SUPPLEMENT 1 to NBS CIRCULAR 499

Nuclear Data

UNITED STATES DEPARTMENT OF COMMERCE

NATIONAL BUREAU OF STANDARDS

NUCLEAR DATA

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NUCLEAR DATA

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

Compiled by
National Bureau of Standards Nuclear Data Group
Katharine Way, Marion Wood, Karin Thew
With the Help of Abstracts Prepared by Special Readers

[Issued April 25, 1951]

Supplement 1 (January to July 1950) to
National Bureau of Standards Circular 499

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The Bureau group, as before, owes a great deal to Bureau colleagues for their help and encouragement. They were assisted in particular by Millicent Scott Norloff and Lilla Fano, who worked on this supplement in its early stages and who are now with other Bureau groups.

Contents

EXPLANATION OF SUPPLEMENT I

1. General Organization

The new data presented in Supplement I to *National Bureau of Standards Circular 499* are arranged in a way which will make possible easy incorporation into the big *Nuclear Data Table*. The printed pages are punched on the right hand side so that, if they are inserted between pages of the *Table*, the new information will be on a left hand page. It will thus lie just opposite the data of the *Table* which were printed on right hand pages only. Comparisons of new and old data without page turning will thus be possible in many cases. Unfortunately it was not possible, for reasons of economy, to spread the new material out so that there would be a one-to-one correspondence between the old and new pages. Those who make frequent use of the data may want to cut up the supplement and paste appropriate pieces on the blank pages opposite the pertinent pages of the big *Table*.

The new data are arranged in four columns. The first column on the left identifies the nucleus about which new information is given. In the style of the main *Table* the mass number is set in heavy type at the top, the charge number at the lower left, and the neutron number at the lower right. In cases of isomerism the half-life of the isomer in question is given just underneath the charge and neutron numbers. Since the half-life used in this column is for purposes of identification, the value given is the one which was placed first in the big *Table*. New (and possibly better) values of the half-life are listed in the second or data column.

In addition to new information about half-life values, the second column contains new data on radiations, moments, cross sections, etc. in the tabular style of *Circular 499*. A few new policies and categories of material covered are noted in the next section. Corrections to the main *Table* are indicated where errors have been noticed and data published in previous years which were unintentionally omitted have been included.

The third column has been used for comments, details of methods of production, or arguments for mass assignments. All statements in this column are condensations of comments by experimenters with the exception of obvious cross reference guides and sentences in parentheses (   ). These last have been used occasionally to indicate remarks by the compilers to call attention to similarities, discrepancies, etc.

The fourth column contains the name of the senior author of the paper abstracted, the journal, volume, and page number. The year is given with the reference key (e.g. 50B7) in the second column. The references, with names of all authors, have all been collected in a list at the end of the table. Just preceding this list will be found a summary of the journals covered for this supplement. The intention was to survey all journals whose dates lay between January 1st and July 1st, 1950, but delay in receiving some of the foreign periodicals made it impossible to do this exactly.

In some cases data already listed in *Circular 499* from reports or other advance information were presented in more detailed form during the six month's period covered. To deal with such cases most economically a list was made of Additions to Old References which gives the old reference key used in the *Table* for the data in question followed by the newer and better reference.

2. Special Details

New Classes of Information Included. Several new types of data not tabulated in the main *Table* have been included in this supplement and will be reported in the later supplements, namely:

1. Nuclear scattering lengths
2. Packing fractions and mass differences
3. Notes on isotope shifts
4. Ranges of α particles in photographic emulsions
5. Information on nuclear reactions in the light elements, $Z \leqslant 20$

The last category is by far the largest. The data which come under it were omitted in *Circular 499* because of the compilation of W. F. Hornyak, T. Lauritsen, P. Morrison, and W. A. Fowler entitled *Energy Levels of Light Nuclei, III* and that of D. E. Alburger and E. M. Hafner on

Nuclear Energy Levels, Z-11 to 20, both of which appeared in the Reviews of Modern Physics for October 1950. This present supplement contains new data on light element nuclear reactions which appeared before July 1st and which were not included in the above compilations. It can therefore be used as a supplement to these excellent reviews. Some additional remarks on the low Z elements are made in the next two paragraphs.

Light Element Reactions. An attempt was made to follow the order and style of the compilation of Hornyak, et al., as much as possible. Studies of reactions leading to information about a product nucleus through Q values or γ-rays have been reported under the product in question. For instance, a study of the γ-rays accompanying the reaction Be^9-α-n is listed under C^{12}. Studies of reactions leading to information about the intermediate, compound nucleus are listed under the compound nucleus. The reaction in such cases is written with four members in order to make a differentiation, e.g. the notation C^{12}-d-p-C^{13} indicates that information about N^{14} is being given. In the compilation of Hornyak, et al., cross sections are listed under the compound nucleus. The attempt to follow these compilers in this respect led to some difficulty since *Nuclear Data* gave neutron cross sections under the target nucleus. The rather unhappy compromise was decided upon of listing neutron cross sections in the previous manner and following Hornyak, et al., for charged particle cross sections.

Use of Mass Number as Superscript. In the main *Table*, a mass number as a superscript in listing reactions, e.g. Sb^{123}-n-γ, was used exclusively to denote the use of enriched material by the experimenter. In light particle reactions, however, a number of cases turn up in which the experimenter is fairly sure of the reacting isotope because of the energetics of the reaction or because of starting with a monoisotopic or nearly monoisotopic substance. In such cases it seemed to make the applications clearer if the superscript were used and accordingly this was done, e.g. N^{15}-p-α, Na^{23}-d-p, C^{12}-p-pn.

Methods for Measuring γ Energies. In the main *Table* the measurement of γ-ray energies by means of a spectrometer through photo or Compton electrons was indicated by "s". If the experimenter definitely stated that energies of conversion electrons were measured, the designation was "sc". It now seems desirable to distinguish between different types of spectrometers and to state explicitly, where possible, whether measurements were made by means of conversion, photo, or Compton electrons. Accordingly the abbreviations "sl", "sπ", and "s$\pi\sqrt{2}$" have been adopted to denote lens, semicircular, and double focusing spectrometers respectively, and the abbreviations "ce^-", "pe^-", and "Compt" to indicate conversion, photo, or Compton electrons.

Spin and Parity Assignments. It was the policy in the big *Table* to put spins on the disintegration schemes only when they had been measured directly. In the supplement, where only one paper is reported at a time, it seemed helpful and unambiguous to indicate the author's estimates of the spins and parities of the various levels.

Levels. An attempt was made in the main *Table* to record in the box for a given nucleus all the information about the levels of that nucleus which could be derived from the γ-rays accompanying the disintegration of any of its parents. In order to save space in the supplement, data on γ-rays have been listed only once, under the parent nuclei. It was felt that users of the *Table* would be warned of the existence of level information through the existing cross references and could easily make revisions of numbers where necessary.

Magnetic Moments. The policy in listing values of magnetic moments was to report them in such a way that they would be comparable with the values compiled by H. L. Poss which were used in the main *Table*. Poss calculated all magnetic moments without diamagnetic correction and took the value of the proton moment to be 2.7934 nuclear magnetons. In cases where frequencies have not been compared directly to the H^1 frequency, the following intermediate values have been used in calculating the μ values listed:

$\nu(Na^{23})/\nu(H^1) = 0.26450$ 49B7
$\nu(D^2)/\nu(H^1) = 0.307013$ 47B29
$\nu(B^{11})/\nu(H^1) = 0.320827$ 49A12

The observed frequency ratios are given in all cases.

Methods of Production. An innovation in reporting reactions has been to give the lowest stated energy of the bombarding particle which produced the reaction. This has been placed just in front of the symbol for the incident particle. For instance Dy-10 Mev p-n means that the reaction Dy-p-n was found to take place with 10 Mev protons. It does not imply that a search was made for the threshold, merely that this was the lowest (possibly the only) energy used by the experimenter which led to the reaction in question.

Fission and Spallation. As in *Circular 499* information about fission and spallation processes has been omitted. This type of information includes identification of special products, yields of products, reaction cross sections, etc. It is planned to give a year's list of papers on such subjects in the next supplement.

3. New Abbreviations

b	coefficient in angular correlation function, $1 + b\cos^2\theta$.
Beγn	measurement of γ-ray energy by observation of photo neutrons in Be. The neutron binding energy has been taken to be 1.67 Mev.
ce^-	conversion electron
Compt	Compton electron
Dγp, Dγn	measurement of γ-ray energy by observation of photo protons or photo neutrons in D. The deuteron binding energy has been taken to be 2.23 Mev.

f	packing fraction in units of 10^{-4} mass units
f	nuclear scattering length. Where possibility of confusion with the packing fraction occurs, a special note is made.
f	fission in abbreviations for methods of production or detection, such as Bi-f
Λ	order of transition. $\Lambda = 1$ for electric dipole, 2 for electric quadrupole or magnetic dipole, etc.
ΔM	mass difference in mass units
μ	micron, 10^{-4} cm
pe^-	photo electron
sl	lens spectrometer
$s\pi$	180° spectrometer
$s\pi\sqrt{2}$	double focusing spectrometer
σ_{el}	elastic scattering cross section in barns
σ_s free	scattering cross section for free atom in barns. σ_s free = $[A^2/(A+1)^2]\sigma_s$ bound
σ_{in}	inelastic scattering cross section in barns. The energy loss is indicated.

Alphabetical Index to Elements

(continued on next page)

Alphabetical Index to Elements - continued

I HYDROGEN H

H	σ_s coh **1.76** f=-3.75±0.03x10^{-13} cm	50H3	From reflection at critical angle from liquid mirror.	D.J.Hughes, et al., PR **77**, 291.
	σ_t(0.22-0.60 Mev) graph* σ_t(1.90-4.05 Mev) graph**	50B15	*C-d-n and **D-d-n sources. Paraffin and H_2O scatterers.	E.Bretscher, E.B.Martin, HPA **23**, 15.
	σ_t(95 Mev) **0.073**	50D1	Be-190 Mev d-n. Bi-f detector.	J.DeJuren, N.Knable, PR **77**, 606.
	σ_t(163 Mev) **0.047**	50T9	Be-171 Mev p-n. Triple coincidence pc telescope.	A.E.Taylor, et al., Nature **165**, 967.
1 1 0	μ Corrections to table	49G11 49T1	Factor of 10^{-3} omitted from values given in Bohr magnetons.	
2 1 1	I **1** I μ **0.857606** I	50L6	$\nu(H^2)/\nu(H^1)$ (D_2O;H_2O) = 0.1535059 ± 0.0000007.	E.C.Levinthal, PR **78**, 204.
	μ **0.857615*** I **0.857611**** I	50L12	*$\nu(H^2)/\nu(H^1)$ (D_2O; paraffin oil) = 0.15350733 ± 0.00000025. **$\nu(H^2)/\nu(H^1)$ (D_2O;H_2O) = 0.15350669 ± 0.00000025.	G.Lindström, PR **78**, 817.
	q **0.00277**	50N3	Used data of 40K10; re-calculated $\frac{\partial^2 V}{\partial z^2}$.	G.F.Newell, PR **78**, 711 and **77**, 141.
	σ_t(0.26-3.8 Mev) table for D_2O	50B15	C-d-n and D-d-n sources.	See H.
	σ_t(95 Mev) **0.104**	50D1	Be-190 Mev d-n. Bi-f detector	J.DeJuren, N.Knable, PR **77**, 606.
	σ(2.65 Mev t,n)He^4 **0.41**	50A18	t's from Li-n-α.	E.Almquist, Can. J. Res. **28A**, 433.
3 1 2	β^- composite spectrum	50C14	Combined results of 49B22, 49C8, 49G7, 49H1 show allowed shape.	E.P.Cooper, F.T.Rogers, Jr., PR **77**, 402.
	D-d-p Q=**3.96**	50I2	Based on Q=7.16 for Be-d-α.	D.R.Inglis, PR **78**, 104.

2 HELIUM He

4 2 2	H^3-p-γ yield Level: 21.6	50A8	Level from Breit-Wigner fit of yield data. Asymmetric γ's with $E_\gamma > 17.5$.	H.V.Argo, et al., PR **78**, 691.
	$\Delta M(D_2-He^4)=256.04x10^{-4}$MU	50E5	Correction for small inhomogeniety in magnetic field.	H.Ewald, Z. Naturforsch. **5a**, 1.

3 LITHIUM Li

Li	σ(2.65 Mev t,n)	**1.5**		50A18	t's from Li-n-α.	E.Almquist, Can. J. Res. **28A**, 433.
	Relative isotopic abundances 6 **7.43%** 7 **92.57%**			50H23	Abundances in LiI^+.	R.F.Hibbs, Y-604.
8 3 5	Be^9-γ-p σ threshold ~ 18*			50T4	*Bethe's masses give 16.86. $E_\gamma \leq$ 24 Mev.	E.W.Titterton, Nature **165**, 721.

4 BERYLLIUM Be

7 4 3	$[\lambda(BeF_2)-\lambda(Be)]/\lambda(Be)=-1.7x10^{-3}$			49L26		R.F.Leininger, et al., PR **76**, 897.
	$[\lambda(BeF_2)-\lambda(Be)]/\lambda(Be)=-1.0x10^{-2}$			49B62		P.Benoist, et al., PR **76**, 1000.
8 4 4	Be^9-γ-p Broad level in Be^8: ~ 3			50T4	Histogram of α pair energies. Broad max. between 3 and 4 Mev.	E.W.Titterton, Nature **165**, 721.
9 4 5	σ_t (95 Mev)	**0.396**		50D1	Be-190 Mev d-n. Bi-f detector.	J.DeJuren, N.Knable, PR **77**, 606.
	Be^9-p-p Level: 2.39			50R14		E.H.Rhoderick, Proc. Roy. Soc. **A201**, 348.
10 4 6	β^-	**0.54**	**scin**	50B5	Enriched sample.	P.R.Bell, J.M.Cassidy, PR **77**, 301.
	Be^9-d-p Q=**4.68**			50I2	Based on Q=7.16 for Be-d-α.	D.R.Inglis, PR **78**, 104.

5 BORON B

B	$\sigma_a(296°)/\sigma_a(476°)=1.27$			49R14	Indicates 1/v absorber.	W.Ramm, Z. Naturforsch. **4a**, 245.
10 5 5	I	**3**	**Mic**	50W3	q coupling of $H_3B^{10}CO$ = 3.4 Mc/sec.	M.T.Weiss, et al., PR **78**, 202.

6 CARBON C

C	σ_t (1-100 ev)	**4.8**		50S29	Fast chopper.	W.Selove, et al., ANL-4397.
	σ_t (20 kev) (1.4 Mev)	**4.8** **2.4**		50M19	Li-p-n. Monotonic decrease found from 20 kev-1.4 Mev.	D.W.Miller, PR **78**, 806.
	σ_t (0.22-4.05 Mev)	table		50B15	C-d-n and D-d-n sources.	E.Bretscher, E.B.Martin, HPA **23**, 15.
	σ_t (0.6-2.0 Mev) (2.5-4.9 Mev)	graph graph		50F7	Li-p-n. Monotonic decrease. D-d-n. Three maxima.	G.Freier, et al., PR **78**, 508.
	σ_{in} (2.5 Mev)	< **0.006**		50B6	D-d-n. γ's looked for.	L.E.Beghian, et al., PR **77**, 286.
	σ_t (95 Mev) σ_{in}	**0.498** **0.22**		50D1	Be-190 Mev d-n. Bi-f detector. σ_{in} from poor geometry experiment.	J.DeJuren, N.Knable, PR **77**, 606.
	σ_t (153 Mev)	**0.330**		50T9	Be-171 Mev p-n. Triple coincidence pc telescope.	A.E.Taylor, et al., Nature **165**, 967.

(C continued on next page)

6 CARBON C (continued)

11 6 5	C^{12}-p-d?		50L15	Particle group of ~ 10 Mev observed. If d's, threshold = 16.7. E_p = 31.5.	C.Levinthal, et al., PR **78**, 199.
	C^{12}-p-pn threshold = 18.5±0.3	σ, f	50A14	E_p = 0-350 Mev. σ has peak of 82 mb at ~ 50 Mev.	L.Aamodt, et al., UCRL-526.
12 6 6	Be^9-α-n Max in E_n: 1.2?,3.2,4.8,7.7		50W11	Consistent with levels in C^{12} at 2.5, 4.5, 7.1. Po α's.	B.G.Whitmore, W.B.Baker, PR **78**, 799.
	Be^9-α-n γ's: 4.40,7.2 (faint)		50P8	NaI scin pair spectrometer. No γ, 2-4 Mev. Po α's.	R.W.Pringle, et al., PR **78**, 627.
	C^{12}-p-p		50R14	No inelastic scattering for E_p = 4.73. Cellophane target.	E.H.Rhoderick, Proc. Roy. Soc., **A201**, 348.
	N^{15}-p-α	Q=**4.96**	50F12	α's compared to ThC α of range 4.796 cm.	J.M.Freeman, Proc. Phys. Soc., Lond., **A63**, 668.
13 6 7	Relative isotopic abundance	**1.124 ± 0.005%**	50B14	From ratio 44/45, with highly purified CO_2.	E.W.Becker, W.Vogell, Z.Naturforsch. **5a**, 174.
14 6 8	τ	'**6360**^{y} "**5513**	50M10	'With CO_2-CS_2 filled G-M counter. "With CO_2-CH_4 filled pc counter.	W.W.Miller, et al., PR **77**, 714.
15 6 9	τ β^-	**2.4**^{s} **8.8** a	50H10	Produced by C^{14}-2.8 Mev d-p. Delayed γ ?	E.L.Hudspeth, et al., PR **77**, 736.

7 NITROGEN N

N	σ_t (95 Mev)	**0.570**	50D1	Be-190 Mev d-n. Bi-f detector.	J.DeJuren, N.Knable, PR **77**, 606.
	σ_a (th n's)	**0.1**	50K6	Intensity of capture γ's compared to intensity in Be.	B.B.Kinsey, et al., PR **77**, 723.
13 7 6	C^{12}-p-pn-C^{11}	σ, f	50A14	See C^{11}.	L.Aamodt, et al., UCRL-526.
14 7 7	μ	**0.40368** I	50P6	$\nu(N^{14})/\nu(D^2)$ (HNO_3) = 0.47070 ± 0.00005.	W.G.Proctor, F.C.Yu, PR **77**, 716.
	$\bar{\sigma}$(fast n, 2n)10^mN for E_n > 10.7	**1.9mb**	50W12	Li-0.5 Mev d-n. E_n (max)=13.8.	H.Wäffler, HPA **23**, 239.
	C^{12}-d-p-C^{13}		50G11	p yield averaged over angle for Q >-2.2. E_d = 14.	H.E.Gove, et al., MIT Progress Report, April 1950.
15 7 8	Relative isotopic abundance N^{15}/N^{14} studied		50Y1	High ratio in radioactive minerals increases with age.	H.Yagoda, W.C.White, PR **78**, 330(A).
	μ	**-0.28301** I	50P6	$\nu(N^{15})/\nu(D^2)$ (NH_4OH) = 0.66004 ± 0.00004.	W.G.Proctor, F.C.Yu, PR **77**, 716.
	O^{18}-p-α	Q=**3.97**	50F12	α's compared to ThC α of range 4.796 cm.	J.M.Freeman, Proc. Phys. Soc., Lond., **A63**, 668.

8 OXYGEN O

0	σ_t(0.26-0.65 Mev) 'graph 50B15 σ_t(2.0-3.8 Mev) "graph	'C-d-n and "D-d-n sources. H_2O and D_2O scatters used.	E.Bretscher, E.B.Martin, HPA **23**, 15.
	σ_t(0.5-1.80 Mev) 'graph 50F7 σ_t(2.5-4.8 Mev) "graph	'Li-p-n and "D-d-n sources. Resonances at 1.04,1.33,3.5 ?, 4.4.	G.Freier, et al., PR **78**, 508.
	σ_t(95 Mev) **0.663** 50D1	Be-190 Mev d-n. Bi-f detector.	J.DeJuren, N.Knable, PR **77**, 606.
16 8 8	O^{16}-p-p 50R14	No inelastic scattering for E_p= 4.73. Cellophane target.	E.H.Rhoderick, Proc. Roy. Soc. **A201**, 348.
	F^{19}-p-α 50F12 Q=**8.06**	E_p= 0.840. α energies relative to α's of Li-p-α (Q=17.28).	J.M.Freeman, Proc. Phys. Soc., Lond., **A63**, 668.
	F^{19}-p-α 50S16 Q=**8.068, 1.969**	α energies relative to Po α as standard.	E.N.Strait, et al., PR **78**, 337(A).
17 8 9	F^{19}-d-α 50F13 Q=**6.79,6.03,5.26,2.81** Ground state Q not studied	Reaction distinguished from F-d-n-Ne^{20}→ O^{16} + α reaction by observing ΔE_α with ΔE_d.	A.P.French, et al., Proc. Phys. Soc., Lond., **A63**, 667.
18 8 10	Relative isotopic abundance 50B14 **0.206 ± 0.003%**	Measured with very pure CO_2. Took account of all rare molecules.	E.W.Becker, W.Vogell, Z. Naturforsch. **5a**, 174.

9 FLUORINE F

19 9 10	$\bar{\sigma}$(fast n,2n)1.87^{h}F **0.0104** 50W12 for E_n > 10.4	Li-0.5 Mev d-n. E_n(max)=13.8.	H.Wäffler, HPA **23**, 239.
	σ_{in} (2.5 Mev) **0.62** 50B6 F-n-n Level: 1.3	σ_{in} from intensity of 1.3 Mev γ's (coincidence counters) and absolute n intensity (p recoil ic).	L.E.Beghian, et al., PR **77**, 286.
20 9 11	β^- **5.03** s 50J4 γ_1 **1.64** s,a γ_2 **2.45** a γ_1/γ_2=8 $\beta\gamma$ coincidences* $\gamma\gamma$ coincidences**	*5.03 β^- linked with γ. **Due to bremsstrahlung ? No lower energy γ with intensity ~ that of 1.64 γ.	J.V.Jelley, Proc. Phys. Soc., Lond., **A63**, 538.
	F^{19}-d-p 50N8 Levels: 1.08, 252*,329*, 3.93*	*These levels may belong to to O^{16}-d-p reaction.	Y.A.Nemilov, L.I.Gedeonov, Doklady Akad. Nauk, SSSR **70**, 219; NSA **4**, #3525.
	F^{19}-d-p 50S2 Q=**4.36,3.70,3.32,3.06,2.33** Levels: 0.66,1.04,1.30,2.03	No p groups from Q=4.4-6.4 with rel. int. > 0.05.	E.N.Strait, et al., MIT Prog. Rep., Jan. 1950.
	F^{19}-n-γ 50K8 Q=**6.63**	From capture γ energies.	B.B.Kinsey, et al., PR **78**, 481.

10 NEON Ne

20 10 10	F^{19}-d-n 50F13 Level: 9.7 for α emission	Reaction distinguished from F^{19}-d-α reaction. See O^{17}.	A.P.French, et al., Proc. Phys. Soc., Lond., **A63**, 667.
	Na^{23}-p-α 50F12 Q=**2.35**	E_p= 0.590. Magnetic analyzer calibrated with known α's.	J.M.Freeman, Proc. Phys. Soc., Lond., **A63**, 668.
21 10 11	Ne^{20}-n-α 50S25 Resonances at E_n=2.47,2.96,3.4?	E_n= 2.2-3.4.	C.P.Sikkema, Nature **165**, 1016.
23 10 13	τ **40.2**^{s} 50B28 β 7% **1.18** sπ 93% **4.21** sπ γ ~ **2.8** a 50P9	Produced by Ne^{22}-d-p. Ne^{22} enriched to 96%.	50B28: H.Brown, V.Perez-Mendez PR **78**, 812; 50P9: V.Perez-Mendez, H. Brown, PR **78**, 812.

11 SODIUM Na

Na	Neutron scattering resonance 50H9 E_0 σ_0 Γ **3000**ev **550** ~ **170**ev	From values obtained conclude I=2.	C.T.Hibdon, et al., PR **77**, 730.
21 11 10	Ne^{20}-p-γ 47B18 Resonance at E_p=1.165	This resonance is accompanied by the 20^{s}Na period.	K.J.Broström, et al., Nature **160**, 498.
22 11 11	β^{+} **0.542** s 50M6	Fermi plot linear to 0.025.	P.Macklin, et al., PR **78**, 318(A)
	No $\beta\gamma$ angular correlation 50S21		D.T.Stevenson, M.Deutsch, PR **78**, 640(A).
	Ne^{21}-p-γ 47B18 Resonance at E_p=0.765		K.J.Broström, et al., Nature **160**, 498.
23 11 12	$\bar{\sigma}$(fast n,p)40.7^{s}Ne for E_n > **1** 50J3 '**0.080** "**0.036** '"**0.001** $\bar{\sigma}$(fast n,α) 12^{s}F for E_n > **1** '**0.119** "**0.095** '"**0.011**	'Li-0.75 Mev d-n. "B-0.75 Mev d-n. '"Be-0.75 Mev d-n. Thick sample, corrected. n flux measured by U^{238} fission; BF_3 and H filled ic.	J.V.Jelley, E.B.Paul, Proc. Phys. Soc., Lond., **A63**, 112.
	Ne^{22}-p-γ 47B18 ~ 20 resonance peaks for E_p=0.5-1.5		K.J.Broström, et al., Nature **160**, 498.
24 11 13	τ **15.1**^{h} 50C23	Ion exchange chemistry.	J.W.Cobble, private communication, June 1950.
	γ **2.755** sl;ce^{-} 50W2	Compared with Co^{60} 1.332 γ.	J.L.Wolfson, PR **78**, 177.
	Crossover γ not found 50B20 < 5x10^{-5} photons/disintegration	Consistent with assumption that 2.76 γ is emitted first.	G.R.Bishop, et al., PR **77**, 416.
	No $\beta\gamma$ angular correlation 50A15		R.A.Allen, H.Halban, Nature **164**, 538.
	Na^{23}-d-p 50N8 Levels: 0.71, 1.67	Protons detected by photo plate after traversing Al wedge.	Y.A.Nemilov, L.I.Gedeonov, Doklady Akad. Nauk, SSSR **70**, 219, and NSA **4**, #3525.
	Na^{23}-d-p 50W6 Q=**4.77,4.23,3.45,2.94,2.22,** **1.33,0.96,0.78,0.50,0.12**	E_d= 2.0,2.5,3.0. Protons observed with pc. Ranges measured in air and Al.	W.D.Whitehead, N.P.Heydenburg, PR **78**, 338(A).

