA Program Committee of SURA 2008-2016
- 8) University Academic Civil Rights Investigation Committee 2015-2016

## **PARTIAL RECORD OF SERVICE TO SCIENCE COMMUNITY**

- 1) Program Advisory Committee for 88" Cyclotron at Lawrence Berkeley Natl. Lab. Chair 1994-1999
- 2) Program Advisory Committee for HRIBF at Oak Ridge Natl. Lab. Chair 1999-2006
- 3) Program Advisory Committee for ATLAS at Argonne Natl. Lab. Member, then chair 2007-2014
- 4) Publication Committee of the Division of Nuclear Physics of the APS Chair 2003-2004
- 5) DOE/NSF Nuclear Science Advisory Committee (NSAC) Member 2014-2016
- 6) NSAC Sub-committee to write long-range plan for U.S. nuclear physics Member 2015
- 7) Member of numerous ad hoc DOE and NSF committees struck to judge various labs and proposals
- 8) Referee for at least 10 journals

## **PUBLICATIONS**

1. DELAYED PROTON EMISSION FOLLOWING THE DECAY OF  $^{17}\text{Ne}$   
R. McPherson, J.C. Hardy and R.E. Bell  
Physics Letters **11** (1964)65.
2. DELAYED PROTONS FOLLOWING THE DECAY OF  $^{29}\text{S}$   
J.C. Hardy and R.I. Verrall  
Phys. Letters **13** (1964)148.
3. CALCIUM-37  
J.C. Hardy and R.I. Verrall  
Phys. Rev. Letters **13** (1964)764.
4. DELAYED PROTONS FOLLOWING  $^{21}\text{Mg}$  AND  $^{25}\text{Si}$  DECAY  
R. McPherson and J.C. Hardy  
Can. J. Phys. **43** (1965)1.
5. DELAYED PROTONS FOLLOWING THE DECAY OF ARGON-33  
J.C. Hardy and R.I. Verrall  
Can. J. Phys. **43** (1965)418.
6. DECAY OF CARBON-9  
J.C. Hardy, R.I. Verrall, R. Barton and R.E. Bell  
Phys. Rev. Letters **14** (1965)376.

7. LOG FT VALUES AND T=3/2 ANALOGUE STATES  
J.C. Hardy and B. Margolis  
Phys. Lett. **15** (1965)276.
8. NEW INFORMATION ON THE EMISSION OF DELAYED PROTONS FOLLOWING THE DECAY OF  
 $^{17}\text{Ne}$ ,  $^{21}\text{Mg}$  AND  $^{25}\text{Si}$   
J.C. Hardy and R.E. Bell  
Can J. Phys. **43** (1965)1671.
9. SUPERALLOWED LOG FT VALUES FOR TRANSITIONS BETWEEN T=3/2 ANALOGUE STATES  
J.C. Hardy, R.I. Verrall and R.E. Bell  
Nucl. Phys. **81** (1966)113.
10. AN IMPROVED NOMOGRAM FOR LOG FT VALUES  
R.I. Verrall and J.C. Hardy  
Nucl. Instr. & Methods **42** (1966)258.
11. T=3/2 ANALOGUE LEVELS IN MASS 25 AND 29  
J.C. Hardy and D.J. Skyrme  
in *Isobaric Spin in Nuclear Physics*, Academic Press Inc., New York (1966) pg. 701.
12. ENERGY LEVELS OF  $^{38}\text{Ca}$  FROM THE REACTION  $^{40}\text{Ca}(p,t)^{38}\text{Ca}$   
J.C. Hardy, D.J. Skyrme and I.S. Towner  
Phys. Lett. **23** (1966)487.
13. EFFECTS OF A SPIN-DEPENDENT INTERACTION POTENTIAL IN THE DWBA ANALYSIS OF  
TWO-NUCLEON TRANSFER REACTIONS  
I.S. Towner and J.C. Hardy  
Phys. Lett. **25B** (1967)98.
14. DETERMINATION OF THE SIGNS OF SHELL-MODEL MATRIX ELEMENTS FROM TWO-  
NUCLEON STRIPPING DATA  
J.C. Hardy and I.S. Towner  
Phys. Lett. **25B** (1967)577.
15.  $^{91}\text{Y}$  AND THE FAILURE OF THE CLOSED SHELL AT  $^{88}\text{Sr}$   
J.C. Hardy, W.G. Davies and W. Darcey  
Nucl. Phys. **A121** (1968)103.
16. THE LOCATION AND ISOSPIN-FORBIDDEN ALPHA DECAY OF THE LOWEST T=2 STATE IN  $^{28}\text{Si}$   
R.L. McGrath, J.C. Hardy and J. Cerny  
Phys. Lett. **27B** (1968)443.
17. CARBON-10 AND MASS MEASUREMENTS FOR LIGHT NUCLEI  
H. Brunnader, J.C. Hardy and J. Cerny  
Phys. Rev. **174** (1968)1247.
18. NEW NUCLIDES  $^{19}\text{Na}$  AND  $^{23}\text{Al}$  OBSERVED VIA THE  $(p,^6\text{He})$  REACTION  
J. Cerny, R.A. Mendelson Jr., G.J. Wozniak, John E. Esterl and J.C. Hardy  
Phys. Rev. Letters **22** (1969)612.

