SUPPLEMENT 3 to NBS CIRCULAR 499

Nuclear Data

UNITED STATES DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

NUCLEAR DATA

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UNITED STATES DEPARTMENT OF COMMERCE, Charles Sawyer, Secretary
NATIONAL BUREAU OF STANDARDS, A. V. Astin, Acting Director

NUCLEAR DATA

A Collection of Experimental Values of Half-lives, Radiation Energies, Relative Isotopic Abundances, Nuclear Moments, and Cross Sections

Compiled by

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With the Help of Abstracts Prepared by Special Readers

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Supplement 3 (January 1951 to July 1951) to
National Bureau of Standards Circular 499

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PUBLICATION OF FUTURE SUPPLEMENTARY MATERIAL

This Supplement, number 3, is the last one which will be issued in conjunction with Nuclear Data, National Bureau of Standards Circular 499 *, and sent to purchasers of the original volume.

The NBS Nuclear Data group and its associated readers is continuing to collect current nuclear data and is now sending its tabular summaries to Nuclear Science Abstracts **, (NSA), the semi-monthly abstract journal of the Atomic Energy Commission. The first NBS list appeared in the issue of January 15, 1952 (Vol. 6, #1).

Every three months NSA will cumulate (by element and isotope) all the items which have appeared in the lists of the preceding six issues and every twelve months will make a grand cumulation for the entire year. These cumulations will appear in special index numbers. Since NSA is a journal which is published regularly and distributed widely it is believed that the NBS lists which it will carry will serve as accessible and convenient supplements to present and future NBS tables and to other collections of nuclear data.

The present Supplement covers nuclear data reported from January 1, 1951 to July 1, 1951. The first NSA cumulation of March 30, 1952 will cover material published from July 1, 1951 to about December 1, 1951 and future cumulations will carry succeeding material so that there will be no gaps in coverage.

* Nuclear Data, National Bureau of Standards Circular 499, is for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C., price $4.25. This price includes the three supplements.

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	σ_t(13.9 Mev) 0.77	51L1		A.H.Lasday, PR **81**, 139.
	σ_t(39 Mev) 0.223 (64.5 Mev) 0.126 (97 Mev) 0.074	51T3	Be(*d,n*). Recoil *p* telescope.	A.E.Taylor, et al., Phil. Mag. **42**, 328.
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$^{2}_{1\ 1}$	σ_s coh 5.2 σ_s bound 7.4	51S20	Powder diffraction technique. λ_n = 1.057 A or 1.315 A. σ_s bound obtained from new transmission measurements or deduced from literature values. Most data obtained with two or more compounds and believed accurate to 6 - 8%.	C.G.Shull, E.O.Wollan, PR **81**, 527.
	μ 0.857608 I	51S18	$\nu(D)/\nu(H)$ $[D_2;H_2]$ = 0.15350612 ± 0.00000005.	B.Smaller, et al., PR **81**, 896.
	q 2.738×10^{-3} M	51K6		H.G.Kolsky, et al., PR **81**, 1061.
	D(γn) Angular distribution of photo *n*'s for E_γ = 2.51	51B10	Results give σ(mag)/σ(el)=0.61. Ga^{72} γ's.	G.R.Bishop, et al., PR **81**, 219.
$^{3}_{1\ 2}$	$Li^6(n,\alpha)$ Q = 4.80 ic	51F1	Average from measurements of E_α and E_{H^3} in grid ic.	U.Facchini, et al., PR **81**, 475.
	D(*d,p*) Q = 4.030 ± 0.006 sπ	51S19		E.N.Strait, et al., PR **81**, 747.

2 HELIUM He

He	σ_s coh 1	51M3	Total reflection method. Positive scattering phase.	A.W.McReynolds, G.W.Johnson, PR **82**, 334(A).
$^{3}_{2\ 1}$	$Li^6(p,\alpha)$ Q = **4.021** ± 0.006 sπ	51S19		E.N.Strait, et al., PR **81**, 747.
$^{4}_{2\ 2}$	$\sigma[D(d,n)He^3]$, $\sigma[D(d,p)H^3]$ tables	51M9	Give absolute σ for E_d = 120, 140,160,250,300 kev.	K.G.McNeill, G.M.Keyser, PR **81**, 602.
	$D(d,n)$ Angular distribution studied	50B87	b = 0.15 + 0.0027E (kev). E_d = 100, 200 kev.	I.Bartholdson, Arkiv Fysik **2**, 271.
	$H^3(p,\gamma)He^4$ Q = **19.2**	51R1	E_p = 0.94. E_γ measured with pair spectrometer.	R.S.Rochlin, B.D.McDaniel, PR **82**, 298(A).
	$Li^7(p,\alpha)$ Q = **17.340** ± 0.014 sπ	51S19		See He^3, 51S19.
	$Li^7(p,\alpha)$ Q = **17.338** ± 0.011 sπ	51W5		W.Whaling, C.W.Li, PR **81**, 150 and **81**, 661(A).
$^{5}_{2\ 3}$	$\sigma[D(t,n)He^4]$ **graph** E_t = 0.1 − 0.2 Mev	51A4	Results disagree with resonance formulae. Based on D − D σ's.	D.L.Allan, M.J.Poole, Proc. Roy. Soc. **A204**, 488.
	$D(t,n)He^4$ Angular distribution ~ uniform	51A6	E_t = 0.125, 0.175, 0.200.	D.L.Allan, M.J.Poole, Proc. Roy. Soc. **A204**, 500.

3 LITHIUM Li

Li	σ_a(pile n) **64** osc	51G16	Based on σ_a (B) = 710.	B.Grimeland, et al., Compt. Rend. **232**, 2089.
$^{6}_{3\ 3}$	q **4.6 x 10⁻⁴** I	51S7	From $q(Li^6)/q(Li^7) = 2.3 \times 10^{-2}$.	N.A.Schuster, G.E.Pake, PR **81**, 157.
	$Be^9(p,\alpha)$ Q = **2.142** ± 0.006 sπ	51S19		E.N.Strait, et al., PR **81**, 747.
$^{7}_{3\ 4}$	No α emitting level below 7.4 Mev	51C20	$B^{11}(\gamma,\alpha)Li^7$; $Li^7 \rightarrow t + \alpha$ not found with E_γ = 17.6.	M.E.Calcraft, E.W.Titterton, Phil. Mag. **42**, 666.
	$Li^6(d,p)$ Q = **5.019** ± 0.007 sπ	51S19		See Li^6, 51S19.
	$Li^6(d,p)$ No $p\gamma$ angular correlation	51T13	Indicates I(0.478 level) = 1/2. pc for p's, scin for γ's. E_d = 0.6.	J.Thirion, Compt. Rend. **232**, 2418.
	$Be^9(d,\alpha)$ Q = **7.150** ± 0.008 sπ	51S19		See Li^6, 51S19.
	$Be^9(d,\alpha)$ Q = **7.151** ± 0.010 sπ	51W5		W.Whaling, C.W.Li, PR **81**, 150 and **81**, 661(A).
	$B^{10}(n,\alpha)$ Q = **2.85, 2.35**	50F78	Thermal n's; ic with BF_3 and A. Higher Q in 7.5% of reactions.	H.Fränz, H.Westmeyer, Z. Phys. **128**, 617.

Be	σ_{in}(2.5 Mev) <0.014	51G24	From γ intensity (coincidence counters) and absolute n intensity (recoil p's).	M.A.Grace, et al., PR **82**, 969.
	σ_t(2 - 6 Mev) graph $E_0 \sim 2.7$ $\sigma_0 = 3.4$ $\Gamma \sim 0.6$	51S27	D(d,n) and N(d,n). High pressure ic detector.	G.H.Stafford, Proc. Phys. Soc., Lond., **A64**, 388.
	σ_t(13.9 Mev) 1.4	51L1		A.H.Lasday, PR **81**, 139.
	New reference for data reported in 50K8		Be^8.	B.B.Kinsey, et al., Can. J. Phys. **29**, 1.
7 4 3	E(Li^7 recoil) 56.6 ev ΔM($Be^7 - Li^7$) 860 ± 8 kev e^-(Auger) 36 ev No X-rays observed	51S13	Recoils not monoenergetic, possibly due to surface effects.	P.B.Smith, J.S.Allen, PR **81**, 381.
	Li^6(d,n) No $n\gamma$ angular correlation	51T14	Indicates I(0.434 level) = 1/2. Two scin counters. E_d = 0.55.	J.Thirion, Compt. Rend. **233**, 37.
	B^{10}(p,α) Q = 1.152 ± 0.004 Sπ	51S19		E.N.Strait, et al., PR **81**, 747.
8 4 4	Li^7(d,n) $n\gamma$ angular correlation b - 0.45	51T10		J.Thirion, T.Muller, Compt. Rend. **232**, 1093.
	Li^7(d,n) $n\gamma$ angular correlation	51T14	Indicates I(4.9 level) = 1. Two scin counters. E_d = 0.55.	See Be^7, 51T14.
	Li^7(p,γ) Isotropic distribution for for resonant γ's	51N4	γ's detected by C stars in photoplates.	H.Nabholz, et al., PR 82, 963.
	Be^9(p,d) Q = 0.562 ± 0.004 Sπ	51S19		See Be^7, 51S19.
	B^{11}(γ,t) α emission levels 2.9,4.0	51C20	E_γ = 17.6. B loaded emulsions.	M.E.Calcraft, E.W.Titterton, Phil. Mag. 42, 666.
9 4 5	I 3/2 ? I	51G8	Study of BeF_2 shows I not 1/2, probably not 5/2.	H.S.Gutowsky, et al., PR 81, 635.
	I 3/2 I	51S17		N.A.Schuster, G.E.Pake, PR **81**, 886.
	μ - 1.1777 I	51S33	$\nu(Be^9)/\nu(H^1)$ [$BeCl_2$] = 0.140531 ± 0.000011.	R.E.Sheriff, D.Williams, PR **82**, 651.

5 BORON B

9 (5 4)	$B^{10}(\gamma,n)$ Q = **-7.6** 51S6	Threshold observed.	R.Sher, et al., PR **81**, 154.
10 (5 5)	$[\sigma(n,\alpha)Li]/[\sigma(n,\alpha)Li(0.477\ level)]$ **4.27 %** 51C21	B loaded emulsions; thermal *n*'s.	P.Cüer, J.P.Longchamp, Compt. Rend. **232**, 1824.
	$[\sigma(n,\alpha)Li]/[\sigma(n,\alpha)Li(0.477\ level)]$ curve given as $f(E_n)$ 51B8	Ratio has max. of ~2 at E_n = 3. E_n = th - 4.	H.Bichsel, et al., PR **81**, 456.
	$Be^9(p,n)$ **yield curve** 51C10		J.M.Cassels, et al., Phil. Mag. **42**, 215.
	$B^{11}(\gamma,n)$ Q = **-11.1** 51S6	Threshold observed.	See B^9, 51S6.
11 (5 6)	μ **2.6888** I 51S33	$\nu(B^{11})/\nu(H^1)$ $[Na_2B_2O_4]$ = 0.32085 ± 0.00002. Li substandard used.	R.E.Sheriff, D.Williams, PR **82**, 651.
	$B^{10}(d,p)$ Q = **9.235** ± 0.011 sπ 51S19		E.N.Strait, et al., PR **81**, 747.
	$B^{10}(d,p)$ No $p\gamma$ angular correlation 51T13	Indicates I(2.3 level) = 1/2. pc for *p*'s, scin for γ's. E_d = 0.79.	J.Thirion, Compt. Rend. **232**, 2418.
	$B^{11}(\gamma,\alpha)Li^7$ 51C20	E_γ = 17.6. Li^7 left in ground state. B loaded emulsions.	M.E.Calcraft, E.W.Titterton, Phil. Mag. **42**, 666.
	$C^{13}(d,\alpha)$ Q = **5.160** ± 0.010 sπ 51S19		See $B^{10}(d,p)$, 51S19
12 (5 7)	β_1^- ~96 % (13.4)* a 51V2 β_2^- ~ 4 % ~**9.1** aβγ	B(600 kev *d*). β_1 and β_2 absorbed by 7.2 and 4.8 gm/cm^2 C respectively.	G.Vendryes, Compt. Rend. **232**, 1549 and **233**, 391. *Value of 50H1.
	$B^{11}(d,p)$ Q = **1.136** ± 0.005 sπ 51S19		See B^{11}, 51S19.

6 CARBON C

C '	σ_t(13.9 Mev) **1.24** 51L1		A.H.Lasday, PR **81**, 139.
	σ_t(39 Mev) **1.10** 51T3 (64.5 Mev) **0.784** (97 Mev) **0.508**	Be(*d,n*). Recoil *p* telescope.	A.E.Taylor, et al., Phil. Mag. **42**, 328.
	σ_t(~100 - 240 Mev) **graph** 51D7	Be(*p,n*). Bi-f detector.	J.DeJuren, B.J.Moyer, PR **81**, 919.
	σ_t(156 Mev) **0.330** 51T2	Be(171 Mev *p,n*).	A.E.Taylor, et al., Phil. Mag. **42**, 20.
	New reference for data reported in 50K8	C^{13}.	B.B.Kinsey, et al., Can. J. Phys. **29**, 1.
12 (6 6)	$N^{15}(p,\alpha)$ Q = **4.960** ± 0.007 sπ 51S19		E.N.Strait, et al., PR **81**, 747.

(C continued on next page)

6 CARBON C (continued)

$^{13}_{6\ 7}$	$B^{10}(\alpha,p)$ Q = ~**3.8, 0.24, -0.22** $S\pi$	51F13	Po α's, photoplates. Q = -0.22 observed only for p's at 90°.	G.M.Frye, M.L.Wiedenbeck, PR **82**, 960.
	$C^{12}(d,p)$ No C^{13} level found below 3.11	51B3	E_d = 8. Photoplate. Various angles used.	M.Blundell, J.Rotblat, PR **81**, 144.
	$C^{12}(d,p)$ Angular distributions show 1/2 − for ground and 1/2 + for 3.11 level	51R10	E_d = 8. Photoplates.	J.Rotblat, Nature **167**, 1027.
$^{14}_{6\ 8}$	τ **5580**^{y} ± 45	50E59	Data of 49E5 corrected for wall loss in argon-alcohol G-M counter.	A.G.Engelkemeir, W.F.Libby, Rev. Sci. Inst. **21**, 550.
	τ **5370**^{y} ± 200	51M30	Gas counting of CO_2 and CS_2 mixtures.	G.G.Manov, L.F.Curtiss, J. Res., N.B.S. **46**, 328.
	$B^{11}(\alpha,p)$ Q = **0.75** $S\pi$	51F13	Po α's, photoplates.	See C^{13}, 51F13.

7 NITROGEN N

N	σ_s coh **9.1** σ_s bound **10**	51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
	σ_s coh ~**10**	51M3	Total reflection method. Positive scattering phase.	A.W.McReynolds, G.W.Johnson, PR **82**, 344(A).
	New reference for data reported in	50P6	N^{14}.	W.G.Proctor, F.C.Yu, PR **81**, 20.
	New reference for data reported in	50K8	N^{15}.	B.B.Kinsey, et al., Can. J. Phys., **29**, 1.
$^{13}_{7\ 6}$	$C^{12}(p,n)$ **yield curve**	51C10		J.M.Cassels, et al., Phil. Mag. **42**, 215.
$^{14}_{7\ 7}$	$O^{16}(d,\alpha)$ Q = **3.112** ± 0.006 $S\pi$	51S19		E.N.Strait, et al., PR **81**, 747.
	σ(th n,p) **1.77**	51C25	Based on σ_a (B) = 703. Used N and B loaded emulsions.	P.Cüer, et al., J. Phys. Rad., **12**, 68.
$^{15}_{7\ 8}$	μ **-0.28311** I	51P2	$\nu(N^{15})/\nu(N^{14})$ [HNO_3] = 1.4027 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **81**, 20.
	$N^{14}(d,p)$ Q = **8.615** ± 0.009 $S\pi$	51S19		See N^{14}, 51S19.
$^{16}_{7\ 9}$	γ_1 100%* **6.13** γ_2 8%* **7.10** } pair s	51M1	γ of 6.91 could have been missed. Deduce N^{16} ground state I = 2−. Produced by O (pile n,p).	C.H.Millar, et al., PR **81**, 150. [Cf. levels O^{16}.] *Relative intensity.

8 OXYGEN O

O	σ_s coh 3.9*	51M3	Total reflection method. Positive scattering phase.	A.W.McReynolds, G.W.Johnson, PR **82**, 344(A) and * verbal report.
15 (8 7)	τ 2.12^m	51D8		D.B.Duncan, J.E.Perry, PR **82**, 809.
	$\sigma[N^{14}(p,\gamma)O^{15}]$ yield curves E_0 / σ_0 (mb) / Γ(kev) 0.70 / 0.001 / 100 1.064 / 0.37 / 4.8 1.55 / 0.006 / 50 1.748 / 0.03 / 11 1.815 / 0.11 / 7 2.356 / 0.21 / 14 2.489 / 0.35 / 11 2.60 / 0.05 / 1270	51D8	β^+ of O^{15} observed. Yield curves obtained for Be_3N_2 thick target, N_2 gas target, and thin N layer absorbed on thin Cu foil. E_p = 0.25 - 2.6. 0.277 resonance could not be studied.	See above.
16 (8 8)	$\bar{\sigma}$(fast *n,p*)7.35^{s}N ~8mb	51C1	For total Be(15 Mev *d,n*) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
	$F^{19}(p,\alpha)$ Q = 8.118 ± 0.009 sπ	51S19		E.N.Strait, et al., PR **81**, 747.
17 (8 9)	I 5/2 I μ -1.8934 I	51A8	$\nu(O^{17})/\nu(D^2)$ [H_2O;D_2O] = 0.88313 ± 0.00004.	F.Alder, F.C.Yu, PR **81**, 1067.
	I 5/2 ? Mic q -0.005 Mic	51G19		S.Geschwind, et al., PR **83**, 209(A).
	$O^{16}(d,p)$ No $p\gamma$ angular correlation	51T13	Indicates I(0.790 level) = 1/2. pc for *p*'s, scin for γ's. E_d = 0.79.	J.Thirion, Compt. Rend. **232**, 2418.
	$O^{16}(d,p)$ Q = 1.917 ± 0.005 sπ $F^{19}(d,\alpha)$ Q = 10.050 ± 0.010 sπ	51S19		See O^{16}, 51S19.
	$Ne^{20}(n,\alpha)$ Q = 0.75 ± 0.05	51J7	$H^3(p,n)$. pc calibrated with Po α's.	C.H.Johnson, et al., PR **82**, 117.
18 (8 10)	I 0 Mic	51M20		S.L.Miller, et al., PR **82**, 454.

9 FLUORINE F

F	σ_s coh 3.8 σ_s bound ~3.5	51S20	See H^2.	C.G.Shull, E.O.Wollan, PR **81**, 527.
17 (9 8)	τ 66^s β^+ 1.7 a	51L4		M.J.W.Laubenstein, et al., PR **81**, 654(A).
19 (9 10)	σ_{in}(2.5 Mev) 0.5	51G24	Result of 50B6 revised.	M.A.Grace, et al., PR **82**, 969.
	μ 2.6282 I	51S33	$\nu(F)/\nu(H^1)$ [HF] = 0.94086 ± 0.00005	R.E.Sheriff, D.Williams, PR **82**, 651.

10 NEON Ne

21 10 11	σ[Ne (n,α)] graph 51J7 Resonances at E_n = 2.12, 2.45,* 2.62, 2.72, 2.87,* 3.26*	$H^3(p,n)$. E_n = 1.8 - 3.4. * Strong resonances attributable only to Ne^{20}.	C.H.Johnson, et al., PR **82**, 117.
	$Na^{23}(d,\alpha)$ 51F2 Q = 6.84, 6.46, 5.09, 4.08	E_d = 0.83 - 0.93. Air abs., ic. Levels in Ne^{21} at 0.38, 1.75, 2.76.	A.P.French, D.M.Thomson, Proc. Phys. Soc., Lond., **A64**, 203.
	$Na^{23}(d,\alpha)$ Q = 6.902 ± 0.010 Sπ 51S19		E.N.Strait, et al., PR **81**, 747.
22 10 12	$F^{19}(\alpha,p)$ 51J3 Levels 0.4, 1.41	Angular distribution of p's studied for α's of 3.7 and 4.1.	J.D.Jolley, F.C.Champion, Proc. Phys. Soc., Lond., **A64**, 88.

11 SODIUM Na

20 11 9	τ 0.23^s 51S38 β^+	Na($\lessapprox$76 Mev γ, $3n$). β^+ energy of > 3.5 and < 7.3 Mev calculated.	R.K.Sheline, PR **82**, 954.
21 11 10	β^+ 2.53 Sπ 51S11	Produced by Mg (18.5 Mev p,α).	G.E.Schrank, J.R.Richardson, PR **81**, 660(A).
22 11 11	$Na^{23}(\gamma,n)$ Q = -12.6 51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
23 11 12	μ 2.2165 I 51S33 2.2167 I	$\nu(Na^{23})/\nu(H^1)$ [NaBr] = 0.264492 ± 0.000015. $\nu(Na^{23})/\nu(H^1)$ [$Na_2B_2O_4$] = 0.264518 ± 0.000014.	R.E.Sheriff, D.Williams, PR **82**, 651.
24 11 13	τ 15.06^h 51S14	Points out error in 49W19.	J.H.Sreb, PR **81**, 469.
	τ 15.0^h 51S25	Solution of Na_2CO_3 used. Followed 3.5 half lives.	W.K.Sinclair, A.F.Holloway, Nature **167**, 365.
	I 4 M 51S29		K.F.Smith, Nature **167**, 942.
	β^- 0.003% 4.17 sl,scin 51T12 γ 0.05 % ~4 sl;pe$^-$,Compt	Used straight line Fermi plot although log ft = 12.7. 5.53 β not detected, log ft > 15.	J.F.Turner, P.E.Cavanagh, Phil. Mag. **42**, 636.
	γ (2.76) 50S76 $\alpha = 3 \times 10^{-6}$	Consistent with quadrupole transition.	K.Siegbahn, S.du Toit, Arkiv Fysik **2**, 211.
	$Na^{23}(d,p)$ 51S1 Q = 4.73, 4.26, 4.17, 3.39, 2.89, 2.86, 2.17, 1.32 Sπ	E_d = 2.0. Levels 0.47, 0.56, 1.34, 1.84, 1.87, 3.41.	A.Sperduto, W.W.Buechner, PR **82**, 304(A).
	$Na^{23}(d,p)$ Q = 4.731 ± 0.009 Sπ 51S19		E.N.Strait, et al., PR **81**, 747.