12 MAGNESIUM Mg

Mg	σ_{in}(2.5 Mev) **1.0** Mg-n-n Level: 1.35	50B6	σ_{in} from intensity of 1.35 Mev γ's (coincidence counters) and absolute n intensity (p recoil ic).	L.E.Beghian, et al., PR **77**, 268.
	Mg-p-p Levels: 1.36, 1.82	50R14	σ for 1.36 level ~ 0.8 assuming isotropy.	E.H.Rhoderick, Proc. Roy. Soc. **A201**, 348.
24 12 12	Na^{23}-d-n Q=**9.23,8.40,7.99,7.57,5.07,1.53,0.59** Levels: 0.83,1.24,1.66,4.16,7.70,8.64	49M56	E_d=1.4. Recoil p's detected by Ilford C_2 plates.	C.E.Mandeville, PR **76**, 436.
	Al^{27}-p-α Q=**1.58**	50F12	E_p=0.940. Magnetic analyzer calibrated with known α's.	J.M.Freeman, Proc. Phys. Soc., Lond., **A63**, 668.
25 12 13	Al^{27}-d-α Q=**6.62,6.04,5.68,5.08,4.75** Levels: 0.58,0.94,1.54,1.87	50F14	E_d=0.93. Ionization chamber with air absorption cell.	A.P.French, P.B.Treacy, Proc. Phys. Soc., Lond., **A63**, 665.

13 ALUMINUM Al

Al	σ_t (84 Mev) **1.14** σ_{el} (84 Mev) **0.65** σ_{in} (84 Mev) **0.49**	50B11	Be-190 Mev d-n. C-n-2n detection. σ_{el} from angular integration. σ_{in} from poor geometry experiment.	A.Bratenahl, et al., PR **77**, 597.
	σ_t (95 Mev) **0.99** σ_{in} (95 Mev) **0.42**	50D1	Be-190 Mev d-n. Bi-f detector. σ_{in} from poor geometry exp.	J.DeJuren, N.Knable, PR **77**, 606.
25 13 12	Mg^{24}-p-γ Resonances at E_p=0.222, 0.417	50G1	Separated isotopes. β^+ detection with G-M counter.	T.Grotdal, et al., PR **77**, 296.
26 13 13	Mg^{25}-d-n Q=**5.58,3.58,1.95,0.45**	50S17	E_d=1.47. Ilford C_2 plates. Levels: 2.00,3.63,5.13.	C.P.Swann, et al., PR **78**, 338(A).
27 13 14	σ(fast n,γ)2.3^mAl **1-6mb** Resonances observed	50H21	Li-p-n. E_n=0.15-0.70.	R.L.Henkel, H.H.Barschall, PR **79**, 218(A).
	Mg^{26}-d-n Q to ground state = **5.68**	50S30	E_d=1.43. Ilford C_2 plates. Levels: 0.88,1.92,2.75,3.65, 4.33,5.32,5.81.	C.P.Swann, C.E.Mandeville, PR **79**, 240(A).
	Al^{27}-p-p Spectrum of scattered p's continuous	50L5	E_p=30.4. Photo plate detection.	C.Levinthal, et al., PR **78**, 199.
	Al^{27}-p-p Levels: 0.80?, 0.97, 2.15	50R14	E_p=4.57. σ for 0.97 level ~ 0.12 assuming isotropy.	E.H.Rhoderick, Proc. Roy. Soc. **A201**, 348.
28 13 15	Al^{27}-n-γ Q=**7.72**	50K8	From capture γ energies. γ to ground state predominant.	B.B.Kinsey, et al., PR **78**, 481.
	Al^{27}-d-p Q=**5.72,4.71,4.35,4.07,3.49, 3.05,2.69,2.39,2.08,1.59, 0.94,0.70,0.40,0.04.**	50W6	E_d=3.0. Protons observed with argon filled pc. Ranges measured in air and Al.	W.D.Whitehead, N.P.Heydenburg, PR **78**, 338(A).

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14 SILICON Si

29 14 15	Si-n-γ Q=8.38	50K8	From capture γ energies.	B.B.Kinsey, et al., PR **78**, 481.
30 14 16	Al^{27}-α-p Q=2.4,0.0,-1.3,-2.6	50L10	pγ coincidence measurements.	H.H.Landon, PR **78**, 338(A).
	Si-n-γ Q=11.00	50K8	From capture γ energies.	B.B.Kinsey, et al., PR **78**, 481.

15 PHOSPHORUS P

32 15 17	β^- 1.718 sl Bump at ~ H_ρ=1000	50A1	β shape constant over 5 half lives. No correction gives linear plot.	H.M.Agnew, PR **77**, 655.

16 SULPHUR S

S	σ_t(15-750 kev) Nine maxima observed	50P12		R.E.Peterson, et al., PR **79**, 218(A).
	σ_{in}(2.5 Mev) 0.44 S-n-n Level: 2.35	50B6	σ_{in} from intensity of 2.35 Mev γ's (coincidence counters) and absolute n intensity (p recoil ic).	L.E.Beghian, et al., PR **77**, 286.
	Relative isotopic abundances 32 95.00% 34 4.24 % 33 0.74% 36 0.017%	50H23		R.F.Hibbs, Y-604.
	32 95.018% 34 4.215% 33 0.750% 36 0.017%	50M17	Meteoritic values. Constant for 10 different samples.	J.Macnamara, H.G.Thode, PR **78**, 307.
	Marked variation in terrestrial S^{32}/S^{34} ratio	49T20		H.G.Thode, et al., Can. J. Res. **27B**, 361.
	No variation in S abundances in 4 meteoritic and 4 terrestrial samples	49T21		A.Trofimov, Doklady Akad. Nauk, SSSR **66**, 181; NSA **4**, #734.
33 16 17	S-n-γ Q=8.66	50K8	From capture γ energies. Assignment doubtful.	B.B.Kinsey, et al., PR **78**, 481.
35 16 19	Fermi plot linear down to 6 kev	50G9	Used electrostatic spectrograph for low energies.	L.Gross, D.R.Hamilton, PR **78**, 318(A).
	β^- 0.167 sπ Fermi plot linear down to 4 kev	50L4		L.M.Langer, et al., PR **77**, 798.

Cl	$\sigma_a(296°)/\sigma_a(476°)$=1.26			49R14	Indicates 1/v absorber.	W.Ramm, Z. Naturforsch. **4a**, 245.
	Neutron scattering resonance $E_o \sim$ **73ev**			50H25		C.T.Hibdon, C.O.Muehlhause, PR **79**, 219(A).
	σ_t(95 Mev)	**1.28**		50D1	Be-190 Mev d-n. Bi-f detector.	J.DeJuren, N.Knable PR **77**, 606.
	q coupling ratios					
	$TlCl^{35}/TlCl^{37}$	**1.27**	M	50Z3	Magnetic resonance.	H.Zeiger, et al., PR **78**, 340(A).
	RCl^{35}/RCl^{37}	**1.266**		50D9	From resonances found with polycrystalline dichlorethylene in oscillator coil.	H.G.Dehmelt, H.Krüger, Naturwiss, **37**, 111.
	FCl^{35}/FCl^{37}	**1.270**	Mic	49G25		D.A.Gilbert, et al., PR **76**, 1723.
	$M(Cl^{35})/M(Cl^{37})$ = **0.945978 ± 0.000004**		Mic	49G25	Agrees well with mass ratio of Townes, et al., PR **73**, 1334 (1948).	See above.
$^{36}_{17}$ $_{19}$	Cl-n-γ	Q=**8.56**		50K8	From capture γ energies. γ to ground state weak.	B.B.Kinsey, et al., PR **78**, 481.
$^{37}_{17}$ $_{20}$	μ	**0.6833**	**I**	50P6	$\nu(Cl^{35})/\nu(Cl^{37})$ (HCl) = 1.2014 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **77**, 716.
$^{38}_{17}$ $_{21}$	Cl-n-γ	Q=**6.11**		50K8	From capture γ energies. γ to ground state weak.	B.B.Kinsey, et al., PR **78**, 481.
	τ	**37.3^m**		50C23	Ion exchange chemistry.	J.W.Cobble, private communication, June 1950.

18 ARGON A

36 18 18	σ(th n,γ)34.1^{d}A	6	50M5	2.6 kev X-rays counted in pc after decay of 1.78^{h}A. (σ corrected for abundance of A^{36} of 0.337%.)	G.E.McMurtrie, D.P.Crawford, PR **77**, 840.
37 18 19	A^{36}-d-p Q=6.49,5.05,3.93,2.95,2.09,1.86, 1.42,0.64		50Z2	Enrichment of 96% compared to 26% of 49D29. E_p measured with pc.	A.Zucker, W.W.Watson, PR **79**, 241.
40 18 22	f=-6.19±0.02 ΔM(Ca^{40}-A^{40})=3.2±0.8x10^{-4} MU		50R11	From Δf(C_3H_4-A^{40}).	T.R.Roberts, A.O.Nier, PR **79**, 198(A).

19 POTASSIUM K

39 19 20	$\bar{\sigma}$(fast n,2n)7.5^{m}K for $E_n > 13.2$	~ 0.009	50W12	Li-0.5 Mev d-n. E_n(max)=13.8.	H.Wäffler, HPA **23**, 239.
39, 41 19 20,22	$g_I(K^{39})/g_I(K^{41})$=1.8218 $\Delta\nu(K^{39})/\Delta\nu(K^{41})$=1.81768		50O1	From h.f.s. studies of J=1/2, Δm_I=±1, Δm_J=0 transition.	S.A.Ochs, et al., PR **78**, 184.
40 19 21	β's /sec(gram of K)=30.5 E_γ /sec(gram of K)= 4.5		50S13	$\tau_\beta=13.2x10^{8y}$. Internal Na standard.	F.W.Spiers, Nature **165**, 356.
	β's /sec(gram of K)=31 γ's /sec(gram of K)= 3.6		50F9	Counters immersed in KCl solution. Na calibration.	W.R.Faust, PR **78**, 624.
	β^-	1.36 s	50A7	K^{40} enriched to 7.13%; thin source. Spectral shape unallowed.	D.E.Alburger, PR **78**, 629.
	$\tau_K=114x10^{8y}$		50G19	From measurement of ratio of A to K in several minerals.	E.K.Gerling, et al., Doklady Akad. Nauk, SSSR **68**, 553; NSA **4**,#1824.
	K-n-γ	Q=7.76	50K8	From capture γ energies. γ to ground state weak.	B.B.Kinsey, et al., PR **78**, 481.
41 19 22	A^{40}-d-n Q=6.0,4.6,2.9,1.6 Levels 1.4,3.1,4.4		50W7	E_n measured by coincidence absorption of p recoils.	D.C.Worth, PR **78**, 378.
42 19 23	K-n-γ	Q=7.39	50K8	From capture γ energies. γ to ground state weak.	B.B.Kinsey, et al., PR **78**, 481.

20 CALCIUM Ca

40 20 20	$\sigma_s$coh f* =0.49x10^{-12} cm	3.0	50S24	Neutron diffraction studies. * Nuclear scattering length.	C.G.Shull, et al., ORNL-694, 34.
	f** =-6.11 ΔM(Ca^{40}-A^{40})=3.2x10^{-4} MU		50R11	From Δf(C_3H_4-Ca^{40}). ** Packing fraction.	T.R.Roberts, A.O.Nier, PR **79**, 198(A).
44 20 24	$\sigma_s$coh f* =0.18x10^{-12} cm	0.4	50S24	Neutron diffraction studies. * Nuclear scattering length.	See Ca^{40}.

21 SCANDIUM Sc

Sc	Relative isotopic abundances 50L3 41 < **0.001 %** 46 < **0.002%** 42,43,48,49 < **0.0002%** 44 < **0.0005%** 47 < **0.01 %**	Ms with electron multiplier for high sensitivity. Oxygen isotopes interfere with measurements of 46 and 47.	W.T.Leland, PR **77**, 634.
44 21 23 2.44^d	τ **2.4^d** 50B52 γ **0.271** $s\pi; ce^-, pe^-$	Produced by K^{41}-17 Mev α-n, chem.	J.A.Bruner, L.M.Langer, PR **79**, 606. These results supersede those of J.A.Bruner, L.M.Langer, PR **79**, 236(A). 50B35.
3.96^h	τ **4.0^h** 50B52 β^+ **1.463** $s\pi$ γ **1.16** $s\pi; ce^-, pe^-$ $\beta^+/\gamma \sim 1/2$	$\beta\gamma$ coincidence rate indicates one β^+. 2^{nd} β^+ of 50B35 now attributed to Sc^{43}. Fermi plot of 1.463 β^+ straight.	
45 21 24	μ **4.7494** I 50P5	$\nu(Sc^{45})/\nu(Na^{23})$ (Sc_2O_3) $= 0.9183 \pm 0.0001$.	W.G.Proctor, F.C.Yu, PR **78**, 471.
	μ **4.7504** I 50H15	$\nu(Sc^{45})/\nu(H^1)$ $(ScCl_3)$ $= 0.242939 \pm 0.000003$	D.M.Hunten, PR **78**, 806.
	$\bar{\sigma}$(fast n,2n)2.4^d and $3.9^h Sc^{44}$ 50W12 for $E_n > 9.2$ **0.039**	Li-0.5 Mev d-n. E_n(max)=13.8.	H.Wäffler, HPA **23**, 239.
46 21 25	$\gamma\gamma$ polarization direction correlation observed 50M18	Results indicate two successive electric quadrupole transitions.	F.Metzger, M.Deutsch, PR **78**, 551.
	$\gamma\gamma$ angular correlation **scin** 50N5 No $\beta\gamma$ angular correlation	b=0.13±0.04 indicating I=4,2,0	T.B.Novey, PR **78**, 66.
	$\gamma\gamma$ delayed coincidences 50N7 $\tau = 13^{\mu s}$	No delay found with Co^{60}.	B.D.Nag, et al., Nature **164**, 1001.

22 TITANIUM Ti

45 22 23	Ti-γ-n 50O2 threshold=13.3	From comparison with Cu^{63} threshold of 10.85 Mev.	W.E.Ogle, R.E.England, PR **78**, 63.
46 22 24	$\bar{\sigma}$(fast n,2n)3.08^hTi **0.053** 50W12 for $E_n > 10$	Li-0.5 Mev d-n. E_n(max)=13.8.	H.Wäffler, HPA **23**, 239.

23 VANADIUM V

V	Neutron scattering resonance 50H25 E_o σ_o Γ $\sim$ **2700ev** $\sim$ **420** $\sim$ **780ev**	Resonance scattering integral = 192 b. From Breit-Wigner formula, σ_s=5.0, $\sigma_s$coh=0.03.	M.Hamermesh, C.O.Muehlhause, PR **78**, 175.
50 23 27	Relative isotopic abundance 0.28% 50H23		R.F.Hibbs, Y-604.
52 23 29	V-n-γ Q=**7.30** 50K8	From capture γ energies. γ to ground state weak.	B.R.Kinsey, et al., **78**, 481.

24 CHROMIUM Cr

49 24 25	Cr-γ-n threshold=13.4	5002	From comparison with Cu^{63} threshold of 10.85 Mev.	W.E.Ogle, R.E.England, PR **78**, 63.
50 24 26	f=-7.96	50D5	From $\Delta f(C_2H-Cr^{50})=14.30$ and $f(C_2H)=6.336$.	H.E.Duckworth, et al., PR **78**, 479.
52 24 28	f=-8.25	50D5	From $\Delta f(C_2H_2-Cr^{52})=17.47$ and $f(C_2H_2)=9.218$.	See above.
55 24 31	No 2^h activity observed	50M20	Reaction: Mn-16 Mev n-p, chem. If $\tau \sim 2^h$, $\sigma < 5x10^{-5}$. If $\sigma > 10^{-2}$, $\tau < 15^m$ or $> 100^d$.	D.R.Miller, PR **78**, 808.
	No 2^h activity observed	50N2	Reaction: Cr^{54}-d-p and Fe^{58}-n-α.	M.E.Nelson, M.L.Pool, PR **77**, 682.

25 MANGANESE Mn

Mn	σ_s coh $>$ **1.9** σ_s bound **1.87** σ_s free **1.80** σ_a (0.025ev) **13.5**	50B12	σ's from analysis of graphs for σ_t. $\sigma_t=1.80+2.14/E^{\frac{1}{2}}$; $E_n=10^{-2}-10ev$. $\sigma_t=2.14/E^{\frac{1}{2}}$; $E_n=(2-4)x10^{-3}ev$. Scattering length negative. See Ni.	P.J.Bendt, I.W.Ruderman, PR **77**, 575.
	$\sigma_a(296°)/\sigma_a(476°)=1.27$	49R14	Indicates 1/v absorber.	W.Ramm, Z. Naturforsch. **4a**, 245.
	E_o $\sim$ **3000ev**	50H9	Mn, Na resonances overlap.	C.T.Hibdon, et al., PR **77**, 730.
51 25 26	τ **44.3^m** p 26^dCr	50B32	Produced by Cr-d-n.	W.H.Burgus, J.W.Kennedy, J. Chem. Phys. **18**, 97.
54 25 29	Produced by Fe-pile n's ?	50A4	Found in spectroscopically pure Fe after Oak Ridge irradiation	T.Alper, L.duPreez, Nature **165**, 689.
55 25 30	μ **3.4622** I	50P6	$\nu(Mn^{55})/\nu(Na^{23})$ $(LiMnO_4)$ $= 0.9372 \pm 0.0001$.	W.G.Proctor, F.C.Yu, PR **77**, 716.
	μ **3.4656** I	50C7	$\nu(Mn^{55})/\nu(H^1)$ $[Ca(MnO_4)_2]$ $= 0.24813 \pm 0.00014$	W.H.Chambers, et al., PR **78**, 640(A).
	σ_t E_n Scatterer **3.47** 7.7ev Hf^{even} **3.41** 10.0 Sm^{152} **3.38** $\sim$15 W^{186} **6.17** 115 Co^{59} $\sim$**17** 480 Zn^{67} **4.15** 2400 Cr^{53} **3.55** $\sim$3500 Na^{23}	50M28	σ_t measured for neutrons selected by resonance scatterers.	C.O.Muehlhause, AECU-659; NSA **4**, #1515.

(Mn continued on next page)

25 MANGANESE Mn (continued)

56 25 31	τ 2.586^h γ 0.1% 2.7 Dγp 0.2% 3.0 Dγp	50B20		G.R.Bishop, et al., PR **77**, 416.
	Mn-d-p Q=5.01,3.47,3.13,2.85,0.48,0.13,-0.19	50W6		W.D.Whitehead, N.P.Heydenburg, PR **78**, 338(A).
	Mn-n-γ Q=7.25	50K8	From capture γ energies. γ to ground state predominant.	B.B.Kinsey, et al., PR **78**, 481.
57 25 32	No activity	50N2	From Fe^{57}-fast n and Cr^{54}-20 Mev α.	M.E.Nelson, M.L.Pool, PR **77**, 682.

26 IRON Fe

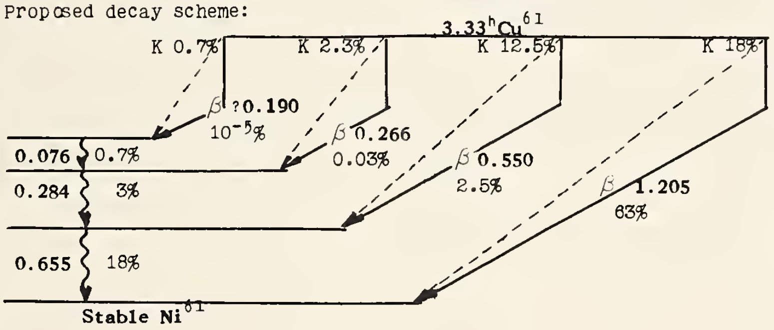
Fe	$\sigma_a(296°)/\sigma_a(476°)=1.27$	49R14	Indicates 1/v absorber.	W.Ramm, Z. Naturforsch. **4a**, 245.
53 26 27	β^+ 2.8 a γ ? weak if present	50N2	Produced by Cr^{50}-20 Mev α-n.	M.E.Nelson, M.L.Pool, PR **77**, 682.
54 26 28	f=-8.03	50D5	From $\Delta f(C_2H_3-Fe^{54})=19.91$ and $f(C_2H_3)=11.887$.	H.E.Duckworth, et al., PR **78**, 479.
55 26 29	Fe^{54}-d-p Q=7.1	50H13		J.A.Harvey, PR **78**, 345(A).
	$Fe^{54?}$-n-γ Q=9.28	50K8	Assigned to Fe^{54}. Natural Fe used.	B.B.Kinsey, et al., PR **78**, 481.
56 26 30	f=-8.52	50D8	From $\Delta f(Si^{28}-Fe^{56})=3.32$ and $f(Si^{28})=-5.20$.	H.E.Duckworth, et al., PR **78**, 386 and **78**, 330(A).
	$\bar{\sigma}$(fast n,p)2.6^{h}Mn ′0.094 for E_n > 6 ″0.072	50W12	′Li-0.5 Mev d-n. E_n(max)=13.8. ″B -0.5 Mev d-n. E_n(max)=13. Barrier=6.8.	H.Wäffler, HPA **23**, 239.
57 26 31	Fe^{56}-d-p Q=5.4	50H13		See Fe^{55}.
	$Fe^{56?}$-n-γ Q=7.63	50K8	Assigned to Fe^{56}. Natural Fe used.	See Fe^{55}.

Co	σ_s coh 1.0	50S24	Neutron diffraction studies. Reflected n's highly polarized.	C.G.Shull, et al., ORNL-694,34.
	$\sigma(296°)/\sigma(476°)=1.27$	49R14	Indicates 1/v absorber.	W.Ramm, Z. Naturforsch. **4a**, 245.
58 27 31 9.3^h	τ 8.8^h γ 0.025 sl;ce$^-$ K/L=1.9 For Mn-17 Mev α reaction: $\sigma(\alpha,n)8.8^h\mathrm{Co}/\sigma(\alpha,n)72^d\mathrm{Co}=1.7$	50S22	8.8^h and 72^d isomers produced by: Mn-17 Mev α, Ni-18 Mev d, Ni-fast n, Co-18 Mev d, Co-fast n; chem.	K.Strauch, UCRL-659; PR **79**, 487.
72^d	γ 0.805 sl;ce$^-$ $\alpha_K=2.5\times10^{-4}$	50S22		See above.
59 27 32	μ 4.6397 I	50P6	$\nu(\mathrm{Co}^{59})/\nu(\mathrm{Na}^{23})$ $[K_3Co(CN)_6]$ $= 0.89709 \pm 0.00009$ High μ puts odd p in $f_{7/2}$ orbit.	W.G.Proctor, F.C.Yu, PR **77**, 716.
60 27 33 10.7^m	γ 0.0589 sπ,ce$^-$ K/L=3.5	50C10	Relative intensities from photographic plate.	R.L.Caldwell, ANL-4408 and PR **78**, 407.
5.2^y	τ $5.1^y\pm0.1$	50B39		A.R.Brosi and B.H.Ketelle, private communication.
	γ_2 1.175 sl;ce$^-$ γ_3 1.332 sl;ce$^-$	49A16		D.E.Alburger, PR **76**, 435.
	β_2 0.319 sl γ_2 $\alpha=1.73\times10^{-4}$ γ_3 $\alpha=1.29\times10^{-4}$	50W9	Theoretical values of Rose for α_K's for electric quadrupole are 1.55×10^{-4} and 1.18×10^{-4} respectively.	M.A.Waggoner, et al., PR **78**, 295 and **79**, 236(A).
	γ_2 1.174 sl;ce$^-$ $\alpha=2.32\times10^{-4}$ γ_3 1.338 sl;ce$^-$ $\alpha=1.83\times10^{-4}$	50D2	See above.	M.Deutsch, K.Siegbahn, Arkiv för Fysik **2**, 9 and PR **77**, 680.
	No $\beta\gamma$ angular correlation	50A15		R.A.Allen, H.Halban, Nature **164**, 538.
	No $\beta\gamma$ angular correlation	50S21		D.T.Stevenson, M.Deutsch, PR **78**, 640.
	No $\beta\gamma$ angular correlation	50N5		T.B.Novey, PR **78**, 66.
	No parity change in I=4,2,0 levels	50W10	$\gamma\gamma$ polarization direction correlation.	A.H.Williams, M.L.Wiedenbeck, PR **78**, 822.
	No parity change in I=4,2,0 levels	50M18	$\gamma\gamma$ polarization direction correlation.	F.Metzger, M.Deutsch, PR **78**, 551.
	No delayed $\beta\beta$, $\beta\gamma$, $\gamma\gamma$ coincidences,$(0.005-1)^{\mu s}$	50D6		M.Deutsch, W.E.Wright, PR **77**, 139.
	Co-d-p Q=5.19,4.80,4.38,3.91,3.46,3.02,2.39	50B40		W.O.Bateson, E.Pollard, PR **79**, 241(A).
	Co-n-γ Q=7.73	50K8	From capture γ energies. γ to ground state weak.	B.B.Kinsey, et al., PR **78**, 481.