19. THE  $^{31}\text{P}(t,p)^{33}\text{P}$  REACTION AND THE USEFULNESS OF DOUBLE-STRIPPING IN DISTINGUISHING AMONG SHELL-MODEL CALCULATIONS  
W.G. Davies, J.C. Hardy and W. Darcey  
Nucl. Phys. **A128** (1969)465.
20. TABLES OF FRACTIONAL PARENTAGE COEFFICIENTS IN THE ISOSPIN FORMALISM FOR THE  $J=3/2$  AND  $5/2$  SHELLS  
I.S. Towner and J.C. Hardy  
Nuclear Data **A6** (1969)153.
21. ISOSPIN PURITY AND DECAY OF THE  $T=3/2$  ANALOGUE STATE IN  $^{17}\text{F}$   
J.C. Hardy, John E. Esterl, R.G. Sextro and J. Cerny  
in *Nuclear Isospin* ed. J. Anderson, S. Bloom, J. Cerny and W. True (Academic Press 1969).
22. ISOBARIC ANALOGUE STATES AND COULOMB DISPLACEMENT ENERGIES IN THE  $(1d_{5/2})$  SHELL  
J.C. Hardy, H. Brunnader, J. Cerny and J. Jaenecke  
Phys. Rev. **183** (1969)854.
23. DIRECT TWO-NUCLEON TRANSFER REACTIONS AND THEIR INTERPRETATION IN TERMS OF THE NUCLEAR SHELL MODEL  
I.S. Towner and J.C. Hardy  
Advances in Physics **18** (1969)401.
24. A SIMPLE METHOD FOR INVESTIGATING THE PARENTAGE OF STATES USING TWO-NUCLEON TRANSFER REACTIONS  
J.C. Hardy, H. Brunnader and J. Cerny  
Phys. Rev. Letters **A137** (1969)1439.
25. ISOSPIN-FORBIDDEN DECAY PROPERTIES OF THE LOWEST  $T=2$  STATES IN  $^{20}\text{Ne}$ ,  $^{24}\text{Mg}$ ,  $^{28}\text{Si}$ ,  $^{32}\text{S}$  AND  $^{40}\text{Ca}$   
R.L. McGrath, J. Cerny, J.C. Hardy, G. Goth and A. Arima  
Phys. Rev. **C1** (1970)184.
26.  $^{34}\text{Ar}$  AND  $T=1$  STATES IN  $^{34}\text{Cl}$  FROM TWO-NUCLEON PICKUP REACTIONS  
H. Brunnader, J.C. Hardy and J. Cerny  
Nucl. Phys. **A137** (1969)487.
27.  $T=2$  AND  $T=3$  ANALOGUE STATES,  $28 \leq A \leq 40$   
J.C. Hardy, H. Brunnader and J. Cerny  
Phys. Rev. **C1** (1970)561.
28. THE STRUCTURE OF  $^{16}\text{O}$  AND THE  $^{17}\text{O}(p,d)^{16}\text{O}$  REACTION  
R.A. Mendelson, J.C. Hardy and J. Cerny  
Phys. Letts. **31** (1970)126.
29. THE  $(^3\text{He}, ^6\text{He})$  REACTION ON  $^6\text{Li}$  AND  $^7\text{Li}$   
A.D. Bacher, R.L. McGrath, J. Cerny, R. de Swiniarski, J.C. Hardy and R.J. Slobodrian  
Nucl. Phys. **A153** (1970)409.
30. TWO-NUCLEON TRANSFER REACTIONS WITH POLARIZED PROTONS  
J.C. Hardy, A.D. Bacher, G.R. Plattner, J.A. Macdonald and R.G. Sextro