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12 MAGNESIUM

Mg	σ_{in}(2.5 Mev) **0.8** 51G24	Results of 50B6 revised.	M.A.Grace, et al., PR **82**, 969.
$^{24}_{12\ 12}$	$\bar{\sigma}$(fast *n,p*) 14.9^{h}Na **39 mb** 51C1	For total Be(15 Mev *d,n*) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
	$Mg^{25}(\gamma,n)$ Q = **−7.1** 51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
$^{25}_{12\ 13}$	μ **−0.85493*** I 51A11	$\nu(Mg^{25})/\nu(N^{14})$ [$MgCl_2$] = 0.84714 ± 0.00008. * Using $\mu(N^{14})$ = 0.40368 of 51P2.	F.Alder, F.C.Yu, PR **82**, 105.
	$Ne^{22}(\alpha,n)$ Q = **−0.916, −1.71** 51O3	E_α = 4.4 Mev. Ilford C2 plates; recoil *p*'s.	Z.M.I.Ollano, R.R.Roy, Nuovo Cim. **8**, 77.
	$Mg^{26}(\gamma,n)$ Q = **−10** 51S6	From observed threshold.	See Mg^{24}, 51S6.
	$Mg^{24}(d,p)$ Q = **5.094** ± 0.010 Sπ 51S19 $Al^{27}(d,\alpha)$ Q = **6.694** ± 0.010 Sπ		E.N.Strait, et al., PR **81**, 747.
	$Al^{27}(d,\alpha)$ 51T15 New Q's = **2.73*, 2.57*, −0.29, −1.16, −1.94, −2.37, −3.06, −4.09, −5.20**	* Level at 4.01 resolved into two. Otherwise checked values of 50S68. Photoplates.	E.C.Toops, et al., PR **83**, 212(A) and **85**, 280.

13 ALUMINUM Al

Al	σ_a(0.025 ev) **0.219** osc 51B29	Based on σ_a(B) = 710.	P.Benoit, et al., J. Phys. Rad. **12**, 584.
	σ_t(2 − 6 Mev) **graph** 51S27 E_0 = **2.55** σ_0 = **3.2**	See Be, 51S27. 3 Mev resonance not found but not ruled out.	G.H.Stafford, Proc. Phys. Soc., Lond., **A64**, 388.
	σ_t(~100 − 240 Mev) **graph** 51D7	Be(*p,n*). Bi-f detector.	J.DeJuren, B.J.Moyer, PR **81**, 919.
$^{27}_{13\ 14}$	$\bar{\sigma}$(fast *n,p*) 9.6^{m}Mg **25 mb** 51C1	For total Be(15 Mev *d,n*) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
	μ **3.6395** I 51S33	$\nu(Al^{27})/\nu(H^1)$ [$AlCl_3$] = 0.260579 ± 0.000013. Sc substandard used.	R.E.Sheriff, D.Williams, PR **82**, 651.
	$Mg^{24}(\alpha,p)$ Q = **−1.614** ± 0.010* 51K8	From shift in resonance pattern between this reaction and inverse.	S.G.Kaufmann, et al., PR **81**, 317(A) and * priv. comm. to J.R.Stehn.
	$Si^{29}(d,\alpha)$ 51P10 Q = **5.99, 5.16, 4.99, 3.27** Sπ	E_d = 1.8.	D.M.Van Patter, et al., PR **83**, 212(A) and "Errata" J10, PR **83**, 196.
$^{28}_{13\ 15}$	$Al^{27}(d,p)$ 51E11 Q = **5.494, 5.463, 4.479, 4.127, 3.869, 3.357, 3.296, 3.226, 3.010, 2.916, 2.842, 2.514, 2.036, 1.907, 1.621, 1.562, 1.463, 0.809, 0.735, 0.595, 0.366, 0.338, 0.325, 0.059, −0.241, −0.298, −0.361, −0.817**	E_d = 1.2 − 1.8 and 2.0. Other less intense groups were observed. Yield of 0.031 level is 55% of ground state yield.	H.A.Enge, PR **81**, 317(A), **83**, 212(A) and "Errata" J8, PR **83**, 196.
	$Si^{30}(d,\alpha)$ Q = **3.120** ± 0.010 Sπ 51S19		E.N.Strait, et al., PR **81**, 747.

14 SILICON Si

Si	$\Delta M(Si^{30}-Si^{29})/\Delta M(Si^{30}-Si^{28})$ **0.49941** ± 0.00005 Mic	51G10	From isotope shift in J = 1→2 transition in $Si^{30,29,28}H_3Cl^{35}$.	S.Geschwind, R.Gunther-Mohr, PR **81**, 882 and **82**, 346(A).
28 14 14	$\bar{\sigma}$(fast *n,p*)2.3^{m}Al **45** mb	51C1	For total Be(15 Mev *d,n*) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
	Al^{27} (*p,n*) **yield curve**	51C10		J.M.Cassels, et al., Phil. Mag. **42**, 215.
	Si^{29} (γ,*n*) Q = **-8.4**	51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
	P^{31} (*p*,α) Q = **1.85**	51F6	Q averaged for E_p = 0.680, 0.900, 1.025.	J.M.Freedman, J.Seed, Proc. Phys. Soc., Lond., **A64**, 313.
29 14 15	$\bar{\sigma}$(fast *n,p*)6.56^{m}Al **36** mb	51C1	See Si^{28}, 51C1.	See Si^{28}, 51C1.
	Si^{28} (*d,p*) Q = **6.246** ± 0.008 P^{31} (*d*,α) Q = **8.170** ± 0.020	51S19		E.N.Strait, et al., PR **81**, 747.
	Si^{28} (*d,p*); P^{31} (*d*,α) Levels **1.282, 2.038, 2.436, 3.073, 3.623, 4.078, 4.840, 4.897, 4.934**	51E6	From Q values of *d,p* and *d*,α reactions. E_d = 1.8.	P.M.Endt, et al., PR **81**, 317(A) and **83**, 491.
30 14 16	Al^{27} (α,*p*) Q = **2.30, 0.14, -1.24**	51S15	Po α source. Photoplates.	H.Slätis, et al., PR **81**, 641.
	Si^{29} (*d,p*) Q = **8.39, 6.14, 4.87, 4.60, 3.31, 2.77** } Sπ	51P10	E_d = 1.8.	D.M.Van Patter, et al., PR **83**, 212(A).
31 14 17	Si^{30} (*d,p*) Q = **4.364, 3.604, 2.666** Sπ	51P1	E_d = 1.8. Levels 0.76, 1.70. Cf. Motz, PR **80**, 595.	D.M.Van Patter, et al., PR **82**, 304(A) and **81**, 747.

15 PHOSPHORUS P

P	New reference for data reported in	50L56	P^{31}.	R.Ricamo, Nuovo Cim. 8, 383.
	σ_t (1.9 – 3.6 Mev) **graph** σ (1.9 – 3.6 Mev *n,p*) **graph**	51R11	Many resonances observed on both graphs; up to 2.5 Mev several coincide.	R.Ricamo, Nuovo Cim. 8, 383.
29 15 14	Si^{28} (*d,n*) Q = **0.36**	51S21	E_d = 1.4. Photoplates. Single *n* group.	C.P.Swann, C.E.Mandeville, PR **82**, 772(A).
30 15 15	P(γ,*n*) * Q = **-12.4** S(γ,*d*) ** Q = **-19.1**	51K4	E_o / Γ / $\sigma \times 10^3$ Mev-b. * **19.0** / **7.5** / **120** ** **24?, 26** / **3** / **4.1**	L.Katz, A.S.Penfold, PR **81**, 815 and **81**, 660(A).
31 15 16	μ **1.13096** I	51S33	$\nu(P)/\nu(H^1)$ [H_3PO_4] = 0.404869 ± 0.000026. Li substandard used.	R.E.Sheriff, D.Williams, PR **82**, 651.
	σ(fast *n,p*)2.62^{h}Si **120** mb	51C1	For total Be(15 Mev *d,n*) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.

(P continued on next page)

15 PHOSPHORUS P (continued)

32 15 17	τ **14.59**^{d} 51S25	Used Na_2HPO_4. Followed 3 half lives.	W.K.Sinclair, A.F.Holloway, Nature **167**, 365.
	β^- **1.704** sl 51J11		E.N.Jensen, R.T.Nichols, PR **83**, 215(A).
	σ(pile n,γ) 22^sP ~**1** * 51Y1	Result in doubt by factor of 5 *.	L.Yaffe, F.Brown, PR **82**, 332(A) and *verbal report.
	$P^{31}(d,p)$ Q = **5.52,5.02,4.42,4.16, 3.81,3.30,2.82,2.25** 51A2	Al absorbers with pc. Levels 0.50,1.10,1.36,1.71,2.22, 2.70,3.27.	R.C.Allen, W.Rall, PR **81**, 60.
	$P^{31}(d,p)$ Q = **5.704** ±0.009 sπ 51S19		E.N.Strait, et al., PR **81**, 747.
33 15 18	τ **25.2**^{d} 51J11 β^- **0.26** sl	S(pile n) and P(pile n).	E.N.Jensen, R.T.Nichols, PR **83**, 215(A).
	τ **25**^{d} 51S43 β^- **0.25** s No γ	0.5 γ/β^- < 0.07. * S($\leqslant$48 Mev γ,p), Cl($\leqslant$48 Mev $\gamma,2p$); chem. 22^s activity may be P^{34} *.	R.K.Sheline, et al., PR **83**, 215(A) and *verbal report.
	τ **22**^{s} 51Y1	Produced by $P^{32}(n,\gamma)$. Energetic β's or γ's or both present.	See P^{32}, 51Y1.

16 SULPHUR S

S	σ_{in}(2.5 Mev) **0.4** 51G24 S(n,n) Level at 2.4	Results of 50B6 revised.	M.A.Grace, et al., PR **82**, 969.
	σ_t(2-4; 5-6 Mev) **graph** 51S27 Maximum at 2.85	D(d,n) and N(d,n). High pressure ic detector.	G.H.Stafford, Proc. Phys. Soc., Lond., **A64**, 388.
	$\Delta M(S^{33}-S^{32})/\Delta M(S^{34}-S^{32})$ **0.50071** ±0.00003 Mic 51G10	From frequencies of J = 1 → 2 transistion in $O^{16}C^{12}S^{34,33,32}$.	S.Geschwind, R.Gunther-Mohr, PR **81**, 882 and **82**, 346(A).
	New reference for data reported in 50K46	S^{35}.	T.Wentink, Jr., et al., PR **81**, 948.
32 16 16	σ_t(1.9 - 3.6 Mev) **graph** 51R11	Many resonances observed; up to 3 Mev, several coincidences with those of the $\sigma(n,p)$ graph of 50L56.	R.Ricamo, Nuovo Cim. **8**, 383.
	P(p,γ) 51G17 16 levels between (10.0 + 0.4) and (10.0 + 1.7) Mev	~12 Mev γ presumably to ground from 1.265 resonance.	G.R.Grove, J.N.Cooper, PR **82**, 505.
33 ? 16 17	S^{34} ? (γ,n) Q = **-10.8** 51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
33 16 17	$S^{32}(d,p)$ Q = **6.422** ±0.011 sπ 51S19		E.N.Strait, et al., PR **81**, 747.

17 CHLORINE Cl

Cl	σ_a (pile *n*) **31.1** osc 51G16	Based on σ_a (B) = 710.	B.Grimeland, et al., Compt. Rend. **232**, 2089.
	q coupling ratios found to depend on molecule used Mic 51G6		S.Geschwind, et al., PR **81**, 288.
	q coupling ratio RCl^{35}/RCL^{37} **1.26878** I 51L9	5 different compounds used; agree within ± 0.00005.	R.Livingston, PR **82**, 289.
	New reference for data reported in 50R58	Cl^{34}.	L.Ruby, J.R.Richardson, PR **81**, 659(A).
33 17 16	S(*p*,γ) 51H22 E_o = ~**1.37,1.61,1.69,1.8,1.86**	Resonances above 1.9 Mev not resolved.	T.D.Hanscome, C.W.Malich, PR **82**, 304(A).
35 17 18	μ **0.8211** I 51P2	$\nu(Cl^{35})/\nu(D)$ [HCl] = 0.63827 ± 0.00006.	W.G.Proctor, F.C.Yu, PR **81**, 20.
36 17 19	β^- **0.716** 51W17 C_{2T} fits spectral shape	Data of 49W16 re-evaluated.	C.S.Wu, L.Feldman, PR **82**, 457.
	C_{2T} fits spectral shape 51F9	High pressure argon pc.	H.W.Fulbright, J.C.D.Milton, PR **82**, 274.
[**36** 17 19; **38** 17 21]	Cl(*d*,*p*) 51E1 Q = **6.26,3.94,3.46,3.03,2.76, 2.40,1.84,1.18,0.69,0.44**	E_d = 3.5. Largest Q probably belongs to Cl^{36} ground state.	W.W.Ennis, PR **83**, 304(A).
37 17 20	μ **0.6835** I 51P2	Using ratio of 50P6 and $\mu(C^{35})$ of 51P2.	See Cl^{35}, 51P2.

18 ARGON A

A	σ_s coh **0.5 - 0.6*** 51M3	Total reflection method. Positive scattering phase.	A.W.McReynolds, G.W.Johnson, PR **82**, 344(A) and *verbal report.

19 POTASSIUM K

40 19 21	β's/sec (gm of K) **27*** 50H85 γ's/sec (gm of K) **3.1**** K's/sec (gm of K) **<15*****	*4π counter. **Counter calibrated with Co and Na. ***From X-rays and Auger e^-'s.	F.G.Houtermans, et al., Z. Phys. **128**, 657.
	β's/sec (gm of K) **32** 51D1	Counter calibrated with Ra(E + F). No correction for self-scattering.	C.F.G.Delaney, PR **81**, 158.
	K/β^- **< 0.2** 51G23	Supersedes 50G53.	T.Gráf, Arkiv Fysik **3**, 171.
	β^+/β^- **<6 x 10^-4** scin 51C12	From $\gamma\gamma$ coincidences and β^+ efficiency. γ delay < 1^s.	S.A.Colgate, PR **81**, 1063.
	β^+/γ **≲0.01** 51G11	From ratio of γ's to annihilation quanta.	M.L.Good, PR **81**, 1058.
	γ **1.459** {s; pe^-, Compt} 51G9		M.L.Good, PR **81**, 891.

(K continued on next page)

19 POTASSIUM K (continued)

42 (19 23)	τ 12.5[h]	51S25	Solution of K_2CO_3 used. Followed 4 half lives.	W.K.Sinclair, A.F.Holloway, Nature **167**, 365.
42* (19 23)	b	50B60	Negative sign omitted from *Supplement 2*. Should read: b -0.062	*Correction to *Supplement 2*.

20 CALCIUM Ca

Ca	σ_s coh 3.0 σ_s bound 3.5	51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
40 (20 20)	σ_s coh 3.0 σ_s bound 3.2	51S20	See H^2, 51S20.	See above.
41 (20 21)	τ several months K X-rays	51S37	Ca(n,γ) products studied one year after irradiation.	V.L.Sailor, J.J.Floyd, PR **82**, 960.
42 (20 22)	$\bar{\sigma}$(fast n,p)12.44[h]K 120 mb	51C1	For total Be(15 Mev d,n) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
44 (20 24)	σ_s coh 0.4	51S20	See H^2, 51S20.	See Ca, 51S20.

21 SCANDIUM Sc

45 (21 24)	μ 4.7494 I	51P2	$\nu(Sc^{45})/\nu(Na^{23})$ [$Sc(NO_3)_3$] = 0.9183 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **81**, 20.
46 (21 25) 20[s]	γ 0.135 scin	51D6	Sc(slow n,γ).	E.der Mateosian, M.Goldhaber, PR **82**, 115.
85[d]	τ 84[d] β^- 0.5% 1.2 sl	51P5	No higher energy β^- found; careful chem.	F.T.Porter, C.S.Cook, PR **81**, 640.
	β_1^- 97.7% 0.34 a β_2^- 2.3% 1.52 a $\gamma\gamma$ delay, (>0.36 Mev β)(<1 Mev γ) delay of 12.2[μs]	51N3	Log ft_1 = 6.3, log ft_2 = 10.1.	B.D.Nag, et al., Ind. J. Phys. **24**, 479.
	β^+/β^- $<1.6\times10^{-5}$	51M16	See 18.5[m]Br^{80}, 51M16.	W.Mims, H.Halban, Proc. Phys. Soc., Lond., **A64**, 311.
48 (21 27)	τ 1.86[d] β^- 0.60 a 3.23 Mev of γ energy follows β^-	51S40	V(n,α).	K.Shure, MIT Progress Report, May 1951, 129 and Thesis.

22 TITANIUM Ti

Ti	σ_t (13.9 Mev) **2.2**	51L1		A.H.Lasday, PR **81**, 139.
	New reference for data reported in	50T51	Ti^{45}.	M.Ter-Pogossian, et al., PR **81**, 285.
46 (22 24)	Sc^{45} (*p,n* and *γ*) 22 resonances for $E_p < 4$	51B4	*n* threshold at $E_p = 2.9$. Above threshold *n* and *γ* peaks coincide.	W.D.Baker, et al., PR **81**, 48.
47 ? (22 25)	Ti^{48} ?(*γ,n*) Q = **-11.6**	51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
47 (22 25)	Ti^{46} * (*d,p*) Q = **6.5**	51H6	$B_n = 8.7$. Rel σ. *Mass assignments from intensities and positions of proton peaks. Enriched material only for Pb. All Q's relative to 5.50 for Al(*d,p*). σ's are given relative to σ for this reaction.	J.A.Harvey, PR **81**, 353.
48 (22 26)	$\bar{\sigma}$(fast *n,p*) 1.83^{d}Sc **23** mb	51C1	For total Be(15 Mev *d,n*) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
	Ti^{49} (*γ,n*) Q = **-8.7**	51S6	Lowest Ti threshold.	See Ti^{47}, 51S6.
	Ti^{47} * (*d,p*) Q = **8.8**	51H6	$B_n = 11.1$. Rel σ. *See Ti^{47}.	See Ti^{47}, 51H6.
49 (22 27)	$\bar{\sigma}$(fast *n,p*) 57^{m}Sc **6.5** mb	51C1	See Ti^{48}, 51C1.	See Ti^{48}, 51C1.
	Ti^{48} * (*d,p*) Q = **5.92**	51H6	$B_n = 8.15$. Rel σ. *See Ti^{47}.	See Ti^{47}, 51H6.

23 VANADIUM V

V	σ_a (pile *n*) **4.79** osc	51G16	Based on σ_a (B) = 710.	B.Grimeland, et al., Compt Rend. **232**, 2089.
	σ_t (13.9 Mev) **2.5**	51L1		A.H.Lasday, PR **81**, 139.
50 (23 27)	V^{51} (*γ,n*) Q = **-10.8**	51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
51 (23 28)	μ **positive**	51P2		W.G.Proctor, F.C.Yu, PR **81**, 20.
	μ **5.1378** I	51S33	$\nu(V^{51})/\nu(H^1) = 0.262753 \pm 0.000012$ [V_2O_5] Sc substandard used.	R.E.Sheriff, D.Williams, PR **82**, 651.
52 (23 29)	V^{51*} (*d,p*) Q = **5.02, 4.23**	51H6	$B_n = 7.25$. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.

24 CHROMIUM Cr

Cr	σ_s coh **1.7** σ_s bound **3.8**	51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
	σ_{in}(2.5 Mev) **1.2** Cr(*n*,*n*) Level at 1.4	51G24	From γ intensities (coin. counters) and absolute *n* intensity (recoil *p*'s).	M.A.Grace, et al., PR **82**, 969.
	σ_a(pile *n*) **2.9** osc	51G16	Based on σ_a (B) = 710.	B.Grimeland, et al., Compt. Rend. **232**, 2089.
51 24 27	$Cr^{52}(\gamma,n)$ Q = **-11.6**	51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
52 24 28	$\bar{\sigma}$(fast *n*,*p*)3.74^{m}V **15 mb**	51C1	For total Be(15 Mev *d*,*n*) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
	V^{51}(*p*,*n* and γ) 26 resonances for E_p < 4	51B4	*n* threshold at E_p = 1.55. Most *n* and γ peaks coincide.	W.D.Baker, et al., PR **81**, 48.
	$Cr^{53}(\gamma,n)$ Q = **-7.5**	51S6	Lowest Cr threshold observed.	See Cr^{51}.
53 24 29	(1.3 - 2.3)^h activity previously assigned to Cr^{55} now assigned to Cr^{53}	51C2	Produced by Cr^{52}(10 Mev *d*,*p*) and Cr^{52}(th *n*,γ).	D.O.Caldwell, H.F.Stoddart, PR **81**, 660(A).
	Not produced by Fe^{56}(th *n*,α)	50F77	Cf. P.Hänni, et al., HPA **23**, 513.	H.Faraggi, Compt. Rend. **231**, 1475.

25 MANGANESE Mn

Mn	σ_a(pile *n*) **12.6** osc	51G16	Based on σ_a (B) = 710.	B.Grimeland, et al., Compt. Rend. **232**, 2089.
	New reference for data reported in	50P6	Mn^{55}.	W.G.Proctor, F.C.Yu, PR **81**, 20.
52 25 27	τ **6.2^d**	51H25	Cr(19 Mev *d*,*n*); chem.	H.R.Haymond, et al., J. Chem. Phys. **19**, 382.
54 25 29	τ_1 **2.1^m**	51C2	Produced by Fe^{54}(14 Mev *n*,*p*) and Fe^{56}(10 Mev *d*,α).	D.O.Caldwell, H.F.Stoddart, PR **81**, 660(A).
55 25 30	I **5/2**	51B30	From paramagnetic resonance spectra of two Mn salts.	B.Bleaney, D.J.E.Ingram, Proc. Roy. Soc. **A205**, 336.
	μ **3.4619** I	51S33	$\nu(Mn^{55})/\nu(H^1)$ [$Ca(MnO_4)_2$] = 0.247866 ± 0.000012. Supersedes 3.4656 value. Sc substandard used.	R.E.Sheriff, D.Williams, PR **82**, 651.
56 25 31	No $\beta_3\gamma_3$ angular correlation	50W75		M.Walter, et al., HPA **23**, 697.