Ni	σ_s coh f=1.03x10^{-12} cm*	13.5		50S24	Neutron diffraction studies. *Nuclear scattering amplitude.	C.G.Shull, et al., ORNL-694, 34.
	σ_s coh σ_s bound σ_s free σ_a (0.025ev)	> 13.9 18.0 17.4 5.0		50B12	From analysis of graphs for σ_t σ_t=17.4+0.79/E$^{\frac{1}{2}}$, E$_n$>0.08ev σ_t= 4.1+0.79/E$^{\frac{1}{2}}$, E$_n$=0.002-0.005ev.	P.J.Bendt, I.W.Ruderman, PR **77**, 575.
57 28 29	τ β^+ 50% γ e$^-$ 1% of β^+ Co K X-ray	36.4^h 0.845 1.9 0.114	 sl a,scin,γn sl pc	50F10	Produced by Fe-30 Mev α; chem. 2 γ's in cascade, but not following β^+. Only part of hard γ's in coincidence with β^+. β^+/K X-ray=1.0.	G.Friedlander, et al., BNL-51 (S-5), 46.
58 28 30	σ_s coh f=1.48x10^{-12} cm*	27.6		50S24	Neutron diffraction studies. *Nuclear scattering amplitude.	C.G.Shull, et al., ORNL-694, 34.
	f=-8.09			50D8	From Δf(Si^{29}-Ni^{58})=3.07 and f(Si^{29})=-5.02.	H.E.Duckworth, et al., PR **78**, 386.
59 28 31	Ni^{58}-d-p	Q=6.8		50H13	Value is for ground state.	J.A.Harvey, PR **78**, 345(A).
	Ni-n-γ	Q=9.01		50K8	From capture γ energies. γ to ground state predominant.	B.B.Kinsey, et al., PR **78**, 481.
59,63 28 31,35	γ 100%* 17%* 17%* 17%*	8 kev 15 kev 38 kev 80 kev > 500 kev	a a a a a	50T5	Produced by Ni-n-γ, chem. Continuous β spectrum not found. *Relative to 8 kev γ.	D.G.Thomas, J.D.Kurbatov, PR **77**, 151.
60 28 32	σ_s coh f=0.28x10^{-12} cm*	0.97		50S24	Neutron diffraction studies. *Nuclear scattering amplitude.	C.G.Shull et al., ORNL-694, 34.
	f=-8.54			50D8	From Δf(Si^{30}-Ni^{60})=2.90 and f(Si^{30})=-5.64.	H.E.Duckworth, et al., PR **78**, 386.
61 28 33	Ni-n-γ	Q=8.55		50K8	From capture γ energies. γ to ground state predominant.	B.B.Kinsey, et al., PR **78**, 481.
62 28 34	σ_s coh f=-0.85x10^{-12} cm*	9.1		50S24	Neutron diffraction studies. *Nuclear scattering amplitude.	C.G.Shull, et al., ORNL-694, 34.

Cu	$\sigma_a(296°)/\sigma_a(476°)=1.28$	49R14	Indicates 1/v absorber.	W.Ramm, Z. Naturforsch. 4a, 245.
	σ_s coh >6.6 σ_s bound 8.5 σ_s free 8.2 σ_a (0.025ev) 3.4 f positive (from Cu-Ni alloy)	50B12	σ's from analysis of graphs for σ_t. $\sigma_t=8.2+0.54/E^{\frac{1}{2}}$; E_n=0.06-10 ev. $\sigma_t=1.9+0.54/E^{\frac{1}{2}}$; E_n=0.002-0.004 ev.	P.J.Bendt, I.W.Ruderman, PR 77, 575.
	σ_t (84 Mev) 2.15 σ_{el} (84 Mev) 1.37 σ_{in} (84 Mev) 0.83	50B11	Be-190 Mev d-n. C-n-2n detector. σ_{el} from angular integration, σ_{in} from poor geometry experiment.	A.Bratenahl, et al., PR 77, 597.
	σ_t (95 Mev) 2.00 σ_{in} (95 Mev) 0.78	50D1	Be-190 Mev d-n. Bi-f detector. σ_{in} from poor geom. experiment.	J.DeJuren, N.Knable, PR 77, 606.
61 29 32	K X-rays/β^+=0.38±0.08	50B34	Previous result of 0.55 (49B16) now corrected to 0.45±0.06.	R.Bouchez, et al, J. de phys. et rad. 11, 105.
	γ 5%* 0.070 sπ,sl;ce^- K/L =10 7%* 0.279 sl;pe^- 12%* 0.652 sl;pe^- No harder γ	50B4	Produced by Ni-p-n, chem. *% of β^+ from comparison with annihilation γ. α_K for 0.07γ assumed to be 0.10.	F.Boehm, et al. PR 77, 295.
	β^+ 4% 0.550 sπ 96% 1.205 sπ γ 0.93%* 0.076 sπ;ce^- 4.5%* 0.284 sπ;ce^-,pe^- 25%* 0.655 sπ;ce^-,pe^-	50O3	Produced by Ni-d-n, 2n; chem. Sources of ~ 10^{-2} mg/cm^2. *% of β^+. K capture %'s calculated for allowed transitions. Decay scheme gives K/β^+=0.55.	G.E.Owen, et al., PR 78, 686.

Proposed decay scheme:



	Negligible amount of Cu^{64} found in Cu^{61} made from Ni-d.	50C5	From study of Auger electrons.	C.S.Cook, C.H.Chang, PR 78, 171.
62 29 33	Cu^{63}-γ-n threshold = 10.8	50M11	N^{14} and F^{19} γ-n thresholds taken as 10.54 and 10.40.	J.McElhinney, W.E.Ogle, PR 78, 63.
	Cu^{63}-n-2n f,σ threshold = 11.2	50F5	D-10.5 Mev d-n. Angle varied.	J.L.Fowler, J.M.Slye, Jr. PR 77, 787.

(Cu continued on next page)

63 29 34	q	**-0.26±0.10**	49B61	Recalculated from data of 36S7 and 48P11.	P.Brix, Z. Phys. **126**, 725.
	Cu-p-p No inelastically scattered p's		50R14	Intensity of any inelastic <0.01 of elastic group. E_p=4.73	E.H.Rhoderick, Proc. Roy. Soc. **A201**, 348.
	σ(14 Mev n,2n)9.9^{m}Cu	**0.33**	50F5	σ for β^+ activity only. Graph.	See Cu^{62}.
	$\bar{\sigma}$(fast n,2n)9.9^{m}Cu for E_n > 10.9	'**0.314** "**0.360**	50W12	'Li-0.5 Mev d-n. E_n(max)=13.8. "B -0.5 Mev d-n. E_n(max)=13.	H.Wäffler, HPA **23**, 239.
	$\bar{\sigma}(\gamma,n)$9.9^{m}Cu	**~ 1** Mev b	49H44	E_γ < 335 Mev. 1/E spectrum and effective E_γ of 20 Mev assumed.	A.C.Helmholz, K.Strauch, PR **78**, 86(A).
64 29 35	β^- and β^+ Fermi plots straight down to ~ 50 and ~ 100 kev, resp.		49L24	Sources 5 and 75 μg/cm^2.	L.M.Langer, et al., PR **76**, 1725.
	β^- and β^+ Fermi plots straight down to < 50 kev		4906	Source ~ 10^{-4} μg/cm^2.	G.E.Owen, et al., PR **76**, 1726.
	$(K+\beta^+)/\beta^-$ =1.62±0.11		50R12	From ms study of products.	J.H.Reynolds, PR **79**, 243(A).
	Cu-n-γ	**Q=7.91**	50K8	From capture γ energies. γ to ground state predominant.	B.B.Kinsey, et al., PR **78**, 481.
65 29 36	q	**-0.15±0.10**	49B61	See Cu^{63}.	See Cu^{63}.
	Cu-p-p No inelastically scattered p's		50R14	See Cu^{63}.	See Cu^{63}.
	f=-7.87		50D5	From previous $\Delta f(Pt^{195}-Cu^{65})$ and new $\Delta f(C_3H_3-Pt^{195})$.	H.E.Duckworth, et al., PR **78**, 479.
	$\bar{\sigma}$(fast n,p)2.65^{h}Ni for E_n > 6	**0.029**	50W12	Li-0.5 Mev d-n. E_n(max)=13.8. Threshold=1.31, barrier=7.2.	H.Wäffler, HPA **23**, 239.
67 29 38	τ β^- γ/β ~ 1	**58.5^h** **0.54 a**	50K5	Produced by Ni^{64}-20 Mev α-p and Zn^{67}-fast n-p; chem.	D.N.Kundu, M.L.Pool, PR **78**, 488.

30 ZINC Zn

Zn	Isotope shifts of Zn^{66} and Zn^{68} relative to Zn^{64} have sense predicted by specific mass effect. 50C24		M.F.Crawford, et al., Can. J. Res. **28A**, 138.
64 30 34	$\bar{\sigma}$(fast n,2n)38^{m}Zn '0.190 50W12 for E$_n$ > 11.8 "0.072	'L1-0.5 Mev d-n. E$_n$(max)=13.8 "B- 0.5 Mev d-n. E$_n$(max)=13.	H.Wäffler, HPA **23**, 239.
65 30 35	β^+ 0.325 sl 49M57 γ 1.114 sl;pe$^-$,ce$^-$,Compt weak 1.38 sl;Compt	Weak γ at 0.17 or 0.08 depending on K or L origin in U. Weak γ's due to impurities?	K.C.Mann, et al., PR **76**, 1719.
	γ 0.210 50C15 $\alpha\sim$0.1 e$^-$ 0.200	$\beta^+\gamma$, β^+e$^-$ coincidences. (Note Cu-p-n threshold of 2.16 of 48S33.)	R.A.Cohn, J.D.Kurbatov, PR **78**, 318(A).
66 30 36	$\bar{\sigma}$(fast n,p)4.34^{m}Cu '0.062 50W12 for E$_n$ > 6 "0.058	'L1-0.5 Mev d-n. E$_n$(max)=13.8 "B- 0.5 Mev d-n. E$_n$(max)=13. Barrier = 7.3.	H.Wäffler, HPA **23**, 239.

31 GALLIUM Ga

Ga	E$_0$ $\sigma_0\Gamma^2$ 50L14 100 ev Possibly double 278 ev ~9,000	σ_t=7.3+0.35/E$^{\frac{1}{2}}$. E$_n$=0.05-5 ev.	M.Levin, et al., CUD-47.
66 31 35	β^+ 1.7% 0.40 sπ 50M24 6.9% 0.88 sπ 4.3% 1.4 sπ 87% 4.14 sπ γ strong 1.03 sπ;pe$^-$,Compt 2.75 sπ:pe$^-$,Compt 4.8 sπ;pe$^-$,Compt	Produced by Cu-α-n. No 4.14 β^+, 1.03 γ coincidences. If in cascade, τ of 1.03 γ > 1$^{\mu s}$. 4.14 β has allowed shape.	R.D.Moffat, L.M.Langer, PR **79**, 237(A).
69,71 31 38,40	Discrepancies between μ(I) and μ(M) removed by correcting latter, assuming charge and μ spread over nuclear volume 50B37	μ(I):48P9. μ(M):48B17.	G.J.Béné, et al., PR **78**, 66.
	Discrepancies between μ(I) and μ(M) confirmed to be about 0.7%. Correction of 50B37 inapplicable 50K10	Recalculated μ(M) ratios: μ(Ga^{69})/μ(H^1)=0.7146 ± 0.0015. μ(Ga^{71})/μ(H^1)=0.9078 ± 0.0015.	P.Kusch, PR **78**, 615.
72 31 41	τ 14.08^h 50B20 γ 0.13% 3.05 Dγp 0.03% 3.35 Dγp	Intensities from Segrè-Helmholz formula are 0.04% assuming Λ=3 and decay scheme of 48H23.	G.R.Bishop, et al., PR **77**, 416.
74,76 ? 31 43,45 ?	τ 14.5^d 50H22 β^- 1.7 No γ	Produced by Ge-fast n-p, chem. No P or S impurity in target.	W.J.Heiman, ISC-64,15.

32 GERMANIUM Ge

70 32 38	$\bar{\sigma}$(fast n,p)20.3^{m}Ga for E_n >6	'**0.071** "**0.048**		50W12	'Li-0.5 Mev d-n. E_n(max)=13.8. "B -0.5 Mev d-n. E_n(max)=13. Barrier = 7.8.	H.Wäffler, HPA **23**, 239.
	$\bar{\sigma}$(fast n,2n)39.6^{h}Ge for E_n >11.0	'**0.396** "**0.500**		50W12	'Li-0.5 Mev d-n. E_n(max)=13.8. "B -0.5 Mev d-n. E_n(max)=13.	See above.

33 ARSENIC As

71 33 38	K			50M25	Produced by Ga-23 Mev α-2n.	J.Y.Mei, et al., PR **79**, 237(A).
	γ	**0.173**	**s;ce$^-$**			
72 33 39	β^+	**0.26**	**s**	50M25	Produced by Ga-23 Mev α-n. Many weak γ's out to ~ 3.0.	See above.
		0.67	**s**			
		1.85	**s**			
		2.49	**s**			
		3.38	**s**			
	γ	**0.702**	**s;ce$^-$**			
		0.835	**s;pe$^-$**			
79 ?	τ	**9^m**		50B7	Produced by Se-23 Mev γ; chem.	F.D.S.Butement, Nature **165**, 149.

34 SELENIUM Se

73 34 39	K 68% β^+ 32%			49H29	No γ.	H.H.Hopkins, Jr., PR **77**, 717.
74 34 40	I	**0 ?**	**Mic**	50G5	No hyperfine structure.	S.Geschwind, et al., PR **78**, 174.
76 34 42	$\Delta M(Se^{76}-Se^{74})=1.9984$ MU			50G5	Assuming $\Delta M(Se^{80}-Se^{76})=4.0013$.	See above.
	$\bar{\sigma}$(fast n,p)26^{h}As for E_n>6	**0.033**		50W12	Li-0.5 Mev d-n. E_n(max)=13.8. Barrier = 8.1.	H.Wäffler, HPA **23**, 239.
77 34 43	I	**1/2 ?**	**Mic**	50G5	No hyperfine structure.	S.Geschwind, et al., PR **78**, 174.
	q	< **0.002**				
	$\Delta M(Se^{77}-Se^{76})=1.0017$ MU				See Se^{76}.	
78 34 44	I $\Delta M(Se^{78}-Se^{76})=2.0000$ MU	**0 ?**	**Mic**	50G5	No hyperfine structure. See above.	See above.
79 34 45	Relative abundance	< **0.01%**		50G5		See above.
81 34 47 59^m	τ	**57^m**		49B59	Produced by Se-d-p; ms.	I.Bergström, S.Thulin, PR **76**, 1718.
	γ	**0.104** α~∞	**sπ;ce$^-$** K/L=3.9			
17^m	β^-	**1.38**	**sπ**	49B59		See above.
82 34 48	I $\Delta M(Se^{82}-Se^{80})=2.0022$ MU	**0 ?**	**Mic**	50G5	No hyperfine structure. See Se^{76}.	S.Geschwind, et al., PR **78**, 174.

35 BROMINE Br

79 35 44	$\bar{\sigma}$(n,2n) 6.4^mBr for $E_n > 10.7$	**0.386**	50W12	Li-0.5 Mev d-n. E_n(max)=13.8	H.Wäffler, HPA **23**, 239.
80 35 45 4.5^h	γ_1 γ_2	**0.049** pc **0.037** pc α=**1.3**	50R7		P.Rothwell, D.West, Proc. Phys. Soc. Lond., **A63**, 539.
	γ_1 γ_2	**0.0481** sl **0.0363** sl	50L7	Λ_1=3(magnetic), Λ_2=1(electric) from conversion cœfficients.	I.J.Lidofsky, et al., PR **78**, 318(A).
	$\gamma\gamma$ angular correlation observed		50R13		L.I.Rusinov, E.I.Chuikin, Doklady Akad. Nauk, SSSR **68**, 1029; NSA **4**, # 1827.
18.5^m	β^-	**1.99** sl	50L7	β spectrum has allowed shape.	I.J.Lidofsky, et al., PR **78**, 318(A).
	$(K+\beta^+)/\beta^- = 0.090$		50R12	From ms study of products.	J.H.Reynolds, PR **79**, 243(A).
81 35 46	σ(pile n,γ) 35.5^hBr	**2.8**	50C23		J.W.Cobble, private communication, June 1950.
82 35 47	τ	**35.9^h**	50C23		See above.
	τ	**36.0^h**	50B10		E.Berne, PR **77**, 568.
	$(K+\beta^+)/\beta^- < 0.0003$		50R12	From ms study of products.	J.H.Reynolds, PR **79**, 243(A).
87 35 52	γ $\gamma\gamma$ coincidences	**5.2** a	50S28		A.F.Stehney, N.Sugarman, ANL-4397.

36 KRYPTON Kr

81 36 45	τ	**13^s**	50K13	Grows from 4.7^hRb^{81}.	D.G.Karraker, D.H.Templeton, UCRL-460.
83 36 47 1.88^h	γ	**0.0327** s;ce$^-$ K/L=**0.44**	50B13	Kr fission products separated by ms. No 0.046 γ found.	I.Bergström, et al., PR **77**, 851.
85 36 49 ~ 10^y	β^-	**0.72** a	50P14	Fission Kr from old slug.	R.Powers, ISC-64.

37 RUBIDIUM Rb

81 37 44	τ	4.7^h		50K14	Produced by Br-18 Mev α; chem, ms. Parent of 13^{5}Kr.	D.G.Karraker, D.H.Templeton, UCRL-635.
	K					
	β^+	0.995	s			
	γ	0.95	a			
82 37 45 6.3^h	β^+	0.67	s	50K14	Produced by Br-18 Mev α; chem, ms.	See above.
	γ	1.2	a			
		~0.7	a			
84 37 47	τ	34^d		50K14	Produced by Br-18 Mev α; chem, ms.	See above.
	K					
	β^+	1.55	s			
	γ	0.85	a			
	e^-	~0.37	s			
86 37 49	$\beta\gamma$ angular correlation					
		b=0.06	scin	50S27	Results of 49F16 in error.	R.Stump, S.Frankel, PR **79**, 243(A).
		b=0.04	scin	50N5	Averaged over whole β spectrum.	T.B.Novey, PR **78**, 66.
		b=0.02	scin	50R6	Averaged over whole β spectrum.	S.L.Ridgway, PR **78**, 821.
		b=0.09	sl	50S21	For β's of 1/3 maximum energy.	D.T.Stevenson, M.Deutsch, PR **78**, 640(A).
	β^- ~12%	0.5	a$\beta\gamma$	50M4	Produced by Rb-slow n; chem.	C.E.Mandeville, E.Shapiro, PR **77**, 439.
87 37 50	β^-	0.270	scin	50B38		P.R.Bell, et al., ORNL-694.
	Hard γ ?					

38 STRONTIUM Sr

85 38 47	γ	0.185		50C20	Produced by Rb-d, chem. No 0.510 γ e^- coincidences. No 0.800 γ observed.	L.S.Cheng, J.D.Kurbatov, PR **79**, 237(A).
		α large				
		0.510				
	Xe^- coincidences					

39 YTTRIUM Y

88 39 49 105^d	$\gamma\gamma$ angular correlation consistent with I=(2,1,0)			50B27	New measurements with scin counters. In agreement with large % of crossover γ.	E.L.Brady, M.Deutsch, PR **78**, 558.
91 39 52 57^d	β^-	1.56	sl	50A1	Correction factors for ΔI=2, yes, and ΔI=3, no, ~ equally good.	H.M.Agnew, PR **77**, 655.

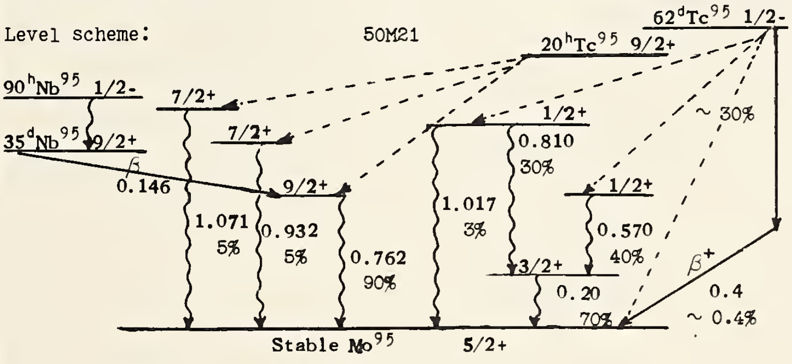
40 ZIRCONIUM Zr

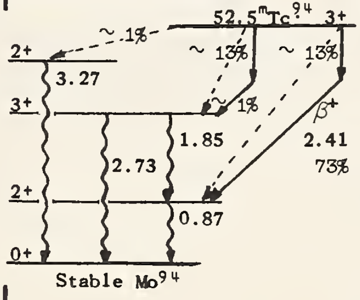
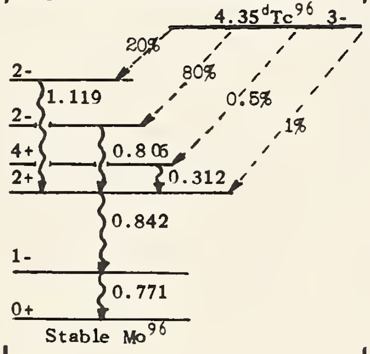
$_{40}^{87}{}_{47}$	τ β^+	1.5^h 2.41 s	5004	Produced by Nb-high energy p; chem.	G.D.O'Kelley, F.L.Reynolds, UCRL-550.
$_{40}^{89}{}_{49}$	τ β^+	80^h 1.0 s	5004	Produced by Nb-high energy p.	See above.
$_{40}^{90}{}_{50}$	$\bar{\sigma}$(fast n,2n)4.5^mZr for $E_n > 12.2$	0.128	50W12	Li-0.5 Mev d-n. E_n(max)=13.8.	H.Wäffler, HPA **23**, 239.
$_{40}^{91}{}_{51}$	Zr^{90}-d-p	Q=5.0	50H13	From most energetic p group.	J.A.Harvey, PR **78**, 345(A).
$_{40}^{92}{}_{52}$	Zr^{91}-d-p	Q=6.5	50H13		See above.
$_{40}^{93}{}_{53}$	β^-	~ 0.190 a	50B36		G.E.Boyd, Q.V.Larson, ORNL-685.
	τ β^-	~ $5x10^{6\,y}$ 0.060 a	50S23	τ from ratio of activity to that of Zr^{65} produced in fission.	E.P.Steinberg, L.E.Glendenin, PR **78**, 624.

41 NIOBIUM Nb

$_{41}^{93}{}_{52}$	μ	6.1451 I	50S11 (49A12)	$\nu(Nb^{93})/\nu(B^{11})$ (Nb_2O_5) = 0.71687 ± 0.00040.	R.E.Sheriff, et al., PR **78**, 476.
$_{41}^{94}{}_{53}$	γ	0.0415 sπ;ce$^-$ K/L=0.31	50C10		R.L.Caldwell, PR **78**, 407.
$_{41}^{95}{}_{54}$ 35^d	No $\beta\gamma$ angular correlation		50S27		R.Stump, S.Frankel, PR **79**, 243(A).

42 MOLYBDENUM Mo

$_{42}^{95}{}_{53}$	Level scheme: 		50M21		H.Medicus, et al., HPA **23**, 299. Spin and parity assignments by above authors.
$_{42}^{97}{}_{55}$	$\bar{\sigma}$(fast n,p)76^mNb for $E_n > 6$	18mb	50W12	Li-0.5 Mev d-n. E_n(max)=13.8.	H.Wäffler, HPA **23**, 239.
$_{42}^{99}{}_{57}$	γ 5* 10* 4* 2*	0.138 0.740 0.782 0.844 (sπ;pe$^-$ Compt)	50M23	Fission Mo in equilibrium with Tc daughter used. * Relative intensities.	N. Marty, Comptes rendus **230**, 1270.