Phys. Rev. Letters **25** (1970)298.

31. ISOSPIN PURITY AND DELAYED PROTON DECAY:  $^{17}\text{Ne}$  AND  $^{33}\text{Ar}$   
J.C. Hardy, J.E. Esterl, R.G. Sextro and J. Cerny  
Phys. Rev. **3C** (1971)700.
32. THE REACTIONS  $^{11}\text{B}(p,t)^9\text{B}$  AND  $^{11}\text{B}(p,^3\text{He})$ : IS THERE STRONG ISOSPIN MIXING IN MASS-9?  
J.C. Hardy, J.M. Loiseaux, J. Cerny and G. Garvey  
Nucl. Phys. **A162** (1971)552.
33. BETA-DELAYED PROTON DECAY OF  $^{13}\text{O}$ : A VIOLATION OF MIRROR SYMMETRY  
J.E. Esterl, J.C. Hardy, R.G. Sextro and J. Cerny  
Phys. Letts. **33B** (1970)287.
34. SPIN-DEPENDENCE IN THE REACTIONS  $^{16}\text{O}(p,t)^{14}\text{O}$  AND  $^{16}\text{O}(p,^3\text{He})^{14}\text{N}$   
D.G. Fleming, J.C. Hardy and J. Cerny  
Nucl. Phys. **A162** (1971)225.
35. ISOSPIN MIXING AND  $\beta$ -DELAYED PROTON EMISSION  
J.C. Hardy  
Proc. Int. Conf. on Heavy Ion Physics, Dubna (1971) D-7-4769, pg. 261.
36. FIRST FORBIDDEN NON-UNIQUE BETA TRANSITIONS AND MIRROR COMPARISONS IN LIGHT NUCLEI  
I.S. Towner and J.C. Hardy  
Nucl. Phys. **A179** (1972)489.
37. A HIGH-RESOLUTION DETECTION SYSTEM FOR SHORT-LIVED GASEOUS ACTIVITIES  
J.E. Esterl, R.G. Sextro, J.C. Hardy, G.J. Ehrhardt and J. Cerny  
Nucl. Instr. & Methods **97** (1971)229.
38. USE OF THE ( $^7\text{Li},^7\text{Be}$ ) REACTION TO MEASURE THE MASS OF  $^{26}\text{Na}$   
G.C. Ball, W.G. Davies, J.S. Forster and J.C. Hardy  
Phys. Rev. Lett. **28** (1972)1497.
39.  $\beta$ -DELAYED PROTON DECAY OF  $^9\text{C}$   
J.E. Esterl, D. Allred, J.C. Hardy, R.G. Sextro, J. Cerny  
Phys. Rev. **C6** (1972)373.
40. MIRROR ASYMMETRY OF FERMI BETA DECAY  
J.C. Hardy, H. Schmeing, J.S. Geiger, R.L. Graham and I.S. Towner  
Phys. Rev. Letts. **29** (1972)1027.
41. TWO NUCLEON TRANSFER REACTIONS IN LIGHT NUCLEI  
J.C. Hardy  
Proc. Symposium on Two Nucleon Transfer and Pairing Excitations, Argonne Physics Division (1972) 202.
42. A PROGRAM FOR NUCLEAR PHYSICS IN THE SEVENTIES AND BEYOND  
J.C. Hardy, A.B. McDonald and J.C.D. Milton  
AECL-4596 (1972)