26 IRON Fe

Fe	σ_s coh 11.4 σ_s bound 11.7	51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527 and **81**, 327(A).
	σ_{in}(2.5 Mev) 2 (0.8γ) 0.14 (2.2γ)	51G24	See Cr, 51G24.	M.A.Grace, et al., PR **82**, 969.
	σ_a(pile *n*) 2.38 osc	51G16	Based on σ_a (B) = 710.	B.Grimeland, et al., Compt. Rend. **232**, 2089.
53 26 27	Fe(γ,*n*) Q = -13.8	51K14	σ graph for E_γ = 13.8 - 24.	L.Katz, et al., PR **82**, 271.
54 26 28	σ_s coh 2.2 σ_s bound 2.5	51S20	See H^2, 51S20.	See Fe, 51S20.
55 26 29	Mn^{55}(*p,n*) Q = -1.05, -1.47, -1.99, -2.41, -3.13	51S2	E_p = 2.97, 3.42, 3.77. Photo plate. Levels 0.42, 0.94, 1.36, 2.08.	P.H.Stelson, W.M.Preston, PR **82**, 305(A) and **82**, 655.
56 26 30	σ_s coh 12.6 σ_s bound 13	51S20	See H^2, 51S20.	See Fe, 51S20.
	$\bar{\sigma}$(fast *n,p*)2.59^{h}Mn 18.5 mb	51C1	For total Be(15 Mev *d,n*) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
57 26 31	σ_s coh 0.64 σ_s bound 2	51S20	See H^2, 51S20.	See Fe, 51S20.
57 ? 26 31	Fe(*n*,γ) E_γ = 5.9	51M26	Prominent ground state γ of 50K8 also observed.	W.E.Meyerhof, et al., PR **83**, 203(A).

27 COBALT Co

Co	σ_a(pile *n*) 34.9 osc	51G16	Based on σ_a (B) = 710.	B.Grimeland, et al., Compt. Rend. **232**, 2089.
	New reference for data reported in	50S24	Co.	C.G.Shull, E.O.Wollan, PR **81**, 527.
	New reference for data reported in	50P6	Co^{59}.	W.G.Proctor, F.C.Yu, PR **81**, 20.
58 27 31	Co^{59}(γ,*n*) Q = -10.0	51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
59 27 32	σ(th *n*,γ)5.2^{y}Co 34	51Y2	Based on σ(Au) = 93.	L.Yaffe, et al., PR **82**, 552.
60 27 33 5.2^y	τ_2 5.25 ± 0.21^y	51S25	Used liquid $CoCl_2$. Followed for 1.7 years.	W.K.Sinclair, A.F.Holloway, Nature **167**, 365.
	Co^{59*}(*d,p*) Q = 5.4	51H6	B_n = 7.7. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.

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28 NICKEL Ni

Ni	σ_s coh 13.4 σ_s bound 17.3	51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
	σ_a (pile *n*) 4.2 osc	51G16	Based on σ_a (B) = 710.	B.Grimeland, et al., Compt. Rend. **232**, 2089.
	New reference for data reported in	50W58	Ni^{63}.	H.W.Wilson, PR **82**, 548.
57 28 29	Ni(γ,*n*) Q = −12.0	51K14	σ graph for E_γ = 12 − 23.	L.Katz, et al., PR **82**, 271.
58 28 30	σ_s coh 27.0 σ_s bound 27.0	51S20	See H^2, 51S20.	See Ni, 51S20.
59 28 31	τ 7.5 x 10^{4y} Co K X-ray	51B5	Produced by Ni^{58}(*n*,γ). τ from X-ray count and cross section.	A.R.Brosi, et al., PR **81**, 391.
	τ 7.5 x 10^{5y} γ's of 15,38,80 kev not found pc	51W14	τ based on σ[Ni^{58}(*n*,γ] = 4.2. γ's were reported in 50T5.	H.W.Wilson, PR **82**, 548.
60 28 32	σ_s coh 0.97 σ_s bound 1	51S20	See H^2, 51S20.	See Ni, 51S20.
60 ? 28 32	$Ni^{61?}$ (γ,*n*) Q = −7.5	51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
62 28 34	σ_s coh 9.1 (−) σ_s bound 9	51S20	See H^2, 51S20.	See Ni, 51S20.
63 28 35	τ 85^y β^- 0.067 a,pc	51B5	Produced by Ni^{62}(*n*,γ). τ from β count and cross section.	See Ni^{59}, 51B5.

29 COPPER Cu

Cu	σ_{in} (2.5 Mev) 1.2 (1.1γ) 0.3 (2.2γ)	51G24	See Cr, 51G24.	M.A.Grace, et al., PR **82**, 969.
	σ_a (pile *n*) 3.50 osc	51G16	Based on σ_a (B) = 710.	B.Grimeland, et al., Compt. Rend. **232**, 2089.
	σ_t (~100 − 240 Mev) graph	51D7	Be(*p*,*n*). Bi-f detector.	J.DeJuren, B.J.Moyer, PR **81**,919.
63 29 34	μ 2.2216 I	51S33	$\nu(Cu^{63})/\nu(H^1)$ [Cu_2Cl_2] = 0.265107 ± 0.000015. Sc substandard used.	R.E.Sheriff, D.Williams, PR **82**, 651.
	$q(Cu^{63})/q(Cu^{65})$ 1.081 I	51B26	Observed splitting due to q and crystal field of $K_3Cu(CN)_4$.	G.Becker, H.Krüger, Naturwiss. **38**, 121.
	σ(4.2 − 6.5 Mev *p*,*n*)38.3^{m}Zn σ(6.3 Mev) 0.28	51B20	Stacked foils. Measured β^+'s and annihilation radiation.	J.P.Blaser, et al., HPA **24**, 3.
	σ(17.6 Mev γ,*n*)9.9^{m}Cu 0.085	51S42	Corrected for self-absorption.	S.Shimizu, Mem. Coll. Sci. Univ., Kyoto, **25A**, 193; NSA **5**, #1365.
	Isotope shift has sense predicted by specific mass effect	50B88	Result similar to that for Zn(50C24).	P.Brix, W.Humbach, Z.Phys. **128**, 506.

(Cu continued on next page)

29 COPPER Cu (continued)

64 (29 35)	$Cu^{63*}(d,p)$ Q = 5.6	51H6	B_n = 7.8. Rel σ. *See Ti^{47}, 51H6. Cycle check.	J.A.Harvey, PR **81**, 353.
65 (29 36)	μ **2.3810** I	51S33	$\nu(Cu^{65})/\nu(H^1)$ [Cu_2Cl_2] = 0.284120 ± 0.000015. Sc substandard used.	R.E.Sheriff, D.Williams, PR **82**, 651.
	$q(Cu^{63})/q(Cu^{65})$ **1.081** I	51B26	See Cu^{63}, 51B26.	See Cu^{63}, 51B26.
	σ(2.8–6.5 Mev p,n)250^{d}Zn σ(6.3 Mev) **0.48**	51B20	Stacked foils. Measured β^+'s and γ's.	See Cu^{63}, 51B20.
	$\bar{\sigma}$(fast n,p)2.56^{h}Ni **3.2 mb**	51C1	For total Be(15 Mev d,n) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
	Isotope shift	50B88	See Cu^{63}, 50B88.	See Cu^{63}, 50B88.

30 ZINC Zn

63 (30 33)	Cu(p,n)38.3^{m}Zn Q = **−4.2**	51B20	Threshold measured with stacked foils. E_p = 6.5.	J.P.Blaser, et al., HPA **24**, 3.
	Zn(γ,n)38.3^{m}Zn Q = **−11.6**	51K14	σ graph for E_γ = 11.6 – 24.5.	L.Katz, et al., PR **82**, 271.
65 (30 35)	Cu(p,n)250^{d}Zn Q ~ **−2.7**	51B20	See Zn^{63}, 51B20.	See Zn^{63}, 51B20.
	$Zn^{64*}(d,p)$ Q = **5.69**	51H6	B_n = 7.92. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.
66 (30 36)	σ(6.05 – 6.5 Mev p,n)9.4^{h}Ga σ(6.3 Mev) **0.16**	51B20	Stacked foils. Measured β^+'s and γ's.	See Zn^{63}, 51B20.
	$\bar{\sigma}$(fast n,p)4.34^{m}Cu **11 mb**	51C1	For total Be(15 Mev d,n) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
67 (30 37)	σ(2.5 – 6.5 Mev p,n)78.3^{h}Ga σ(6.3 Mev) **0.32**	51B20	Stacked foils. Measured ce^-'s.	See Zn^{63}, 51B20.
68 (30 38)	σ(3.4 – 6.5 Mev p,n)68^{m}Ga σ(6.3 Mev) **0.50**	51B20	Stacked foils. Measured β^+'s and annihilation radiation.	See Zn^{63}, 51B20.
68* (30 38)	σ's	49H5	*Table* should read: (th n,γ)13.8^{h}Zn 0.085 49H5 (th n,γ)52^{m}Zn 0.89 49H5	*Correction to *Table*.

31 GALLIUM Ga

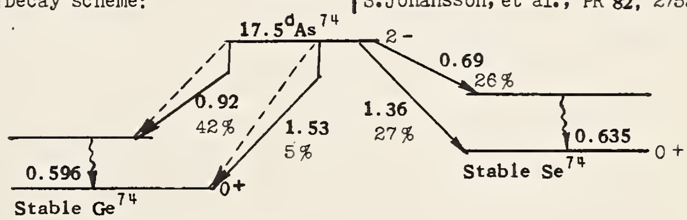
66 (31 35)	Zn(p,n)9.4^{h}Ga Q = **−6.05**	51B20	Threshold measured with stacked foils. E_p = 6.5.	J.P.Blaser, et al., HPA **24**, 3.
66* (31 35)	γ energies	50H74	3.25γ reported is pair line of 4.27γ. Energies should read: γ 1.06 4.27 } scin 2.75 4.8 }	*Correction to *Supplement 2*.
67 (31 36)	Zn(p,n)78.3^{h}Ga Q > **−2**	51B20	See Ga^{66}, 51B20.	See Ga^{66}, 51B20.
68 (31 37)	Zn(p,n)68^{m}Ga Q = **−3.4**	51B20	See Ga^{66}, 51B20.	See Ga^{66}, 51B20.

32 GERMANIUM Ge

Ge	Relative isotopic abundances 51G7 70 20.45 % 74 36.58 % 72 27.41 % 76 7.79 % 73 7.77 %	Some evidence that relative abundances vary with ores.	R.P.Graham, et al., Can. J. Chem. **29**, 89.
	σ_s coh 8.8 51S20 σ_s bound 8.5	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
70 32 38	$\bar{\sigma}$(fast n,p)20.3^{m}Ga 51C1 14.5 mb	For total Be(15 Mev d,n) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.

33 ARSENIC As

As	New reference for data reported in 50B7	As^{79}.	F.D.S.Butement, Proc. Phys. Soc. Lond., **A64**, 395.
74 33 41	β^+ 42 % 0.92 s 51J6 5 % 1.53 s β^- 26 % 0.69 s 27 % 1.36 s γ 0.5963 $s\pi\sqrt{2}$; pe$^-$ 0.6352 $s\pi\sqrt{2}$; pe$^-$ (0.92β^+) γ, (0.69β^-) γ coincidences	Decay scheme:	S.Johansson, et al., PR **82**, 275.



Log ft 1.36β^- = 9.7 *.
Log ft 1.53β^+ = 9.9 *.
*With ($W_0{}^2$-1) correction. β^- has shape consistent with ΔI = 2, yes.

76 33 43	τ 27.6^h 51B6 γ 0.58 1.76 } scin 1.20 2.02 }	Produced by As(n,γ); purity > 99.99 %; no chem. Double crystal spectrometer used.	J.K.Bair, F.Maienschein, PR **81**, 463.
	β^+/β^- ≤ 0.07 % 51M16	See 18.5^{m}Br^{80}, 51M16. Ratio found attributable to hard γ's.	W.Mims, H.Halban, Proc. Phys. Soc., Lond., **A64**, 311.
	$\beta_3\gamma_1$ angular correlation 50W75	b = + 0.08 ± 0.02.	M.Walter, et al., HPA **23**, 697.
77 33 44	β^- 0.679 sl 51J1 No γ sl;ce$^-$,pe$^-$	Allowed shape.	E.N.Jensen, et al., PR **81**, 143.
	β^- 0.700 sl 51C4 No γ, no ce$^-$	Allowed shape. Not p 17.5^{s}Se.	R.Canada, A.C.G.Mitchell, PR **81**, 485.
78 33 45	τ 90^m 51S40 E(disintegration) = 4.1	No γ follows 4.1β.	K.Shure, MIT Progress Report, May 1951, 129 and Thesis.

34 SELENIUM Se

Se	σ_s coh **10.0** σ_s bound **~10**	51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
76 34 42	$\bar{\sigma}$(fast n,p)26.8^{h}As **16.5** mb	51C1	For total Be(15 Mev d,n) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
	$Se^{77}(\gamma,n)$ Q = **-7.5**	51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
77 34 43 17.5^s	τ **17.5^s** γ **0.160** sl;ce$^-$,pe$^-$	51C23	Observed in decay of 57.2^{h}Br.	R.Canada, et al., PR **82**, 750.
	γ **0.150** scin	51D6	Se(slow n,γ).	E.der Mateosian, M.Goldhaber, PR **82**, 115.
79 34 45	3.9^m activity assigned to Se^{79}	50F75	Produced by Br(n,p); chem. Yield indicates Se^{79}. Not p 18^m or 57^m Se^{81}.	A.Flammersfeld, W.Herr, Z. Naturforsch., **5a**, 569.

35 BROMINE Br

Br	σ_s coh **5.7** σ_s bound **6.0**	51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
	New reference for data reported in	50E57	Br.	P.A.Egelstaff, B.T.Taylor, Nature **167**, 683.
79 35 44	μ **2.0999** I	51S33	$\nu(Br^{79})/\nu(H^1)$ [NaBr] = 0.250579 ± 0.000012. Sc substandard use.	R.E.Sheriff, D.Williams, PR **82**, 651.
80 35 45	$Br^{79}(n,\gamma)\left\{\begin{matrix}4.4^h\\18.5^m\end{matrix}\right. Br^{80}$ neutron capture levels	51C3	Ratio of isomeric activities function of distance from source; differs for thermal and resonance n's.	P.C.Capron, A.J.Verhoeve-Stokkink, PR **81**, 336.
4.4^h	τ **4.58^h**	51M16		W.Mims, H.Halban, Proc. Phys. Soc., Lond., **A64**, 311.
	$\gamma\gamma$ delay < 4 x 10^{-3} μs	51W13		W.E.Wright, M.Deutsch, PR **82**, 277.
18.5^m	β^- 100% **2.11** sπ β^+ 2.8% **0.868** sπ	51L8	Br(n,γ); Szilard-Chalmers separation.	J.Laberrique-Frolow, Compt. Rend. **232**, 1201.
	β^+/β^- = 3.7%	51M16	Using $(K+\beta^+)/\beta^-$ of 50R12, K/β^+ = 1.43 ± 0.17.	See **4.4^h** Br^{80}, 51M16.
81 35 46	μ **2.2632** I	51S33	$\nu(Br^{81})/\nu(H^1)$ [NaBr] = 0.270063 ± 0.000015. Sc substandard use.	See Br^{79}, 51S33.
82 35 47	τ **35.1^h**	51W9	No appreciable Br^{80}, P^{32}, S^{35} present.	F.P.W.Winteringham, Nature **167**, 155.
	τ **35.7^h**	51S25	Solution of $CaBr_2$ used. Followed 5 half lives.	W.K.Sinclair, A.F.Holloway, Nature **167**, 365.
	γ **0.547** **0.822**; **0.615** **1.026**; **0.682** 1.0* **1.306**; **0.752** 0.25* **1.453** } sl;pe$^-$	51H19	Last three γ's have τ~35^h. * Relative intensities.	P.Hubert, J.Laberrique-Frolow, Compt Rend. **232**, 2420.

(Br continued on next page)

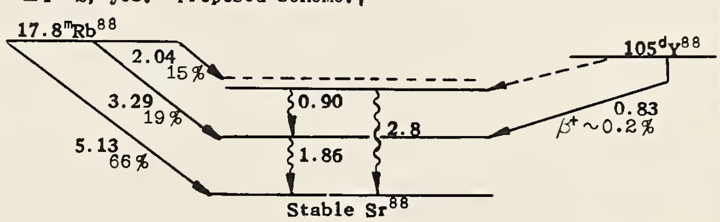
35 BROMINE Br (continued)

82 35 47	β^+/β^- < 2 x 10^{-4}	51M16	See 18.5^{m}Br^{80}, 51M16.	W.Mims, H.Halban, Proc. Phys. Soc., Lond., **A64**, 311.
	No isomeric transition found unless τ_β < 18^m	51B12	Assumed scheme similar to Br^{80}. Used Szilard-Chalmers reaction.	A.Berthelot, et al., Compt. Rend. **232**, 498.
83 35 48	τ **2.4^h** β^- **0.940** sl	51D3	No γ.	R.B.Duffield, L.M.Langer, PR **81**, 203 and **81**, 298(A).
	Rb^{87}(γ,α) Q = **-16**	51H3	From observed threshold. E_0 = 22.5; Γ = 6.6; σ = 4 x 10^{-4} Mev - b.	E.L.Harrington, et al., PR **81**, 660(A).
84 35 49	τ **32^m** β^- 35% **1.72** sl 16% **2.53** sl 9% **3.56** sl 40% **4.68** sl	51D3	Produced by U^{235} fission; chem. $\gamma\gamma$ and $\beta\gamma$ coincidences but no $\beta\gamma$ for E_β > 3.5. 4.68 β has allowed shape. Suggest β's are from short-lived daughter of 32^m state.	See Br^{83}, 51D3.

36 KRYPTON Kr

79 36 43	τ **34^h** K ~90% β^+ ~10% **0.595** sl γ **0.044** sl;ce$^-$ **0.263** sl;ce$^-$ α_K ~0.016 *	51B16	Kr(pile n); ms. No β^- observed. F-K plot straight down to 110 kev. Log ft = 5.3. K/β^+ ratio suggests both K and β^+ go to same level. * Assuming γ follows β^+.	I.Bergström, PR **82**, 112.
83 36 47 1.88^h	τ **1.90^h** γ_1 **0.0093** sl;ce$^-$,L/M~3 γ_2 **0.0322** sl;ce$^-$ K/L+M = 0.35	51B11	e_1^-/e_2^- = 0.8; γ's probably in cascade.	I.Bergström, PR **81**, 638.
88 36 52	γ **0.027** * sl	50S75	* Follows soft β emission. e$^-$$\beta$ coincidence measurements.	K.Siegbahn, S.Thulin, Arkiv Fysik **2**, 212.
89 36 53	τ **3.14^m** β^- **3.9** * Results indicate β's and neutrinos emitted in same direction	51K13	* From max. recoil energy of Kr^{89} of 115 ± 5 ev.	O.Kofoed-Hansen, P.Kristensen, PR **82**, 96; K.Danske Vidensk. Selsk. Mat.-fys. Medd. **26**, #6.
	τ **3.18^m** β^- ~65% **4.0** a ~35% **2.0** a γ	51K10	Fission; ms. p 15.4^{m}Rb. Cyclotron and isotope separator operated simultaneously. Genetic relation from decay curve.	O.Kofoed-Hansen, K.O.Nielsen, PR **82**, 96; K.Danske Vidensk. Selsk. Mat.-fys. Medd. **26**, #7.
90 36 54	τ **33^s** β^- complex **3.2** a γ	51K10	Fission; ms. p 2.74^{m}Rb. See Kr^{89}, 51K10.	See above.
91 36 55	τ **10^s** β^- complex ~**3.6** a γ?	51K10	Fission; ms. p 100^s and 14^{m}Rb. See Kr^{89}, 51K10.	See above.

84 37 47	τ_1 e^- K X-ray	**23**^{m} **0.32**		50F79	Produced by Rb(fast $n,2n$) with Li(d,n) and not Be(d,n); chem.	A.Flammersfeld, Z. Naturforsch. **5a**, 687.
85 37 48	μ	**1.3485**	I	51Y3	$\nu(H^1)/\nu(Rb^{85})$ [RbCl] = 10.357105 ± 0.000030.	E.Yasaitis, B.Smaller, PR **82**, 750.
86 37 49	β^-	**0.670** **1.760**	s$\beta\gamma$ s	51M2	Soft β has allowed shape. ΔI = 2, yes for hard β.	P.A.Macklin, PR **82**, **344**(A).
	β^-	**0.67**	scin	51P8		J.P.Palmer, PR **82**, 772(A).
	β^+/β^- < 1.6 x 10^{-5}			51M16	See 18.5^{m}Br^{80}, 51M16.	W.Mims, H.Halban, Proc. Phys. Soc., Lond., **A64**, 311.
87 37 50	μ	**2.7412**	I	51S33	$\nu(Rb^{87})/\nu(H^1)$ [Rb_2CO_3] = 0.327101 ± 0.000023. Al substandard use.	R.E.Sheriff, D.Williams, PR **82**, 651.
	μ	**2.7421**	I	51Y3	$\nu(H^1)/\nu(Rb^{87})$ [RbCl] = 3.0561097 ± 0.0000055.	See Rb^{85}, 51Y3.
88 37 51	τ β^- 15% 19% 66% γ	**17.8**^{m} **2.04** **3.29** **5.13*** **0.90** **1.86** **2.8**	 sl sl sl sl; pe$^-$ sl; pe$^-$, Compt sl; pe$^-$, Compt	51B2	*Spectral shape indicates ΔI = 2, yes. Proposed scheme:	M.E.Bunker, et al., PR **81**, 30.