92 ?	τ		44^m		50M21	Produced by Mo-6.8 Mev p; chem.	H.Medicus, et al., HPA **23**, 299.
43 49?	γ_1		0.389	sl;ce^-		τ (γ_1) found with spectrometer.	
	γ_2		1.51	sl;Compt		τ (γ_2) not determined.	
?	τ		51.5^m		50M21	Produced by Mo-4.9 Mev p and Mo-6.4 Mev d; chem. γ converted in Tc. Not p 53^m β^+.	See above.
	γ		0.0344	sl;ce^- K/L=1.2			
94	τ		52.5^m		50M21	Proposed decay scheme: 	See above. 1.5γ listed under 44^mTc above could belong here. 52.5^m τ measured for β^+. γ's through 9 cm Pb have $\tau=51^m$. Produced by Mo-6.8 Mev p; chem.
43 51	β^+		0.9 ?	sl			
			2.41	sl			
	γ	21*	0.874	sl;ce^-,Compt $\alpha_K=0.001$			
		2.5*	1.85	sl;Compt			
		0.3*	2.73	sl;Compt			
		0.3*	3.27	sl;Compt			
	All β^+ in coincidence with γ's.						
	* Relative number of quanta						
95	τ		60^d		50M21	Produced by Mo-6.8 Mev p; chem.	See above.
43 52	β^+	~0.4%	0.40	cc			
62^d	γ	70*	0.201	sl;ce^-,pe^-		α = 0.036 K/L = 7.1	
		40*	0.570	sl;pe^-,Compt		α = 0.0022	
		30*	0.810	sl;pe^-,Compt		α = 0.0010	
		3*	1.017	sl;Compt;a coin		Decay scheme same as that in table. See also Mo^{95}.	
	* Relative number of quanta						
20^h	γ	~ 90*	0.762	sl;ce^-	50M21	No $\gamma\gamma$ coincidences. γ/X ~ 1.	See above.
		~ 5*	0.932	sl;ce^-		No β^+ in cc.	
			0.948 ?	sl;ce^-		Produced by Mo-6.8 Mev p; chem.	
		~ 5*	1.071	sl;ce^-		For decay scheme see Mo^{95}.	
	* Relative number of ce^-						
96	τ		4.35^d		50M21	Proposed decay scheme: 	See above. Produced by Mo-6.8 Mev p; chem. Continuous e^- spectrum accounted for at least in part by back scattering and Compton effect. End point is 0.8. If 0.312γ were from highest level, branching with 1.119γ would cause very low intensity.
43 53	γ	25*	0.312	sl;ce^- K/L=6.4			
		123*	0.771	sl;ce^-,pe^- $\alpha=6x10^{-4}$			
		91*	0.806				
		100*	0.842				
		10*	1.119	sl;ce^-,pe^- $\alpha=2.7x10^{-4}$			
	* Relative number of ce^-						
97	γ		0.0958	sl;ce^- K/(L+M)=1.6	50M21		See above.
43 54							
99							
43 56	β^-		0.30	sl	50K2	No γ, no e^-.	B.H.Ketelle, J.W.Ruch, PR **77**, 565.

44 RUTHENIUM RU

97 44 53	γ		**0.217**	**sl;pe$^-$**	50M26		J.Y.Mei, et al., PR **79**, 237(A).
103 44 59	β^-	strong	**0.205**	**sl**	50S26		A.J.Saur, et al., PR **79**, 237(A).
		weak	**0.670**	**sl**			
	β^-	90%	**0.204**	**sl**	50M26		J.Y.Mei, et al., PR **79**, 237(A).
		10%	**0.684**	**sl**			
	γ		**0.494**	**sl;pe$^-$,ce$^-$**			
	β^-	92%*	**0.15**	**a**	50M4	* From $\beta\gamma$ coincidence rate.	C.E.Mandeville, E.Shapiro, PR **77**, 439.
		8%	**0.68**	**a**		** From βe^- coincidence rate.	
	γ		**0.52** α=**0.04****	**a**$\beta\gamma$		No $\gamma\gamma$ coincidences. Hard β not in coincidence with γ.	
106 44 62	β^-		**0.0392**	**sl**	50A1	No γ.	H.M.Agnew, PR **77**, 655.

45 RHODIUM Rh

103 45 58 57^m	e^-		**0.037**	**sl**	50S26	Interpreted as L line of 0.040γ since no 0.057e^-'s are found.	A.J.Saur, et al., PR **79**, 237(A).
	e^-		**0.035**	**sl**	50M26	L line; K and M Lines also reported at meeting.	J.Y.Mei, et al., PR **79**, 237(A).
103 45 58 stable	σ($\leqslant$ 20 Mev γ,p) threshold ~ 8		**3.5x10^{-3}**		50C2	Angular and energy distribution of protons studied.	N.W.Curtis, et al., PR **77**, 290.
104 45 59 44s	No γ				47C17	All electromagnetic radiation attributed to bremsstrahlung.	B.N.Cacciapuoti, Nuovo Cim. **4**, 31.
106 45 61	γ		> **2.23**	**Dγn**	50G14		M.Goldhaber, E.der Mateosian, BNL-51 (S-5), 62.
	No delayed $\beta\beta$, $\beta\gamma$, or $\gamma\gamma$ coincidences, (0.005-1)μs				50D6		M.Deutsch, W.E.Wright, PR **77**, 139.
	$\gamma\gamma$ angular correlation				50B27	Correlation coefficients one half those expected for level spins of 0, 2, 0 in Pd^{106}.	E.L.Brady, M.Deutsch, PR **78**, 558.
	$\gamma\gamma$ polarization direction correlation				(1) 50M18 (2) 50W10	J.A.Spiers, PR **78**, 75 (50S14) suggests results indicate 1.25 Mev level is double.	(1) F.Metzger, M.Deutsch, PR **78**, 551. (2) A.H.Williams, M.L.Wiedenbeck, PR **78**, 822.

46 PALLADIUM Pd

104 46 58	f = -6.12±0.05				50D5	From $\Delta f(Pd^{104}-C_2H_2)=15.34\pm0.04$ and $f(C_2H_2)=9.218\pm0.017$.	H.E.Duckworth, et al., PR **78**, 479.
108 46 62	f = -5.85±0.04				50D5	From $\Delta f(Pd^{108}-C_2H_3)=17.74\pm0.03$ and $f(C_2H_3)=11.887\pm0.018$.	See above.
109 46 63	Mass assignment of 13^h activity by ms				50B18		I.Bergstrom, et al., Arkiv för Fysik **1**, 281.

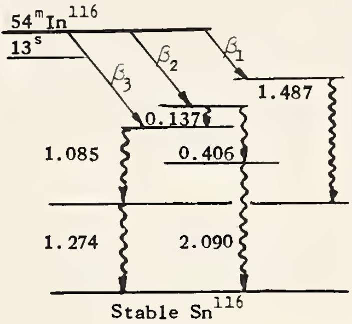
47 SILVER Ag

Ag	$\sigma_a(296°)/\sigma_a(476°)=1.23$	49R14	σ_a decreases as 1/v.	W.Ramm, Z.Naturforsch. **4a**, 245.
	σ_o (Doppler corrected) 10,000 Γ 0.17ev E_o 5.17ev	50S5	Transmission measurements with time-of-flight spectrometer.	W.Selove, PR **77**, 557.
	Ag-γ-p E_p(max)=13, peak at 7	50D3		B.C.Diven, G.M.Almy, PR **79**, 242.
? 47 ?	Activities of 6^m,11^m,35^m Hard β's, some γ's	50C21	Produced by Ag-6.5 Mev d; chem.	C.Chamie, J. de phys. et rad. (8) **11**, 77.
109 47 62	$\bar{\sigma}$(fast n,p)13^hPd for $E_n > 6$	50W12		H.Wäffler, HPA **23**, 239.
	$'$7.5mb $''$5.9mb		$'$Li-0.5 Mev d-n. E_n(max)=13.8. $''$B -0.5 Mev d-n. E_n(max)=13. Barrier = 9.8.	
110 47 63 24^s	γ 0.66 scin	50C8		E.C.Campbell, M.Goodrich, PR **78**, 640(A).
110 47 63 225^d	γ $1.67 < E_\gamma < 2.23$	50D7		E.der Mateosian, M.Goldhaber, PR **78**, 326(A).
	Mass assignment by ms	50B18		I.Bergström, et al., Arkiv för Fysik **1**, 281.

48 CADMIUM Cd

Cd	$\sigma_a(296°)/\sigma_a(476°)=0.93$	49R14		W.Ramm, Z.Naturforsch. **4a**, 245.
109 48 61	γ 0.0875 sπ,ce$^-$ 0.0863 ? sπ,ce$^-$	50C22	Produced by Cd^{108}-pile n's.	J.M.Cork, et al., PR **79**, 238(A).
111 48 63	μ -0.5923 I	49P24	$\nu(Cd^{111})/\nu(Na^{23})$ ($CdCl_2$) = 0.8016 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **76**, 1728.
111 48 63 48^m	γ_2 τ=0.081$^{\mu s}$	50D6		M.Deutsch, W.E.Wright, PR **77**, 139.
113 48 65	μ -0.6196 I	49P24	$\nu(Cd^{113})/\nu(Na^{23})$ ($CdCl_2$) = 0.8386 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **76**, 1728.
115 48 67 2.33^d	γ 0.3355 0.3437 0.4519 0.3489 0.5591 0.3693 0.7131 $\}$ sπ; ce$^-$	50C22	Produced by Cd^{114}-pile n's. All γ's converted in In.	J.M.Cork, et al., PR **79**, 238(A).
	γ 0.495 0.529	50A9	Previously reported as one γ at 0.520.	D.E.Alburger, et al., BNL-64 (S-6).
115 48 67 43^d	β^- 1.53 s,a γ 0.5253? s,a	50C22		J.M.Cork, et al., PR **79**, 238(A).

49 INDIUM In

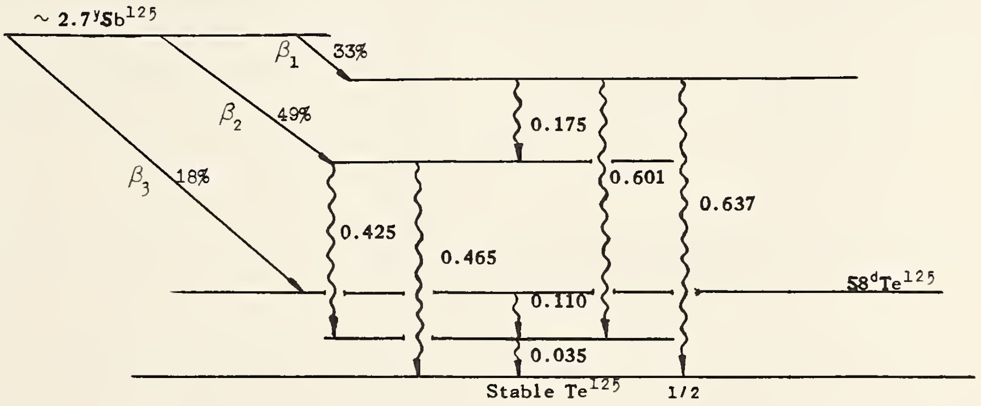
113 49 64	q	1.144	M	50M2	No higher moments. Striking similarity to In^{115}.	A.K.Mann, P.Kusch, PR 77, 427.
115 49 66	q	1.161	M	50M2	No higher moments.	See above.
116 49 67	β_1^- 21%	0.60		50S12		H. Slätis, et al., PR 78, 498.
	β_2^- 28%	0.87				No transition observed between 54^m and 13^s states.
	β_3^- 51%	1.00				$\beta\gamma$ coincidence rate consistent with decay scheme.
	γ 3%	0.137	K/L large			E (disintegration)=3.36 ± 0.05.
	25%	0.406				
	54%	1.085	$\alpha=8.4x10^{-4}$			
	75%	1.274	$\alpha=5.7x10^{-4}$			
	21%	1.487				
	25%	2.090				

50 TIN Sn

Sn	σ_t (95 Mev)	3.18		50D1	Be-190 Mev d-n. Bi-f detector.	J.DeJuren, N.Knable, PR 77, 606.
? ? 50 ? 4.5^h	p 70^mIn			50L11	Produced by Sb->100 Mev d,chem.	M.Lindner, I.Perlman, PR 78, 499.
115 50 65	μ	-0.9134	I	49P24 (49B7)	$\nu(Sn^{115})/\nu(Na^{23})$ ($SnCl_2$) = 1.2362 ± 0.0001.	W.G.Proctor, F.C.Yu, PR 76, 1728.
117 50 67 14.5^d	γ Sn^{116}-n-γ Sn^{117}-n-n	0.152	sl;ce⁻	50N6	Pile yields from two reactions about equal.	C.N.Nelson, et al., ORNL-685, 50.
Stable	$\bar{\sigma}$ (fast n,p)1.95^h for E_n >6	0.8mb		50W12	Li-0.5 Mev d-n, E_n(max)=13.8. Threshold=1.17, barrier=10.3.	H.Wäffler, HPA 23, 239.
119 50 69	τ γ Sn^{118}-n-γ	279^d 0.064 chem	 sl;ce⁻	50N6		C.N.Nelson, et al., ORNL-685, 50.
123 50 73	τ β^-	136^d 1.42	 sl	50K11	Only e⁻'s observed attributed to 0.390 γ of In^{113}. β shape indicates $\Delta I=2$, yes.	B.H.Ketelle, et al., PR 79, 242(A).
124 50 74	$\bar{\sigma}$ (fast n,2n)39.5^mSn for E_n >8.5	≥0.471		50W12	Li-0.5 Mev d-n. E_n(max)=13.8. 130^d isomer not included.	H.Wäffler, HPA 23, 239.
125 50 75	τ β^-	9.9^d 2.33	 sl	50K11	See Sn^{123}. β shape indicates $\Delta I=2$, yes.	B.H.Ketelle, et al., PR 79, 242(A).

121 51 70	μ	**3.3426**	I	50P5 (49B7)	$\nu(Sb^{121})/\nu(Na^{23})$ ($NaSbF_6$) = 0.9048 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **78**, 471.
	$\bar{\sigma}$(fast n,2n)17^mSb for $E_n > 9.25$	$>^{\prime}$**0.380** $>^{\prime\prime}$**0.656**		50W12	′Li-0.5 Mev d-n. E_n(max)=13.8. ″B -0.5 Mev d-n. E_n(max)=13.	H.Wäffler, HPA **23**, 239.
122 51 71 2.8^d	No $\beta\gamma$ angular correlation			50R6	b= + 0.011 ± 0.013.	S.L.Ridgway, PR **78**, 821.
123 51 72	μ	**2.5340**	I	50P5 (47B29)	$\nu(Sb^{123})/\nu(D^2)$ ($NaSbF_6$) = 0.8442 ±0.0001.	W.G.Proctor, F.C.Yu, PR **78**, 471.
124 51 73 60^d	$\beta\gamma$ angular correlation No $\gamma\gamma$ angular correlation			50R6	Probably connected with most energetic β. Re-analysis of β spectrum using forbidden shapes suggested. b=-0.168 ± 0.025.	S.L.Ridgway, PR **78**, 821.
125 51 74	β_1^- 33%	**0.128**	sl	50S19	ft = $8.1x10^6$	K.Siegbahn, W.Forsling, Arkiv för Fysik **1**, 505.
	β_2^- 49%	**0.299**	sl		$7.6x10^7$	
	β_3^- 18%	**0.616**	sl		$2.4x10^9$	
	γ_1	**0.035**	sl;ce$^-$		γ_4/γ_5 = 3. γ_6/γ_7 = 2.	
	γ_2	**0.110** K/(L+M)=**1.1**	sl;ce$^-$		e^- at 22.4 Kev interpreted as Auger line.	
	γ_3	**0.175**	sl;ce$^-$		Coincidence measurements support decay scheme.	
	γ_4	~ **0.425**	sl;ce$^-$,pe$^-$			
	γ_5	~ **0.465**	sl;pe$^-$			
	γ_6	**0.601**	sl;pe$^-$			
	γ_7	~ **0.637**	sl;pe$^-$			

Proposed decay scheme:



119 52 67	K 50L11 γ **1.6** a	Produced by Sb-100 Mev d.	M.Lindner, I.Perlman, PR **78**, 499.
121 52 69 143^d	γ_1 **0.082** sπ,ce$^-$ 50K4 $\alpha \sim \infty$ K/L=0.75 γ_2 **0.213** sπ,ce$^-$ α_K=0.09 K/L=7.3 $e_1^- e_2^-$ and $e_1^- \gamma_2$ coincidences	Produced by Sb-d; chem. Double slit π spectrograph used for $e^- e^-$ coincidences. γ_1 assumed completely converted. Unconverted 0.0365 γ, if present, < 2% of total X and γ.	R.Katz, R.D.Hill, M.Goldhaber, PR **78**, 9.
	No $\gamma\gamma$ delayed coincidences 50D6 $(5x10^{-3}-1)^{\mu s}$		M.Deutsch, W.E.Wright, PR **77**, 139.
17^d	γ **0.610** 50K4 α_K=0.004		R.Katz, R.D.Hill, M.Goldhaber, PR **78**, 9.
123 52 71 $\sim$ 100^d	γ_1 **0.0885** sπ,ce$^-$ 50K4 $\alpha \sim \infty$ K/L=0.68 γ_2 **0.159** sπ,ce$^-$;a α_K=0.18 K/L=8.9 $e_1^- e_2^-$ and $e_1^- \gamma_2$ coincidences	Produced by Sb-d; chem, and Te^{122}-n-γ. See Te^{121}. Correction to table: τ = 90^d 49H25	See above.
	No $\gamma\gamma$ delayed coincidences 50D6 $(5x10^{-3}-1)^{\mu s}$		M.Deutsch, W.E.Wright, PR **77**, 139.
	No $\gamma\gamma$ delayed coincidences 50M22 Delay < $3x10^{-3 \mu s}$		F.K.McGowan, ORNL-694, 19.
Stable	I **1/2** S 50F8 $\mu(Te^{123})/\mu(Te^{125})$=0.88	Visible region studied with enriched materials.	G.R.Fowles, PR **78**, 744.
125 52 73 58^d	γ_2 **0.035** sl;ce$^-$ γ_1 **0.110** sl;ce$^-$ K/(L+M)=1.1	e^- at 22.4 Kev interpreted as Auger line. See Sb^{125}	K.Siegbahn, W.Forsling, Arkiv för Fysik **1**, 505.
	No $\gamma\gamma$ delayed coincidences 50D6 $(5x10^{-3}-1)^{\mu s}$		M.Deutsch, W.E.Wright, PR **77**, 139.
Stable	I **1/2** S 50F8	See Te^{123}.	See Te^{123}.
128 52 76	$\bar{\sigma}$(fast n,2n)9.3^{h}Te **0.390** 50W12 for E_n > 8.5	Li-0.5 Mev d-n. E_n(max)=13.8. 90^d activity did not appear.	H.Wäffler, HPA **23**, 239.
130 52 78	$\bar{\sigma}$(fast n,2n) 72^m and 32^d Te 50W12 for E_n > 7.5 **0.653**		See above.
	τ **1.4x10$^{21 y}$** 50I3 for double β decay	From relative isotopic abundances of Xe in old Te ores.	M.G.Inghram, J.H.Reynolds PR **78**, 822.

53 IODINE I

127 53 74	$\bar{\sigma}$(fast n,2n)13^dI for $E_n > 9.3$	'**463mb** ''**587mb**		50W12	'Li-0.5 Mev d-n. E_n(max)=13.8. ''B -0.5 Mev d-n. E_n(max)=13.	H.Wäffler, HPA **23**, 239.
	$\bar{\sigma}$(fast n,p)9.3^hTe for $E_n > 6$	$\geqslant$**6.9mb**			Li-0.5 Mev d-n. E_n(max)=13.8. Threshold ~ 0, barrier=10.6.	
128 53 75	K/β^- =0.053			50R12	Ms study of product Te and Xe.	J.H.Reynolds, PR **79**, 243(A).
129 53 76	β	~**0.12**	**pc**	50B31		C.J.Borkowski, A.R.Brosi, ORNL-607, 52.
	γ	**0.039** α_K~**6**	**pc** K/L~**40**			
	$\beta\gamma$ and βX coincidences					
134 53 81	τ	**54.7**^{m}		50P10	Produced by U^{235} fission.	A.C.Pappas, MIT Progress Report, April 1950, 29.

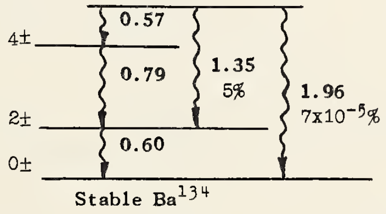
54 XENON Xe

125 54 71	τ K γ weak I K X-ray	**20**^{h} **0.6**	 **a** **a**	50A5	Produced by Te^{122}-α-n, chem. Few β^+ if any.	L.D.Anderson, M.L.Pool, PR **77**, 142.
127 54 73 34^d	τ	**32**^{d}		50A5	Produced by Te^{124}-α-n, chem.	See above.
129 54 75	I	**1/2**	**S**	50K9	Infra-red lines of separated isotope studied.	J.Koch, E.Rasmussen, PR **77**, 722.
	μ	**-0.7725**	**I**	50P5 (49B7)	$\nu(Xe^{129})/\nu(Na^{23})$ $(Xe+Fe_2O_3)$ = 1.0456 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **78**, 471.
131 54 77 ~ 12^d	τ γ	**11.5**^{d} **0.163** K/L=**4.5**		50C6	Product of Cs^{131} produced from Ba^{131}.	L.S.Cheng, J.D.Kurbatov, PR **78**, 319(A).
stable	I	**3/2**	**S**	50K9	Isotope shift ~ that for Kr but of reversed order, heavier Xe isotopes having greater λ.	See Xe^{129}.
	q	~**-0.15**				
133 54 79	τ	**5.270**^{d}		50M15	Details of work reported in 49M25. τ determined by ms abundance comparisons.	J.Macnamara, C.B.Collins, H.G.Thode, PR **78**, 129.
	γ	**0.0824** **0.0836** **0.0952** ? **0.236**		49T4	γ rays omitted from table.	S.Thulin, et al., PR **76**, 871.

55 CESIUM Cs

133 55 78	No α activity	49B46	$\tau_\alpha > 4\times10^{15\,y}$. Photographic plate.	E.Bestenreiner, E.Broda, Nature **164**, 919.
134 55 79 3.15^h 2.3^y	γ **0.1280** $s\pi$;ce$^-$ K/L=**0.64**	50C10	K-L and L-M energy differences fit Cs and not Ba.	R.L.Caldwell, PR **78**, 407.
	No βe^-, $\beta\gamma$, or $\gamma\gamma$ delays between $(5\times10^{-3}$ and $5)^{\mu s}$	50D6.		M.Deutsch, W.E.Wright, PR **77**, 139.
	No $\gamma\gamma$ coincidences Delay $< 3\times10^{-3\,\mu s}$	49B39		R.E.Bell, H.E.Petch, PR **76**, 1409.
	No $\beta\gamma$ angular correlation	50S21		D.T.Stevenson, M.Deutsch, PR **78**, 640(A).
	No $\gamma\gamma$ polarization direction correlation	50W10		A.H.Williams, M.L.Wiedenbeck, PR **78**, 822.
	$\gamma\gamma$ polarization direction correlation observed	50M18	Results indicate same parity of levels in main cascade.	F.Metzger, M.Deutsch, PR **78**, 551.
	$\gamma\gamma$ angular correlation consistent with I=4,2,0	50B27	Complexity of decay scheme makes conclusions difficult.	E.L.Brady, M.Deutsch, PR **78**, 558.

Possible γ scheme



137 55 82	β^- **0.523** sl shape consistent with $\Delta I=2$, yes	50A1	High energy β's not studied. ft=4.41×10^9.	H.M.Agnew, PR **77**, 655.
	γ **0.6614** $s\pi$;ce$^-$ ±**.0007**	50L9	From comparison with Au line measured by DuMond.	L.M.Langer, R.D.Moffat PR **78**, 74.

56 BARIUM Ba

128 ? 56 72 ?	τ **2.4^d** β^+ ~ **3** a e$^-$ **0.3** a γ	50F11	Tentative assignment based on absence of 5.5^h daughter. Produced by Cs-85 Mev p.	R.W.Fink, D.H.Templeton, J. Am. Chem. Soc. **72**, 2818.
	τ **2.4^d** β^+ **3.1** a	50T8	Produced by Cs-250 Mev p.	C.C.Thomas, E.O.Wiig, J. Am. Chem. Soc. **72**, 2818.
129 56 73	τ **2.0^h** β^+	50F11	Assignment from evidence for 31^h Cs daughter. See Ba^{128}.	See Ba^{128}.
	τ **1.8^h** β^+	50T8	See Ba^{128}.	See Ba^{128}.
131 56 75	γ **0.497** sl,pe$^-$ Several less intense γ's	50D4	Cs^{131} removed. Ba^{133} allowed to decay.	E.B.Dale, et al., PR **78**, 640(A).

57 LANTHANUM La

134 57 77	τ 6.5^m K 56% β^+ 44% 2.7 a K X-ray a No γ, no e^-	50J5	Assignment from 60 Mev threshold for Ce parent from La-p-6n and fact that La^{133} and La^{135} have been identified by ms. d 72^hCe.	B.M.Jones, UCRL-656.
138 57 81	γ 1.05 scin Less than 0.4 particles with $E > 0.1$/sec/gm La	50P7	0.7γ's/sec/gm La. If one γ per disintegration, $\tau = 1.2x10^{11y}$	R.W.Pringle, et al., PR **78**, 303.
139 57 82	$\bar{\sigma}$(fast n,p)84^mBa 1.1mb for $E_n > 6$	50W12	Li-0.5 Mev d-n. E_n(max)=13.8. Threshold= 1.65?, barrier=11.0.	H.Wäffler, HPA **23**, 239.
140 57 83	τ 40.0^h γ $4\%^*$ 2.55 Dγp $0.1\%^*$ 2.9 Dγp	50B20	* % of disintegrations. Measured relative to Na^{24}, ThC″, etc.	G.R.Bishop, et al., PR **77**, 416.