43. TWO NUCLEON TRANSFER REACTIONS INDUCED BY POLARIZED PROTONS  
 J.C. Hardy, A.D. Bacher, G.R. Plattner, J.A. Macdonald and R.G. Sextro  
 Polarization Phenomena in Nuclear Reactions, ed. H.H. Barschall and W. Haeberli (University of Wisconsin Press, 1971) 794.
44. NUCLEAR PARENTAGE SIMPLY OBTAINED FROM TWO-NUCLEON TRANSFER REACTIONS  
 J.C. Hardy, H. Brunnader and J. Cerny  
 Paper 8.55 of the Intern. Conf. on Properties of Nuclear States, ed. M. Harvey, R.Y. Cusson, J.S. Geiger and J.M. Pearson (University of Montreal Press, 1969).
45. DELAYED PROTON AND ALPHA PRECURSORS  
 J.C. Hardy  
 Nuclear Data, **A11** (1973)341.
46. FERMI  $\beta$ -DECAY: THE HALF LIVES OF  $^{26}\text{Al}^m$ ,  $^{34}\text{Cl}$ ,  $^{38}\text{K}^m$  AND  $^{42}\text{Sc}$   
 J.C. Hardy and D.E. Alburger  
 Phys. Lett. **42B** (1972)341.
47. MASS AND  $\beta$ -DECAY OF  $^{25}\text{Ne}$ , A  $T_z = +5/2$  NUCLIDE  
 D.R. Goosman, D.E. Alburger and J.C. Hardy  
 Phys. Rev. **C7** (1973)1133.
48. A NEW  $N=Z$  ISOTOPE: KRYPTON 72  
 H. Schmeing, J.C. Hardy, R.L. Graham, J.S. Geiger and K.P. Jackson  
 Phys. Lett. **44B** (1973)449.
49. SUPERALLOWED BETA DECAY  
 J.C. Hardy  
 AECL-4447 (1973).
50. SUPERALLOWED  $0^+ \rightarrow 0^+$  NUCLEAR BETA DECAYS  
 I.S. Towner and J.C. Hardy  
 Nucl. Phys. **A205** (1973)33.
51. THE MASS EXCESS AND LOW LYING LEVEL STRUCTURE OF  $^{14}\text{B}$   
 G.C. Ball, G.J. Costa, W.G. Davies, J.S. Forster, J.C. Hardy and A.B. McDonald  
 Phys. Rev. Letts. **31** (1973)395.
52. MIRROR NUCLEI  $A \leq 100$   
 J.C. Hardy  
 AECL-4604 (1973).
53. FERMI BETA DECAY: THE MASSES OF  $^{22}\text{Mg}$ ,  $^{26}\text{Si}$ ,  $^{30}\text{S}$  AND  $^{34}\text{Ar}$   
 J.C. Hardy, H. Schmeing, W. Benenson, G.M. Crawley, E. Kashy and H. Nann  
 Phys. Rev. **C9** (1974)252.
54. ANALYZING POWERS FOR TWO-NUCLEON TRANSFER REACTIONS IN THE  $1p$  SHELL  
 J.A. Macdonald, Joseph Cerny, J.C. Hardy, H.L. Harney, A.D. Backer. and G.R. Plattner  
 Phys. Rev. **C9** (1974)1694.
55. THE DECAY OF  $^{34}\text{Ar}$ : A MIRROR COMPARISON OF SUPERALLOWED BETA DECAY  
 J.C. Hardy, H. Schmeing, J.S. Geiger and R.L. Graham

Nucl. Phys. **C9** (1974)157.