	β_1^- ~22% β_2^- ~22% β_3^- ~56% $\beta\gamma$ and $\gamma\gamma$ coincidences	**1.8** **3.8** **5.1**	a$\beta\gamma$ a$\beta\gamma$ a	51G13	Rb(paraffin slowed n,γ). Several γ's with average energy ~2.2 Mev. 5.1β^- end point by comparison with Cl^{38} β^-.	K.Geiger, Z. Naturforsch. **6a**, 54.
90 37 53	τ β^- complex γ	**2.74**^{m} **5.7**	 a	51K10	Fission; chem. d 25^s ms separated Kr. See Kr^{89}, 51K10.	O.Kofoed-Hansen, K.O.Nielsen, PR **82**, 96; K.Danske Vidensk. Selsk. Mat.-fys. Medd. **26**, #7.
91 37 54	τ_1 β^- complex γ	**100**^{s} **4.6**	 a	51K10	Fission; chem for both isomers. Both d 10^s ms separated Kr. See Kr^{89}, 51K10. 14^m activity p 9.7^{h}Sr; chem., but yield of Sr implies 100^s activity is also its parent.	See above.
	τ_2 β^- complex γ	**14**^{m} **3.0**	 a	51K10		

38 STRONTIUM Sr

85 38 47 70m	γ 0.152, 0.233 } $s\pi$; ce⁻	51T11	Produced by Rb(10 Mev *d*); chem.	M.Ter-Pogossian, F.T.Porter, PR **81**, 1057.
65d	τ 65d K γ 0.513 $s\pi$; pe⁻, ce⁻	51T11	Produced by Rb(10 Mev *d*); chem. No annihilation radiation observed.	See above.
86 38 48	$Sr^{87}(\gamma,n)$ Q = **−7.2**	51S6	Lowest Sr threshold. See, however, PR **84**, 387.	R.Sher, et al., PR **81**, 154.
87 38 49 2.75h	τ **2.80**h γ **0.394** $s\pi\sqrt{2}$; ce⁻ K/L = 7.2	51H24	d of 80hY.	E.K.Hyde, G.D.O'Kelley, PR **82**, 944.
	γ **0.388** $s\pi$; ce⁻	51T11	Rb(10 Mev *d*); chem.	See Sr^{85}, 51T11.
stable	$Sr^{88}(\gamma,n)$ Q = **−10.9**	51S6	From observed threshold.	See Sr^{86}, 51S6.
	$Sr^{86*}(d,p)$ Q = **6.3**	51H6	B_n = 8.5. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.
88 38 50	$\bar{\sigma}$(fast *n,p*) 17.8mRb **0.9** mb	51C1	For total Be(15 Mev *d,n*) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
89 38 51	$Sr^{88*}(d,p)$ Q = **4.3**	51H6	B_n = 6.6. Rel σ. *See Ti^{47}.	See Sr^{87}, 51H6.

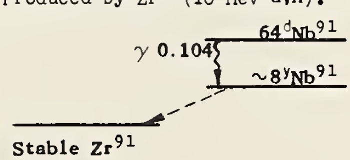
39 YTTRIUM Y

Y	σ_a(0.025 ev) **1.2** osc	51B29	Based on σ_a(B) = 710.	P.Benoit, et al., J. Phys. Rad. **12**, 584.
86 39 47	τ **14.6**h β_1^+ ~50% **1.19** $s\pi\sqrt{2}$ β_2^+ ~50% **1.80** $s\pi\sqrt{2}$ γ **1.4** a	51H24	d of 17hZr. Y removed from purified Zr 24h after *p* bombardment of Nb. No ce⁻'s. β_1^+ probably forbidden.	E.K.Hyde, G.D.O'Kelley, PR **82**, 944.
87 39 48 14h	β^+ < 0.1% of ce⁻'s γ **0.389** $s\pi\sqrt{2}$; ce⁻ K/L = 8.3	51H24	d of 2.0hZr. Also found six ce⁻'s of γ's of E > 1 Mev.	See above.
80h	No β^+ No γ?	51H24	d of 14hY; p of 2.75hSr. 0.485 γ of 50M68 could have been missed.	See above.

40 ZIRCONIUM Zr

Zr	σ_t (0.003— 10 ev)	**graph**	51E8	σ is ~7.1 between 0.07 and 10 ev.	P.A.Egelstaff, B.T.Taylor, Nature **167**, 896.
	σ_t (13.9 Mev)	**2.4**	51L1	Indicates small radius for Zr^{90}.	A.H.Lasday, PR **81**, 139.
86 40 46	τ No β^+	**17**^{h}	51H24	Nb(100 Mev *p*); chem. τ from growth of Y^{86}.	E.K.Hyde, G.D.O'Kelley, PR **82**, 944.
87 40 47	τ β^+	**1.6**^{h} **2.10** s$\pi\sqrt{2}$	51H24	Nb(100 Mev *p*); chem. No γ or ce^- observed.	See above.
88 40 48	τ γ K X-rays	~**150**^{d} **0.406** s$\pi\sqrt{2}$; ce^-	51H24	p of 105^dY. Nb(100 Mev *p*); chem. Repurified after several months.	See above.
89 40 49 80.1^h	τ_2 β^+ γ	**79.3**^{h} **0.905** sl ~**0.93** α~0.005; $\tau > 10^{-7s}$	51S24	No $\beta\gamma$, Xγ, or $\gamma\gamma$ (other than annih. radiation) coincidences. Not known whether γ is converted in Zr or Y.	K.Shure, M.Deutsch, PR **82**, 122.
	β^+ γ	**0.910** s$\pi\sqrt{2}$ **0.027**, **0.396**, **0.917**, **1.27** } s$\pi\sqrt{2}$; ce^-	51H24	Nb(100 Mev *p*); chem. Repurified after several days. Also observed Auger e^-'s.	See Zr^{86}, 51H24.
90 40 50	$\bar{\sigma}$(fast *n,p*) 61^hY	**3.1** mb	51C1	For total Be(15 Mev *d,n*) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.

41 NIOBIUM Nb

91 41 50	τ_1 γ Nb X-ray τ_2 Zr X-ray	**64**^{d*} **0.1035** sl; ce^- α~50, K/L = 2.1 crit a ~8^{y*} crit a	51O1	Produced by Zr^{90}(10 Mev *d,n*). 	J.Ovadia, P.Axel, PR **82**, 332(A) and *verbal report.
92 41 51	$Nb^{93}(\gamma,n)$	Q = **-8.7**	51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
93 41 52	μ	**6.1451** I	51S33	$\nu(Nb^{93})/\nu(H^1)$ [Nb_2O_5] = 0.244428 ± 0.000012. Sc substandard used.	R.E.Sheriff, D.Williams, PR **82**, 651.
94 41 53	$Nb^{93*}(d,p)$	Q = **5.0**	51H6	B_n = 7.3. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.
96 41 55	τ β^- 2.39 Mev of γ energy follows β^- Add 49K18 to 49K19 in *Table* under Nb^{96}	**24.4**^{h} **0.61** a	51S40	Produced by $Mo^{96}(n,p)$.	K.Shure, MIT Progress Report, May 1951 and Thesis.

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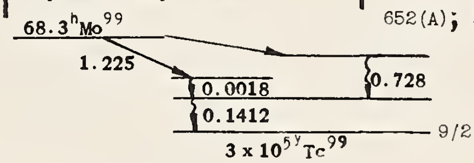
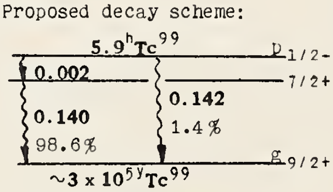
42 MOLYBDENUM Mo

Isotope	Radiation	Value	Code	Remarks	Reference
93 (42 51)	Mo^{92*} (d,p)	Q = 6.1	51H6	B_n = 8.3. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.
95 (42 53)	μ	−0.9098 I I of 5/2 assumed	51P2	$\nu(Mo^{97})/\nu(Mo^{95})$ [K_2MoO_4] = 1.0210 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **81**, 20.
97 (42 55)	μ	−0.9289 I I of 5/2 assumed	51P2	$\nu(Mo^{97})/\nu(N^{14})$ [K_2MoO_4, HNO_3] = 0.9208 ± 0.0001.	See above.
99 (42 57)	β^- 87% γ v. weak v. weak 13% See also Tc^{99}	1.225 s 0.141 s 0.182 s 0.360 s 0.728 s	51M6	Proposed decay scheme: 	H.Medicus, et al., PR **81**, 652(A); HPA **24**, 72.
	β^- ~13% $\beta\gamma$ and $\gamma\gamma$ coincidences	~0.54 sl	51M18	Other values and decay scheme as in 51M6, q.v.	H. Medicus, et al., HPA **24**, 72.

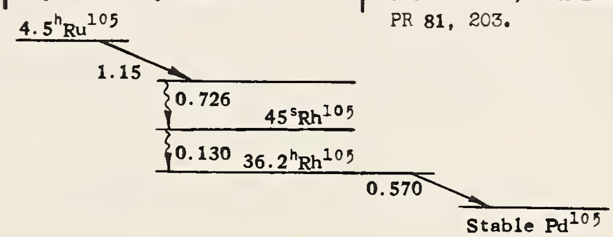
43 TECHNETIUM Tc

Isotope	Radiation	Value	Code	Remarks	Reference
99 (43 56) 5.9h	γ_1 γ_2	0.0018 s α large 0.1412 s α = 0.09, K/L = 7.9	51M6	No β transitions found between 5.9h Tc and Ru^{99} ground state.	H.Medicus, et al., PR **81**. 652(A); HPA **24**, 72.
	γ_2 98.6% γ_3 1.4%*	0.1403 K/L = 7.7 0.1423 K/L = 2.5	51M21	Proposed decay scheme: 	J.W.Mihelich, et al., PR **82**, 972, and **83**, 216(A). *Measured e⁻ intensities and assumed γ_3 M4.
~3 x 10^{5y}	τ β^-	2.12 x 10^{5y} 0.312 a	51F5	Absolute β counting of weighed samples.	S.Fried, et al., PR **81**, 741.
	β^-	0.292 sl	51T5	Spectral shape indicates ΔI = 2, yes, but ΔI = 3, no, not excluded.	S.I.Taimuty, PR **81**, 461.
	β^-	0.293 s	51W3	Spectral shape indicates ΔI = 2, yes or no.	C.S.Wu, L.Feldman, PR **82**, 332(A).

44 RUTHENIUM Ru

Isotope	Radiation	Value	Code	Remarks	Reference
105 (44 61)	τ β^- γ	4.5^h 1.150 sl 0.726 sl; pe⁻, Compt	51D3	Produced by Ru(n,γ). No $\gamma\gamma$ coincidences. $\beta\gamma$ coincidences indicate cascade. See Rh^{105}.	R.B.Duffield, L.M.Langer, PR **81**, 203.

45 RHODIUM Rh

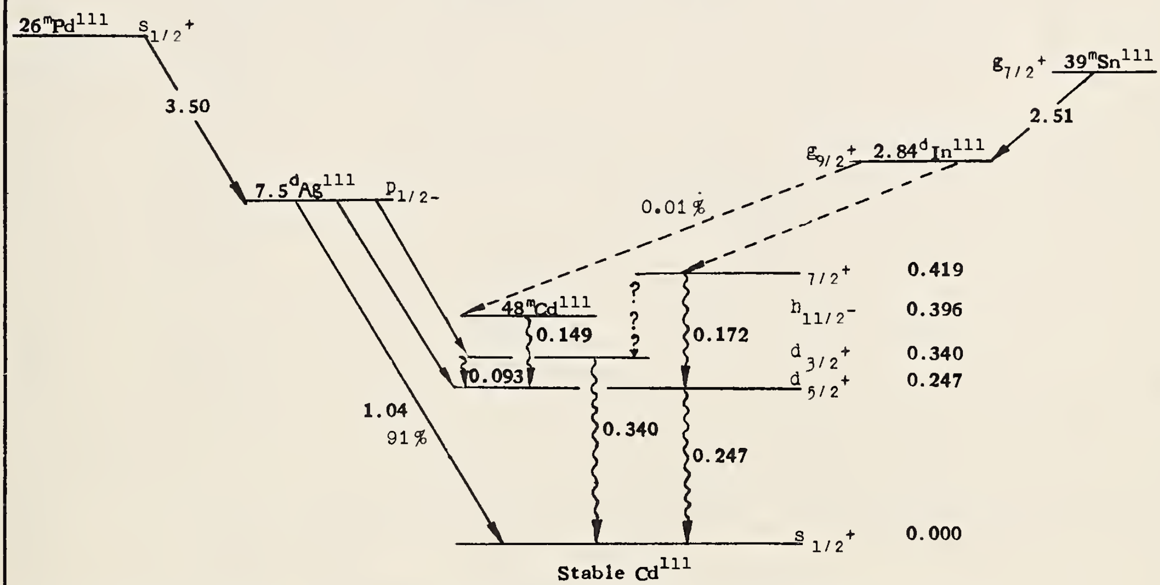
104 45 59	$Rh^{103}(n,\gamma)$ { 4.34^{m} / 44^{s} } Rh^{104} neutron capture levels			51C3	Ratio of isomeric activities function of distance from source; differs for thermal and resonance n's.	P.C.Capron, A.J.Verhoeve-Stokkink, PR **81**, 336.
	$Rh^{103*}(d,p)$ Q = **4.6**			51H6	B_n = 6.8. Rel σ. * See Ti^{47}.	J.A.Harvey, PR **81**, 353.
4.34^{m}	γ	**0.052**	scin	51D6	Rh(slow n,γ).	E.der Mateosian, M.Goldhaber, PR **82**, 115.
105 45 60 45^{s}	τ_1	**45^{s}**		51D3	Proposed decay scheme: 	R.B.Duffield, L.M.Langer, PR **81**, 203.
	γ	**0.130**	sl;ce⁻			
		K/L = 1.4				
36.5^{h}	τ_2	**36.2^{h}**		51D3		
	β^-	**0.570**	sl			
	No γ					
	τ_2	**35^{h}**		51M29	Re-affirm presence of 0.3γ.	C.E.Mandeville. E.Shapiro, PR **82**, 953.
	γ	**0.3**	a		$\beta\gamma$ coincidences/β ~0.08.	
106 45 61	γ strong	**0.511**	sl; pe⁻	51A1	Strong γ's are of ~ equal intensity but no crossover found. More than one cascade probable which may explain angular correlation.	D.E.Alburger, et al., PR **82**, 332(A).
	strong	**0.621**	sl; pe⁻			
	weak	**0.87**	sl; pe⁻			
	weak	**1.045**	sl; pe⁻			
	weak	**1.55**	sl; pe⁻			
	~2%	**2.9**	scin			

46 PALLADIUM Pd

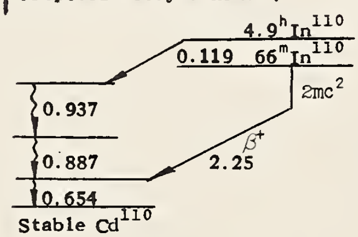
104 46 58	$Pd^{105}(\gamma,n)$ Q = **−7.2**	51S6	Lowest Pd threshold observed.	R.Sher, et al., PR **81**, 154.

Ag	New reference for data reported in	50W73	Ag^{107}, Ag^{109}.	E.J.Wolicki, et al., PR **82**, 486.
107 47 60 stable	σ_s coh **8.7** σ_s bound **10**	51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
	μ **−0.111** S	51B19	Hfs measurements; ms separated isotopes.	P.Brix, et al., Naturwiss. **38**, 68; Z. Phys. **130**, 88.
108 47 61	Ag^{107}* (d,p) Q = **4.8**	51H6	B_n = 7.0. Rel σ. *See Tl^{47}.	J.A.Harvey, PR **81**, 353.
109 47 62 39.2^s	γ ~**0.087** cc;ce⁻	51D5	See also Cd^{109}, 51D5. Possibly another γ of ~0.059.	B.Dreyfus, et al., Compt. Rend. **232**, 617.
stable	μ **−0.129** S	51B19	Hfs measurements; ms separated isotopes.	See Ag^{107}, 51B19.
	σ_s coh **2.3** σ_s bound **6**	51S20	See H^2, 51S20.	See Ag^{107}, 51S20.
	$\bar{\sigma}$(fast n,p) 13.1^hPd **2.0** mb	51C1	For total Be(15 Mev d,n) spectrum. Relative to 285 mb for S^{32}.	B.L.Cohen, PR **81**, 184.
110 47 63 270^d	β^+/β^- $\leqslant$ 0.05%	51M16	See $18.5^m Br^{80}$, 51M16. Ratio found attributable to hard γ's.	W.Mims, H.Halban, Proc. Phys. Soc., Lond., **A64**, 311.
24.5^s	β^- 60-70% **2.24** 40-30% **2.82** γ strong **0.66** weak ~**0.9** (all) scin	51G20	$Ag^{109}(n,\gamma)$. 24^s activity studied using pneumatic tube. 0.9γ probably sum of 0.885 and 0.935γ's of 50S1.	M.Goodrich, PR **82**, 759.
111 47 64	$\beta\gamma$ delay of $0.10^{\mu s}$	51E9	~14% of coincidences delayed.	D.Engelkemeir, PR **82**, 552.
112 47 65	β^- **4.2** scin	51P8	Cd^{113}($\leqslant$70 Mev γ,p).	J.P.Palmer, PR **82**, 772(A).
	τ **3.20^h** β^- **3.5** a No γ follows 3.5 Mev β^-	51S40	Produced by In(n,α).	K.Shure, MIT Progress Report, May 1951 and Thesis.
113 47 66	β^- **2** scin	51P8	Cd^{114}($\leqslant$70 Mev γ,p).	See Ag^{112}, 51P8.

Cd	New reference for data reported in 50G59		Cd^{115}.	P.S.Gill, et al., Ind. J. Phys. **24**, 566.
109 48 61	γ ? ~**0.80** cc;Compt	51D5	Ag(7 Mev *d*,2*n*)Cd^{109}; chem. See also Ag^{109}, 51D5.	B.Dreyfus, et al., Compt. Rend. **232**, 617.
110 48 62	σ(4.5 - 6.5 Mev *p*,*n*)66^mIn σ(6.3 Mev) **0.115**	51B20	Stacked foils. K/β^+ assuming allowed transition.	J.P.Blaser, et al., HPA **24**, 3.
111 48 63 48.7^m	γ_1 100% **0.1496** sl;ce^- K/L = 2.0 γ_2 100% **0.246** sl;ce^- K/L = 5.1	51M11	Produced by Cd^{111}(*n*,*n*), Cd^{112}(*n*,2*n*), Ag(α,*pn*), Pd(α,*n*). γ_1/γ_2 (unconverted) = 0.33. This indicates γ_1 is E3. *	C.L.McGinnis, PR **81**, 734 and ***83**, 686. See also In^{111}.



Stable	σ(3 - 6.5 Mev *p*,*n*)2.84^dIn σ(6.3 Mev) **0.19**	51B20	Stacked foils. γ's and ce^-'s measured.	See Cd^{110}, 51B20.
	σ(2.5 - 10 Mev *p*,*n*)2.84^dIn σ(6.3 Mev) ~**0.4**	51M11	Stacked foils.	See 48.7^mCd^{111}, 51M11.
	Cd(e^-,e^-)48^mCd Levels **1.33,1.75**	51W1	E_e = 1.2 - 2.3. Excitation curve found. σ(1.5 Mev) ~ 10^{-10}.	B.Waldman, W.C.Miller, PR **82**, 305(A).
112 48 64	σ(3.1 - 6.5 Mev *p*,*n*)23^m, 9^mIn σ(6.3 Mev) **0.075**	51B20	Stacked foils. Estimated branching. Assumed α = 9.	See Cd^{110}, 51B20.
114 48 66	σ(3.5 - 6.5 Mev *p*,*n*)50^dIn σ(6.3 Mev) **0.047**	51B20	Stacked foils. Measured 2.0 β^-'s and 0.192 γ's.	See Cd^{110}, 51B20.
	σ(3.5 - 10 Mev *p*,*n*)50^dIn σ(6.3 Mev) ~**0.09**	51M11	Stacked foils.	See Cd^{111}, 51M11.
115 48 67 2.3^d	No $\beta\gamma$ angular correlation	49G21	b = + 0.02 ±0.02	R.L.Garwin, PR **76**, 1876.

In	New reference for data reported in 50S12	In^{116}.	H.Slätis, et al., Arkiv Fysik **2**, 321.
108 ? 49 59 ?	τ **50^m** 51M11 β^+ **2.31** sl γ **0.285** sl;ce^-	d 4^hSn. α = 0.06 if assignment of γ is correct.	C.L.McGinnis, PR **81**, 734.
109 49 60	τ **4.2^h** 51M11 γ 0.6 * **0.058** K/L = 0.9 1 * **0.205** K/L = 3 0.080 * **0.347** sl;ce^- 0.016 * **0.427**	Produced by Ag(α,2n); chem. *Relative intensities of ce^-'s.	See above.
110 49 61 5.0^h	τ_1 **5.0^h** 51M11 γ_1 (IT ?) **0.119** K/L = 4.5 **0.590 ?** γ_2 1 * **0.661** sl;ce^- γ_3 0.13 * **0.885** γ_4 0.11 * **0.935**	Produced by Ag(α); chem. *Relative intensities of ce^-'s.	See above.
	τ_1 **4.9^h** 51B1 γ **0.119** **0.654** **0.887** **0.937**	Proposed decay scheme *: 	E.Bleuler, et al., PR **82**, 333(A) and *verbal report.
66^m	τ_2 **66^m** 51B1 β^+ **2.25** γ **0.654**		
	Cd(p,n) 66^mIn Q = **−4.5** 51B20	Stacked foils. E_p = 6.5 Mev.	J.P.Blaser, et al., HPA **24**, 3.
111 49 62	γ_1 **0.1721** sl;ce^- 51M11 α = 0.12; K/L = 6.6 γ_2 **0.2466** sl;ce^- α = 0.064; K/L = 5.19 γ_3 **0.093** sl;ce^- γ_4 **0.330** sl;ce^- Cd(p,n) Q = **−2.4** ± 0.2	Produced by Cd(α); Ag(α); chem. β^+ < 0.06 % of K capture. See Cd^{111} for decay scheme. (Transitions to 0.396 level)/(transitions to 0.419 level) = 1 x 10^{-4}. *	C.L.McGinnis, PR **81**, 734 and *PR **83**, 686.
	$\gamma_1\gamma_2$ angular correlation 51R2 b **−0.06** ± 0.02 Consistent with M1 and E2	No spin change in $0.08^{\mu s}$ state before emission of 0.247 γ.	D.M.Roberts, R.M.Steffen, PR **82**, 332(A).
	$\gamma_1\gamma_2$ angular correlation 51A13 b **−0.16** *	b found to depend on source material. *Thick metal source.	H.Aeppli, et al., PR **82**, 550; HPA **24**, 335.
111 * 49 62	Decay scheme, τ of Cd^{111} *	τ of Cd^{111} should be 48^m, not 4.8^m.	*Correction to *Table*.
112 49 63	Cd(p,n) 23^m and 9^mIn 51B20 Q ~ **−3.1**	Stacked foils. E_p = 6.5 Mev.	See In^{110}, 51B20.
113 49 64 1.73^h	γ (0.39) 51T17 α = 0.35		D.A.Thomas, et al., PR **82**, 981.