58 CERIUM Ce

133 58 75	τ 6.3^h K β^+ 1.3 a γ 1.8 a	50J5	Produced by La-70 Mev p,7n; chem. Assignment from known daughter and above threshold. Possible e^-. p 4^hLa.	B.M.Jones, UCRL-656.
134 58 76	τ 72.0^h K, no γ	50J5	Produced by La-60 Mev p,6n; chem. See La^{134}.	See above.
135 58 77	τ 22^h $\beta^+ < 1\%$ 0.8 a	50J5	Produced by La-50 Mev p,5n; chem.	See above.
137 58 79	e^- 0.24 a	50J5		See above.
138 58 80	σ(th n,γ) > 120^dCe/ σ(th n,γ)28^dCe = 1.4	50M9	Abundances of 4719 assumed. Pile irradiated samples studied after decay of 28^dCe.	A.J.Moses, D.S.Martin,Jr., ISC-77.
141 58 83	β^- 0.24 a$\beta\gamma$ 0.56 sπ γ 0.146 sπ;pe^-,ce^- 0.315 sπ;pe^- Other weak γ's	49T12	This paper incompletely reported in table. Decay scheme of table proposed here. Suggest 0.146γ delayed. No $\gamma\gamma$ coincidences.	M.Ter-Pogossian, et al., PR **76**, 909.
	τ 33.1^d	49W23		D.Walker, Proc. Phys. Soc., Lond., **A62**, 799.
142 58 84	σ(~1 Mev n,γ) 3.6mb	50H6	Given in table as 1.2mb.	D.J.Hughes, D.Sherman, PR **78**, 632.
143 58 85	β^- ~ 1.1 a γ 0.040 a 0.20 a 0.87 a	50S8	13.8^h Pr daughter was repeatedly removed. Each β accompanied by ~ 0.18 Mev of γ energy.	E.Shapiro, C.E.Mandeville, PR **78**, 319(A).

59 PRASEODYMIUM Pr

Pr	No α activity				49B46	τ_α $>1.3\text{x}10^{15y}$. Photo plate.	E.Bestenreiner, E.Broda, Nature 164, 658.
138 59 79	τ		2.0^h		50J5	* Relative abundances of radiations from absorption data. Produced by Ce-30 Mev p-3n; chem.	B.M.Jones, UCRL-656.
	K	1.00*					
	β^+	0.14	1.4	a			
	e^-	0.04	0.24	a			
	γ	0.22	0.16	a			
		0.36	0.50	a			
		0.75	1.3	a			
139 59 80	τ		4.5^h		50J5	Produced by Ce-20 Mev p-2n; chem. No e^- observed.	See above.
	K	1.00*					
	β^+	0.06	1.0	a			
	γ	0.04	1.0	a			
		p 140^dCe					
141 59 82	μ		4.5669	I	50C12 (49B7)	$\nu(\text{Pr}^{141})/\nu(\text{Na}^{23})$ $[\text{Pr}(\text{NO}_3)_3]$ = 1.2362 ± 0.0006.	W.H.Chambers, et al., PR 78, 482.
	$\bar{\sigma}$ (fast n,2n)3.5^mPr for E_n >9.4		′0.374 ″0.486		50W12	′Li-0.5 Mev d-n. E_n(max)=13.8. ″B -0.5 Mev d-n. E_n(max)=13.	H.Wäffler, HPA 23, 239.
142 59 83	β^-	20%	0.66	sπ	50R8	Suggests that 4 γ's of 48C23 are in parallel with 1.59 γ and that these follow 0.66 β^-.	E.R.Rae, Proc. Phys. Soc., Lond., A63, 293.
		80%	2.23	sπ			
	γ	weak	0.135	sπ;pe$^-$,ce$^-$			
			1.59	sπ;pe$^-$			
143 59 84	Reference for τ = 13.7^d should be 49F18 instead of 49B56						

60 NEODYMIUM Nd

Nd	No α activity				49B46	τ_α $>2.6\text{x}10^{14y}$. Photo plate.	E.Bestenreiner, E.Broda, Nature 164, 658.
138 ?	τ		22^m		50J5	Produced by Pr-40 Mev p. Chemistry shows it a rare earth.	B.M.Jones, UCRL-656.
	β^+		2.4	a			
	e^- ?						
139 60 79	τ		5.5^h		50J5	Produced by Pr-40 Mev p-3n; ion exchange. * Relative abundances of radiations from absorption data. Small amount of Pr^{139} may have been present.	See Nd^{138}.
	K	1.00*					
	β^+	0.11	3.1	a			
	e^-	0.03	0.28	a			
	γ	0.10	1.3	a			
		p 140^dCe					
147 60 87	β^-	33%	0.17	a	50M7	Both β's coupled with γ's. No βe^- coincidences.	C.E.Mandeville, PR 78, 319(A).
		67%	0.78	a			
	γ	strong	0.035	a			
			0.58	a			
	No $\beta\gamma$ delays between $3\text{x}10^{-8}$ - 10^{-3s}				49M55		F.K.McGowan, ORNL-481, 30.
149 60 89	No $\beta\gamma$ delays between $3\text{x}10^{-8}$ - 10^{-3s}				49M26		F.K.McGowan, ORNL-366, 34.

61 PROMETHIUM Pm

143 61 82	τ	**285**^{d}		50W8	Produced by Pr-15Mev α-2n; ion exchange. No other activity with $\tau > 5^{m}$. No α.	G.Wilkinson, H.G.Hicks, UCRL-751.
	$\gamma \sim 30\%$	**0.95**	**a**			
	K and L X-rays					
147 61 86	τ	**2.26**^{y}		50I1	From fission yield of Sm^{147} assuming smooth yield curve.	M.G.Inghram, et al., AECD-2759.
	β^-	**0.229**	**sl**	50A1	Fermi plot linear.	H.M.Agnew, PR **77**, 655.

62 SAMARIUM Sm

Sm	$\sigma_a(296°)/\sigma_a(476°)=1.00$			49R14		W.Ramm, Z. Naturforsch.**4a**, 245.
	α	Range = **7.05**μ (1.13 cm air)		49H40	Ilford C2 plates. Long range α's due to Po impurity.	C.Haenny, et al., HPA **22**, 611.
	τ_a	**6.7x10**$^{11\,y}$		49P25	Ilford C2 plates.	E.Picciotti, Comptes rendus **229**, 117.
	α	Range = **7.04**μ				
	No second α group			49B46	Intensity of any 2nd group is < 1% of 1.13 cm group.	E.Bestenreiner, E.Broda, Nature **164**, 658.
? 62 ?	τ	**8**^{m}		50B7	Produced by Sm-23 Mev γ, chem. Radiation not α's.	F.D.S.Butement, Nature **165**, 149.
149 62 87	σ(pile n,γ)	**47,000**		50I1	From ms measurement of fission yields assuming smooth yield curve.	M.G.Inghram, et al., AECD-2759.
151 62 89	τ	**122**^{y}		50I1	See above.	See above.
	σ(pile n,γ)	**7,200**				
	β^-	**0.0755**	**sl**	50A1	Fermi plot linear.	H.M.Agnew, PR **77**, 655.
	$\beta\gamma$ delay	< **0.002**$^{\mu s}$		50M22		F.K.McGowan, ORNL-694, 19.
153 62 91	β^- 67%	**0.68**	**sl**	50H17		J.M.Hill, L.R.Shepherd, Proc. Phys. Soc., Lond., **A63**, 126.
	33%	**0.80**	**sl**			
	γ	**0.1015**	**sl,ce**$^-$			
		$\alpha \sim$ **2.5**, K/L$\sim$ **5**				
	$\beta\gamma$ delay < 0.1$^{\mu s}$					
	$\beta\gamma$ delay < 0.002$^{\mu s}$			50M22		See Sm^{151}.

Eu	$\sigma_a(296°)/\sigma_a(476°)$ = 1.56			49R14	Decrease >1/v.	W.Ramm, Z. Naturforsch.4a, 245.
$^{150}_{63}\,{}_{87}$	τ	15^h		50B7	Produced by Eu-23 Mev γ; chem.	F.D.S.Butement, Nature 165, 149.
$^{152}_{63}\,{}_{89}$ 9.2^h	β^-	1.880	sl	50H17	~ 0.9γ/β = 0.5. $e^-\gamma$ but no $\beta\gamma$ coincidences. $\gamma\gamma$ coincidences connected with ~ 0.13γ.	J.M.Hill, L.R.Shepherd, Proc. Phys. Soc., Lond., A63, 126.
	K					
	γ	0.120	sl;p$\bar{e}$,ce$^-$			
	weak	~ 0.41	sl;pe$^-$			
		0.82	sl;pe$^-$			
		0.94	sl;pe$^-$			
	Sm K X-ray		crit. a			
152,154 5^y	β^- complex	1.58	sl	50H17	Xe$^-$ coincidences. e^-'s of 0.120γ in coincidence with γ of ~ 1 Mev. $\beta\gamma$ coincidences for E_β<0.7. E_γ(total) ~ 1.3.	See above.
	γ's in agreement with those of 48S24					
	γ (kev)	Gd	Sm	50C4	Gd and Sm indicate that the γ's appear to be converted in these elements. All measurements by photographic spectrometer.	J.M.Cork, et al., PR 77, 848.
		123.2	122.0			
		336.4	244.3			
		343.8	720.4			
		448.4	964			
		778	1,086			
		1,116				
154,155	β^-	0.14	sl	50K12	$\beta\gamma$ and βe^- coincidences. 0.145β coincident with 0.085 or 0.101γ. 0.145β and 0.250β probably belong to Eu^{155}.	B.H.Ketelle, ORNL-607, 50.
		0.25				
		0.59				
		0.90				
		1.88				
	γ	0.085	sl			
		0.101				
		0.725				
		1.005				
		1.288				
$^{155}_{63}\,{}_{92}$	β^-	0.23		50W10	Correction. Table value = 2.23.	L.Winsberg, NNES 9, paper 199.
$^{159\,?}_{63?}\,{}_{96?}$	τ	17^m		50B7	Produced by Gd-23 Mev γ.	F.D.S.Butement, Nature 165, 149.

64 GADOLINIUM Gd

Gd	$\sigma_a(296°)/\sigma_a(476°)$ = 1.49			49R14	σ_a decreases faster than 1/v.	W.Ramm, Z. Naturforsch.4a, 245.
	Relative isotopic abundances 152 0.20% 157 15.64% 154 2.16% 158 24.96% 155 14.68% 160 22.01% 156 20.36%			50L3	Mass spectrometer with electron multiplier used for high sensitivity. 149 <0.001 % 159 <0.002% 150 <0.0005% 161 <0.001% 151 <0.0003% 162 <0.002% 153 <0.0005%	W.T.Leland, PR 77, 634.
151 64 87	τ	150^d		50H18	τ determined from ratio of 0.265γ to 0.106γ at two times 590 days apart. Produced by Eu-d-2n, chem, ion exchange.	R.E.Hein, A.F.Voigt, ISC-80; AECU-843.
	K, no β^+					
	γ	0.265	a			
	e^-	0.220	a			
	Eu K X-ray	crit	a			
153 64 89	τ	236^d		50H18	Produced by Eu-d-2n, Gd-n-γ, chem, ion exchange.	See above.
	K, no β^+					
	γ	0.106	a			
	e^-		a			
	Xe^- coincidences					
	Eu K X-ray	crit	a			
	No delays observed			50M22		F.K.McGowan, ORNL-694, 19.
155 64 91	σ (pile n,γ)	41,000		50I1	From ms measurement of fission yield assuming smooth yield curve.	M.G.Inghram, et al., AECD-2759.
157 64 93	σ (pile n,γ)	59,500		50I1	E_n probably greater than in experiment of 47L19.	

65 TERBIUM Tb

Tb	α/K capture <5x10^{-6} for isotopes 153 through 157, and 160			50W13		G.Wilkinson, UCRL-635; PR 79, 815.
153 65 88	K, no β^+			50W13	* % relative to K X-ray. Produced by Eu-31 Mev α-2n, chem. Assignment based on α yields. Genetic relationship with Gd^{153} not established.	G.Wilkinson, H.G.Hicks, UCRL-421; PR 79, 815.
	γ 10%*	0.23	a			
	2%	1.2	a			
	e^- 2%	0.15	a			
	0.1%	~ 0.3	a			
	K,L X-rays		a			
154 65 89	β^+ 0.4%*	2.6	a,s	50W13	Produced by Eu-19 Mev α-n and Gd-10 Mev p-n, chem. Assignment based on yields. Hard e^- may be β^- to Dy^{154}.	See above.
	γ 3%	1.3	a			
	e^- 10%	0.13	a,s			
	2%	0.8	a,s			
	K, L X-rays		a			
155 65 90	τ	190^d		50W13	Produced by Eu-19 Mev α-2n, chem. Assignment based on yields.	See above.
	γ 30%*	1.4	a			
	e^- 40%	0.1	a			
	K,L X-rays		a			

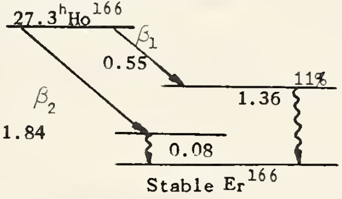
(Tb continued on next page)

65 TERBIUM Tb (continued)

156 65 91	τ 5.0^h β^+ 20%* 1.3 a K,L X-rays a	50W13	Produced by Eu-19 Mev α-n and Gd-10 Mev p-n. Assignment based on yield.	G.Wilkinson, H.G.Hicks, UCRL-421; PR **79**, 815. * % relative to K X-ray.
157 ? 65 92?	τ 4.7^d γ 30%* 1.4 a e^- ~20% 0.09 a ~10% 0.2 a K,L X-rays a	50W13	Produced by Gd-10 Mev p-n, chem. Could be Tb^{157} or Tb^{158}. (Tb^{157} seems unlikely if $E_{dis} > 1.4$. 3.6^m activity (38P5) was possibly Gd^{161}.)	See above.
160 65 95	τ 71^d β^- 16% 0.396 sπ 41% 0.521 sπ 43% 0.860 sπ γ 0.085 sπ;ce$^-$ 0.200 sπ;ce$^-$ 0.300 sπ;ce$^-$ 0.886 sπ;ce$^-$ 0.970 sπ;ce$^-$	50B19	γ of 0.212 not found. No β^+. Highly purified sample from Oak Ridge bombarded in Argonne pile.	S.B.Burson, et al., PR **77**, 403.
	τ 76^d γ 86.5 297.8 92.6 375.2 176.2 391.0 196.4 410.3 214.7 876 282.0 962 kev sπ;pe$^-$	50C17	Highly purified sample from G.Boyd. Decay scheme based on differences proposed.	J.M.Cork, et al., PR **78**, 304.
	No $\beta\gamma$ delays between $.03^{\mu s}$ and $1000^{\mu s}$	49M55		F.K.McGowan, ORNL-481, 30.
162,163	τ 22^m	50B7	Produced by Dy-23 Mev γ.	F.D.S.Butement, Nature **165**, 149.

66 DYSPROSIUM Dy

Dy	$\sigma_a(276°)/\sigma_a(476°)=1.28$	49R14	Probably decreases faster than 1/v.	W.Ramm, Z.Naturforsch. **4a**, 245.
	Relative isotopic abundances 156 0.064% 162 25.36% 158 0.105% 163 24.91% 160 2.36 % 164 28.47% 161 18.73 %	50L3	Mass spectrometer with electron multiplier used for high sensitivity.	W.T.Leland, PR **77**, 634.
165 66 99 1.25^m	γ 0.1090 sπ;ce$^-$ K/L=0.08	50C10	K/L from photo plate intensities.	R.L.Caldwell, PR **78**, 407.
2.42^h	γ 0.0878 sπ;ce$^-$ ~ 0.275 sπ;ce$^-$	50C10		See above.
	$\beta\gamma$ delay $< 0.003^{\mu s}$	50M22		F.K.McGowan, ORNL-694, 19.
	σ(th n,γ) 82^hDy 4,400	50B30	Based on σ(th n,γ) 2.42^hDy = 2620.	F.D.S.Butement, Proc. Phys. Soc., Lond., **A63**, 532.
166 66 100	τ 82^h β^- 0.22 a γ < 0.05 a	50B30	Produced by Dy-n-γ, n-γ. Activity proportional to square of n flux. p 27^hHo.	See above.
	$\beta\gamma$ delay $< 0.003^{\mu s}$	50M22		F.K.McGowan, ORNL-694, 19.

Ho	Relative isotopic abundances 161, 162, 163, 164 <0.04 % 166, 167, 168 <0.001% 169 <0.004%	50L3	See Dy.	W.T.Leland, PR 77, 634.
160 67 93	τ 22.5^m β^+ 0.5%* ~ 1.3 a γ 100%* ~ 1.2 a e^- 10%* 0.17 a K,L X-rays a	50W13	* % of K X-ray. Produced by Tb-38 Mev α-3n, chem. Assignment from α yield.	G.Wilkinson, H.G.Hicks, UCRL-677; PR 79, 815.
161 67 94	τ 4.6^h γ 100%* 1.1 a e^- 10%* 0.1 a K,L X-rays a	50W13	Produced by Tb-19 Mev α-2n, Dy-10 Mev p-n, and Dy-19 Mev d-2n; chem. Assignment from α yields.	See above.
162 67 95	τ 65.0^d β^- 15%* 0.8 a,s γ <10%* ~ 1 a e^- 10%* 0.1 a K,L X-rays a	50W13	Produced by Tb-19 Mev α-n, Dy-10 Mev p-n, and Dy-19 Mev d-2n; chem. Assignment from α yields. (4.6^h, 65^d now interchanged.)	See above.
163 67 96	τ 5.2^d γ 10%* ~ 0.5 a 25%* 1.4 a e^- 4%* 0.4 a K,L X-rays a	50W13	Produced by Dy-10 Mev p-n, Dy-19 Mev d-n,2n; chem. Not produced by Tb-α or Ho-fast n.	See above.
164 67 97	τ 34.0^m β^- 0.95 a	50W13	Produced by Dy-10 Mev p-n, chemistry inconclusive.	See above.
	τ 41.5^m	50W12	Produced by Ho-n-2n.	H.Wäffler, HPA 23, 239.
165 67 98	$\bar{\sigma}$(fast n,2n)41.5^{m}Hp for E_n >6.5 $\left.\right\}$ '1.04 "0.35	50W12	'Li-0.5 Mev d-n. E_n(max)=13.8. "B -0.5 Mev d-n. E_n(max)=13.	See above.
166 67 99	β_1^- ~10% 0.55 sl β_2^- 1.84 sl γ 0.080 sl;pe$^-$,ce$^-$ α_L~0.4 K/L<1 11% 1.36 sl;pe$^-$ βe^- coincidences. Delay <0.3$^{\mu s}$	50S20	Proposed decay scheme: 	K.Siegbahn, H.Slätis, Arkiv för Fysik 1, 559.
	β^- 1.84 γ 0.081 α large 1.5 α~0	50A12	$\beta\gamma$ coincidences.	N.M.Anton'eva, et al., Doklady Akad. Nauk S.S.S.R. 70, 397; NSA 4, # 3215.
169 ? 67 ?	τ 44^m	50B7	Produced by Er-23 Mev γ. Might be Er^{163} or Er^{165}.	F.D.S.Butement, Nature 165, 149.

68 ERBIUM Er

Er	Relative isotopic abundances 162 0.154% 167 22.82% 164 1.60 % 168 27.02% 165 - - 170 15.04% 166 33.36 %	50L3	Mass spectrometer with electron multiplier used for high sensitivity. 160 $<$0.005% 169 $<$0.15% 161 $<$ 0.01 % 171 $<$ 0.01% 163 $<$ 0.01 % 172 $<$ 0.01%	W.T.Leland, PR 77, 634.
	162 0.136% 167 22.94% 164 1.56 % 168 27.07% 166 33.41 % 170 14.88% Extremely pure sample	50H4	160 $<$ 0.0008% 169 $<$ 0.008 % 161 $<$ 0.0008% 171 $<$ 0.005 % 163 $<$ 0.0009% 172 $<$ 0.0014% 165 $<$ 0.003 %	R.J.Hayden, et al., PR 77, 299.
$^{163}_{68}{}_{95}$	τ 11.2^h γ 20% 1.1 a e^- 0.1% 0.08 a K,L X-rays	50W16	Produced by Dy-38 Mev α, and not by Ho-19 Mev d; ion exchange. p 5.1^{d}Ho.	G.Wilkinson, H.G.Hicks, UCRL-744.
$^{169}_{68}{}_{101}$	β 0.33 scin	49B60	Allowed shape.	P.R.Bell, J.Cassidy, ORNL-481, 15.
$^{?}_{68}{}_{?}$ 2.5^s	γ 0.185 scin	50C18	Two conversion peaks from pile irradiated very pure Er.	E.C.Campbell, J.H.Kahn, ORNL-694, 15.

69 THULIUM Tm

$^{170}_{69}{}_{101}$	τ 127^d β^- 0.990 sl γ 0.0854 sl;ce$^-$	50A1	Fermi plot slightly concave. No correction factors fit.	H.M.Agnew, PR 77, 655.
	$\beta\gamma$ angular correlation Coincidence studies support 49F13.	50N5	b = -0.26 in $1+b\cdot\cos^2\theta$ when X-rays are eliminated.	T.B.Novey, PR 78, 66.
	γ 0.0848 sπ,ce$^-$	50C10		R.L.Caldwell, PR 78, 407.
	βe^- delay = 0.0016$^{\mu s}$	50B16	73 kev ce$^-$ of 85 kev γ.	R.E.Bell, R.L.Graham, PR 78, 490.
	γ 0.198 sl;pe$^-$ 0.360 sl; Compt $\sim$0.550 sl; Compt	50G16	Last group may be double.	P.J.Grant, Nature 165, 1018.
$^{?}_{69}{}_{?}$	τ 19^m	50B7	Produced by Yb-23 Mev γ.	F.D.S.Butement, Nature 165, 149.

70 YTTERBIUM Yb

Yb	Relative isotopic abundances 168 **0.13%** 173 **16.08%** 170 **3.03%** 174 **31.91%** 171 **14.27%** 176 **12.80%** 172 **21.77%**	50L3	Mass spectrometer with electron multiplier 166 $<$ **0.001 %** 175 $<$ **0.005 %** 167 $<$ **0.0005%** 177 $<$ **0.001 %** 169 $<$ **0.0005%** 178 $<$ **0.0005%**	W.T.Leland, PR **77**, 634.
169 70 99	τ **31.8**^{d}	49W23		D.Walker, Proc. Phys. Soc., Lond., **A62**, 799.
175 70 105	γ **0.1375** **0.2826** **0.2589** **0.3963** **sπ,ce$^-$**	50C16	Lines are converted in Lu.	J.M.Cork, et al., PR **78**, 95.
	$\beta\gamma$ delay $<$ 0.004$^{\mu s}$	50M22		F.K.McGowan, ORNL-694, 19.
177 70 107	γ **0.150** **scin** K/L=3	50M22		See above.

71 LUTETIUM Lu

Lu	Relative isotopic abundances 175 **97.40%** 176 **2.60%**	50H4	173 $<$ **0.008%** 177 $<$ **0.006%** 174 $<$ **0.008%** 178 $<$ **0.006%**	R.J.Hayden, et al., PR **77**, 299.
177 71 106	β^- **0.475** **s** γ_3 **0.112** **s;ce$^-$** γ_2 **0.205** **s;ce$^-$**	50A13	$\alpha_K:\alpha_L:\alpha_M$ = 1:2:0.5 for γ_3. L line only of γ_2 observed.	N.M.Anton'eva, et al., Doklady Akad. Nauk, S.S.S.R. **70**, 597; NSA **4**, # 3216.
178 ?	τ **8**^{h}	50B7	Produced by Hf-23 Mev γ; chem.	F.D.S.Butement, Nature **165**, 149.
179 ?	τ **22**^{m}	50B7	Produced by Hf-23 Mev γ; chem.	See above.

72 HAFNIUM Hf

181 72 46^{d} 109	$\gamma\gamma$ delay of 0.011$^{\mu s}$	50B24	Hard and soft γ's follow 22$^{\mu s}$ state but no γ precedes it.	W.C.Barber, PR **78**, 82(A) and 641(A).
	$\gamma\gamma$ delay of 0.011$^{\mu s}$ γ **0.132** **scin** K/L=**1.2**	50M22	0.132 γ has τ=22$^{\mu s}$. 0.011$^{\mu s}$ state not found in 5.5^{h}Hf.	F.K.McGowan, ORNL-694, 19.
	No delayed or instantaneous coincidences for $E_\gamma >$ 0.25	49L22	No counts with 1 mm Pb in front of both counters.	A.Lundby, PR **76**, 1809.
	γ_2 **0.1327** K/L $\sim$ **1** γ_3 **0.1357** K/L $\sim$ **0.2** γ_4 **0.3445** **sπ,ce$^-$** γ_5 **0.4810** γ_6 **0.612**	50C9	Coincident: $\gamma_2\gamma_4$, $\gamma_2\gamma_5$, $\gamma_3\gamma_4$. Non-coincident: $\gamma_4\gamma_5$. K line only of γ_4 observed. γ's of 0.089 and 0.342 with Lu K,L,M differences observed.	J.M.Cork, et al., PR **78**, 299.
	γ_5/γ_4=3.5 γ_5/γ_4~2.5	49J5 49C11	References interchanged on table.	
5.5^{h}	τ **5.5**^{h} β^- **0.445** **aβe$^-$** $\sim$ **0.70** **a** γ's **0.130 ?** **a** **0.340** **a** **0.470** **a**	50B25	No delayed coincidences. 0.087 γ in 46^{d}Hf^{181} reported by 49J5 interpreted as transition to 5.5^{h} state.	S.B.Burson, K.W.Blair, PR **78**, 89(A) and ANL-4397.