56. USE OF THE  $^{14}\text{C}(^{18}\text{O}, ^{12}\text{Be})^{20}\text{Ne}$  REACTION TO MEASURE THE MASS OF  $^{12}\text{Be}$   
G.C. Ball, J.G. Costa, W.G. Davies, J.S. Forster, J.C. Hardy and A.B. McDonald  
Phys. Lett. **49B** (1974)33.
57. A NEW DELAYED PROTON PRECURSOR: CHROMIUM 45  
K.P. Jackson, J.C. Hardy, H. Schmeing, R.L. Graham, J.S. Geiger and K.W. Allen  
Phys. Lett. **49B** (1974)341.
58. FERMI BETA DECAY,  $A > 40$ : THE MASSES OF  $^{42}\text{Sc}$ ,  $^{36}\text{V}$ ,  $^{50}\text{Mn}$  AND  $^{54}\text{Co}$   
J.C. Hardy, G.C. Ball, J.S. Geiger, R.L. Graham, J.A. Macdonald and H. Schmeing  
Phys. Rev. Lett. **33** (1974)320.
59. NUCLEAR SPECTROSCOPY FROM DELAYED-PARTICLE EMISSION  
J.C. Hardy  
Nuclear Spectroscopy II, Chapter IXB, edited by J. Cerny, Academic Press (1974).
60. A LOW SPIN ISOMER IN  $^{74}\text{Br}$ : ITS HALF-LIFE AND DECAY SCHEME  
H. Schmeing, R.L. Graham, J.C. Hardy and J.S. Geiger  
Nuclear Physics **A233** (1974)63.
61. FERMI BETA DECAY:  $A > 40$ : THE HALF-LIVES OF  $^{46}\text{V}$ ,  $^{50}\text{Mn}$  AND  $^{54}\text{Co}$   
J.C. Hardy, H.R. Andrews, J.S. Geiger, R.L. Graham, J.A. Macdonald and H. Schmeing  
Phys. Rev. Lett. **33** (1974)1647.
62. SUPERALLOWED  $0^+ \rightarrow 0^+$  NUCLEAR BETA DECAYS AND CHARGE DEPENDENT MIXING  
J.C. Hardy, H.R. Andrews, G.C. Ball, J.S. Geiger, R.L. Graham, J.A. Macdonald, H. Schmeing and I.S. Towner  
Proc. of Inter. Conf. on Nuclear Structure and Spectroscopy Amsterdam 9-13 Sept. 1974, pg. 485.
63. SUPERALLOWED NUCLEAR BETA DECAY  
J.C. Hardy, H. Schmeing, J.S. Geiger, R.L. Graham and I.S. Towner  
Bulletin of the Academy of Sciences USSR (Physical Series)**39** (1975)51.
64. THE DECAY OF  $^{74}\text{Kr}$   
H. Schmeing, J.C. Hardy, R.L. Graham and J.S. Geiger  
Nucl. Phys. **A242** (1975)232.
65. THE SUPERALLOWED BETA DECAY OF  $^{18}\text{Ne}$ ,  $^{22}\text{Mg}$ , AND  $^{26}\text{Si}$   
J.C. Hardy, H. Schmeing, J.S. Geiger and R.L. Graham  
Nucl. Phys. **A246** (1975) 61.
66. DOES THE CABIBBO ANGLE SOMETIMES VANISH IN NUCLEAR BETA DECAY?  
J.C. Hardy and I.S. Towner  
Phys. Lett. **58B** (1975) 261.
67. SUPERALLOWED  $0^+ \rightarrow 0^+$  NUCLEAR BETA DECAYS AND CABIBBO UNIVERSALITY  
J.C. Hardy and I.S. Towner  
Nucl. Phys. **A254** (1975) 221.
68. SUPERALLOWED BETA DECAY: FROM NUCLEAR MASSES TO THE Z VECTOR BOSON



J.C. Hardy and I.S. Towner

Atomic Masses and Fundamental Constants 5, Plenum Press, N.Y. 1976. pg 66.