(In continued on next page)

113 49 64	μ **5.4970** I	51P2	$\nu(In^{113})/\nu(Na^{23})$ $[In(NO_3)_3]$ = 0.82667 ± 0.00008.	W.G.Proctor, F.C.Yu, PR **81**, 20.
	No Cd K X-rays Cd L X-rays ?	51C19	τ(K capture) > 10^{14y} τ(L capture) ~ 10^{12y} ?	S.G.Cohen, Nature **167**, 779.
114 49 65 50^d	Cd(p,n) Q = **-3.0**	51M11	Stacked foils.	C.L.McGinnis, PR **81**, 734.
115 49 66 4.50^h	Levels found in production of 4.5^hIn by In(n,n) **0.60, 0.96, 1.37**	51E7	Existence of β^- decay of metastable state confirmed.	A.A.Ebel, C.Goodman, PR **82**, 130(A).
	τ ~10^{14y} β^- a	51C19	β^- crudely measured to be a few hundred kev.	See In^{113}, 51C19.
	μ **5.5086** I	51P2	$\nu(In^{115})/\nu(Na^{23})$ $[In(NO_3)_3]$ = 0.82841 ± 0.00008.	See In^{113}, 51P2.
116 49 67	In^{115*} (d,p) Q = **4.4**	51H6	B_n = 6.6. Rel σ. *See Tl^{47}.	J.A.Harvey, PR **81**, 353.

50 TIN Sn

Sn	σ_t(42 Mev) **3.25**	50H71	Used C^{12}($n,2n$) detector.	R.H.Hildebrand, C.E.Leith, PR **80**, 842.
108 ? 50 58	τ **4.0^h** K	51M11	Produced by Cd(39.6 Mev α); chem. p 50^mIn.	C.L.McGinnis, PR **81**, 734.
111 50 61	τ **35^m** K 71% β^+ 29% **1.51** sl	51M11	Produced by Cd(39.6 Mev α); chem. F-K plot linear. No ce^-'s. See Cd^{111} for decay scheme.	See above.
113 50 63 112^d	(L capture)/(K capture) ~ 0.8 No 0.085γ (< 1% of In^{113} 0.39γ)	51T17	(K Auger e^-)/(ce^- of 0.39γ) = 0.61.	D.A.Thomas, et al., PR **82**, 961.
117 50 67	σ(3.5 - 6.5 Mev p,n)2.8^hSb σ(6.3 Mev) **0.07**	51B20	Stacked foils. Based on forth-coming decay scheme.	J.P.Blaser, et al., HPA **24**, 3.
118 50 68	Sn^{117*} (d,p) Q = **7.1**	51H6	B_n = 9.4. Rel σ. *See Tl^{47}.	J.A.Harvey, PR **81**, 353.
120 50 70	σ(3.5 - 6.5 Mev p,n)16.6^mSb σ(6.3 Mev) **0.12**	51B20	Stacked foils. Based on decay scheme of 50B92.	See Sn^{117}, 51B20.
122 50 72	σ(3.5 - 6.5 Mev p,n)2.8^dSb σ(6.3 Mev) **0.14**	51B20	Stacked foils. β's measured.	See Sn^{117}, 51B20.

51 ANTIMONY Sb

120 51 69 16.6^m	β^+ ~88% γ 8%* 35%* 4%*	**1.70** **0.90** **1.30** **2.20**	sl sl; pe$^-$ sl; pe$^-$ sl; Compt	50B92	Produced by Sn(p,n), threshold = 3.5. β^+ (~12%) of 2.40 with ~same τ inconsistent with threshold.	J.P.Blaser, et al., HPA **23**, 623. *% of all β^+.
120 51 69	No evidence of 6.0^d activity No 1.1 Mev γ		Compt, pe$^-$	51B31	Sn(6.8 Mev p,n); Sb(32 Mev γ,n).	J.P.Blaser, et al., HPA **24**, 245.
121 51 70	μ	**3.3426**	I	51P2	$\nu(Sb^{121})/\nu(Na^{23})$ [$NaSbF_6$] = 0.90480 ± 0.00009.	W.G.Proctor, F.C.Yu, PR **81**, 20.
122 51 71 3.5^m	γ	**0.068**	scin	51D6	Sb^{121}(slow n,γ). Sb^{121} enriched to 97.7%.	E.der Mateosian, M.Goldhaber, PR **82**, 115.
2.8^d	β^-	**1.450*** **2.015***	s$\beta\gamma$ s	51M2	Low energy β^- has allowed spectrum.	P.A.Macklin, et al., PR **82**, 334(A) and *verbal report.
	$\beta\gamma$ angular correlation b b	 **0.07*** **0.16****		51S5	*Total correlation coefficient. **Coefficient for small ΔE_β in high energy region only.	I.Shaknov, PR **82**, 333(A).
	Sb^{121}* (d,p)	Q = **4.4**		51H6	B_n = 6.6. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.
123 51 72	μ	**2.5341**	I	51P2	$\nu(Sb^{123})/\nu(D)$ [$NaSbF_6$] = 0.84423 ± 0.00008.	W.G.Proctor, F.C.Yu, PR **81**, 20.
124* 51 73 21^m	β_1^-			49G8	β_1 may not go to ground as indicated in decay scheme.	*Correction to *Table*.
60^d	$\beta\gamma$ angular correlation* No $\gamma\gamma$ angular correlation**			51S4	*Involves highest energy β; measured as function of E_β.	D.T.Stevenson, PR **82**, 333(A) and **verbal report.
128 ? 51 77	τ	**1.1^h**		51P6	Fission; chem. Yield 0.1%.	A.C.Pappas, MIT Progress Report January 1951.

52 TELLURIUM Te

Te	Resonance	E_0 = **2.2** ev	51H11	Smaller resonances at higher E_n.	C.J.Heindl, et al., PR **81**, 325(A).
124 52 72	$Te^{125}(\gamma,n)$	Q = **-6.8**	51S6	Lowest Te threshold.	R.Sher, et al., PR **81**, 154.
125* 52 73 58^d	Reference number			Number for K.Siegbahn, W. Forsling, Arkiv Fysik **1**, 505 is 50S19.	*Addition to *Supplement 1*.
131 52 79	γ 22%	>**2.23**	51E12	From fission product Be(γ,n) and direct observation.	W.K.Ergen, ANP-59.
133 52 81	τ_2 β^- ~20% ~80%	~**2^m** **1.2*** **2.4***	51P12	Short lived daughter found in decay of 63^mTe^{133}.	A.C.Pappas, MIT Progress Report, May 1951, 65 and *priv. comm.

124 (53, 71)	High energy β^+ to ground and not to excited state of Te^{124}			51S40		K.Shure, MIT Progress Report, May 1951, 129, and Thesis.
	(1.5 β^+) γ coincidences * No (2.2 β^+) γ coincidences			51S4	* Isotropic.	D.T.Stevenson, PR **82**, 333(A).
125 (53, 72)	γ	**0.0355**	sl;ce$^-$	51B15	d 20^hXe. No ce$^-$'s of 0.109γ observed.	I.Bergström, PR **82**, 111.
126 (53, 73)	K 58%			51P9	I(*n*,2*n*); Sz-Ch reaction. Observed annihilation radiation. $\gamma\gamma$ and γX coincidences. $\beta_1^-\gamma$ coincidences, probably 0.382γ. No $\beta_2^-\gamma$ coincidences.	M.L.Perlman, G.Friedlander, PR **82** 449.
	β^+ ~2%					
	β_1^- 10%	**0.85**	sl			
	β_2^- 30%	**1.24**	sl			
	γ	**0.382**	sl;ce$^-$			
	weak	**0.640**	scin			
	Te X-rays		pc			
	$\beta\gamma$ angular correlation			51S4	b = 0.13 for E_β = 0.460.	See I^{124}, 51S4.
127 (53, 74)	μ	**2.7940**	I	51S33	$\nu(I^{127})/\nu(H^1)$ [KI] = 0.200044 ± 0.000010. D substandard used.	R.E.Sheriff, D.Williams, PR **82**, 651.
	μ	**2.7945**	I	51W12	$\nu(I^{127})/\nu(D)$ = 1.30337 ± 0.0002.	H.Walchli, et al., PR **82**, 97.
	μ	**2.7947**	I	51Y3	$\nu(H^1)/\nu(I^{127})$ [KI] = 4.99763 ± 0.00015.	E.Yasaitis, B.Smaller, PR **82**, 750.
129 (53, 76)	τ	**1.72 x 10^{7y}**		51K16	I^{129}/I^{127} determined by ms. CH_3I used in counter.	S.Katcoff, et al., PR **82**, 688.
	β^-	**0.13**	a			
	μ	**2.6037**	I	51W12	$\nu(I^{129})/\nu(D)$ = 0.86744 ± 0.0001.	See I^{127}, 51W12.
131 (53, 78)	τ	**8.04^d**		51S25	NaI solution used. Followed three half lives.	W.K.Sinclair, A.F.Holloway, Nature **167**, 365.
	τ	**8.141^d**		51S16	[No details given.]	J.H.Sreb, PR **81**, 643.
	β_1^-	**0.255**	scin	51B17	$\gamma_1\gamma_2$ coincidences. $\gamma_1\gamma_4$ coincidences reported here not confirmed, P.R.Bell, priv. comm.	P.R.Bell, et al., PR **82**, 103. See also N.F.Verster, et al., Physica **17**, 637 and 658; B.H. Ketelle, et al., PR **84**, 585.
	γ_1 **0.080** γ_4 **0.638**		scin			
	γ_2 **0.284** γ_6 **0.720**		scin			
	γ_3 **0.364**		scin			
	β_2^-	**0.606**	sl	51Z1	0.364γ used as internal energy standard. $e^-_{K_4}/e^-_{K_6}$ ~5. $\alpha_{K_4}/\alpha_{K_6}$ ~1.	H.Zeldes, et al., PR **81**, 642.
	β_3^- ~1%	**0.810**	sl			
	γ_4	**0.635**	sl;ce$^-$			
	γ_6	**0.720**	sl;ce$^-$			
	New or different results *			51C5	Authors note that proposed decay scheme is inconsistent with relative intensities. * Cf. 49C13.	J.M.Cork, et al., PR **81**, 482.
	β^-	**0.305**	sπ			
		0.600	sπ			
	γ	**0.637**	sπ;ce$^-$			
		0.723	sπ;ce$^-$			

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131 53 78	$\beta_2\gamma_2$ delay $< 4 \times 10^{-3}$ µs $\gamma_2\gamma_1$ delay $< 4 \times 10^{-3}$ µs 51W13		W.E.Wright, M.Deutsch, PR **82**, 277.
131* 53 78	γ_3	α of 49K14 should be 0.02 not 0.2.	*Correction to *Table*.
132 53 79	γ 2.7% 2.0 51E12	From fission product Be(γ,*n*) and direct observation.	W.K.Ergen, ANP-59.

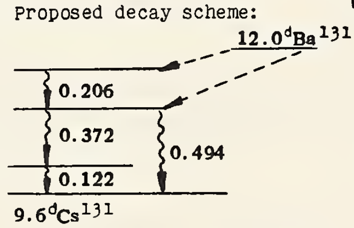
54 XENON Xe

125 54 71	τ 18^h 51B15 K No β^- or β^+ observed γ 0.054 0.187 } 0.096 0.243 } sl;ce$^-$ 0.106 } 0.460 scin	Xe(pile *n*); ms. 0.460γ weak. K/L for 0.054γ ~4.2. K/L for 0.187γ ~4.6.	I.Bergström, PR **82**, 111.
127 54 73 ~34^d	K 51B21 γ 0.057 0.170 } 0.145 0.200 } sl;ce$^-$ weak 0.365 scin	Xe(pile *n*,γ); ms. Observed Auger e$^-$'s of I.	I.Bergström, PR **82**, 111 and Nature **167**, 634.
129 54 75	τ 8.0^d 51B21 γ 0.196 sl;ce$^-$ K/L+M ~2.1	Xe(pile *n*); ms.	See above.
	μ −0.7726 I 51P2	$\nu(Xe^{129})/\nu(Na^{23})$ [Xe + Fe_2O_3] = 1.0457 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **81**, 20.
133 54 79 ~2^d	τ_1 2.30^d 51B11 γ 0.2328 sl;ce$^-$ K/L = 2.9	Produced by Xe(pile *n*,γ); ms.	I.Bergström, PR **81**, 638.
5.27^d	γ 0.08 cc;ce$^-$ 51B28	Fission product Xe.	H.Behrens, Z. Naturforsch. **6a**, 249.
135 54 81 9.2^h	γ 0.05 } 0.14 } 0.19 } cc;ce$^-$ 51B28 0.26 }	Assigned to Xe^{135} rather than Xe^{133} through decay rate. ~75 cases useful for energy evaluation.	See above.
	β^- 0.905 sl 51B16 γ 0.248 sl;ce$^-$ $\beta^-\gamma$ coincidences	Fission; ms. F - K plot straight. Log ft = 5.5.	I.Bergström, PR **82**, 1120.

55 CESIUM Cs

Cs	σ_s coh 3.0 σ_s bound ~7	51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
	New reference for data reported in	50W63	Cs^{137}.	M.A.Waggoner, PR **82**, 906.
128 55 73	τ **3.1^m** β^+ ? **3** *	51F7	Cs(96 Mev *p*)Ba; chem. d 2.4^dBa. *β^+ reported for Ba^{128} (50F11, 50T8) probably belongs here.	R.W.Fink, E.O.Wiig, J. Am. Chem. Soc. **73**, 2365.
131 55 76	τ **10^d** K, no β^+ No γ	51K11	d $12.0^d Ba^{131}$. Observed Auger e^-'s. Previously observed ce^-'s belong to Ba^{131}.	E.Kondaiah, Arkiv Fysik **2**, 295.
132 55 77	$Cs^{133}(\gamma,n)$ Q = **−9.0**	51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
133 55 78	μ **2.5649** I	51S33	$\nu(Cs^{133})/\nu(H^1)$ [CsCl] = 0.131169 ± 0.000006.	R.E.Sheriff, D.Williams, PR **82**, 651.
134 55 79	β^+/β^- < 8.6×10^{-5}	51M16	See $18.5^m Br^{80}$, 51M16. Isomer studied not stated.	W.Mims, H.Halban, Proc. Phys. Soc., Lond., **A64**, 311.
137 55 82	β_2^- 92% **0.51** sπ β_1^- 8% **1.17** sπ	51L12	Log ft_2 = 9.2. ΔI_2 = 2, yes. Log ft_1 = 11.6 ΔI_1 = 2, no. C_{2T} describes shape of β_1. See also Ba^{137}.	L.M.Langer, R.J.D.Moffat, PR **82**, 635.

56 BARIUM Ba

Ba	σ_s coh **3.5** (+)	51S36		C.G.Shull, et al., ORNL-1005, 13.
131 56 75	τ **13^d** K, no β^+ γ_1 ~20% **0.122** K/L~3.5, α=0.8 * γ_2 ~16% **0.206** α=0.15 * γ_3 ~20% **0.372** α=0.03 * γ_4 ~80% **0.494** α=0.01 * (s; ce^-, pe$^-$) Intensity of γ > 0.494 is < 5%	51K11	Proposed decay scheme: 	E.Kondaiah, Arkiv Fysik **2**, 295. Coincidences for $e_1^- e_2^-$ and $e_1^- e_3^-$ but not for $e_1^- e_4^-$. $\gamma\gamma$ coincidence rate supports decay scheme. *Assuming E2 for γ_1 from K/L ratio.
	γ **0.46**, **0.83** a coin, Compt $\gamma\gamma$ coincidences *	51C18	Ba(pile *n*,γ); chem. γ groups at 0.16,0.42,1.2 Mev by absorption. *Probably 0.46γ and γ ~0.2 Mev.	W.H.Cuffey, PR **82**, 461.
136 56 80	$Ba^{137}(\gamma,n)$ Q = **−7.1**	51S6	Lowest Ba threshold.	R.Sher, et al., PR **81**, 154.
137 56 81 2.60^m	γ **0.663** sl; ce^- α_K = 0.097 ± 0.005	51W19	α_K(theoretical) = 0.094 for M4.	M.A.Waggoner, PR **82**, 906.
139 56 83	Ba^{138} * (*d,p*) Q = **3.0**	51H6	B_n = 5.2. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.

57 LANTHANUM La

Isotope	Property	Value	Method	Key	Remarks	Reference
La	σ_a (0.025 ev)	**8.4**	osc	51B29	Based on σ_a (B) = 710.	P.Benoit, et al., J. Phys. Rad. **12**, 584.
	Relative isotopic abundance 137	<**0.0002** %		51H23		D.C.Hess, M.G.Inghram, ANL-4602, 42.
	New reference for data reported in 50J5				La^{134}.	B.J.Stover, PR **81**, 8.
131 57 74	τ β^+	**58**^{m} **1.6**	 a	51G14	Ba($\leqslant$90 Mev *p*); chem, ms.	M.M.Gransden, W.S.Boyle, PR **82**, 447.
132 57 75	τ β^+ γ	**4.5**^{h} **3.5** **1.0**	 a a	51G14	See above.	See above.
138 57 81	$La^{139}(\gamma,n)$	Q = **-8.8**		51S6	From observed threshold.	R.Sher, et al., PR **81**, 154.
139 57 82	μ	**2.7622**	I	51S33	$\nu(La^{139})/\nu(H^1)$ [$LaCl_3$] = 0.141264 ± 0.000009.	R.E.Sheriff, D.Williams, PR **82**, 651.

58 CERIUM Ce

Isotope	Property	Value	Method	Key	Remarks	Reference
Ce	σ_s coh	**2.2**	(+)	51S36		C.G.Shull, et al., ORNL-1005,13.
	New reference for data reported in 50J5				$Ce^{133,134,135,137}$.	B.J.Stover, PR **81**, 8.
137 58 79	γ	**0.257** K/L ~4	sπ; ce$^-$	51H14	Ce^{136} (pile *n*,γ). No isomer with τ > 1^d observed.	R.D.Hill, PR **82**, 449.
139 58 81	γ	**0.1655** K/L $\gtrsim$4	sπ; ce$^-$	51H14	Ce^{138} (pile *n*,γ). No isomer with τ > 1^d observed.	See above.
141 58 83	γ	**0.145** K/L ~7	sπ; ce$^-$	51H14	Ce^{140} (pile *n*,γ).	See above.
144 58 86	γ	**0.034** **0.095** **0.041** **0.106** **0.053** **0.134*** **0.080*** K/L~7	sπ; ce$^-$	51E10	*K,L,M lines in Pr seen. Other γ's tentatively identified from single ce$^-$ lines.	W.S.Emmerich, et al., PR **82**, 968.

59 PRASEODYMIUM Pr

Pr	New reference for data reported in 50J5				$Pr^{138,139}$.	B.J.Stover, PR **81**, 8.
140 59 81	τ	3.5^m		51S3	Produced by Ce(10 Mev p,n).	B.J.Stover, PR **81**, 8.
144 59 85	γ	0.695 *	sl;pe$^-$	51A1	Photo n's produced in Be and D(?). 2.19γ compared with 2.2γ of Bi^{214}.	D.E.Alburger, et al., PR **82**, 332(A) and *verbal report.
	weak*	1.48 *	sl;pe$^-$			
	~3%*	2.19	sl;pe$^-$			

60 NEODYMIUM Nd

Nd	New reference for data reported in 50J5				$Nd^{138,139}$.	B.J.Stover, PR **81**, 8.
143 60 83	I	7/2		50B86	Paramagnetic resonance with ethyl sulfate.	B.Bleaney, H.E.D.Scovil, Proc. Phys. Soc., Lond., **A63**, 1369.
	μ^{143}/μ^{145}	1.61				
	μ	1.4 *		51E3	* From data of 50B86. Sign not determined.	R.J.Elliott, K.W.H.Stevens, Proc. Phys. Soc., Lond., **A64**, 205.
	I	7/2	s	51M24		K.Murakawa, J.S.Ross, PR **82**, 967.
	μ	-1.0	s			
145 60 85	I	7/2	Mic	50B86	See Nd^{143}.	See Nd^{143}, 50B86.
	μ	0.85 *		51E3	* From data of 50B86. Sign not determined.	See Nd^{143}, 51E3.
	I	7/2	s	51M24		See Nd^{143}, 51M24
	μ	-0.62	s			
147 60 87	τ	11.6^d		51K5	Produced by Nd(n,γ). γ's of 0.309 (1%) and 0.391 (2%) also observed; may be due to impurities.	E.Kondaiah, PR **81**, 1056.
	β^- 32%	0.350	s			
	65%	0.780	s			
	γ 66%	0.091	s;ce$^-$,pe$^-$ α~0.9,K/L~6.5			
	32%	0.520	s;pe$^-$			
	β_1^-	0.38	s	51E4	Produced by Nd(n,γ). β_3X, $\beta_3 e_1^-$, $\beta_2 e_2^-$, and $\beta\gamma$ coincidences. No $\gamma\gamma$, γX, or XX coincidences.	W.S.Emmerich, J.D.Kurbatov, PR **81**, 1062.
	β_2^-	0.60	s			
	β_3^-	0.82	s			
	γ_1	0.0915	s;ce$^-$			
	γ_2	0.320	s;ce$^-$			
	γ_3	0.534	s;ce$^-$			
149 60 89	β^-	1.4	a	50K71		B.H.Ketelle, ORNL-286. Quoted in NNES **9**, page 2052.
	γ	0.5	a			

61 PROMETHIUM Pm

145 61 84	τ Nd K,L X-rays	~30^y		51B18	Ion exchange. d 410^dSm. τ from relative K X-ray intensities of Sm^{145} and the Pm^{145} formed from it in a known time.	F.D.S.Butement, Nature **167**, 400.
149 61 88	τ β^-	48^h 1.05	 s	51K5	No γ's observed.	E.Kondaiah, PR **81**, 1056.
151 ? 61 90	γ X-ray	1	a	50K71	No parent with $\tau > 0.5^s$. β^- same as in 49K2. This 12^m activity possibly Nd^{151}.	B.H.Ketelle, ORNL-286. Quoted in NNES **9**, page 2053.