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73 TANTALUM Ta

178,179	τ 9.35^m β^+ 3%* 1.06 a γ 3% ~ 1.5 a e^- 50% 0.08 a K, L X-rays	50W1	*% of K X-ray. Produced by Hf-10 Mev p and decay of 21^{d}W; chem. (E_{dis} very large for Ta^{179}. E_{e-} ~ same as that of 19^{s}Hf.)	G.Wilkinson, UCRL-625.
181 73 108	σ(14 Mev d,p) 0.140	50G11	Proton yield averaged over angle.	H.E.Gove, et al., MIT Progress Report, April 1950, 86.
	σ(15 Mev d,p) 117^{d}Ta 0.89	50S18	Based on σ[Al(d,pα)Na^{24}] 47C14.	K.H.Sun, et al., PR 78, 338(A).
182 73 109 117^d	γ 0.0460 0.0844 0.1975 0.0584 0.0998 0.2211 0.0653 0.1132 0.2280 } $s\pi$, ce$^-$ 0.0672 0.1515 0.2623 0.0748 0.1784	50C16	Conversion lines reinterpreted taking account of fine structure in L lines.	J.M.Cork, et al., PR 78, 95.
	β^- 0.5 a γ 1.2 a Hard γ's/0.5β ~ 1.2 e^-/β ~ 0.7	50E2	From comparisons with Sc and Co and $\beta\gamma$, $\beta\beta$ coincidences. $\beta\gamma/\beta$ = constant showing all β and soft e^- coincide with hard γ.	D.W.Engelkemeir, et al., ANL-4478.
	No delays > 0.004$^{\mu s}$	50M22		F.K.McGowan, ORNL-694, 19.
183 ? 73 110 ?	τ 6^d	50B7	Produced by W-23 Mev γ; chem.	F.D.S.Butement, Nature 165, 149.
185 ? 73 112 ?	τ 48^m	50B7	Produced by W-23 Mev γ; chem.	See above.

74 WOLFRAM W

W	Neutron resonance at 18 ev assigned to W^{186}. Γ=0.039	49G9	Unintentionally omitted in table.	M.Goldhaber, et al., BNL-C-9, 96.
178,179	τ 21.0^d γ ~ 2%* 0.27 p 9.3^{m}Ta chem	50W1	*% of K X-ray. No e^-. Produced by Ta-50 Mev p; chem.	G.Wilkinson, UCRL-625.
182 74 108	Ta-14 Mev d-n. E_n(max)=14.5	50P11	Some evidence for n groups.	R.A.Peck, Jr., PR 78, 338(A).
183 74 109 stable	I 1/2 S	50F8	Sample enriched to 90% in W^{183}.	G.R.Fowles, PR 78, 744.
	Δf(W^{183}-Ni^{61})=8.49 ± 0.02	50D8		H.E.Duckworth, et al., PR 78, 386.
186 74 112	Δf(W^{186}-Ni^{62})=9.03 ± 0.02	50D8		See above.
187 74 113	γ 0.133 scin K/L=5 τ=0.55$^{\mu s}$	50M22		F.K.McGowan, ORNL-694, 19.
188 74 114	τ months p Re^{188}	50L8	Produced by W-n-γ, n-γ. Observed only through daughter.	M.Lindner, J.S.Coleman; PR 78, 67.
	τ ~ 90^d γ 1.67 < E < 2.23 γn	50A9	Produced by W-n. Assignment tentative.	D.E.Alburger, et al., BNL-64 (S-6).

75 RHENIUM Re

Re	$E_0(n,\gamma)$ in ev 50H19 2.15 (Re^{185}), 4.5, 5.9, 7.2, 11.2, 13.2, 17.6	Possibly others at 20.5, 34, 40, 52, 75, 156, 270, 580, 1800.	W.W.Havens, Jr., et al., CUD-36 and 45.
$^{?}_{75}$?	τ ~ 1^h 50C11	Produced by Os-19 Mev d, chem.	T.C.Chu, UCRL-624; PR 79, 582.
$^{185}_{75}$ 110	σ(32 Mev α,n) 41.5^h Ir 0.21 50C11 σ(32 Mev α,2n) 11.8^h Ir 1.2		See above.
$^{186}_{75}$ 111	$\beta\gamma$ delay $< 0.004^{\mu s}$ 50M22		F.K.McGowan, ORNL-694, 19.
$^{187}_{75}$ 112	σ(22 Mev α,n) 12.6^d Ir 0.24 50C11 σ(32 Mev α,n) 12.6^d Ir 0.15 σ(22 Mev α,n) 3.2^h Ir 0.01 σ(32 Mev α,n) 3.2^h Ir 0.006 σ(22 Mev α,3n) 41.5^h Ir 0.13 σ(32 Mev α,3n) 41.5^h Ir 0.81 σ(22 Mev α,4n) 11.8^h Ir 0.009		T.C.Chu, UCRL-624; PR 79, 582.
189,191	τ 17^m 50B7	Produced by Os-23 Mev γ, chem.	F.D.S.Butement, Nature 165, 149.

76 OSMIUM Os

$^{?}_{76}$?	τ 50^d 50C11	Produced by Re-38 Mev α, chem. Milked from Ir's. Not 95^dOs.	T.C.Chu, UCRL-624; PR 79, 582.
$^{182}_{76}$ 106	τ 24^h 50J5 K, no β^+	Produced by Re-40 Mev p-4n, chem. p 12.7^hRe.	B.M.Jones, UCRL-656.PR 80. 99.
$^{183}_{76}$ 107	τ 12.0^h 50J5 γ 18%* 0.34 a 10% 1.6 a e^- 18% 0.15 a ~ 1% 0.42 a K,L X-rays	* % of K X-ray. Produced by Re-25 Mev p-3n, chem. p Re^{183}.	See above.
$^{187}_{76}$? 111 ?	τ 35^h 50C11	Produced by Re-38 Mev α, chem. Milked from Ir's. d 11.8^hIr?	T.C.Chu, UCRL-624; PR 79, 582.
$^{190}_{76}$? 114 ?	τ_1 6^h 50C11 τ_2 9.5^m	Produced by Re-38 Mev α, chem. 6^hOs possibly d 12.6^dIr. 9.5^mOs d 3.2^hIr.	See above.
$^{191}_{76}$ 115	τ 16.0^d 50C11	Produced by Os-19 Mev d.	See above.
$^{193}_{76}$ 117	τ 30.6^h 50C11 β^- 1.15 a	Produced by Os-19 Mev d.	See above.
$^{194}_{76}$ 118	τ months 50L8 p 19^hIr	Produced by Os-n-γ, n-γ. Os^{194} not observed directly.	M.Lindner, J.S.Coleman, PR 78, 67.

187	τ		11.8^h		50C11	* % of K X-ray	T.C.Chu, UCRL-624; PR 79, 582.
77 110	β^+	0.2%*	2.2	s		Produced by Re-α; f, σ, chem	
	γ	75%*	1.3	a		and Os-19 Mev d. See Re^{185}	
	e^-	22%*	0.28	s,a		and Re^{187} for σ's from	
		2.5%*	1.2	s,a		enriched samples.	
	K,L X-rays					High proportion of L X-rays.	
	p 35^hOs ?					(Bohr-Wheeler E_{dis} ~ 1 Mev.)	
188	τ		41.5^h		50C11	Produced by Re-α; f, σ, chem	See above.
77 111	β^+	0.3%*	2	s,a		and Os-19 Mev d. See Re^{185}	
	γ	55%*	1.8	a		and Re^{187} for σ's.	
	e^-	8%*	0.16	s,a		(Bohr-Wheeler E_{dis} ~ 1.5 Mev.)	
		0.7%*	0.85	s,a			
189 ?	τ		$>100^d$		50C11	Produced by Re-40 Mev α; chem.	See above.
77 112 ?							
190	τ		3.2^h		50C11	Produced by Re-α; f, σ, chem	See above.
77 113	β^+		1.7	s		and Os-19 Mev d. See Re^{187}.	
	e^-		0.2	s,a		Yield very similar to that of	
			0.8	s		12.6^d activity.	
	p 9.5^mOs					(Bohr-Wheeler E_{dis} ~ 1 Mev.)	
190	τ		12.6^d		50C11	Produced by Re-α; f, σ, chem	See above.
77 113	γ	45%*	0.17	a		and Os-19 Mev d. See Re^{187}.	
10.7^d		42%*	0.55	a			
	e^-	7%*	0.17	a			
		4%*	0.5	a			
	K?,L X-rays						
	p 6^hOs						
192	γ		0.0574	sπ,ce$^-$	50C10	No ce$^-$ from a 30 kev line.	R.L.Caldwell, PR 78, 407.
77 115							
1.42^m							
192	τ		74.7^d		50C11	Produced by Os-19 Mev d.	T.C.Chu, UCRL-624, PR 79, 582.
77 115							
70^d	No $\beta\gamma$ angular correlation				49G21		R.L.Garvin, PR 76, 1876.
	No delayed $\beta\beta$, $\beta\gamma$, or $\gamma\gamma$				50D6		M.Deutsch, W.E.Wright, PR 77,
	coincidences, $(0.005-1)^{\mu s}$						139.
194	No ce$^-$ between 20 and 275 kev				50C10		R.L.Caldwell, PR 78, 407.
77 117							
19.0^h							
195,197	τ		66^m		50B7	Produced by Pt-23 Mev γ; chem.	F.D.S.Butement, Nature 165, 149.

78 PLATINUM Pt

190 78 112	Relative abundance **0.012%**	49L25		W.T.Leland, PR **76**, 992.
192 78 114	$\Delta f(Pt^{192}-Zn^{64})$ = 9.24	50D8		H.E.Duckworth, et al., PR **78**, 368.
195 78 117	f = 1.36 ± 0.04 $\Delta f(Pt^{195}-Cu^{65})$ = 9.23	50D5	From $\Delta f(C_3H_3-Pt^{195})$ = 7.86 and $f(C_3H_3)$ = 9.219 assuming $Pt^{195}-Pt^{196}$ is integral.	H.E.Duckworth, et al., PR **78**, 479.
	μ **0.6005** **I**	49P24	$\nu(Pt^{195})/\nu(Na^{23})$ (H_2PtCl_2) = 0.8127 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **76**, 1728.
197 ? 78 119 ?	τ **82^d** β^- ~ **0.54** **a** γ ~ **0.6** **a**	50C3	Produced by Pt-n-γ; chem.	J.M.Cork, et al., PR **77**, 843.
198 78 120	$\Delta f(Pt^{198}-Zn^{66})$ = 9.43	50D8		H.E.Duckworth et al., PR **78**, 386.

79 GOLD Au

198 79 119	No $\beta\gamma$ angular correlation	50R6, 50S27	b = 0.004 ± 0.015.	S.L.Ridgway, PR **78**, 821. R.Stump, S.Frankel, PR **79**, 243(A).
198 ? 79 119 ?	e^- **0.044** **s** **0.058** **s**	49T19	Interpreted as K and L lines of γ's of 0.125 and 0.072 respectively. Produced by Au-pile n's.	B.V.Thosar, Proc. Phys. Soc., Lond., **A62**, 739.
	$\beta\gamma$ delay of $0.04^{\mu s}$ found in 4^h activity produced by Au-n-γ and Au-d-n	50J7	Not produced by Au-p.	P.S.Jastram, et al., PR **79**, 243(A).
199 79 120	γ_1 **65.0** γ_2 **76.6** γ_6 **131.4** γ_3 **98.3** γ_7 **133.7** γ_4 **103.0** γ_8 **138.6** γ_5 **129.2** γ_9 **157.6** } **kev** **$s\pi$; ce$^-$**	50C3	Produced by Pt-n-γ,n-γ. K/L ~1 for γ_4 and γ_9 K/L≪1 for γ_5, γ_6, γ_8 All lines interpreted as converted in Hg. (Note 0.126γ assigned to Pt^{193} on table.)	J.M.Cork, et al., PR **77**, 843.
	$\beta\gamma$ delay < $0.005^{\mu s}$	50M22		F.K.McGowan, ORNL-694, 19.
	No delayed $\beta\beta$, $\beta\gamma$, or $\gamma\gamma$ coincidences, $(0.005-1)^{\mu s}$	50D6		M.Deutsch, W.E.Wright, PR **77**, 139.
201 ? 79 122 ?	τ **27^m**	50B7	Produced by Hg-23 Mev γ; chem.	F.D.S.Butement, Nature **165**, 149.

80 MERCURY Hg

Hg	$\sigma_a(276°)/\sigma_a(476°)=1.35$	49R14	σ_a decreases faster than 1/v.	W.Ramm, Z. Naturforsch.**4a**, 245.
197 80 117 25^{h}	Angular correlation of L e^-'s of 0.135 and 0.165 γ's observed	50F3	b= 0.24.	H.Frauenfelder, et al., PR **77**, 557.
	0.135 γ (K/L < 1) delayed by 0.007$^{\mu s}$ 0.165 γ (K/L ~ 0.1) precedes delay	50M12	0.165 γ may have appreciable lifetime.	F.K.McGowan, PR **78**, 325(A).
199 80 119 stable	μ **0.4994** I	49P24	$\nu(Hg^{199})/\nu(D^2)$ $(HgNO_3)$ = 1.1647 ± 0.0001.	W.G.Proctor, F.C.Yu, PR **76**, 1728.
203 80 123	Mass assignment of 43.5^{d} activity by ms.	50B18		I.Bergström, et al., Arkiv för Fysik **1**, 281.
	βγ delay < 0.02$^{\mu s}$	50B3		D.Binder, PR **77**, 291.
	βγ delay < 0.003$^{\mu s}$	50D6		M.Deutsch, W.E.Wright, PR **77**, 139.

81 THALLIUM Tl

202 81 121	τ **11.50^{d}** γ 60%* **0.435** s,a e^- 10% **0.35** K,L X-rays	50W17	Produced by Hg-d; chem. *Relative to K X-ray. L X-ray more intense than K.	G.Wilkinson, UCRL-750. PR **79**, 1014.
204 81 123	β^- **0.85** a	50E3	Feather analysis.	H.D.Evans, Proc. Phys. Soc. Lond., **A63**, 575.
207 81 126	β^- **1.44** a	50E3	See above.	See above.
208 81 127	γ_X **2.615** sl;pe$^-$,ce$^-$	50W2	Compared with Au^{198} 0.4112 γ and Co^{60} 1.332 γ.	J.Wolfson, PR **78**, 176.
	3.2 Mev γ not found Dγp	50B20	< 0.001 photons per disintegration.	G.R.Bishop, et al., PR **77**, 416.
	Intensities, % of disintegrations γ — I(γ)* — $I(e^-_K)$** — α_K*** G 7.2-11.2 2.64 0.29 L 18-26 1.84 0.084 M 65-95 1.34 0.017 P 12.5-18 0.26 0.017 X 100 0.18 0.18 G K/L=6.3 From $I(ce^-_K)$ of 48M30 M K/L=3.7 and $I(ce^-_L)$ of 39F4	50M27	Lower limits of I(γ) from heights of pe^- lines from thick targets of Au,Th. Upper limits are these values times 1.46 except for X. This factor gives $I(\gamma)+I(ce^-)$ = 83% for F line of Pb^{212} q.v. this supplement. Comparison with theoretical values of α_K of Rose, et al., indicates I=4,3,3,1,0 for levels of table in descending order.	D.G.E.Martin, H.O.W.Richardson, Proc. Phys. Soc., Lond., **A63**, 223. *Unconverted γ's. **Values from 48M30. Not in table. ***For mean value of I(γ).
210 81 129	γ's with E > 2.8 reported by 37D3 and 37N4 not found by Dγp	50B20	< 0.05 photons per disintegration.	G.R.Bishop, et al., PR **77**, 416.

Pb	$\tau_\alpha > 3\text{x}10^{15^y}$		49J10	No activity found with photo plates.	K.Jenkner, E.Broda, Nature **164**, 412.
	Relative isotopic abundances 204 1.37% 207 20.82% 206 26.26% 208 51.55%		50H23		R.F.Hibbs, Y-604.
	σ_t(0.26-0.66 Mev) σ_t(2.35 Mev)	table* 6.02**	50B15	*C-d-n and **D-d-n sources.	E.Bretscher, E.B.Martin HPA **23**, 15.
	σ_t (84 Mev) σ_{el} (84 Mev) σ_{in} (84 Mev)	4.47 2.79 1.83	50B11	Be-190 Mev d-n. C-n-2n detection. σ_{el} from integration over angle. σ_{in} from poor geometry experiment.	A.Bratenahl, et al., PR **77**, 597.
	σ_t (95 Mev) σ_{in} (95 Mev)	4.48 1.79	50D1	Be-190 Mev d-n. Bi-f detector. σ_{in} from poor geometry exper.	J.DeJuren, N.Knable, PR **77**, 606.
	Isotope shifts studied with enriched materials		50G20	$(\nu_{206}-\nu_{204})/(\nu_{208}-\nu_{206})$ = 0.90 for two lines.	F.E.Geiger, Jr., PR **79**, 212(A).
204 82 122 68^m	$\gamma\gamma$ angular correlation found		50G13		M.Goldhaber, et al., BNL-51, 61.
205 82 123	Pb^{206}-γ-n threshold = 8.25		50P13	Based on Cu^{63}-γ-n threshold = 10.9. n's detected.	H.Palevsky, A.O.Hanson, PR **79**, 242(A).
	Pb^{206}-d-t Q=-1.83,-2.10,-2.67,-3.62		50H16	Levels: 0.27, 0.84, 1.79. E$_d$ = 14.	J.A.Harvey, MIT Progress Report, April 1950.
206 82 124	Pb^{207}-γ-n threshold = 6.95		50P13	See Pb^{205}.	See Pb^{205}.
	Pb^{207}-d-t Q=-0.42,-1.28,-1.79,-2.13,-2.64,-3.45		50H16	Levels: 0.86, 1.37, 1.71, 2.22, 3.03.	See Pb^{205}.
	σ_t studied		50A17	Average level spacing ~50 kev.	R.K.Adair, et al., PR **79**, 218(A).
207 82 125	Pb^{206}-n-γ $\sigma[\text{Pb}^{207}(\text{th n},\gamma)]/\sigma[\text{Pb}^{206}(\text{th n},\gamma)]$ = 7	Q=6.68	50K7,50K8	Normal Pb used. Two capture γ's found. Lower energy γ attributed to Pb^{207}, higher to Pb^{208}.	B.B.Kinsey, et al., PR **78**, 77 and **78**, 481.
	Pb^{206}-d-p Q=4.48,3.86,3.53,1.73,0.88, 0.06,-0.18,-0.80		50H16	Levels: 0.62, 0.95, 2.75, 3.60, 4.42, 4.66, 5.28.	See Pb^{205}. Also PR **79**, 241(A) and PR **78**, 345(A).
	Pb^{208}-γ-n threshold = 7.44		50P13	See Pb^{205}.	See Pb^{205}.
	Pb^{208}-d-t Q=-1.10,-1.71,-2.05,-2.71,-3.43		50H16	Levels: 0.61, 0.95, 1.61, 2.33.	See Pb^{205}.
207 ?	τ γ	0.9^s 0.5 scin 1.0 scin	50C8	Produced by Pb-pile n's.	E.C.Campbell, M. Goodrich, PR **78**, 640(A); ORNL-577, 21.
208 82 126	Pb^{207}-n-γ	Q=7.37	50K7,50K8	See Pb^{207}.	See Pb^{207}.
	Pb^{207}-d-p Q=5.14,1.77,1.54,0.01,-0.30,-0.95		50H16	Levels: 3.37, 3.60, 5.13, 5.44, 6.09.	See Pb^{205}. Also PR **79**, 241(A) and PR **78**, 345(A).

(Pb continued on next page)

82 LEAD -Pb (continued)

209 82 127	Pb^{208}-d-p 50H16 Q=**1.65,0.90?,0.09,-0.38,-0.89**	Levels: 0.75?, 1.56, 2.03, 2.54.	See Pb^{205}. Also PR **79**, 241(A) and PR **78**, 345(A).
210 82 128	L X-rays 100* α_1 **10.8 kev** 49S46 45* β_4 **12.7** 95* $\beta_{1,2}$ **13.0** 40* β_3 **13.3** Other weak lines at 7.1,7.4,8.0,8.9, 9.5 kev *Relative intensities	β spectrum shows (atoms ionized in L_I)/(atoms ionized in L_{III})= 31. Suggest that passage of e^-'s from L_{III} to L_I accounts for high intensity of β_3 and β_4 relative to α_1.	L.Salgueiro, M.Valadares, Portugaliae Physica **3**, 21.
212 82 130	Intensities, % of disintegrations 50M27 γ E_γ $I(\gamma)^*$ $I(e^-_K)$ F 0.238 30.1-44 31.3** H 0.300 3.3-4.8 1.2*** See Tl^{208} for notes on $I(\gamma)$	$I(e^-_L)$ α_K K/L Λ 5.7*** 0.71 5.5 1 mag? 0.2*** 0.25 6.0 1 mag? α_K is for higher value of $I(\gamma)$.	D.G.E.Martin, H.O.W.Richardson, Proc. Phys. Soc., Lond., **A63**, 223. *Unconverted γ's. **Value from 48M30. ***Value from 39F4. Not in table.
	β_1 ~ 83% (not 88% as in table) 48M30	Estimated value from intensity of β_2 and γ's.	D.G.E.Martin, H.O.W.Richardson, Proc. Roy. Soc. **A,195**, 287.
	β_1 **0.340** **s** 49G26	Double spectrometer measurement of β's coincident with F ce^-'s. Fermi plot straight.	L.V.Groshev, L.Y.Shavtvalov, Doklady Akad. Nauk,SSSR **68**, 257; NSA **4**, #1767.
214 82 132	γ's 49L28 Table of 86 conversion lines with energies between 0.584 and 1.438	Radon used as source. Multipolarity of lines indicated.	G.D.Latyshev, et al., Izv. Akad. Nauk, Ser. Fiz. **13**, 428; Chem.Abst. **44**, 3364f (1950).

83 BISMUTH Bi

206 83 123	γ **$1.67 < E_\gamma < 2.23$** 50D7		E.der Mateosian, M.Goldhaber, PR **78**, 326(A).
208 83 125	Bi-d-t 50H16 Q=**-1.17,-1.76,-2.18**	Levels: 0.59, 1.01.	J.A.Harvey, MIT Progress Report, April 1950, 67.
209 83 126	τ_α **$> 3x10^{15}$ ^{y}** 49J10	Search for α's with photo plate.	K.Jenkner, E.Broda, Nature **164**, 412.
	μ **4.0399** **I** 50P5	$\nu(Bi^{209})/\nu(D^2)$ $[Bi(NO_3)_3]$ = 1.0468 ± 0.0001	W.G.Proctor, F.C.Yu, PR **78**, 471.
	σ(14 Mev d,p) **0.145** 50G11 for Q > **2.2**	Proton yield averaged over angle.	H.E.Gove, et al., MIT Progress Report, April 1950, 86.
210 83 127	Bi-d-p 50H16 Q=**1.95,0.3,-0.3,-0.8**	Levels: 1.65, 2.2, 2.8.	See Bi^{208}. Also PR **79**, 241(A) and PR **78**, 481.
long	τ **$> 25^y$** 50N4 α **5.12** **ic** **p 4.2^{m}Tl**	Produced by Bi-n, chem and not by Pb-20 Mev d. α and β activity observed after decay of 5^dRaE.	H.M.Neumann, et al., PR **77**, 720.

(Bi continued on next page)

83 BISMUTH Bi (continued)

210 83 127 4.85^d	β^- 8% **1.080** s **1.165** s γ **0.080** a;s,ce$^-$	49Z3		A.S.Zavel'skii, et al., J. Exp. Theor. Phys. USSR **19**, 1136. Phys. Abst. **53**, #3363 (1950).
	Bi-n-γ E_γ (max)=4.17	50K7	From capture γ studies. Single weak, unusually broad peak.	B.B.Kinsey, et al., PR **78**, 77.
212 83 129	γ (0 line) **0.721** $I(\gamma)^*$ $I(e^-_K)^{**}$ α_K^{***} 5.7-8.3% 0.106% 0.015	50M27	*Unconverted γ's per β disint. **Value from 48M30. Not in table. ***For mean value of $I(\gamma)$. See Tl^{208}.	D.G.E.Martin, H.O.W.Richardson, Proc. Phys. Soc., Lond., **A63**, 223.
214 83 131	Monochromatic β^+ observed from pair production of 1.527 and 1.620 γ's	48L17	$E_{\beta^+} = h\nu - 2mc^2 + B$, where B is binding energy of e^- in shell.	G.D.Latyshev, et al., Doklady Akad. Nauk,SSSR **63**, 511. Guide to Russ. Sci. Lit. **3**, 37 (1950).
	γ's Table of 86 converson lines with energies between 0.584 and 1.438	49L28	Radon used as source. Multipolarity of lines indicated.	G.D.Latyshev, et al., Izv. Akad. Nauk, Ser. Fiz **13**, 428. Chem. Abst. **44**, 3364f (1950).
	γ's **1.414,1.760,2.198** K conversion spectra show fine structure separation of 6.2 kev	48G23	1.414 γ has two components of 2.4 kev separation. Satellites weaker on high energy side.	V.V.Gei, et al., Doklady Akad. Nauk,SSSR **63**, 239. Guide to Russ. Sci. Lit. **3**, 33 (1950).
	γ **1.414** L and M conversion spectra show separations of 2.5 and 6.0 kev α_K: α_L: α_M = **5.4**: 1:0.33 (K conversion)/(pair formation) = 440*	49L29	*Previous value was 625. Conversion ratios indicate 0 – 0 transition.	G.D.Latyshev, et al., Izv. Akad. Nauk,SSSR, Ser Fiz **13**, 340. Phys. Abst. **52**, #7253 (1949).
	γ **1.760** (K conversion)/(pair formation)=250 **2.198** (K conversion)/(pair formation)=140	48G24	Ratios are ~ 1/2 theoretical quadrupole values, ~ 1/10 dipole values.	V.V.Gei, et al., Izv. Akad. Nauk,SSSR, Ser. Fiz. **12**, 729. Phys. Abst. **52**, #7250 (1949).
	γ's **0.606,1.120,1.414,1.760** No fine structure found	50B42	Resolving power 0.5-0.2%. Source on 5μ Al foil avoids distortions from glass ampoule.	A.A.Bashilov, et al., Doklady Akad. Nauk,SSSR **70**, 793. NSA **4**, #3800 (1950).
	γ 1* **2.208** sl;pe$^-$ 0.4* **2.452** sl;pe$^-$	50W2	Au and Co lines taken as standards. *Relative inten.	J.L.Wolfson, PR **78**, 176.
	γ of ~ 3 Mev not found < 0.001 photons per disintegration	50B20	Expected from long range α's. Detection by photo p's in D.	G.R.Bishop, et al., PR **77**, 416.