69. MASSES OF  $T_z = +5/2$  NUCLEI IN THE s-d SHELL FROM BETA-DECAY MEASUREMENTS  
D.E. Alburger, D.R. Goosman, C.N. Davies and J.C. Hardy  
Atomic Masses and Fundamental Constants 5, Plenum Press, N.Y. 1976.
70. NUCLEAR LIFETIMES IN THE REGION OF  $10^{-16}$  s MEASURED BY A NEW TECHNIQUE  
J.C. Hardy, J.A. Macdonald, H. Schmeing, H.R. Andrews, J.S. Geiger, R.L. Graham, T. Faestermann, K.P. Jackson, E.T.H. Clifford  
Phys. Rev. Lett. **37** (1976) 133.
71. A NEW SERIES OF BETA-DELAYED PROTON PRECURSORS  
J.C. Hardy, J.A. Macdonald, H. Schmeing, T. Faestermann,  
H.R. Andrews, J.S. Geiger, R.L. Graham and K.P. Jackson  
Phys. Lett. **63B** (1976) 27.
72. FROM PEAKS TO CONTINUA: THE STUDY OF DELAYED PROTON DECAY AMONG LIGHT  
NUCLEI ( $A < 100$ )  
J.C. Hardy  
Proc. Int. Conf. on Nuclei Far From Stability, Cargese, Corsica, France, 19-26 May 1976.
73. A FAST TAPE TRANSPORT SYSTEM FOR USE WITH ON-LINE SEPARATORS  
J.A. Macdonald, J.C. Hardy, H. Schmeing, N.C. Bray, W.L. Perry, R.B. Walker and M. Wightman  
Nucl. Instr. & Meth. **139** (1976) 355.
74. THE CHALK RIVER HELIUM JET AND SKIMMER SYSTEM  
H. Schmeing, V. Koslowsky, M. Wightman, J.C. Hardy, J.A. Macdonald, T. Faestermann, H.R. Andrews,  
J.S. Geiger and R.L. Graham  
Nucl. Instr. & Methods **139** (1976) 331.
75. BETA-DELAYED PROTON EMISSION: A NEW SERIES OF PRECURSORS AND THE  
MEASUREMENT OF  $10^{-16}$ s NUCLEAR LIFETIMES  
J.C. Hardy, J.A. Macdonald, H. Schmeing, T. Faestermann, H.R. Andrews, J.S. Geiger, R.L. Graham and  
K.P. Jackson  
Atomic Energy of Canada report, AECL-5560 (1977).
76. BETA-DELAYED PROTON EMISSION: A NEW SERIES OF PRECURSORS AND THE  
MEASUREMENT OF  $10^{-16}$  NUCLEAR LIFETIMES  
J.C. Hardy, J.A. Macdonald, H. Schmeing, T. Faestermann, H.R. Andrews, J.S. Geiger, R.L. Graham and K.P.  
Jackson  
Proc. Int. School Seminar on Reactions of Heavy Ions with Nuclei and Synthesis of New Elements, Dubna  
report D7-9734 (1976) 197.
77. BETA-DELAYED PROTONS, STRENGTH FUNCTIONS AND NUCLEAR LIFETIME  
MEASUREMENTS IN THE REGION OF  $10^{-16}$ s  
J.C. Hardy  
Proc. of XV Winter School on Nuclear Physics at Zakopane, Poland, Report #963/PL (1977) 321.
78. SUPERALLOWED NUCLEAR BETA DECAY: A NUCLEAR VIEW OF THE Z VECTOR BOSON AND  
SYMMETRY RESTORATION IN HIGH ELECTROMAGNETIC FIELDS  
J.C. Hardy

79. BETA-DECAY STRENGTH FUNCTIONS: ON THE FRONTIERS OF PANDEMONIUM  
J.C. Hardy  
Proc. of the Hirschegg International Workshop V ON Gross Properties of Nuclei and Nuclear Excitation,  
Hirschegg, Austria  
AED-Conf 77-017-001-AED-Conf 77-017-043 (1977) 200.
80. DELAYED PROTON RADIOACTIVITIES  
J. Cerny and J.C. Hardy  
Annual Review of Nuclear Science **27** (1977) 333.
81.  $T_{1/2}$  BETA-DELAYED PROTON PRECURSORS, I: THE DECAY OF  $^{69}\text{Se}$   
J.A. Macdonald, J.C. Hardy, H. Schmeing, T. Faestermann, H.R. Andrews, J.S. Geiger, R.L. Graham and  
K.P. Jackson  
Nucl. Phys. **A288** (1977) 1.
82. RADIOACTIVITY  
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