62 SAMARIUM Sm

Sm	Relative isotopic abundances 142,143,145 146	 <0.0001 % <0.0002 %		51H23		D.C.Hess, M.G.Inghram, ANL-4602, 42.
143 ? 62 81	τ	8^m		51B25	Activity mentioned in 50B7 now tentatively assigned to Sm^{143}.	F.D.S.Butement, Proc. Phys. Soc., Lond., **A64**, 395.
145 62 83	τ K,L X-rays No γ	410^d		51B18	Sm(pile n,γ); ion exchange. γ's of 48C9 not found. p ~30^yPm.	F.D.S.Butement, Nature **167**, 400.
147 62 85	I μ	5/2 - 0.30	S S	51M24		K.Murakawa, J.S.Ross, PR **82**, 967.
149 62 87	I μ	5/2 - 0.25	S S	51M24		See above.

63 EUROPIUM Eu

Eu	New reference for data reported in 50B7		Eu^{150}.	F.D.S.Butement, Proc. Phys. Soc. Lond., **A64**, 395.
152 63 89	0.12γ delayed $< 3 \times 10^{-3}$ μs ~0.37γ delayed $< 3 \times 10^{-3}$ μs	51W13		W.E.Wright, M.Deutsch, PR **82**, 277.
159 ? 63 96	τ 20^m	51B25	Gd($\leq$ 23 Mev γ). Could also be Gd.	F.D.S.Butement, Proc. Phys. Soc., Lond., **A64**, 395.

64 GADOLINIUM

148,149 ? 64 84,85 ?	τ α	7.0^h	51S22	Produced by Sm(30 Mev α); no chem. Not produced by 8 Mev *p* or 15 Mev *d*. Mass assignment from α systematics, shell model.	K.H.Sun, et al., PR **82**, 772(A).

65 TERBIUM Tb

160 65 95	($\sim$0.9β) (0.085γ) delay	1.8×10^{-3} μs	51M28	No other γ follows delay.	F.K.McGowan, ORNL-1005, 24.
162,163 65 97,98	τ	14^m	51B25	Dy ($\leqslant$23 Mev γ). 22^m half life (50B7) high due to impurity.	F.D.S.Butement, Proc. Phys. Soc., Lond., **A64**, 395.

66 DYSPROSIUM Dy

159 66 93	τ Tb K and L X-rays	134^d a	51B24	Dy(pile *n*,γ) and Tb(*d*,2*n*); ion exchange. β^+/disintegration $<$0.001.	F.D.S.Butement, Proc. Phys. Soc., Lond., **A64**, 428.
165 66 99	0.091γ delayed	$<5 \times 10^{-3}$ μs	51W13		W.E.Wright, M.Deutsch, PR **82**, 277

67 HOLMIUM Ho

167,169 67 100,102	τ	96^m	51B25	Er($\leqslant$23 Mev γ). Could also be Er^{163}. 44^m activity (50B7) due to contamination.	F.D.S.Butement, Proc. Phys. Soc., Lond., **A64**, 395.

68 ERBIUM Er

167 68 99	I	7/2	51B9	Paramagnetic resonance with ethyl sulfate.	B.Bleaney, H.E.D.Scovil, Proc. Phys. Soc., Lond., **A64**, 204.
	μ	0.6 *	51E3	* From data of 51B9. Sign not determined.	R.J.Elliott, K.W.H.Stevens, Proc. Phys. Soc., Lond., **A64**, 205.

69 THULIUM Tm

Tm	New reference for data reported in 50B7	$Tm^{172,173,175}$?.	F.D.S.Butement, Proc. Phys. Soc., Lond, **A64**, 395.

70 YTTERBIUM Yb

169 70 99	τ 33^d 51M25 γ / I(γ) / I(ce$^-$) 0.0228 0.0637 1.3 0.0945 0.1104 2.1 4 0.1204 e$^-$e$^-$, e$^-\gamma$, e$^-$ X-ray coincidences γ delay of 0.67$^{\mu s}$	γ / I(γ) / I(ce$^-$) 0.1326 2.0 0.4 0.1426 0.1600 0.1779 1.0 1.0 0.1983 1.7 0.8 0.3080 0.6 0.03	D.S.Martin, Jr., et al., PR 82, 579.
	γ delay of 0.70$^{\mu s}$ 51M19		F.K.McGowan, ORNL-952.

71 LUTETIUM Lu

Lu	New reference for data reported in 50B7	Lu^{178,179}.	F.D.S.Butement, Proc. Phys. Soc., Lond., A64, 395.
170 71 99	τ 1.7^d 51W8 Other results same as those in 49W12	Produced by Tm(>30 Mev α,3n); chem. d 1.87^{h}Hf. Low yield suggests isomer.	G.Wilkinson, H.G.Hicks, PR 81, 540.
171 71 100	τ 8.5^d 51W8 e$^-$ 0.17 a ~0.5 a γ ~1.2 a K,L X-rays	Produced by Tm(38 Mev α,2n); chem. d 16^{h}Hf.	See above.
171 ? 71 100	τ_2 ~600^d 51W8 e$^-$ ~0.1 a γ ~1 a K,L X-rays	Produced by Tm(α); chem.	See above.
172 71 101	τ 6.70^d 51W8 e$^-$ 0.13 a ~0.6 a γ 1.2 a K,L X-rays	Produced by Yb(10 Mev p), Tm(α,n); chem. d ~5^{y}Hf. Previously assigned to Lu$^{173?}$, q.v. 4.0^h activity assigned to Lu^{172} also as in 49W12.	See above.
173 71 102	τ ~500^d 51W8 γ 0.22 a 0.88 a	d 23.6^{h}Hf^{173}. Previously assigned to Lu$^{172\,?}$, q.v.	See above.
174 71 103	τ 165^d 51W8	Other results same as those in 49W12.	See above.

Isotope	Radiation	Energy	Method	Ref.	Remarks	Reference
Hf	σ_t (.003 - 10 ev) graph E_o (ev) 1.10 2.20 ~5.6 ~7.6	 σ_o 3100 3200	 Γ 0.12 0.17	51E8	Below 0.1 ev absorption is given by $\sigma_a = 22E^{-1/2}$. At 0.025 ev $\sigma_a = 134$. Resonance analysis gives $\sigma_s \sim 14$.	P.A.Egelstaff, B.T.Taylor, Nature **167**, 896.
170 72 98	τ β^+	1.87^h 2.4	 s	51W8	Produced by Lu(> 60 Mev *p,6n*); chem. p 2.1^dLu.	G.Wilkinson, H.G.Hicks, PR **81**, 540.
171 72 99	τ e^- γ K,L X-rays	16.0^h 0.15 1.4	 a a	51W8	Produced by Lu(40 Mev *p,5n*), Yb(38 Mev α); chem. p $8.5^d Lu^{171}$.	See above.
172 72 100	τ γ K,L X-rays	$\sim 5^y$ 0.28 0.8	 a a	51W8	Produced by Yb(α); Lu(*p,4n*); Ta(190 Mev *d*); chem. p 6.7^dLu, Previously assigned to Hf^{173} ?.	See above.
173 72 101	τ γ e^- K,L X-rays	23.6^h ~1 0.12 0.22		51W8	Produced by Yb(20 Mev α); Lu(18 Mev *p,3n*); chem. Previously assigned to Hf^{172} ?. p 500^dLu. No other Lu daughter with $1^m < \tau < 500^d$.	See above.
175 72 103	γ K X-rays	0.3422	s;pe^-	51H10	Hf(pile *n*,γ); ms. Resolved this γ and γ_4 of Hf^{181}.	A.Hedgran, S.Thulin, PR **81**, 1072.
179 72 107 19^s	γ	0.215	scin	51D6	Hf(slow *n*,γ).	E.der Mateosian, M.Goldhaber, PR **82**, 115.
181 72 109	e^-'s involved in instantaneous coincidences: 0.024,0.064,0.130,0.270,0.410, 0.440 0.400 β only precedes delay 0.130 and 0.470 γ's follow delay			50F76	Suggests 0.270 e^- and 0.440 e^- (or β) in simple cascade.	E.W.Fuller, Proc. Phys. Soc., Lond. **A63**, 1348.
	$\gamma_2/\gamma_3 \sim 5$ $\gamma_5/\gamma_4 \sim 8$	$K/L(\gamma_3) \sim 8$ $\alpha_K(\gamma_2)/\alpha_K(\gamma_3) = 2$		51H10	Hf(pile *n*,γ); ms. Results support decay scheme of 49C11. See also Hf^{175}.	See Hf^{175}, 51H10.
	See also Ta^{181}, 51M7					

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73 TANTALUM Ta

Ta	New reference for data reported in 50B7	$Ta^{183,185}$.	F.D.S.Butement, Proc. Phys. Soc., Lond. **A64**, 395.
181 73 108	Γ(0.481 level) < 10^{-5}ev consistent with $\tau = 0.01^{\mu s}$ 51M7	Resonant scattering not observed.	P.B.Moon, Proc. Phys. Soc., Lond., **A64**, 76.
	σ(15 Mev *d,p*) 117^dTa **0.3** 51S26	Graph for E_d = 5 – 15 Mev. See 50S18.	K.H.Sun, et al., PR **82**, 459.
182 73 109 117^d	τ **111^d** 51S25	Solid Ta metal used. Followed 3.5 half lives.	W.K.Sinclair, A.F.Holloway, Nature **167**, 365.
	γ **1.121**, **1.189**, **1.219** } $s\pi$; ce^-, pe^- 51C9		J.M.Cork, et al., PR **81**, 642.
	~0.114 γ delayed < 4 x $10^{-3\mu s}$ ~0.310 γ delayed < 4 x $10^{-3\mu s}$ 51W13		W.E.Wright, M.Deutsch, PR **82**, 277.
	Ta^{181*}(*d,p*) Q = **3.8** 51H6	B_n = 6.0. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, **353**.

74 WOLFRAM W

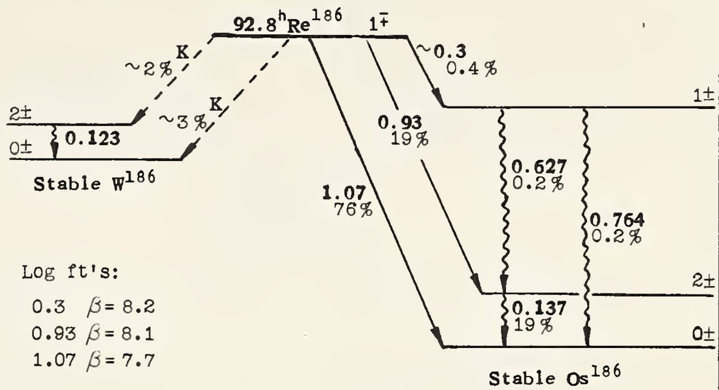
182 74 108	W^{183}(γ,*n*) Q = – **6.0** 51S6	Lowest W threshold.	R.Sher, et al., PR **81**, 154.
188 74 114	τ **65^d** 51L7	W(th *n*,γ)(th *n*,γ). p 18.9^hRe. τ from Re growth.	M.Lindner, J.S.Coleman, J. Am. Chem. Soc. **73**, 1610.

75 RHENIUM Re

Re	New reference for data reported in 50B7	$Re^{189,191}$.	F.D.S.Butement, Proc. Phys. Soc., Lond., **A64**, 395.
183 ? 75 108	τ **120 - 140^d** 51T9 e^- ~**0.1** a **0.30** a **0.76** a γ **1.07** a	Ion exchange chem. on W bombarded with 22 Mev *d* and 44 Mev α.	S.E.Turner, L.O.Morgan, PR **81**, 881.
184 75 109	τ **50^d** 51T9 e^- **0.1** a **0.2** a **0.7** a γ **1.00** a	See Re^{183} ?, 51T9.	See above.
185 75 110	μ **3.1443** I 51A11	$\nu(Re^{185})/\nu(Na^{23})$ [$NaReO_4$] = 0.85114 ± 0.00009.	F.Alder, F.C.Yu, PR **82**, 105.

(Re continued on next page)

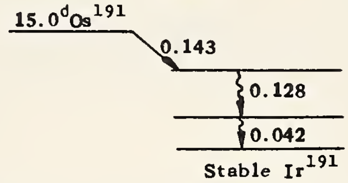
Isotope	Radiation	Intensity	Energy (Mev) / Value	Method	Ref.	Remarks	Reference
$^{186}_{75}$ 111 *	β^-	0.4%	~0.3	sl	51M23	Proposed decay scheme:	F.R.Metzger, R.D.Hill, PR **82**, 646.
		19%	0.93	sl			
		76%	1.07	sl			
	γ_1	~2%	0.123	sπ;ce⁻,sl;pe⁻			
	γ_2	19%	0.137	sπ;ce⁻,sl;pe⁻			
			α_K = 0.35, K/L = 0.6, L/M = 4.4				
	γ_3	0.2%	0.627	sl;pe⁻			
	γ_4	0.2%	0.764	sl;pe⁻			



*Error in *Second Supplement*. 50M87 γ values reported as 0.540 and 0.677 should be 0.627 and 0.764, respectively.

Isotope	Radiation	Intensity	Energy (Mev) / Value	Method	Ref.	Remarks	Reference
$^{186}_{75}$ 111	K	9%			51S39	(0.122γ)/K ≃ 0.5. No γ > 0.136 found. βγ, (W K X-ray)e_1^-, βe_2^- coincidences. Log ft (0.94β) = 7.9; log ft (1.07β) = 7.7. [Decay scheme consistent with that of 51M23.]	R.M.Steffen, PR **82**, 827.
	β^-	24%	0.942	sl			
		67%	1.070	sl			
	γ_1		0.122	sl;ce⁻,pe⁻			
			α_K = 0.4, α_L = 0.7				
	γ_2		0.136	sl;ce⁻,pe⁻			
			α_K = 0.37, α_L = 0.6, α_M = 0.12				
	β^-(0.137γ) delay		~0.0008$^{\mu s}$		51M14	Suggests γ is E2.	F.K.McGowan, PR **81**, 1066.
$^{187}_{75}$ 112	μ		3.1766	I	51A11	$\nu(Re^{187})/\nu(Na^{23})$ [$NaReO_4$] = 0.85987 ± 0.00009.	F.Alder, F.C.Yu, PR **82**, 105.
$^{188}_{75}$ 113	τ		16.9^h		51L7	d 65^{d}W.	M.Lindner, J.S.Coleman, J. Am. Chem. Soc. **73**, 1610.
	0.16γ delayed		< 5 x 10$^{-3 \mu s}$		51W13		W.E.Wright, M.Deutsch, PR **82**, 277.
$^{189}_{75}$ 114 ?	τ		250 - 300^d		51T9	See Re^{183} ?, 51T9.	S.E.Turner, L.O.Morgan, PR **81**. 881.
	e^-		0.16	a			
	γ		1.0	a			

76 OSMIUM Os

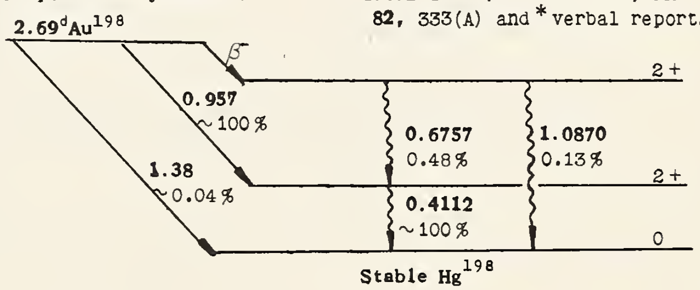
185 76 109	γ 85%* **0.65** scin 15%* **0.88** scin K X-ray 100%* scin	51M22	*Relative values. K capture to ground state in < 10% of disintegrations.	M.M.Miller, R.G.Wilkinson, PR **82**, 981.
191 76 115	β^- **0.143** sl γ **0.042** sl;ce$^-$ K/L~1.5 **0.128** sl;ce$^-$ α_K~0.5, K/L~2.1 (βe^-)/β indicates one β	51K17	Os(pile *n*); chem. 	E.Kondaiah, Arkiv Fysik **3**, 47. Author assigns this activity to Os^{193}.

77 IRIDIUM Ir

192 77 115 1.42ᵐ	γ **continuum** scin	51D6	Ir(slow *n*,γ).	E.der Mateosian, M. Goldhaber, PR **82**, 115.
70ᵈ	τ **74.5ᵈ**	51S25	Ir metal used. Followed four half lives.	W.K.Sinclair, A.F.Holloway, Nature **167**, 365.
	β^+/β^- $< 8 \times 10^{-5}$	51M16	See 18.5ᵐBr^{80}, 51M16.	W.Mims, H.Halban, Proc. Phys. Soc., Lond., **A64**, 311.
	~0.24γ delayed $< 3 \times 10^{-3}$ μs	51W13		W.E.Wright, M.Deutsch, PR **82**, 277.
	γ's not previously reported (kev): **135.9**, **151 or 156**, **169 or 173**, **201.1**, **205.7**, **283**, **396 or 400**, **415.1**, **438**, **484** } Sπ; ce$^-$, pe$^-$	51C17	10 γ's fitted into 5 levels of Pt^{192}; 4 γ's fitted into 3 levels of Os^{192}.	J.M.Cork, et al., PR **82**, 258.

78 PLATINUM Pt

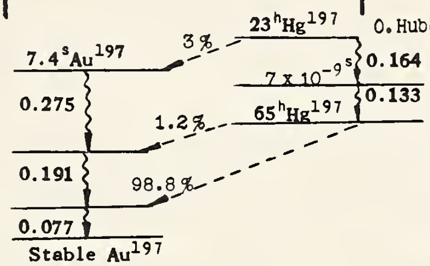
Pt	σ_s coh **11.2** σ_s bound **11.2**	51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
195 78 117	μ **0.6005** I	51P2	$\nu(Pt^{195})/\nu(Na^{23})$ [H_2PtCl_6] = 0.81273 ± 0.00008.	W.G.Proctor, F.C.Yu, PR **81**, 20.
	Pt^{194}* (*d,p*) Q = 3.9	51H6	B_n = 6.1. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.
196 ? 78 118	Pt^{195} ? (*d,p*) Q = 5.7	51H6	B_n = 8.9. Rel σ. See Ti^{47}.	See above.

Au	E_0 (4.93 ev) Γ 0.17 J 1 Γ_n/Γ 0.123	51T1	From σ_s/σ_t curve.	J.Tittman, et al., PR **82**, 344(A); **83**, 746.
	E_0 75 ev , 300 ev	51S8	Weak capture levels.	C.Sheer, et al., PR **82**, 344(A).
197 79 118	Levels in Au^{197} which combine with 7.4^s level. Au(*n*,*n*) **0.54** **1.14** **1.44**	51E7	Possible level at ~1.77. Assign I(0.54 level) = 11/2. I(1.14 level) = 7/2,9/2.	A.A.Ebel, C.Goodman, PR **82**, 130(A).
198 79 119	τ **2.73^d**	51S25	Au colloid and solid give same τ. Followed three half-lives.	W.K.Sinclair, A.F.Holloway, Nature **167**, 365.
	τ **2.66^d** γ ~100% **0.411** sl;pe$^-$,Compt 1.5% **0.670** sl;pe$^-$,Compt 0.4% **1.089** sl;pe$^-$,Compt	51C6	No γ's found at ~0.2 or ~0.3Mev No ce$^-$'s. Critical absorbers show ~66.5 and ~78 kev γ's are Au K X-rays (from absorption of 0.411γ in source).	P.E.Cavanagh, et al., Proc. Phys. Soc., Lond., **A64**, 13. Proposed decay scheme same as that given below.
	β 1.8% **0.295** a$\beta\gamma$ γ 1.43% **0.670** scin 0.33% **1.090** scin	51C24	Branching ratios from $\beta\gamma$ and $\gamma\gamma$ coincidence rates.	P.E.Cavanagh, PR **82**, 791.
	β^- ~100% **0.957** s ~0.04% **1.38*** s γ ~100% **0.4112** s;ce$^-$ α = 0.031 ~0.48% **0.6757** s;ce$^-$ α = 0.044 ~0.13% **1.0870** s;ce$^-$ α = 0.0057 Delay of 0.411γ < 0.5$^{\mu s}$	51E2	Proposed decay scheme: 	L.G.Elliott, J.L.Wolfson, PR **82**, 333(A) and *verbal report.
	γ 98.3% **0.411** sl;ce$^-$ α_K = 0.03, α_{L+M} = 0.015 1.4% **0.673** sl;pe$^-$ 0.25% **1.075** sl;pe$^-$	51H18	Added Hg does not change γ intensities. Two low energy peaks attributed to X-rays.	P.Hubert, Compt. Rend. **232**, 2201.
	β^+/β^- < 3.3 x 10^{-5}	51M16	See 18.5^{m}Br^{80}, 51M16.	W.Mims, H.Halban, Proc. Phys. Soc., Lond. **A64**, 311.
	Au^{197*}(*d*,*p*) Q = **4.1**	51H6	B_n = 6.4. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.
199 79 120	0.16γ delayed < 3 x 10$^{-3\,\mu s}$	51W13		W.E.Wright, M.Deutsch, PR **82**, 277.

Hg	σ_a (pile n)	320	osc	51G16	Used σ_a(B) = 710.	B.Grimeland, et al., Compt. Rend. **232**, 2089.
	σ_s coh σ_s bound	22 26.5		51H20	σ_s(potential) re-measured. Conclude J = 1 or 0, E_0 = −2 ev.	C.T.Hibdon, et al., PR **82**, 560.
	σ_t (42 Mev)	4.51		50H71	Used $C^{12}(n,2n)$ detector.	R.H.Hildebrand, C.E.Leith, PR **80**, 842.
	New reference for data reported in			49P24	Hg^{199}.	W.G.Proctor, F.C.Yu, PR **81**, 20.