84 POLONIUM Po

208 84 124	τ **2.93^y**	50T3	Observed over 3 y period with ic calibrated by Th^{230}.	D.H.Templeton, UCRL-616 and PR **78**, 312.
209 84 125	α **4.90** K/α ~ 0.1	50PGS	K/α from L X-rays (D.G.Karraker, D.H.Templeton, unpublished data).	I.Perlman, et al., PR **77**, 26.
210 84 126	γ **0.803** sl;ce$^-$,pe$^-$ **K/L=3.7**	50A19	Only one γ found.	D.E.Alburger, BNL-64 (S-6), 1.

85 ASTATINE At

211 85 126	Auger e^-/Po^{211} α=0.093	50G22	From ratio of $(\alpha + e^-)$ tracks to total number of α tracks in photo plate.	L.S.Germain, PR **78**, 90(A) and UCRL-770; PR 80, 937.

86 RADON Rn

87 FRANCIUM Fr

222 87 135	τ **14.8^m** β^-	50H20	Produced by Th^{232}-100 Mev p, chem. Assignment from energies of α daughters.	E.K.Hyde, A.Ghiorso, UCRL-593.
223 87 136	γ_1 27%* **0.0486** **crit a** γ_2 6% ~ **0.330** **a** L X-ray 25% **crit a**	50L13	*Quanta per disintegration from calibrated counters and Ac source of known intensity. From X-ray intensity and fluor. yield conclude γ_1 is in cascade with most β's.	M.Lecoin, et al., J. de phys. et rad. (8) **11**, 227.

88 RADIUM Ra

228 88 140	γ ~ **0.030** **a** L X-ray ~ 4%	49L27		M.Lecoin, et al., J. de phys. et rad. (8) 10, 390.

89 ACTINIUM Ac

226 89 137	τ **29^h**	50S9		K.Street, Jr., quoted in UCRL-589 and PR **78**, 475.
227 89 138	β^- < 2% with 3 kev < E_β < 40 kev $\gamma_1$0.22%* **0.0368** **a** γ_2 0.2% ~ **0.300** **a** e ~ 10% ~ **0.012** **cc** L X-ray 5%	50L13	*See Fr^{223}. If X-rays due to conversion of γ_1, expect 17 kev e^-'s in ~ 12% of disintegrations. Then expect β's to ground in 88% of disintegrations. Not found. γ_2 may be connected with α emission.	M.Lecoin, et al., J. de phys. et rad. (8) **11**, 227.

90 THORIUM Th

227 90 137	Intensities, % of disintegrations	50R10	*Photons per disintegration measured with Xe counter whose absolute efficiency was calc. Rough agreement with two earlier measurements.	M.Riou, J. de phys. et rad. (8) **11**, 185.

	E_γ(kev)	$I(\gamma)^*$
(L X-ray)	14.5	11
	50	3
	120	13
	280	50

228 90 138	Intensities, % of disintegrations	50R10	*See above.	See above. **41S10 J.Surugue, CR **213**, 172 (1941). $I(e^-)$ in disagreement with α particle %'s. I(L X-ray) in agreement if fluorescence yield $\doteq$ 0.37.

	E_γ(kev)	$I(\gamma)^*$	$I(e_L^-)^{**}$	$I(e_M^-)^{**}$	α_L	L/M
(L X-ray)	~ 14	7				
	84.0	1.8	4.4	0.6	2.4	7.3
	86.5	0.7	1.7	0.2	2.4	8.5

(Th continued on next page)

90 THORIUM Th (continued)

228 90 138 (continued)	e^- 7.6% Compare I(e_L^- + e_M^-)=6.9% from 50R10	50A11	From photo plate tracks of e^-'s with common origin with α's.	G.Albouy, J.Teillac, CR **230**, 945.
230 90 140	Intensities, % E_γ(kev) I(γ)* I(γ)** (L X-rays) ~ 14 11 9 68 0.85 0.5 140 0.33 }0.3 240 0.05	49C34*, 50R10**	Same type discrepancy here as noted for Th^{228}. High conversion of γ's indicates big spin change not reflected by α particle %'s.	50R10. See Th^{227}. 49C34. I.Curie, J. de phys. et rad. (8) **10**, 381.
232 90 142	α Range=15.1μ*	49K39	*In Ilford B1 emulsion. Cf. U^{234} and U^{238}.	H.Korsching, Z. Naturforsch. **4a**, 563.

91 PROTACTINIUM Pa

230 91 139	τ_α **1400**^{y}* α ~ 3.4x10^{-3}%* p 29^hAc^{226}, chem	50M8	*Assuming K/β^- = 10. Ac separated from large amounts of Pa^{230} and identified by α of daughter.	W.W.Meinke, G.T.Seaborg, UCRL-589 and PR **78**, 475.
235 91 144	τ **23.7**^{m} β **1.4** a No γ's detected a	50M8	Produced by U-9 Mev p-α and U-19 Mev d-αn, chem.	See above.

92 URANIUM U

U	σ_t **4.92**	50D1	Be-190 Mev d-n. Bi-f detector.	J.DeJuren, N.Knable, PR **77**, 606.
233 92 141	σ(d,xn)Np	50M14	Approximate values given for E_d=15 and 50 Mev.	L.B.Magnusson, et al., PR **78**, 363.
234 92 142	α Range=19.0μ*	49K39	*In Ilford B1 emulsion. Cf. U^{238} and Th^{232}.	H.Korsching, Z. Naturforsch. **4a**, 563.
235 92 143	σ(d,xn)Np	50M14	Approximate values given for E_d=45, 70, and 100 Mev.	L.B.Magnusson, et al., PR **78**, 363.
	α 10% **4.576** ic	50PGS	Highly separated U^{235} sample.	I.Perlman, et al., PR **77**, 26.
238 92 146	σ(d,xn)Np	50M14	Approximate values given for E_d=45 and 120 Mev.	L.B.Magnusson, et al., PR **78**, 363.
	α Range=16.3μ*	49K39	*In Ilford B1 emulsion. Cf. U^{234} and Th^{232}.	H.Korsching, Z.Naturforsch. **4a**, 563.

93 NEPTUNIUM Np

231 93 138	τ	50^m		50M14	Produced by U^{233}-45 Mev d-4n. α pulse analysis.	L.B.Magnusson, et al., PR 78, 363.
	α	6.28	ic			
	p $38^m Pa^{227}$					
232 ? 93 139?	τ	13^m		50M14	Produced by U^{233}-17 Mev d-3n. Assignment preliminary. U daughter not yet looked for.	See above.
	γ's		a			
	X-rays		a			
233 93 140	τ	35^m		50M14	Produced by U^{233}-15 Mev d-2n, U^{235}-45 Mev d-4n, chem. No U daughter activity found. *Assuming one L X-ray/dis.	See above.
	$\alpha \sim 10^{-3}\%$*	5.53	ic			
	γ ?		a			
	K,L X-rays		a			
235 93 142	$\alpha \sim 5x10^{-3}\%$			50PGS		I.Perlman, et al., PR 77, 26.

94 PLUTONIUM Pu

232 94 138	K > 85%			50PGS		I.Perlman, et al., PR 77, 26.
	α < 15%					
234 94 140	$\alpha \sim 3\%$			50PGS		See above.
239 94 141	α_0	5.147	sπ	50R9	Based on α_1 (ThC) = 6.089. Possibly weaker α groups.	S.Rosenblum, et al., Comptes rendus 230, 638.
	α_1 ~ 30%	~ 5.100	sπ			

95 AMERICIUM Am

239 95 144	$\alpha \sim 0.01\%$			50PGS		I.Perlman, et al., PR 77, 26.
241 95 146	$\alpha\gamma$ coincidences			50PGS	Preliminary measurements.	See above.
242 95 147 16^h	β	0.63	a	50G8		J.M.Grunlund, et al., PR 78, 69.

96 CURIUM Cm

240 96 144	K < 20%			50PGS		I.Perlman, et al., PR 77, 26.
	α > 80%					
242 96 146	τ	162^d		50H14	Produced by Am^{141}-n-$\gamma\beta$.	G.C.Hanna, et al., PR 78, 617.
244 96 148	τ	$\sim 10^y$		50PGS	Produced by Am^{241}-38 Mev α. Assignment based on unpublished data.	I.Perlman, et al., PR 77, 26.
	α	5.78				

97 BERKELIUM Bk

98 CALIFORNIUM Cf

List of Journals, Volumes and Numbers, Surveyed for Supplement I, January to July, 1950

Journal	*Abbreviation Used*	*Volume, Numbers*
Annalen der Physik	Ann. Phys., Lpz.	**7**, Nos. 1-6*
Annales de Physique	Ann. Phys., Paris	**5**, Jan.-June
Arkiv för Fysik	Arkiv för Fysik	**1**, Nos. 1-6 (1949,1950) **2**, No. 1.
Canadian Journal of Research	Can. J. Research	**28A**, Nos. 1-4
Comptes rendus hebdomadaires des seánces de l'academie des sciences	Comptes rendus	**230**, Nos. 1-26
Guide to Russian Scientific Periodical Literature	Guide to Russ. Sci. Lit.	**3**, Nos. 1-6
Helvetica Physica Acta	Helv. Phys. Acta HPA **	**23**, Nos. 1-4
Indian Journal of Physics	Indian J. Phys.	**24**, Nos. 1-4
Journal of American Chemical Society	J. Am. Chem. Soc.	**72**, Nos. 1-6
Journal de physique et le radium	J. de phys. et rad.	Series (8), **11**, Nos. 1-6
Journal of Chemical Physics	J. Chem. Phys.	**18**, Nos. 1-6
Nature	Nature	**165**, Nos. 4184-4208
Die Naturwissenschaften	Naturwiss.	**37**, Nos. 1-12
Nuclear Science Abstracts	NSA	**4**, Nos. 1-12
Nuovo Cimento	Nuovo Cim.	**7**, Nos. 1-3
Philosophical Magazine	Phil. Mag.	**41**, Nos. 312-317
Physica	Physica	**16**, Nos. 1-5
Physical Review	Phys. Rev. PR **	**77**, Nos. 1-6 **78**, Nos. 1-6
Physics Abstracts	Phys. Abst.	**53**, Nos. 625-630
Portugaliae Physica	Portugaliae Physica	**3**, No. 1 (1949)
Proceedings of the Cambridge Philosophical Society	Proc. Camb. Phil. Soc.	**46**, Nos. 1, 2
Proceedings of the Physical Society	Proc. Phys. Soc., Lond.	**A63**, Nos. 361-366
Proceedings of the Royal Society of London	Proc. Roy. Soc.	**A200**, Nos. 1060-1063, (1949, 1950) **A201**, Nos. 1064-1067 **A202**, No. 1068
Zeitschrift für Naturforschung	Z. Naturforsch.	**5a**, Nos. 1-6 **5b**, Nos. 1-4
Zeitschrift für Physik	Z. Phys.	**127**, Nos. 1-5 **128**, No. 1

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* All numbers are inclusive.

All dates are 1950 except where otherwise noted.

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

Additions to Old References

The following is a list of better references for data already reported in the *Table* from private communications, reports, abstracts, or other advance information.

Reference Key Used in Table	New Reference
1946	
46G31	All neutron energies listed in this reference are average values. Sinh $\sqrt{2E} \cdot e^{-E}$ gives the energy distribution of the prompt fission neutrons used where $E=E_n$ in Mev (TID-235).
1948	
48B18	E. L. Brady, M. Deutsch, Phys. Rev. **78**, 558.
48I7	E. N. Jensen, L. J. Laslett, R. T. Nichols, W. W. Pratt, Phys. Rev. **79**, 243(A).
48J10	A. H. Jaffey, E. K. Hyde, AECD-2794; NSA **4**, #1563.
1949	
49AH*	D. E. Alburger, E. M. Hafner, Rev. Mod. Phys. **22**, 373.
49A7	D. E. Alburger, Phys. Rev. **76**, 435.
49B57	H. Brown, V. Perez-Mendez, Phys. Rev. **78**, 649.
49C15	J. M. Cork, H. B. Keller, W. C. Rutledge, A. E. Stoddard, Phys. Rev. **78**, 95.
49C23	J. M. Cork, H. B. Keller, W. C. Rutledge, A. E. Stoddard, Phys. Rev. **78**, 95.
49D11	M. Goldhaber, E. der Mateosian, J. Miskel, BNL-51(S-5).
49D12	M. Deutsch, W. E. Wright, Phys. Rev. **77**, 139.
49D22	M. Deutsch, W. E. Wright, Phys. Rev. **77**, 139.
49D26	M. Deutsch, W. E. Wright, Phys. Rev. **77**, 139.
49F1	I. Feister, L. F. Curtiss, Phys. Rev. **78**, 179.
49G23	W. Gordy, H. Ring, A. B. Burg, Phys. Rev. **78**, 512.
49H28	D. J. Hughes, D. Sherman, Phys. Rev. **78**, 632.
49H34	M. Deutsch, W. E. Wright, Phys. Rev. **77**, 139.
49J9	C. K. Jen, Phys. Rev. **78**, 339(A).
49P20	L. M. Langer, J. W. Motz, H. C. Price, Jr., Phys. Rev. **77**, 798.
49S15	N. Sugarman, H. Richter, J. Chem. Phys. **18**, 174.
49T18	H. A. Thomas, R. L. Driscoll, J. A. Hipple, Phys. Rev. **78**, 787.
49W21	G. Freier, M. Fulk, E. E. Lampi, J. H. Williams, Phys. Rev. **78**, 508.
1950	
50Ad*	R. K. Adair, Rev. Mod. Phys. **22**, 249.
50HLM*	W. F. Hornyak, T. Lauritsen, P. Morrison, W. A. Fowler, Rev. Mod. Phys. **22**, 291.

---

*These keys appear in the list of Other Collections of Nuclear Data on page 275 of National Bureau of Standards Circular 499 as well as in the regular list of references.

REFERENCES FOR SUPPLEMENT I

For convenience all the 1950 references have been repeated except the group for Volume 9, Division IV, NNES, namely those which have lower case letters in the middle such as 50b2.

1947

47B18 K. J. Broström, T. Huus, J. Koch, Nature **160**, 498.
47C17 B. N. Cacciapuoti, Nuovo Cim. **4**, 31.

1948

48G23 V. V. Gei, G. D. Latyshev, M. V. Pasechnik, Doklady Akad. Nauk,SSSR, **63**, 239.
48G24 V. V. Gei, G. D. Latyshev, M. N. Rumsh, Izv. Akad. Nauk,SSSR, Ser. Fiz. **12**, 729.
48L12 G. D. Latyshev, V. V. Gei, A. A. Bashilov, I. F. Barchuk, Doklady Akad. Nauk, SSSR **63**, 511; Guide to Russian Sci. Lit. **3**, 37 (1950).
48M30 D. G. E. Martin, H. O. W. Richardson, Proc. Roy. Soc. **A195**, 287.

1949

A 49A16 D. E. Alburger, Phys. Rev. **76**, 435.
B 49B39 R. E. Bell, H. E. Petch, Phys. Rev. **76**, 1409.
49B46 E. Bestenreiner, E. Broda, Nature **164**, 919.
49B59 I. Bergström, S. Thulin, Phys. Rev. **76**, 1718.
49B60 P. R. Bell, J. Cassidy, ORNL-481, 15.
49B61 P. Brix, Z. Phys. **126**, 725.
49B62 P. Benoist, R. Bouchez, P. Daudel, R. Daudel, A. Rogozinski, Phys. Rev. **76**, 1000.
C 49C34 I. Curie, J. de phys. et rad. (8) **10**, 381.
G 49G9 M. Goldhaber, L. L. Lowry, A. W. Sunyar, BNL-C-9, 96.
49G21 R. L. Garvin, Phys. Rev. **76**, 1876.
49G25 D. A. Gilbert, A. Roberts, P. A. Griswold, Phys. Rev. **76**, 1723.
49G26 L. V. Groshev, L. Y. Shavtvalov, Doklady Akad. Nauk,SSSR **68**, 257; NSA **4**, #1767.
H 49H29 H. H. Hopkins, Jr., Phys. Rev. **77**, 717.
49H40 C. Haenny, N. Najar, M. Gailloud, Helv. Phys. Acta **22**, 611.
J 49J10 K. Jenkner, E. Broda, Nature **164**, 412.
K 49K39 H. Korsching, Z. Naturforsch. **4a**, 563.
L 49L22 A. Lundby, Phys. Rev. **76**, 1809.
49L24 L. M. Langer, R. D. Moffat, H. C. Price, Jr., Phys. Rev. **76**, 1725.
49L25 W. T. Leland, Phys. Rev. **76**, 992.
49L26 R. F. Leininger, E. Segrè, C. Wiegand, Phys. Rev. **76**, 897.
49L27 M. Lecoin, M. Perey, M. Riou, J. de phys. et rad. (8) **10**, 390.
49L28 G. D. Latyshev, I. F. Barchuk, V. A. Sergienko, Y. K. Ioffe, V. A. Malev, Izv. Akad. Nauk, SSSR Ser. Fiz. **13**, 428; Chem. Abst. **44**, 3364 f (1950).
49L29 G. D. Latyshev, L. A. Sliv, I. F. Barchuk, A. A. Bashilov, Izv. Akad. Nauk,SSSR, Ser. Fiz. **13**, 340; Phys. Abst. **52**, #7253 (1949).
M 49M26 F. K. McGowan, ORNL-366, 34.
49M55 F. K. McGowan, ORNL-481, 30.
49M56 C. E. Mandeville, Phys. Rev. **76**, 436.
49M57 K. C. Mann, D. Rankin, P. N. Daykin, Phys. Rev. **76**, 1719.

1949– Continued

O 49O6 G. E. Owen, C. S. Cook, Phys. Rev. **76**, 1726.
P 49P24 W. G. Proctor, F. C. Yu, Phys. Rev. **76**, 1728.
49P25 E. Picciotti, Comptes rendus **229**, 117.
R 49R14 W. Ramm, Z. Naturforsch. **4a**, 245.
S 49S46 L. Salgueiro, M. Valadares, Portugaliae Physica **3**, 21.
T 49T12 M. Ter-Pogossian, C. S. Cook, H. Goddard, J. E. Robinson, Phys. Rev. **76**, 909.
49T19 B. V. Thosar, Proc. Phys. Soc., Lond., **A62**, 739.
49T20 H. G. Thode, J. Macnamara, C. B. Collins, Can. J. Research, **27B**, 361.
49T21 A. Trofimov, Doklady Akad. Nauk, SSSR **66**, 181; NSA **4**, #734.
W 49W23 D. Walker, Proc. Phys. Soc., Lond., **A62**, 799.
Z 49Z3 A. S. Zavelskii, G. Y. Umarov, S. K. Matushevskii, J. Exp. Theor. Phys. USSR **19**, 1136.

1950

A 50Ad R. K. Adair, Rev. Mod. Phys. **22**, 249.
50A1 H. M. Agnew, Phys. Rev. **77**, 655.
50A2 D. E. Alburger, D. J. Hughes, C. Eggler, Phys. Rev. **78**, 318(A).
50A3 O. H. Arroe, Phys. Rev. **79**, 212(A).
50A4 T. Alper, L. du Preez, Nature **165**, 689.
50A5 D. L. Anderson, Phys. Rev. **77**, 142.
50A6 R. C. Allen, W. Rall, Phys. Rev. **78**, 337(A).
50A7 D. E. Alburger, Phys. Rev. **78**, 629.
50A8 H. V. Argo, H. T. Gittings, A. Hemmendinger, G. A. Jarvis, R. F. Taschek, Phys. Rev. **78**, 691.
50A9 D. E. Alburger, E. der Mateosian, M. Goldhaber, BNL-64 (S-6).
50A10 J. Ambrosen, K. M. Bisgaard, Nature **165**, 888.
50A11 G. Albouy, J. Teillac, Comptes rendus **230**, 945.
50A12 N. M. Anton'eva, A. A. Bashilov, B. S. Dzhelopov, A. V. Zolotavin, Doklady Akad. Nauk, SSSR **70**, 397; NSA **4**, #3215.
50A13 N. M. Anton'eva, A. A. Bashilov, B. S. Dzhelopov, A. V. Zolotavin, Doklady Akad. Nauk, SSSR **70**, 597; NSA **4**, #3216.
50A14 L. Aamodt, V. Peterson, R. Phillips, UCRL-526.
50A15 R. A. Allen, H. Halban, Nature **164**, 538.
50A17 R. K. Adair, C. K. Bockelman, R. E. Peterson, Phys. Rev. **79**, 218(A).
50A18 E. Almquist, Can. J. Research **28A**, 1950.
50A19 D. E. Alburger, BNL-64 (S-6).

B 50B1 C. L. Bailey, W. R. Stratton, Phys. Rev. **77**, 194.
50B2 W. E. Burcham, J. M. Freeman, Phys. Rev. **77**, 287.
50B3 D. Binder, Phys. Rev. **77**, 291 and **78**, 325(A).
50B4 F. Boehm, J. P. Blaser, P. Marmier, P. Preiswerk, Phys. Rev. **77**, 295.
50B5 P. R. Bell, J. M. Cassidy, Phys. Rev. **77**, 301.

REFERENCES FOR SUPPLEMENT I

1950 – Continued

- **B** 50B6 L. E. Beghian, M. A. Grace, G. Preston, H. Halban, Phys. Rev. **77**, 286.
- 50B7 F. D. S. Butement, Nature **165**, 149.
- 50B8 P. R. Bell, B. Weaver, J. M. Cassidy, Phys. Rev. **77**, 399.
- 50B9 P. R. Bell, J. M. Cassidy, Phys. Rev **77**, 409.
- 50B10 E. Berne, Phys. Rev. **77**, 568.
- 50B11 A. Bratenahl, S. Fernbach, R. H. Hildebrand, C. E. Leith, B. J. Moyer, Phys. Rev. **77**, 597.
- 50B12 P. J. Bendt, I. W. Ruderman, Phys. Rev. **77**, 575.
- 50B13 I. Bergström, S. Thulin, G. Andersson, Phys Rev. **77**, 851.
- 50B14 E. W. Becker, W. Vogell, Z. Naturforsch. **5a**, 174.
- 50B15 E. Bretscher, E. B. Martin, Helv. Phys. Acta **23**, 15.
- 50B16 R. E. Bell, R. L. Graham, Phys. Rev. **78**, 490.
- 50B17 C. A. Barnes, G. H. Stafford, D. H. Wilkinson, Nature **165**, 69.
- 50B18 I. Bergström, S. Thulin, N. Svartholm, K. Siegbahn, Arkiv för Fysik **1**, 281.
- 50B19 S. B. Burson, K. W. Blair, D. Saxon, Phys. Rev. **77**, 403.
- 50B20 G. R. Bishop, R. Wilson, H. Halban, Phys. Rev. **77**, 416.
- 50B22 W. O. Bateson, Phys. Rev. **78**, 337(A).
- 50B23 K. Boyer, Phys. Rev. **78**, 345(A).
- 50B24 W. C. Barber, Phys. Rev. **78**, 641(A) and **78**, 82(A).
- 50B25 S. B. Burson, K. W. Blair, Phys. Rev. **78**, 89(A); ANL-4397.
- 50B26 C. E. Bradford, W. E. Bennett, Phys. Rev. **78**, 302.
- 50B27 E. L. Brady, M. Deutsch, Phys. Rev. **78**, 558.
- 50B28 H. Brown, V. Perez-Mendez, Phys. Rev. **78**, 812.
- 50B30 F. D. S. Butement, Proc. Phys. Soc., Lond., **A63**, 532.
- 50B31 C. J. Borkowski, A. R. Brosi, ORNL-607, 52.
- 50B32 W. H. Burgus, J. W. Kennedy, J. Chem. Phys. **18**, 97.
- 50B33 W. E. Burcham, J. M. Freeman, Phil. Mag. **41**, 337.
- 50B34 R. Bouchez, S. R. de Groot, R. Nataf, H. A. Tolhoek, J. de phys. et rad. (8) **11**, 105.
- 50B35 A. Bruner, M. Langer, Phys. Rev. **79**, 236(A).
- 50B36 G. E. Boyd, Q. V. Larson, ORNL-685, 41.
- 50B37 G. J. Béné, P. M. Denis, R. C. Extermann, Phys. Rev. **78**, 66.
- 50B38 P. R. Bell, J. M. Cassidy, R. C. Davis, ORNL-694.
- 50B39 A. R. Brosi, B. H. Ketelle, priv. comm.
- 50B40 W. O. Bateson, E. Pollard, Phys. Rev. **79**, 241(A).
- 50B41 P. R. Bell, Brookhaven Chem. Conf. July 1950.
- 50B42 A. A. Bashilov, N. M. Anton'eva, A. Zolotavin, Doklady Akad. Nauk, SSSR **70**, 793; NSA **4**, #3800 (1950).
- 50B52 J. A. Bruner, L. M. Langer, Phys. Rev. **79**, 606.