197 ($_{80}$ $_{117}$) Decay scheme 51H17

γ	τ	α_K	α_L	α_M
0.077	$23^h, 65^h$		2.5	0.7
0.133	23^h	0.5	1.2	0.4
0.164	23^h	4.6	10.4	4
0.191	$23^h, 65^h$	~1.7	~0.3	
0.275	23^h	~0.5	~0.1	
0.402 ?				



O.Huber, et al., HPA **24**, 127.

Au(6.8 Mev p,n). α's from coincidence measurements with sl and scin. e^-e^- coincidences also shown in 7.4^sAu from Au(n,n). Later paper will discuss spins.

198 ($_{80}$ $_{118}$)	Hg(γ,γ)	E_0: 0.411 Mev	Γ: 3×10^{-5} ev	51M7	τ of 0.411γ = ~$10^{-5\,\mu s}$. Recoil energy loss compensated by Doppler energy of moving source.	P.B.Moon, Proc. Phys. Soc., Lond., **A64**, 76.
203 ($_{80}$ $_{123}$)	τ	46.5^d		51L10		W.S.Lyon, PR **82**, 276.
204* ($_{80}$ $_{124}$)	(~1 Mev n,γ)5.5^mHg			49H5	0.88 mb value should be 88 mb.	*Correction to *Table*.

81 THALLIUM Tl

203 ($_{81}$ $_{122}$)	μ	1.5961	I	51S33	$\nu(Tl^{203})/\nu(H^1)$ = 0.57140 ± 0.00004. [$TlC_2H_3O_2$]	R.E.Sheriff, D.Williams, PR **82**, 651.
204 ($_{81}$ $_{123}$)	Tl^{203}* (d,p)	Q = 4.3		51H6	B_n = 6.5. Rel σ. *See Tl^{47}.	J.A.Harvey, PR **81**, 353.
205 ($_{81}$ $_{124}$)	μ	1.6118	I	51S33	$\nu(Tl^{205})/\nu(H^1)$ = 0.57702 ± 0.00003. [$TlC_2H_3O_2$]	See Tl^{203}, 51S33.
206 ($_{81}$ $_{125}$)	β^- No γ	1.51	sl	51A14	Tl(pile n,γ). Allowed β spectrum.	D.E.Alburger, G.Friedlander, PR **82**, 977.
	Tl^{205}*(d,p)	Q = 3.9		51H6	B_n = 6.2. Rel σ. *See Tl^{47}.	See Tl^{204}, 51H6.

(Tl continued on next page)

207* 81 126	τ reference number 40F2	Reference number should read 40F4 not 40F2.	*Correction to *Table*.
208 81 127	γ ~**0.04** s;ce⁻ 51S28	Finds two γ's of ~0.04; one converted in ThC" and one in ThD.	L.Y.Shavtvalov, J.Exp. Theor. Phys. **20**, 684; Guide to Russ. Sci. Lit. **4**, 85.
	γ_x **2.616** $s\pi\sqrt{2}$;pe⁻ 51H12	Compared with 0.4112γ of Au^{198} via γ_L of Tl^{208}.	A.Hedgran, PR **82**, 128.

82 LEAD Pb

Pb	σ_{in}/σ_{el} <**0.5** $E_n = 4.3$ 51M4	Groups in photo plates indicate levels at ~1.3, 3.3.	C.E.Mandeville, C.P.Swann, PR **82**, 344(A).
	σ_t(2 - 6 Mev) **graph** Maximum at 3.2 51S27	D(*d*,*n*) and N(*d*,*n*). High pressure ic detector.	G.H.Stafford, Proc. Phys. Soc., Lond., **A64**, 388.
	σ_t(13.9 Mev) **5.0** 51L1	Indicates small radius for Pb^{208}.	A.H.Lasday, PR **81**, 139.
	σ_t(42 Mev) **4.44** 50H71	Used C^{12}(*n*,2*n*) detector.	R.H.Hildebrand, C.E.Leith, PR **80**, 842.
	σ_t(~100 - 240 Mev) **graph** 51D7	Be(*p*,*n*). Bi-f detector.	J.DeJuren, B.J.Moyer. PR **81**, 919.
207 82 125	Pb^{206}(th *n*,γ) Q = - **6.734** 51K15	Pair spectrometer for γ's.	B.B.Kinsey, et al., PR **82**, 380.
	Levels **0.54,0.88,1.11** Po^{211} α decay 51N2	Other levels inferred from K capture in Bi^{207}, q.v.	H.M.Neuman, I.Perlman, PR **81**, 958.
208 82 126	Pb^{207}(th *n*,γ) Q = - **7.380** 51K15	Pair spectrometer for γ's.	See Pb^{207}, 51K15.
209 82 127	E(disintegration) ~**0.7** 51S40		K.Shure, MIT Progress Report, May 1951 and Thesis.
210 82 128	γ **0.032** cryst 51F3 **0.037** strongest **0.0467**	Bent crystal spectrometer with photoplates. L X-rays of Bi and Pb.	M.Frilley, et al., Compt.Rend. **232**, 50.
	L X-rays 51F4 Relative intensities compared to those from Bi in X-ray tube	Values the same for lines arising from vacancy in same shell; otherwise different.	M.Frilley, et al., Compt. Rend. **232**, 157.

Bi	σ_{in} (4.3 Mev) ~0 51M4	No inelastic groups in photo plates.	C.E.Mandeville, C.P.Swann, PR **82**, 344(A).
	σ_a (0.026 ev) 0.035 51H1		W.W.Havens, Jr., et al., PR **82**, 345(A).
	σ_t (42 Mev) 4.58 50H71	Used $C^{12}(n,2n)$ detector.	R.H.Hildebrand, C.E.Leith. PR **80**, 842.
	New reference for data reported in 50H16	Bi^{209}.	J.A.Harvey, PR **81**, 353.
	New reference for data reported in 50K7	Bi^{210}.	B.B.Kinsey, et al., PR **82**, 380.
	New reference for data reported in 50P5	Bi^{209}.	W.G.Proctor, F.C.Yu, PR **81**, 20.
202 83 119	τ 95^m 51K3 γ No β^+, no α	d 52^mPo. Not produced by Pb^{204}(18 Mev *d*).	D.G.Karraker, D.H.Templeton, PR **81**, 510.
205 83 122	τ 14.5^d 51K3 γ 0.431, 0.527, 0.550, 0.746, 1.84 } s	d 1.5^hPo.	See above.
206 83 123	τ 6.2^d 51A5 K, no β^+ Changes in γ values of 49S34 γ_4 0.341 γ_5 0.396 *	$\gamma\gamma$ coincidences but no delayed coincidences with delay $0.1^{\mu s} - 100^{\mu s}$. No $\tau_\gamma > 1^s$.	D.E.Alburger, G.Friedlander, PR **81**, 523. * Misprint in *Table*.
207 83 124	τ $\sim 50^y$ 51N2 γ 0.565 K/L~9, 1.063 K/L~4.6, 1.46 K/L~2.8, 2.05, 2.20, 2.33, 2.49 } $s\pi\sqrt{2}$; ce$^-$ L X-rays	From Pb(18 Mev *d*). Also d 7.5^h At^{211}. τ determined by comparison with activity of At parent. γ of 0.137 or 0.064 also found, depending on K or L conversion.	H.M.Neuman, I.Perlman, PR **81**, 958.
209 83 126	τ 2.7×10^{17y} 51F10 α 3.15	Bi loaded Ilford plates kept 2 years at 4° C.	H.Faraggi, A.Berthelot, Compt. Rend. **232**, 2093.
210* 83 127 long	α 50N4	Value should be 5.03 not 5.12; latter includes recoil energy.	* Correction to *Supplement 1*.
4.85^{d*}	β^- % 49Z3	β values and %'s should read: β^- 92% 1.080 s 8% 1.165 s	* Correction to *Supplement 1*.
214 83 131	γ $s\pi$; ce$^-$ 51M32		M.Miwa, S.Kageyama, J. Phys. Soc. Japan **5**, 416. * Relative intensity.

E(γ)	I(ce⁻) *	K/L	E(γ)	I(ce⁻) *	K/L
0.606	50	5.6	1.379	1	
0.766	3		1.414	29	6.7
0.933	4		1.761	4.7	6.7
1.120	15	6.7	2.200	0.8	
1.238	3.4	5.9			

Po	New reference for data reported in	50D53	Po^{214}.	G. von Dardel, Arkiv Fysik, **2**, 337.
202 84 118	τ **52**^{m} α **5.59** ic	51K3	Produced by Bi(>70 Mev *p*), Pb(>120 Mev α); chem. p 95^{m}Bi.	D.G.Karraker, D.H.Templeton, PR **81**, 510.
203 84 119	τ **47**^{m} No α's	51K3	Produced by Bi(37 Mev α,4*n*); chem. p 12^{h}Bi, p 52^{h}Pb.	See above.
204 84 120	τ **3.8**^{h} α ~1% **5.37** ic	51K3	p 27^{h}Tl as well as other activities listed in *Table*.	See above.
205 84 121	τ **1.5**^{h} α~0.25% **5.2** ic	51K3	Produced by Pb^{204}(37 Mev α,3*n*); chem. p 14^{d}Bi, 72^{h}Tl.	See above.
210 84 126	γ **0.800** sl;ce^{-} K/L = 3.7	51A5	No other γ with intensity >5% that of 0.800γ.	D.E.Alburger, G.Friedlander, PR **81**, 523. See also Bi^{206}.
	γ (0.773) α = 0.067 Pb K X-rays crit a	51G15	$\gamma/\alpha = 1.8 \times 10^{-5}$. >85% of soft radiation consists of Pb K X-rays.	M.A.Grace, et al., Proc. Phys. Soc., Lond., **A64**, 493.
211 84 127	τ_1 **0.52**^{s} α **7.43** τ_2 **25**^{s} * α **7.17** *	51L2	Excitation functions of both activities from Pb(α,*n*) similar. Both daughters of At^{211}. 25^{s} activity does not grow from 0.52^{s}. *	R.F.Leininger, et al., PR **82**, 334(A) and *verbal report.
	α 0.07% **6.34** ic 0.48% **6.57** ic 0.57% **6.90** ic 98.88% **7.43** ic	51N2	Bi(25 Mev α,2*n*) $At^{211} \rightarrow Po^{211}$. No At^{210} present. [The three low energy α's are found in decay of At^{211}.]	H.M.Neuman, I.Perlman, PR **81**, 958.

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<202 (85)	τ α	43^s 6.50	 1c	51B14	Bi(380 Mev α); chem.	G.W.Barton, Jr., et al., PR 82, 13.
<203 (85)	τ α	1.7^m 6.35	 1c	51B14	Bi(275 Mev α); chem.	See above.
203 ? (85, 118?)	τ α	7^m 6.10	 1c	51B14	Bi(275 Mev α); chem.	See above.
204 (85, 119)	τ K Possible α*	$\sim 25^m$		51B14	Bi(150 Mev α); chem. p $12^h Bi^{204}$. *See At^{205}.	See above.
205 (85, 120)	τ K ? α ?	$\sim 25^m$ 5.90	 1c	51B14	Bi(150 Mev α); chem. p $14^d Bi^{205}$. α belongs to At^{204} or At^{205}.	See above.
206 (85, 121)	τ K	2.6^h		51B14	Bi(110 Mev α); chem. p $9^d Po^{206}$.	See above.
207 (85, 122)	τ K ~90% α ~10%	2.0^h 5.75	 1c	51B14	Bi(75 Mev α); chem. p $5.7^h Po^{207}$. p $52^h Pb^{203}$ (from Bi recoils).	See above.
208 (85, 123)	τ K No α observed	6.3^h		51B14	Bi(55 Mev α); chem. 5.65 α of 49H13 with $\tau < 5.5^h$ may also be present. p $\sim 3^y Po^{208}$ (5.11 α).	See above.
209 (85, 124)	τ K ~95% α ~ 5%	5.5^h 5.65	 1c	51B14	Bi(65 Mev α); chem. p $\sim 200^y Po^{209}$ (4.86 α).	See above.
211 (85, 126)	K 59.1% α 40.9%	 5.89	 1c	51N2	Produced by Bi(25 Mev α,2n). Branching from study of α's from At^{211} and Po^{211}, assuming three short range α's are in Po^{211}, q. v.	H.M.Neuman, I.Perlman, PR 81, 958.

86 RADON Rn

216 86 130	α **8.01** 1c 51M10	Other results as in 49M16.	W.W.Meinke, et al., PR **81**, 782.

87 FRANCIUM Fr

88 RADIUM Ra

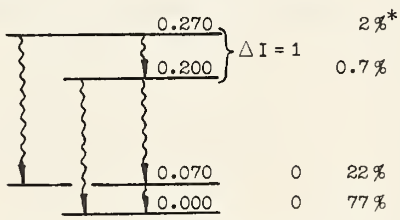
220 88 132	α **7.43** 1c 51M10	Other results as in 49M16.	W.W.Meinke, et al., PR **81**, 782.
221 88 133	τ **30**^{s} 51M10	See above.	See above.

89 ACTINIUM Ac

223 89 134	K ~1% 51M10 α 99% **6.64** 1c	Other results as in 49M16 and 48G5.	W.W.Meinke, et al., PR **81**, 782.

90 THORIUM Th

224 90 134	α **7.13** 1c 51M10	Other results as in 49M16.	W.W.Meinke, et al., PR **81**, 782.
225 90 135	τ **8.0**^{m} 51M10	See above.	See above.
230 90 140	γ **0.0678** sπ; ce^{-} 51R6 L/M = 2, M/N = 2 e^{-} **0.0518** sπ	e^{-}'s of 0.0486, 0.0630, 0.0666 from 0.0678 γ. e^{-} of 0.0518 unassigned.	S.Rosenblum, M.Valadares, Compt. Rend. **232**, 501.
	(0.048 e^{-})/α = 18% 51J8 (0.064 e^{-})/α = 6% L and M e^{-}'s of 0.068 γ ? (0.083 e^{-})/α << 6% K e^{-} of ~0.190 γ ? (Two 0.048 e^{-}'s)/α = 0.3% (0.048 e^{-} and 0.026 e^{-})/α = 0.7% L e^{-} of 0.068 γ and K e^{-} of 0.130 γ ?	Proposed levels in Ra^{226}.	C.J.D.Jarvis, M.A.S.Ross, Proc. Phys. Soc., Lond., **A64**, 535. Detected α's and ce^{-}'s in photoplates impregnated with ionium salt. * Percentage of times level is found in α disintegration.



	(0.051 e^{-})/α = 4.2 % 51P11 (0.067 γ)/α = 0.37% (~0.200γ)/α = 0.07%	αe^{-} coincidences studied with windowless pc. scin for γ's.	C.A.Prohaska, UCRL-1395.
	e^{-}/α = 0.22 51F14	From αe^{-} coincidence measurements with counters.	P.Falk-Vairant, J.Teillac, J. Phys. Rad. **12**, 659.

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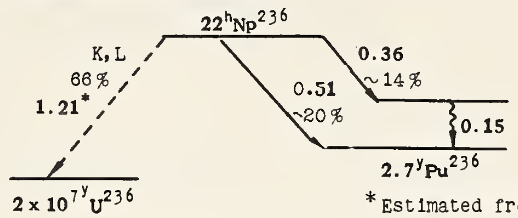
90 THORIUM Th (continued)

Nuclide	Radiation		Energy	Method	Ref.	Remarks	Reference
231 (90 141)	β^-	~40%	~0.100	sl	51S41	UX activity subtracted from spectrum of UY - UX mixture.	P.H.Stoker, et al., Physica **17**, 164.
		~40%	~0.190	sl			
		~20%	0.390	sl			
	γ	0.059	0.082	} sl;ce⁻			
		0.063	0.120 ?	}			
	τ		25.6^h		51J17	Preliminary spectrometer measurements indicate complex β and nine γ's. Estimated E_{dis} = 0.324.	A.H.Jaffey, et al., PR **82**, 498.
	β^-		0.2	a			
	γ		0.035	a			
			~0.070	a			
			⩾0.100	a			
232 (90 142)	α		3.98 ±0.04		51F11	From range of 14.2μ in Ilford half-tone concentrated plates.	H.Faraggi, Ann. Phys., Paris, **6**, 325.
	σ_s coh		12.8		51S20	See H^2, 51S20.	C.G.Shull, E.O.Wollan, PR **81**, 527.
	σ_s bound		12.8				
234 (90 144)	β_1^-	56%	0.192	sπ	50H86	*Based on comparison of areas of ce⁻ lines with β spectra. 0.58 found from γ intensity of 46B12. See also Pa^{234}.	M.Heerschap, et al., Physica **16**, 767.
	β_2^-	44%	0.104	sπ			
	γ		0.090	sπ;ce⁻			
			α_L = 0.19 *				

91 PROTACTINIUM Pa

Nuclide	Radiation		Energy	Method	Ref.	Remarks	Reference
Pa	New reference for data reported in 49S35					Pa^{231}.	G.Scharff-Goldhaber, M.McKeown, PR **82**, 123.
226 (91 135)	τ		1.8^m		51M10	Parent of three α emitters. Assignments from α systematics.	W.W.Meinke, et al., PR **81**, 782.
	α		6.81	ic			
227 (91 136)	τ		38.3^m		51M10	Details of work reported in 49M16 and 48G5.	See above.
	K	15%					
	α	85%	6.46	ic			
228 (91 137)	α	~1.5%	6.09	ic	51M10	Other results as in 49M16 and 48G5.	See above.
		~0.5%	5.85	ic			
231 (91 140)	(0.087 γ)/α = 1.9%				51P11	See Th^{230}, 51P11.	C.A.Prohaska, UCRL-1395.
	(0.300 γ)/α = 23%						
	(0.060 e⁻)/α = 4%						
	(0.200 e⁻)/α = 6.6%						
234 (91 143)	β^-		0.60 ?	sπ	50H86	*Based on comparison of areas of ce⁻ lines with β spectra; 0.44 found from γ intensity of 46B12. Discrepancy will be studied further.	M.Heerschap, et al., Physica **16**, 767.
			1.50	sπ			
			2.32	sπ			
	γ		0.817	sπ;ce⁻			
			α_K = 0.041 *				

U	New reference for data reported in 49S35	U^{234}.	G.Scharff-Goldhaber, M.McKeown, PR **82**, 123.
	σ_c*(0.025 ev) 3.3 σ_s(0.025 ev) 8.2 σ_f(0.025 ev) 3.9 51A12	*σ for n,γ reactions.	Office of Classif. AEC, TID-235; Can. J. Phys. **29**, 203.
228 92 136	α ~80% 6.67 1c 51M10	Other results as in 49M16.	W.W.Meinke, et al., PR **81**, 782.
233 92 141	(0.039 γ)/α = 0.20% (0.080 γ)/α = 0.15% (0.360 γ)/α = 0.19% (0.036 e^-)/α = 6.2% (0.068 e^-)/α = 0.69% (0.260 e^-)/α = 0.28% 51P11	See Th^{230}.	C.A.Prohaska, UCRL-1395.
234 92 142	(0.065 γ)/α = 0.1% (~0.040 e^-)/α = 17% 51P11	See above.	See above.
235 92 143	τ 7.07×10^{8y} ±0.11 51F12	U^{235} enriched to 99.9%. Average specific activity from 5 samples is 4774±42 disintegrations/min. mg.	E.H.Fleming, Jr., et al., PR **82**, 967.
	$N\lambda(U^{235})/N\lambda(U^{234})$ 4.55%±0.21 51S30	Concludes $\tau(U^{235}) \sim 7.07 \times 10^{8y}$.	G.-J.Sayag, Compt. Rend. **232**, 2091.
	α 4.2% 4.20 1c 85.6% 4.40 1c 10.2% 4.58 1c 51G22	Pulse analysis. Highly enriched U^{235}. Possibly another α at 4.47 Mev.	A.Ghiorso, PR **82**, 979.
	σ(th n,γ)U^{236} 100 σ(th n,f) 545 σ_s(th n) 8.2 51A12		See U, 51A12.
236 92 144	τ $\sim 2 \times 10^{7y}$ α 4.5 1c 51G21	U^{235}(slow n). α pulse analysis.	A.Ghiorso, et al., PR **82**, 558.
	τ 2.46×10^{7y} α 4.499 1c 51J9		A.H.Jaffey, et al., AECD-3026 and PR **84**, 785.
237 92 145	$U^{238}(\gamma,n)$ Q = -5.97 51H21		J.R.Huizenga, et al., PR **82**, 651.
238 92 146	σ(th n,γ)23.5^{m}U 2.6 σ_s(th n) 8.2 51A12		See U, 51A12.
239 92 147	$U^{238*}(d,p)$ Q = 2.4 51H6	B_n = 4.6. Rel σ. *See Ti^{47}.	J.A.Harvey, PR **81**, 353.

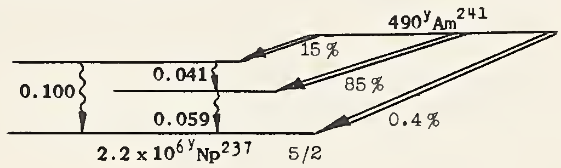
236 93 143	K ~22 % L ~44 % β^- ~14 % 0.36 $s\pi\sqrt{2}$ ~20 % 0.51 $s\pi\sqrt{2}$ γ 0.15 $s\pi\sqrt{2}$; ce$^-$ $\alpha \sim\infty$ K, L X-rays — 5102	Proposed decay scheme: 	D.A.Orth, G.D.O'Kelley, PR **82**, 758. *Estimated from α systematics.