1950 – Continued

- **C** 50C1 L. Cranberg, Phys. Rev. **77**, 155.
- 50C2 N. W. Curtis, J. Hornbostel, D. W. Lee, E. O. Salant, Phys. Rev. **77**, 290.
- 50C3 J. M. Cork, A. E. Stoddard, W. C. Rutledge, C. E. Branyan, J. M. LeBlanc, Phys. Rev. **77**, 843.
- 50C4 J. M. Cork, H. B. Keller, W. C. Rutledge, A. E. Stoddard, Phys. Rev. **77**, 848.
- 50C5 C. S. Cook, C. H. Chang, Phys. Rev. **78**, 171.
- 50C6 L. S. Cheng, J. D. Kurbatov, Phys. Rev. **78**, 319(A).
- 50C7 W. H. Chambers, R. E. Sheriff, D. Williams, Phys. Rev. **78**, 640(A).
- 50C8 C. Campbell, M. Goodrich, Phys. Rev. **78**, 640(A).
- 50C9 J. M. Cork, A. E. Stoddard, W. C. Rutledge, C. E. Branyan, J. LeBlanc, Phys. Rev. **78**, 299.
- 50C10 R. L. Caldwell, Phys. Rev. **78**, 407.
- 50C11 T. C. Chu, Phys. Rev. **79**, 582.
- 50C12 W. H. Chambers, R. E. Sheriff, D. Williams, Phys. Rev. **78**, 482.
- 50C13 C. D. Curling, J. O. Newton, Nature **165**, 609.
- 50C14 E. P. Cooper, F. T. Rogers, Jr., Phys. Rev. **77**, 402.
- 50C15 R. A. Cohn, J. D. Kurbatov, Phys. Rev. **78**, 318(A).
- 50C16 J. M. Cork, H. B. Keller, W. C. Rutledge, A. E. Stoddard, Phys. Rev. **78**, 95.
- 50C17 J. M. Cork, C. E. Branyan, W. C. Rutledge, A. E. Stoddard, J. M. LeBlanc, Phys. Rev. **78**, 304.
- 50C18 E. C. Campbell, J. H. Kahn, ORNL-694, 15.
- 50C19 R. Chastel, Comptes rendus **230**, 2020.
- 50C20 L. S. Cheng, J. D. Kurbatov. Phys. Rev. **79**, 237(A).
- 50C21 C. Chamié, J. de phys. et rad. (8) **11**, 77.
- 50C22 J. M. Cork, W. C. Rutledge, A. E. Stoddard, C. E. Branyan, J. LeBlanc, Phys. Rev. **79**, 238(A).
- 50C23 J. W. Cobble, priv. comm.
- 50C24 M. F. Crawford, W. M. Gray, F. M. Kelly, A. L. Schawlow, Can. J. Research **28A**, 138.
- 50C25 J. H. Coon, LAMS-984.

- **D** 50D1 J. DeJuren, N. Knable, Phys. Rev. **77**, 606.
- 50D2 M. Deutsch, K. Siegbahn, Phys. Rev. **77**, 680; Arkiv för Fysik **2**, 9.
- 50D3 B. C. Diven, G. M. Almy, Phys. Rev. **79**, 242.
- 50D4 E. B. Dale, E. L. Zimmerman, D. G. Thomas, J. D. Kurbatov. Phys. Rev. **78**, 640(A).
- 50D5 H. E. Duckworth, K. S. Woodcock, R. S. Preston, Phys. Rev. **78**, 479; H. E. Duckworth, H. A. Johnson, Phys. Rev. **78**, 179.
- 50D6 M. Deutsch, W. E. Wright, Phys. Rev. **77**, 139.
- 50D7 E. der Mateosian, M. Goldhaber, Phys. Rev. **78**, 326(A).
- 50D8 H. E. Duckworth, H. A. Johnson, R. S. Preston, R. F. Woodcock, Phys. Rev. **78**, 386 & 330(A).
- 50D9 H. G. Dehmelt, H. Kruger, Naturwiss. **37**, 111.

1950 – Continued

E 50E1 L. G. Elliott, priv. comm.
50E2 D. W. Engelkemeir, M. S. Freedman, J. May, ANL-4473.
50E3 H. D. Evans, Proc. Phys. Soc., Lond., **A63**, 575.
50E5 H. Ewald, Z. Naturforsch. **5a**, 1.

F 50F1 L. Feldman, C. S. Wu, Phys. Rev. **78**, 318(A).
50F3 H. Frauenfelder, M. Walter, W. Zünti, Phys. Rev. **77**, 557.
50F4 W. Franzen, J. Halpern, W. E. Stephens, Phys. Rev. **77**, 641.
50F5 J. L. Fowler, J. M. Slye, Phys. Rev. **77**, 787.
50F7 G. Freier, M. Fulk, E. E. Lampi, J. H. Williams, Phys. Rev. **78**, 508.
50F8 G. R. Fowles, Phys. Rev. **78**, 744.
50F9 W. R. Faust, Phys. Rev. **78**, 624.
50F10 G. Friedlander, M. L. Perlman, D. Alburger, E. der Mateosian, A. W. Sunyar, BNL-51 (S-5), 46.
50F11 R. W. Fink, D. H. Templeton, J. Am. Chem. Soc. **72**, 2818.
50F12 J. M. Freeman, Proc. Phys. Soc., Lond., **A63**, 668.
50F13 A. P. French, P. Meyer, P. B. Treacy, Proc. Phys. Soc., Lond., **A63**, 667.
50F14 A. P. French, P. B. Treacy, Proc. Phys. Soc., Lond., **A63**, 665.
50F15 R. L. Folger, H. G. Hicks, J. M. Miller, G. H. Higgins, G. T. Seaborg, UCRL-460.

G 50G1 T. Grodtal, O. M. Lönsjö, R. Tangen, Phys. Rev. **77**, 296.
50G2 H. T. Gittings, H. H. Barschall, G. G. Everhart, Phys. Rev. in press, quoted by D. Phillips, AECU-404.
50G3 E. R. Gaerttner, M. L. Yeater, Phys. Rev. **77**, 570.
50G4 J. C. Grosskreutz, K. B. Mather, Phys. Rev. **77**. 580.
50G5 S. Geschwind, C. H. Townes, Phys. Rev. **78**, 174.
50G6 A. Ghiorso, R. A. James, L. O. Morgan, G. T. Seaborg, Phys. Rev. **78**, 472.
50G7 E. R. Gaerttner, M. L. Yeater, Phys. Rev. **77**, 714.
50G8 J. M. Grunlund, B. G. Harvey, N. Moss, L. Yaffe, Phys. Rev. **78**, 69.
50G9 L. Gross, D. R. Hamilton, Phys. Rev. **78**, 318(A).
50G11 H. E. Gove, J. A. Harvey, M. S. Livingston, K. Boyer, M. Zimmerman, MIT Progress Report, April 1950, 86.
50G13 M. Goldhaber, A. Sunyar, G. Friedlander, BNL-51 (S-5), 61.
50G14 M. Goldhaber, E. der Mateosian, BNL-51 (S-5), 62.
50G15 W. M. Gibson, L. L. Green, Proc. Phys. Soc., Lond., **A63**, 494.
50G16 P. J. Grant, Nature **165**, 1018.

1950 – Continued

G 50G19 E. K. Gerling, N. E. Titov, G. M. Ermolin, Doklady Akad. Nauk, SSSR **68**, 553; NSA **4**, #1824.
50G20 F. E. Geiger, Jr., Phys. Rev. **79**, 212(A).
50G22 L. S. Germain, Phys. Rev. **78**, 90(A) and **80**, 937.

H 50HLM W. F. Hornyak, T. Lauritsen, P. Morrison, W. A. Fowler, Rev. Mod. Phys. **22**, 291.
50H1 W. F. Hornyak, T. Lauritsen, Phys. Rev. **77**, 160.
50H2 R. N. Hall, W. A. Fowler, Phys. Rev. **77**, 197.
50H3 D. J. Hughes, M. T. Burgy, G. R. Ringo, Phys. Rev. **77**, 291.
50H4 R. J. Hayden, D. C. Hess, Jr., M. G. Inghram, Phys. Rev. **77**, 299.
50H5 S. P. Harris, Phys. Rev. **79**, 219(A).
50H6 D. J. Hughes, D. Sherman, Phys. Rev. **78**, 632.
50H7 T. A. Hall, Phys. Rev. **77**, 411.
50H8 D. J. Hughes, C. Eggler, D. E. Alburger, Phys. Rev. **77**, 726.
50H9 C. T. Hibdon, C. O. Muehlhause, W. Selove, W. Woolf, Phys. Rev. **77**, 730.
50H10 E. L. Hudspeth, C. P. Swann, N. P. Heydenburg, Phys. Rev. **77**, 736.
50H11 B. Hamermesh, V. Hummel, Phys. Rev. **78**, 73.
50H12 E. L. Hudspeth, C. P. Swann, Phys. Rev. **78**, 337(A).
50H13 J. A. Harvey, Phys. Rev. **78**, 345(A).
50H14 G. C. Hanna, B. G. Harvey, N. Moss, Phys. Rev. **78**, 617.
50H15 D. M. Hunten, Phys. Rev. **78**, 806.
50H16 J. A. Harvey, MIT Progress Report, April 1950, 67.
50H17 J. M. Hill, L. R. Shepherd, Proc. Phys. Soc., Lond., **A63**, 126.
50H18 R. E. Hein, A. F. Voigt, ISC-80, AECU-843.
50H19 W. W. Havens, Jr., L. J. Rainwater, M. Levin, CUD-45 and 36.
50H20 E. K. Hyde, A. Ghiorso, UCRL-593.
50H21 R. H. Henkel, H. H. Barschall, Phys. Rev. **79**, 218(A).
50H22 W. J. Heiman, ISC-64.
50H23 R. F. Hibbs, Y-604.
50H24 M. Hamermesh, C. O. Muehlhause, Phys. Rev. **78**, 175.
50H25 C. T. Hibdon, C. O. Meuhlhause, Phys. Rev. **79**, 219(A).

I 50I1 M. G. Inghram, R. J. Hayden, D. C. Hess, Jr., AECD-2753.
50I2 D. R. Inglis, Phys. Rev. **78**, 104.
50I3 M. G. Inghram, J. H. Reynolds, Phys. Rev. **78**, 822.

J 50J1 V. R. Johnson, M. J. W. Laubenstein, H. T. Richards, Phys. Rev. **77**, 413.
50J3 J. V. Jelley, E. B. Paul, Proc. Phys. Soc., Lond., **A63**, 112.
50J4 J. V. Jelley, Proc. Phys. Soc., Lond., **A63**, 538.
50J5 B. M. Jones, UCRL-656; Phys. Rev. **80**, 99.

REFERENCES FOR SUPPLEMENT I

1950 – Continued

J 50J7 P. S. Jastram, W. Konneker, M. R. Cleland, Phys. Rev. **79**, 243(A).

K 50K1 L. Katz, A. S. Penfold, H. J. Moody, R. N. H. Haslam, H. E. Johns, Phys. Rev. **77**, 289.
50K2 B. H. Ketelle, J. W. Ruch, Phys. Rev. **77**, 565.
50K3 H. W. Koch, J. McElhinney, E. L. Gasteiger, Phys. Rev. **77**, 329.
50K4 R. Katz, R. D. Hill, M. Goldhaber, Phys. Rev. **78**, 9.
50K5 D. N. Kundu, M. L. Pool, Phys. Rev. **78**, 488.
50K6 B. B. Kinsey, G. A. Bartholomew, W. H. Walker, Phys. Rev. **77**, 723.
50K7 B. B. Kinsey, G. A. Bartholomew, W. H. Walker, Phys. Rev. **78**, 77.
50K8 B. B. Kinsey, G. A. Bartholomew, W. H. Walker, Phys. Rev. **78**, 481.
50K9 J. Koch, E. Rasmussen, Phys. Rev. **77**, 722.
50K10 P. Kusch, Phys. Rev. **78**, 615.
50K11 B. H. Ketelle, C. M. Nelson, G. E. Boyd, Phys. Rev. **79**, 242(A).
50K12 B. H. Ketelle, ORNL-607, 50.
50K13 D. G. Karraker, D. H. Templeton, UCRL-460.
50K14 D. G. Karraker, D. H. Templeton, UCRL-635.

L 50L2 L. M. Langer, Phys. Rev. **77**, 50.
50L3 W. T. Leland, Phys. Rev. **77**, 634.
50L4 L. M. Langer, J. W. Motz, H. C. Price, Jr., Phys. Rev. **77**, 798.
50L5 C. Levinthal, E. A. Martinelli, A. Silverman, Phys. Rev. **78**, 199.
50L6 E. C. Levinthal, Phys. Rev. **78**, 204.
50L7 L. J. Lidofsky, P. A. Macklin, C. S. Wu, Phys. Rev. **78**, 318(A).
50L8 M. Lindner, J. S. Coleman, Phys. Rev. **78**, 67.
50L9 L. M. Langer, R. D. Moffat, Phys. Rev. **78**, 74.
50L10 H. H. Landon, Phys. Rev. **78**, 338(A).
50L11 M. Lindner, I. Perlman, Phys. Rev. **78**, 499.
50L12 G. Lindström, Phys. Rev. **78**, 817.
50L13 M. Lecoin, M. Perey, M. Riou, J. Teillac, J. de phys. et rad (8) **11**, 227.
50L14 M. Levin, L. J. Rainwater, W. W. Havens, Jr., CUD-47.
50L15 C. Levinthal, E. A. Martinelli, A. Silverman, Phys. Rev. **78**, 199.
50L16 C. A. Lee, R. O. Carlson, B. P. Fabricand, I. I. Rabi, Phys. Rev. **78**, 340(A).

M 50Ma J. E. Mack, Rev. Mod. Phys. **22**, 64.
50M1 E. C. Mallary, M. L. Pool, Phys. Rev. **77**, 75.
50M2 A. K. Mann, P. Kusch, Phys. Rev. **77**, 427.
50M3 P. Macklin, L. Feldman, L. Lidofsky, C. S. Wu, Phys. Rev. **77**, 137.
50M4 C. E. Mandeville, E. Shapiro, Phys. Rev. **77**, 439.
50M5 G. E. McMurtrie, D. P. Crawford, Phys. Rev. **77**, 840.
50M6 P. Macklin, L. J. Lidofsky, C. S. Wu, Phys. Rev. **78**, 318(A).
50M7 C. E. Mandeville, Phys. Rev. **78**, 319(A).
50M8 W. W. Meinke, G. T. Seaborg, Phys. Rev. **78**, 475.

1950 – Continued

M 50M9 A. J. Moses, D. S. Martin, Jr., ISC-77.
50M10 W. W. Miller, R. Ballentine, W. Bernstein, L. Friedman, A. O. Nier, R. D. Evans, Phys. Rev. **77**, 714.
50M11 J. McElhinney, W. E. Ogle, Phys. Rev. **78**, 63.
50M12 F. K. McGowan, Phys. Rev. **78**, 325(A).
50M13 R. Malm, W. W. Buechner, Phys. Rev. **78**, 337(A).
50M14 L. B. Magnusson, S. G. Thompson, G. T. Seaborg Phys. Rev. **78**, 363.
50M15 J. Macnamara, C. B. Collins, H. G. Thode, Phys. Rev. **78**, 129.
50M16 W. O. McMinn, M. B. Sampson, M. L. Bullock, Phys. Rev. **78**, 296.
50M17 J. Macnamara, H. G. Thode, Phys. Rev. **78**, 307.
50M18 F. Metzger, M. Deutsch, Phys. Rev. **78**, 551.
50M19 D. W. Miller, Phys. Rev. **78**, 806.
50M20 D. R. Miller, Phys. Rev. **78**, 808.
50M21 H. Medicus, P. Preiswerk, P. Scherrer, Helv. Phys. Acta **23**, 299.
50M22 F. K. McGowan, ORNL-694, 19.
50M23 N. Marty, Comptes rendus **230**; 1270.
50M24 R. D. Moffat, L. M. Langer, Phys. Rev. **79**, 237(A).
50M25 J. Y. Mei, A. C. G. Mitchell, C. M. Huddleston, Phys. Rev. **79**, 237(A).
50M26 J. Y. Mei, C. M. Huddleston, A. C. G. Mitchell, Phys. Rev. **79**, 237(A).
50M27 D. G. Martin, H. O. W. Richardson, Proc. Phys. Soc., Lond., **A63**, 223.
50M28 C. O. Muehlhause, AECU-659; NSA **4**, #1515.

N 50N1 A. O. Nier, Phys. Rev. **77**, 789.
50N2 M. E. Nelson, M. L. Pool, Phys. Rev. **77**, 682.
50N3 G. F. Newell, Phys. Rev. **78**, 711 and **77**, 141.
50N4 H. M. Neumann, J. J. Howland, Jr., I. Perlman, Phys. Rev. **77**, 720.
50N5 T. B. Novey, Phys. Rev. **78**, 66.
50N6 C. N. Nelson, B. H. Ketelle, G. E. Boyd, ORNL-685, 50.
50N7 B. D. Nag, S. Sen, S. Chatterjee, Nature **164**, 1001.
50N8 Y. A. Nemilov, L. I. Gedeonov, Doklady Akad. Nauk, SSSR **70**, 219; NSA **4**, #3525.

O 50O1 S. A. Ochs, R. A. Logan, P. Kusch, Phys. Rev. **78**, 184.
50O2 W. E. Ogle, R. E. England, Phys. Rev. **78**, 63.
50O3 G. E. Owen, C. S. Cook, P. H. Owen, Phys. Rev. **78**, 686.
50O4 G. D. O'Kelley, F. L. Reynolds, UCRL-550.

P 50PGS I. Perlman, A. Ghiorso, G. T. Seaborg, Phys. Rev. **77**, 26.
50P1 V. Perez-Mendez, H. Brown, Phys. Rev. **77**, 404 and **78**, 317(A).
50P2 D. M. Van Patter, W. W. Buechner, E. N. Strait, MIT Progress Report, January 1950, 35.
50P3 D. M. Van Patter, A. Sperduto, MIT Progress Report, January 1950, 27 and 29.
50P4 R. W. Pringle, S. Standil, K. I. Roulston, Phys. Rev. **77**, 841.
50P5 W. G. Proctor, F. C. Yu, Phys. Rev. **78**, 471.

REFERENCES FOR SUPPLEMENT I

1950 – Continued

P 50P6 W. G. Proctor, F. C. Yu, Phys. Rev. **77**, 716.
50P7 R. W. Pringle, S. Standil, K. I. Roulston, Phys. Rev. **78**, 303.
50P8 R. W. Pringle, K. I. Roulston, S. Standil, Phys. Rev. **78**, 627.
50P9 V. Perez-Mendez, H. Brown, Phys. Rev. **78**, 812.
50P10 A. C. Pappas, MIT Progress Report, April 1950, 29.
50P11 R. A. Peck, Jr., Phys. Rev. **78**, 338(A).
50P12 R. E. Peterson, R. K. Adair, H. H. Barschall, C. K. Bockelman, Phys. Rev. **79**, 218(A).
50P13 H. Palevsky, A. O. Hanson, Phys. Rev. **79**, 242(A).
50P14 R. Powers, ISC-64.

R 50R1 V. K. Rasmussen, W. F. Hornyak, C. C. Lauritsen, T. Lauritsen, Phys. Rev. **77**, 617.
50R2 J. M. Robson, Phys. Rev. **77**, 747.
50R3 B. E. Robertson, W. E. Scott, M. L. Pool, Phys. Rev. **78**, 318(A).
50R4 L. Rosen, A. M. Hudson, Phys. Rev. **78**, 533.
50R5 B. Rose, A. R. W. Wilson, Phys. Rev. **78**, 68.
50R6 S. L. Ridgway, Phys. Rev. **78**, 821.
50R7 P. Rothwell, D. West, Proc, Phys. Soc., Lond., **A63**, 539.
50R8 E. R. Rae, Proc. Phys. Soc., Lond., **A63**, 292.
50R9 S. Rosenblum, M. Valadares, B. Goldschmidt, Comptes rendus **230**, 638.
50R10 M. Riou, J. de phys. et rad. (8) **11**, 185; Comptes rendus **229**, 1225.
50R11 T. R. Roberts, A. O. Nier, Phys. Rev. **79**, 198(A).
50R12 J. H. Reynolds, Phys. Rev. **79**, 243(A).
50R13 L. I. Rusinov, E. I. Chuikin, NSA **4**, #1827.
50R14 E. H. Rhoderick, Proc. Roy. Soc. **A201**, 348.

S 50S1 K. Siegbahn, Phys. Rev. **77**, 233.
50S2 E. N. Strait, D. M. Van Patter, W. W. Buechner, MIT Progress Report, January 1950.
50S3 V. L. Sailor, Phys. Rev. **77**, 794.
50S4 N. Sugarman, H. Richter, J. of Chem. Phys. **18**, 174.
50S5 W. Selove, Phys. Rev. **77**, 557.
50S6 A. H. Snell, F. Pleasanton, R. V. McCord, Phys. Rev. **78**, 317(A).
50S7 G. Scharff-Goldhaber, priv. comm.
50S8 E. Shapiro, C. E. Mandeville, Phys. Rev. **78**, 319(A).
50S9 K. Street, Jr., quoted by W. W. Meinke, G. T. Seaborg, UCRL-589.
50S10 G. L. Stukenbroeker, J. R. McNally, Jr., AECD-2797.
50S11 R. E. Sheriff, W. H. Chambers, D. Williams, Phys. Rev. **78**, 476.
50S12 H. Slätis, S. J. du Toit, K. Siegbahn, Phys. Rev. **78**, 498.
50S13 F. W. Spiers, Nature **165**, 356.
50S14 J. A. Spiers, Phys. Rev. **78**, 75.
50S15 S. C. Snowdon, Phys. Rev. **78**, 299 and **78**, 337(A).
50S16 E. N. Strait, D. M. Van Patter, W. W. Buechner, Phys. Rev. **78**, 337(A).

1950 – Continued

S 50S17 C. P. Swann, C. E. Mandeville, W. D. Whitehead, Phys. Rev. **78**, 338(A).
50S18 K. H. Sun, F. A. Pecjak, R. A. Charpie, J. F. Nechaj, Phys. Rev. **78**, 338(A).
50S19 K. Siegbahn, W. Forsling, Arkiv för Fysik **1**, 505.
50S20 K. Siegbahn, H. Slätis, Arkiv för Fysik **1**, 559.
50S21 D. T. Stevenson, M. Deutsch, Phys. Rev. **78**, 640(A).
50S22 K. Strauch, Phys. Rev. **79**, 487.
50S23 E. P. Steinberg, L. E. Glendenin, Phys. Rev. **78**, 624.
50S24 C. G. Shull, E. O. Wollan, W. C. Koehler, W. A. Strauser, ORNL-694, 34.
50S25 C. P. Sikkema, Nature **165**, 1016.
50S26 A. J. Saur, P. Axel, L. G. Mann, J. Ovadia, Phys. Rev. **79**, 237(A).
50S27 R. Stump, S. Frankel, Phys. Rev. **79**, 243(A).
50S28 A. F. Stehney, N. Sugarman, ANL-4397.
50S29 W. Selove, W. Woolf, J. Richards, ANL-4397.
50S30 C. P. Swann, C. E. Mandeville, Phys. Rev. **79**, 240(A).

T 50T1 S. G. Thompson, A. Ghiorso, G. T. Seaborg, Phys. Rev. **77**, 838 and **80**, 781.
50T2 S. G. Thompson, K. Street, Jr., A. Ghiorso, G. T. Seaborg, Phys. Rev. **78**, 298; **80**, 790.
50T3 D. H. Templeton, Phys. Rev. **78**, 312.
50T4 E. W. Titterton, Nature **165**, 721.
50T5 D. G. Thomas, J. D. Kurbatov, Phys. Rev. **77**, 151..
50T8 C. C. Thomas, E. O. Wiig, J. Am. Chem. Soc., **72**, 2818.
50T9 A. E. Taylor, T. G. Pickavance, J. M. Cassels, T. C. Randle, Nature **165**, 967.
50T11 D. G. Thomas, J. D. Kurbatov, Phys. Rev. **76**, 1891.

W 50W1 G. Wilkinson, UCRL-625.
50W2 J. L. Wolfson, Phys. Rev. **78**, 176.
50W3 M. T. Weiss, M. W. P. Strandberg, R. B. Lawrance, C. C. Loomis, Phys. Rev. **78**, 202.
50W4 W. D. Whitehead, C. E. Mandeville, Phys. Rev. **77**, 732.
50W5 W. Whaling, J. W. Butler, Phys. Rev. **78**, 72.
50W6 W. D. Whitehead, N. P. Heydenburg, Phys. Rev. **78**, 338(A).
50W7 D. C. Worth, Phys. Rev. **78**, 378.
50W8 G. Wilkinson, H. G. Hicks, UCRL-751.
50W9 M. A. Waggoner, M. L. Moon, A. Roberts, Phys. Rev. **78**, 295 and **79**, 236(A).
50W10 A. H. Williams, M. L. Wiedenbeck, Phys. Rev. **78**, 822.
50W11 B. G. Whitmore, W. B. Baker, Phys. Rev. **78**, 799.
50W12 H. Wäffler, Helv. Phys. Acta **23**, 239.
50W13 G. Wilkinson, H. G. Hicks, Phys. Rev. **79**, 815.
50W16 G. Wilkinson, H. G. Hicks, UCRL-744.
50W17 G. Wilkinson, UCRL-750.
50W18 R. L. Walker, B. D. McDaniel, M. B. Stearns, Phys. Rev. **79**, 242(A).

Y 50Y1 H. Yagoda, W. C. White, Phys. Rev. **78**, 330(A).

Z 50Z1 A. Zucker, W. W. Watson, Phys. Rev. **78**, 14.
50Z2 A. Zucker, W. W. Watson, Phys. Rev. **79**, 241.
50Z3 H. Zeiger, D. Bolef, I. I. Rabi, Phys. Rev. **78**, 340(A).

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