94 PLUTONIUM Pu

Pu	Relative isotopic abundances in pitchblende — 51P13 238 <0.0003 % lc — 241 <1 % ms 239 100 % lc — 242 <0.01 %* 240 <1 % ms — 244 <1 % ms	Pu^{239} identified from ratio of α counts to fission counts. * Looked for 5$^h\beta$ activity after n bombardment.	D.F.Peppard, et al., J. Am. Chem. Soc., **73**, 2529. [See PR **83**, 1267 and **84**, 165.]
238 94 144	σ(th n, f) $\leqslant$20 — 51H8		G.C.Hanna, et al., PR **81**, 893.
239 94 145	Pu^{239}/U^{238} $\geqslant 1.5 \times 10^{-11}$ — 51P13	Belgian Congo pitchblende. Not accounted for by U^{238} spontaneous fission.	See Pu, 51P13.
	Pu^{239}/U^{238} 1.2×10^{-11} — 51L14	Belgian Congo pitchblende.	C.A.Levine, G.T.Seaborg, J. Am. Chem. Soc. **73**, 3278.
	α 5.13 lc — 51C11	Based on E_α(Po) = 5.298 Mev.	M.Conjeaud, V.Naggiar, Compt. Rend. **232**, 499.
	γ 0.05 ppl; ce$^-$ 0.20 ? ce$^-/\alpha$ = 16 % — 51A3	Tracks counted in which α and e$^-$ had common origin.	G.Albouy, J.Teillac, Compt. Rend. **232**, 326.
	γ 10^{-5}* 0.032 pc 3×10^{-5} 0.0372 pc 7×10^{-5} 0.0523 pc 10^{-5} 0.0592 pc L X-rays/$\alpha \simeq$ 4 % — 51W18	*γ intensity/α. Some γ's may be due to fission products not removed in purification.	D.West, J.K.Dawson, Proc. Phys. Soc., Lond., **A64**, 586.
	γ/α = 0.04 % — 51P11	E_γ = 64 - 73 kev.	C.A.Prohaska, UCRL-1395.

95 AMERICIUM Am

241 95 146	σ(pile *n*,γ) **890** σ(pile *n*,γβ) 150^d Cm **570**	51H5	First σ from decrease in Am^{241} α activity on irradiation. Suggest only 16^h Am^{242} formed.	G.C.Hanna, et al., PR **81**, 486.
	σ(th *n*,*f*) **3.0**	51C22		B.B.Cunningham, A.Ghiorso, PR **82**, 558.
	γ_1 **0.059** γ_2 **0.100** Three α groups $e_1^-/\alpha = 49\%$ $\gamma_1/\alpha = 32\%$	51P11	Proposed decay scheme:	C.A.Prohaska, UCRL-1395.



242 95 147 $\sim 400^y$	σ(pile *n*,γ) **5500** σ(pile *n*,*f*) **2500**	51H8	Ion exchange chem.	G.C.Hanna, et al., PR **81**, 893.
243 95 148	σ(pile *n*,*f*) <25 barns	51H8	See above.	See above.

96 CURIUM Cm

242 96 146	γ **0.043** s;ce⁻,scin Two α groups $e^-/\alpha = 37\%$	51P11	Unconverted γ's/α = 10^{-4}. No αγ coincidences. See Th^{230}.	C.A.Prohaska, UCRL-1395.
	σ(th *n*,*f*) ⩽**5**	51H8		G.C.Hanna, et al., PR **81**, 893.

97 BERKELIUM Bk

98 CALIFORNIUM Cf

244 98 146	α **7.15** ic	51G2	U^{238}(120 Mev C, *6n*).	A.Ghiorso, et al., PR **81**, 154.
246 ? 98 148	τ 35^h α **6.75** ic	51G2	U^{238}(120 Mev C, *4n*). Mass from α systematics.	See above.

Fission Yields

L.E.Glendenin, E.P.Steinberg, M.G.Inghram, D.C.Hess, Phys. Rev. **84**, 860; ANL-4659, 4680.	*Zr and Mo from* U^{235}.
O.Kofoed-Hansen, P.Kristensen, K. Danske Vidensk. Selsk. Mat.-fys. Medd. **26**, #6.	*Ratio of yields of* Kr^{89} *and* Kr^{88} *from* U^{235}.
A.Turkevich, J.B.Niday, Phys. Rev. **84**, 52.	*Yield curve for Th(fast n, f).*
A.C.Wahl, N.A.Bonner, AECD-3230.	*Yields in 115 chain from* U^{235}.

Fission Fragments: Ranges and Energies

D.C.Brunton, W.B.Thompson, Can. J. Res. **28A**, 498.	*Energy distribution for* Pu^{239}*(th n, f).*
S.S.Friedland, Phys. Rev. **84**, 75.	*Energy distribution for* U^{235}*(2.5 and 14 Mev n, f).*
R.B.Leachman, Phys. Rev. **83**, 235.	*Velocity distribution for* U^{235}*(th n, f).*
L.Vigneron, Comptes Rend. **231**, 1473 (1950).	*Ranges in emulsion of fragments from U(slow n, f).*
H.Faraggi, Ann. Phys. Paris **6**, 325.	*Ranges in emulsion of fragments from Th(fast n, f).*

Ternary Fission and Long Range α's

K.W.Allen, J.T.Dewan, Phys. Rev. **82**, 527.	*Short range particles from U(slow n, f).*
H.Faraggi, Ann. Phys., Paris **6**, 325.	*Short range particles from Th(fast n, f).*
E.W.Titterton, Phys. Rev. **83**, 673.	*Long range* α*'s from* U^{238} *and* Th^{232}*(2.5 Mev n, f).*
E.W.Titterton, Phys. Rev. **83**, 1076.	Be^{8} *emission from* U^{238} *and* Th^{232}*(2.5 Mev n, f).*
E.W.Titterton, Nature **168**, 590.	*Long range* α*'s and short range particles from U(slow n, f).*

Fission: n's

J.W.Kunstadter, J.J.Floyd, L.B.Borst, G.J.Weremchuk, Phys. Rev. **83**, 235(A).	*Long period delayed n's.*
T.M.Snyder, R.W.Williams, Phys. Rev. **81**, 171.	*Percentage of n's delayed* ($>8 \times 10^{-9}$ *sec*) $= 3.6 \pm 2.8$.
N.Nereson, AECD-3250.	*Prompt n spectrum from* U^{235}*(n, f) from 0.4 to 7 Mev.*
B.E.Watt, AECD-3070.	*Prompt n spectrum from* U^{235}*(n, f) from 3.3 to 17 Mev.*
F.K.Goward, E.J.Jones, H.H.H.Watson, D.J.Lees, Proc. Phys. Soc., Lond., **A64**, 95.	*Mean energy* $= 1.8 \pm 0.5$.

Photofission

R.L.Garwin, Phys. Rev. **82**, 305(A).	*Yield for* Bi^{209}. $E_{\gamma} \leq 71$.
F.K.Goward, E.J.Jones, H.H.H.Watson, D.J.Lees, Proc. Phys. Soc., Lond., **A64**, 95.	*Yield, integrated* σ *for U.* $E_{\gamma} \leq 23$.
J.McElhinney, W.Ogle, Phys. Rev. **81**, 342.	*Yields relative to* U^{238} *for* U^{233}, U^{235}, Pu^{239}, Th^{232}, Th^{230}. $E_{\gamma} \leq 22$.
W.E.Ogle, J.McElhinney, Phys. Rev. **81**, 344.	σ *curve for* U^{238}. $E_{\gamma} \leq 22$.

(Continued on next page)

List of Fission and Spallation Papers - 1951

Fission: Spontaneous

G.C.Hanna, B.G.Harvey, N.Moss, P.R.Tunicliffe, Phys. Rev. **81**, 466.	*Spontaneous fission rate for* Cm^{242}.
E.Segrè, AECD-3149.	*Spontaneous fission rates for 11 nuclei.*

Fission: Miscellaneous and General

S.G.Al-Salam, Phys. Rev. **84**, 254.	*Meson induced fission.*
R.E.Batzel, G.T.Seaborg, Phys. Rev. **82**, 607.	*Fission of medium weight elements.*
H.Bradner, J.K.Bowker, Phys. Rev. **82**, 265.	*Meson production accompanying U fission.*
J.E.Brolley, Jr., D.H.Cooper, W.S.Hall, M.S.Livingston, L.K.Schlacks, Phys. Rev. **83**, 990.	*Short period activities from* U^{235} *fission.*
J.Jungerman, Phys. Rev. **79**, 632 (1950).	*Fission excitation functions for charged particles.*
N.O.Lassen, K. Danske Vidensk. Selsk. Mat.-fys. Medd. **26**, #5 and #12.	*Total charges of fission fragments in gaseous and solid media.*
W.J.Swiatecki, Phys. Rev. **83**, 178.	*Nuclear compressibility and fission.*

Spallation: Reactions, Products, Yields

R.E.Batzel, D.R.Miller, G.T.Seaborg, Phys. Rev. **84**, 671.	*Yields from Cu(340 Mev p, 190 Mev d, 190 Mev* α, *380 Mev* α).
P.E.Hodgson, Phil. Mag. **42**, 207.	Li^8 *from cosmic ray induced nuclear disintegrations.*
L.Marquez, I.Perlman, Phys. Rev. **81**, 953.	*Yields of* Be^7 *from 335 Mev p's.*
N.Sugarman, R.Peters, Phys. Rev. **81**, 951.	*Yields from Bi(*$\leq$ *48 Mev* γ *and* $\leq$*86 Mev* γ).

List of Packing Fraction Differences, Δf

January - July 1951

Doublet	$\Delta f \times 10^4$		Reference
$C^{12}H_4 - O^{16}$	+22.800	±0.014	A.O.Nier, T.R.Roberts, Phys. Rev. **81**, 507.
$C^{12}H_4 - O^{16}$	+22.732	±0.008	H.Ewald, Z. Naturforsch. **6a**, 293.
$C^{12}_2H_4 - C^{12}O^{16}$	+13.016	±0.008	A.O.Nier, T.R.Roberts, Phys. Rev. **81**, 507.
$C^{12}O^{16}_2 - C^{12}S^{32}$	+4.041	±0.006	A.O.Nier, Phys. Rev. **81**, 624.
$C^{12}_3H_8 - C^{12}O^{16}_2$	+16.583	±0.009	" " " " "
$C^{12}_6H_4 - C^{12}S^{32}_2$	+11.487	±0.007	" " " " "
$C^{12}_3H_8 - N^{14}_2O^{16}$	+14.04	±0.02	A.O.Nier, T.R.Roberts, Phys. Rev. **81**, 507.
$C^{12}_4 - S^{32}O^{16}$	+6.913	±0.002	A.O.Nier, Phys. Rev. **81**, 624
$H_2 - D$	+7.751	±0.008	H.Ewald, Z. Naturforsch. **6a**, 293.
$H_2 - D$	+7.760	±0.008	T.R.Roberts, Phys. Rev. **81**, 624.
$D_2 - He^4$	+64.03	±0.02	A.O.Nier, T.R.Roberts, Phys. Rev. **81**, 507.
$D_3 - C^{12}/2$	+70.49	±0.02	H.Ewald, Z. Naturforsch. **6a**, 293.
$He^4 - D_2$	-64.03	±0.02	A.O.Nier, T.R.Roberts, Phys. Rev. **81**, 507.
$C^{12}/2 - D_3$	-70.49	±0.02	H.Ewald, Z. Naturforsch. **6a**, 293.
$N^{14} - C^{12}H_2$	-8.974	±0.007	H.Ewald, Z. Naturforsch. **6a**, 293.
$N^{14} - C^{12}H_2$	-8.990	±0.009	A.O.Nier, T.R.Roberts, Phys. Rev. **81**, 507.
$N^{14}_2 - C^{12}O^{16}$	+4.028	±0.004	" " " " " "
$D_2O^{17} - D_2HO^{16}$	-1.730	±0.007	H.Ewald, Z. Naturforsch. **6a**, 293.
$H_2O^{18} - Ne^{20}$	+11.195	±0.005	" " " " "
$H_2O^{18} - D_2O^{16}$	-4.156	±0.006	" " " " "
$F^{19}H - D_2O^{16}$	-8.455	±0.008	" " " " "
$Ne^{20} - D_2O^{16}$	-15.344	±0.005	H.Ewald, Z. Naturforsch. **6a**, 293.
$Ne^{20} - D_2O^{16}$	-15.36	±0.02	A.O.Nier, T.R.Roberts, Phys. Rev. **81**, 507.
$Ne^{20} - H_2O^{18}$	-11.195	±0.005	H.Ewald, Z. Naturforsch. **6a**, 293.
$Ne^{20} - A^{40}/2$	+5.640	±0.009	A.O.Nier, T.R.Roberts, Phys. Rev. **81**, 507.
$Ne^{21} - D_2HO^{16}$	-17.720	±0.010	H.Ewald, Z. Naturforsch. **6a**, 293.
$Ne^{22} - D_3O^{16}$	-20.849	±0.007	" " " " "
$Si^{28} - C^{12}O^{16}$	-6.434	±0.011	" " " " "

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998169 O - 52 - 8

List of Packing Fraction Differences, Δf

January - July 1951

Doublet	$\Delta f \times 10^4$	Reference
$P^{31}H - O^{16}_2$	−2.578 ±0.009	H.Ewald, Z. Naturforsch. 6a, 293.
$P^{31}H - S^{32}$	+2.970 ±0.006	" " " " "
$P^{31}H_3 - S^{34}$	+8.610 ±0.006	" " " " "
$S^{32} - O^{16}_2$	−5.536 ±0.006	" " " " "
$S^{32} - P^{31}H$	−2.970 ±0.006	" " " " "
$S^{34} - P^{31}H_3$	−8.610 ±0.006	" " " " "
$H_2S^{34} - HCl^{35}$	+1.872 ±0.007	" " " " "
$HCl^{35} - H_2S^{34}$	−1.872 ±0.007	" " " " "
$A^{36}/2 - H_2O^{16}$	−14.83 ±0.02	A.O.Nier, T.R.Roberts, Phys. Rev. 81, 507.
$A^{40} - Ca^{40}$	−0.08 ±0.02	" " " " " "
$A^{40} - C^{12}_3H_4$	−17.219 ±0.009	" " " " " "
$A^{40}/2 - Ne^{20}$	−5.640 ±0.009	" " " " " "
$A^{40}/2 - D_2O^{16}$	−20.984 ±0.009	" " " " " "
$A^{40}/2 - D_2O^{16}$	−20.976 ±0.006	H.Ewald, Z. Naturforsch. 6a, 293.
$Ca^{40} - A^{40}$	+0.08 ±0.02	A.O.Nier, T.R.Roberts, Phys. Rev. 81, 507.
$Ca^{40} - C^{12}_3H_4$	−17.135 ±0.011	" " " " " "
$Ti^{48}/3 - O^{16}$	−7.49 ±0.04	H.E.Duckworth, R.S.Preston, Phys. Rev. 82, 468.
$Ni^{58} - Sn^{116}/2$	−2.76 ±0.02	" " " " " "
$Ni^{60} - Sn^{120}/2$	−3.61 ±0.03	" " " " " "
$Ni^{61} - Sn^{122}/2$	−3.71 ±0.10	" " " " " "
$Ni^{62} - Sn^{124}/2$	−4.23 ±0.05	" " " " " "
$Kr^{82}/2 - C^{12}_3H_5$	−20.22 ±0.03	C.L.Kegley, H.E.Duckworth, Nature 167, 1025.
$Kr^{84}/2 - C^{12}_3H_6$	−21.67 ±0.03	" " " " "
$Kr^{86}/2 - C^{12}_2O^{16}H_3$	−14.80 ±0.04	" " " " "
$Kr^{86}/2 - Xe^{129}/3$	−3.16 ±0.03	" " " " "
$Sr^{86}/2 - C^{12}_3H_7$	−23.48 ±0.06	H.E.Duckworth, R.S.Preston, Phys. Rev. 82, 468.
$Sr^{86}/2 - C^{12}_2O^{16}H_3$	−14.89 ±0.09	" " " " " "
$Sr^{88}/2 - C^{12}O^{16}_2$	−8.41 ±0.04	" " " " " "

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List of Packing Fraction Differences, Δf

January - July 1951

Doublet	$\Delta f \times 10^4$		Reference
$Pd^{104} - Pb^{208}/2$	-8.15	±0.04	H.E.Duckworth, R.S.Preston, Phys. Rev. **82**, 468.
$Sn^{116}/2 - Ni^{58}$	+2.76	±0.02	" " " " " "
$Sn^{117}/3 - C^{12}_3H_3$	-14.17	±0.04	" " " " " "
$Sn^{120}/2 - Ni^{60}$	+3.61	±0.03	" " " " " "
$Sn^{122}/2 - Ni^{61}$	+3.71	±0.10	" " " " " "
$Sn^{124}/2 - Ni^{62}$	+4.23	±0.05	" " " " " "
$Xe^{129}/3 - C^{12}_2O^{16}H_3$	-11.68	±0.03	C.L.Kegley, H.E.Duckworth, Nature **167**, 1025.
$Xe^{129}/3 - C^{12}_3H_7$	-20.15	±0.03	" " " " "
$Xe^{129}/3 - Kr^{86}/2$	+3.16	±0.03	" " " " "
$Xe^{132}/3 - C^{12}_2O^{16}H_4$	-13.08	±0.03	" " " " "
$Xe^{132}/3 - C^{12}O^{16}_2$	-4.91	±0.02	" " " " "
$Mo^{97} - Pt^{194}/2$	-7.78	±0.02	H.E.Duckworth, R.S.Preston, Phys. Rev. **82**, 468.
$Mo^{98} - Pt^{196}/2$	-7.92	±0.03	" " " " " "
$Pt^{194}/2 - Mo^{97}$	+7.78	±0.02	" " " " " "
$Pt^{196}/2 - Mo^{98}$	+7.92	±0.03	" " " " " "
$Pb^{208}/2 - \dot{P}d^{104}$	+8.15	±0.04	" " " " " "

List of Journals, Volumes and Numbers, Surveyed for Supplement 3, January 1951 to July 1951

Journal	*Abbreviation Used*	*Volume Numbers*
Annalen der Physik	Ann. Phys., Lpz.	**8**, Nos. 1 - 4;* **9**, Nos. 1 - 4.
Annales de Physique	Ann. Phys., Paris	**6**, Jan. - June
Arkiv för Fysik	Arkiv Fysik	**2**, Nos. 1 - 6; **3**, No. 1.
Australian Journal of Scientific Research	Australian J. Sci. Res.	**4A**, Nos. 1,2.
Bulletin of the American Physical Society	BAPS	**25**, Nos. 6,7; **26**, Nos. 1,2.
Canadian Journal of Chemistry	Can. J. Chem.	**29**, Nos. 1 - 6.
Canadian Journal of Physics	Can. J. Phys.	**29**, Nos. 1 - 3.
Comptes rendus hebdomadaires des seánces de l'academie des sciences	Compt. Rend.	**232**, Nos. 1 - 26; **233**, No. 1.
Guide to Russian Scientific Periodical Literature	Guide to Russ. Sci. Lit.	**4**, Nos. 1 - 6.
Helvetica Physica Acta	Helv. Phys. Acta HPA**	**23**, Nos. 6,7; **24**, Nos. 1 - 3.
Indian Journal of Physics	Ind. J. Phys.	**24**, Nos. 9 - 12; **25**, Nos. 1,2.
Journal of American Chemical Society	J. Am. Chem. Soc.	**73**, Nos. 1 - 6.
Journal of Chemical Physics	J. Chem. Phys.	**19**, Nos. 1 - 6.
Journal de Chimie Physique	J. de Chim. Phys.	**47**, Nos. 11 - 12; **48**, Nos. 1 - 6.
Journal of the Physical Society of Japan	J. Phys. Soc., Japan	**5**, Nos. 1 - 6; **6**, No. 1.
Journal de physique et le radium	J. Phys. Radium	**11**, No. 12; **12**, Nos. 1 - 6.
Nature	Nature	**166**, Nos. 4231 - 4235; **167**, Nos. 4236 - 4261.
Die Naturwissenschaften	Naturwiss.	**37**, Nos. 23,24; **38**, Nos. 1 - 12.
Nuclear Science Abstracts	NSA	**5**, Nos. 1 - 12.
Nuovo Cimento	Nuovo Cim.	**7**, Nos. 8 - 10; **8**, Nos. 1 - 6.
Philosophical Magazine	Phil. Mag.	**42**, Nos. 324 - 329.
Physica	Physica	**16**, Nos. 10 - 12; **17**, Nos. 1 - 6.
Physical Review	Phys. Rev. PR**	**80**, No. 6; **81**, Nos. 1 - 6; **82**, Nos. 1 - 6.
Physics Abstracts	Phys. Abst.	**54**, Nos. 637 - 642.
Proceedings of the Cambridge Philosophical Society	Proc. Camb. Phil. Soc.	**47**, Nos. 1,2.
Proceedings of the Physical Society	Proc. Phys. Soc., Lond.	**A63**, No. 372; **A64**, Nos. 373 - 378.
Proceedings of the Royal Society of London	Proc. Roy. Soc.	**A204**, Nos. 1077 - 1079; **A205**, Nos. 1080 - 1083; **A206**, Nos. 1084 - 1087; **A207**, Nos. 1088 - 1089.
Zeitschrift für Naturforschung	Z. Naturforsch.	**5a**, Nos. 10 - 12; **6a**, Nos. 1 - 6.
Zeitschrift für Physik	Z. Phys.	**128**, Nos. 3 - 5.

* All numbers are inclusive.

** These abbreviations are used in the body of the supplement

Additions to Old References

Supplement 3

The following is a list of better references for data already reported in either the *Table*, *Supplement 1* or *Supplement 2*. It is recommended that the new reference be written into the appropriate reference list under the old key number.

Reference Key Used Previously	New Reference
1949	
49B12	G. W. Barton, Jr., A. Ghiorso, I. Perlman, Phys. Rev. **82**, 13.
49B48	S. Bashkin, F. P. Mooring, B. Petree, Phys. Rev. **82**, 378.
49C25	E. Cotton, Ann. Phys., Paris, **6**, 481.
49G24	J. R. Gum, M. L. Pool, Phys. Rev. **80**, 315.
49K11	D. G. Karraker, D. H. Templeton, Phys. Rev. **81**, 510.
49P24	W. G. Proctor, F. C. Yu, Phys. Rev. **81**, 20.
49S2	L. M. Silver, Can. J. Phys. **29**, 59.
49S12	C. G. Shull, E. O. Wollan, Phys. Rev. **81**, 527.
49S35	G. Scharff-Goldhaber, M. McKeown, Phys. Rev. **82**, 123.
49T9	J. M. Mays, C. H. Townes, Phys. Rev. **81**, 940.
1950	
50B7	F. D. S. Butement, Proc. Phys. Soc., Lond., **A64**, 395.
50B67	I. Bergström, Nature **167**, 634.
50D53	G. von Dardel, Arkiv Fysik **2**, 237.
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