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KF6 Bilaga

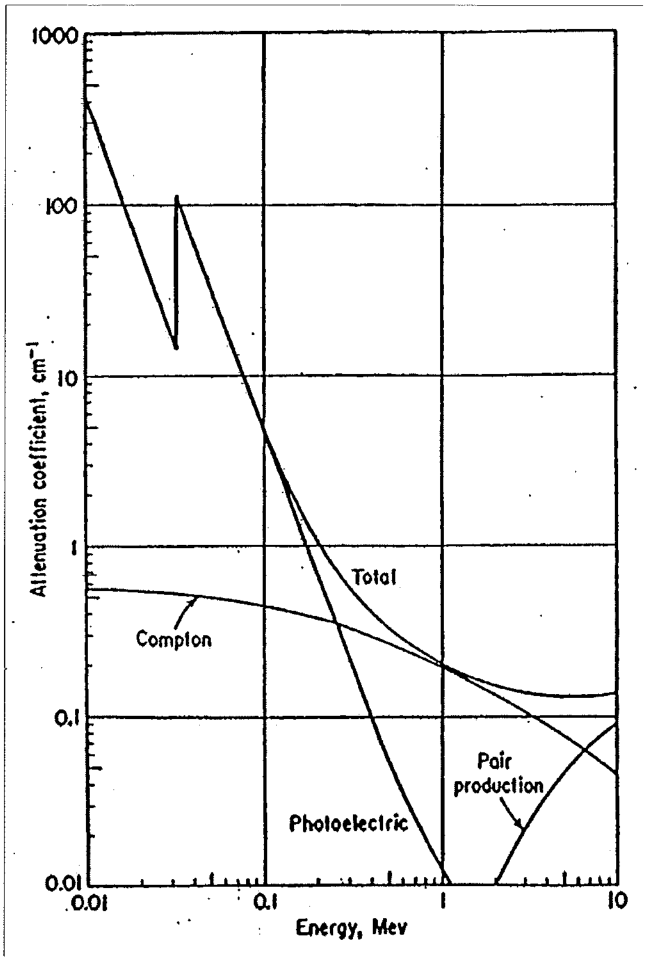
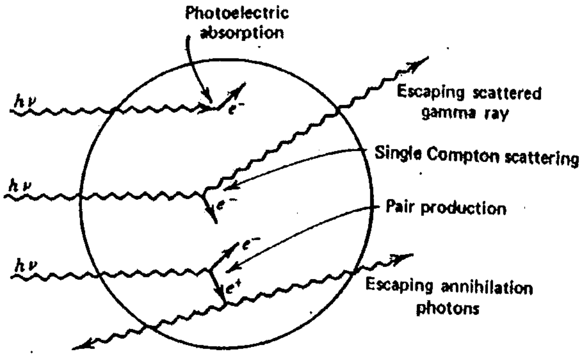


Fig. B1. Gamma-ray attenuation coefficients for sodium iodide versus gamma-ray energy: does not include Rayleigh scattering. (***Reprinted from "Harshaw Scintillation Phophors," The Harshaw Chemical Company, Cleveland,*** 1962; ***data from G. R. White, Natl. Bur. Strands (U.S.) Circ.*** 583, 1957.)



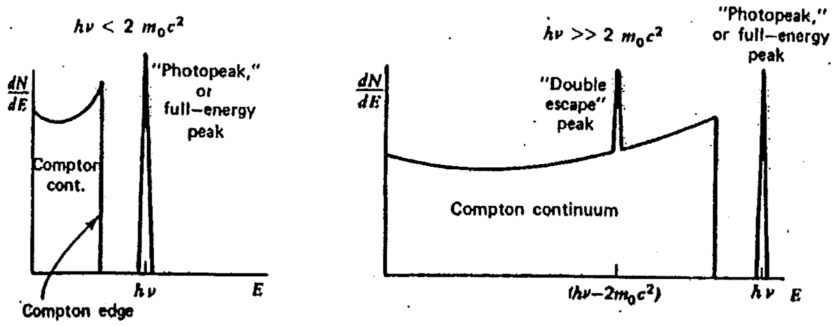


Fig. B2. The "small detector" extreme in gamma-ray spectroscopy. The processes of photoelectric absorption and single Compton scattering give rise to the low-energy spectrum at the left. At higher energies, the pair production process adds a double escape peak shown in the spectrum at the right.

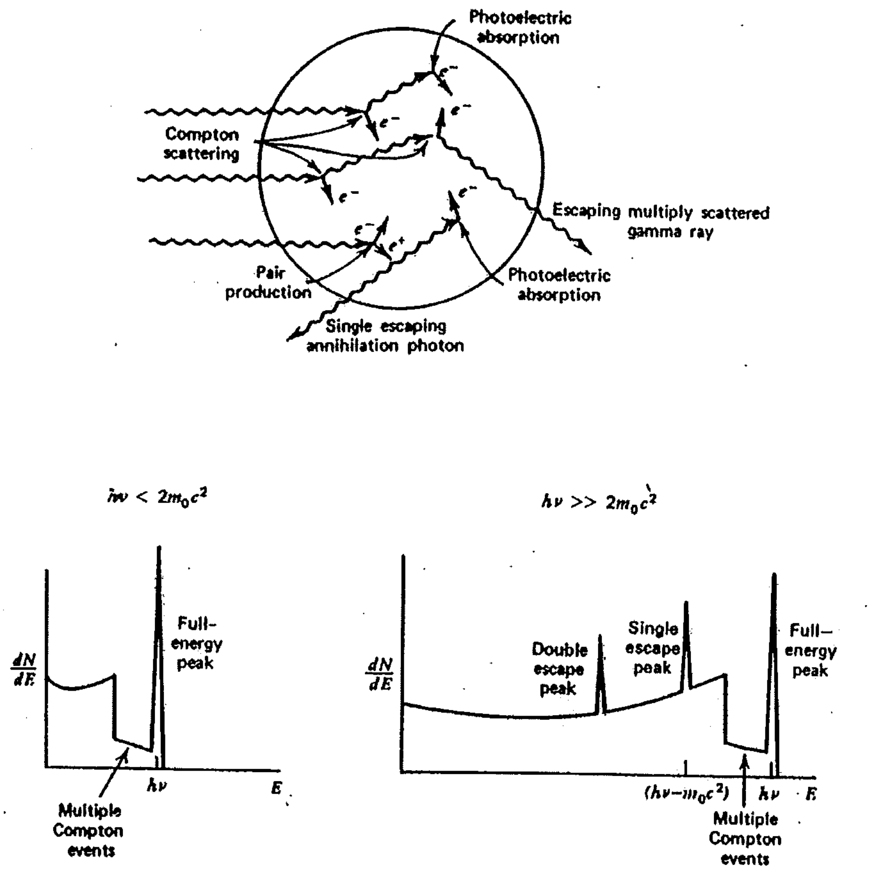


Fig. B3. The case of intermediate detector size in gamma-ray spectroscopy. In addition to the continuum from single Compton scattering and the full-energy peak, the spectrum at the left shows the influence of multiple Compton events followed by photon escape. The full-energy peak also contains some histories that began with Compton scattering. At the right, the single escape peak corresponds to initial pair production interactions in which only one annihilation photon leaves the detector without further interaction. A double escape peak as illustrated in fig B2 will also be present due to those pair production events in which both annihilation photons escape.

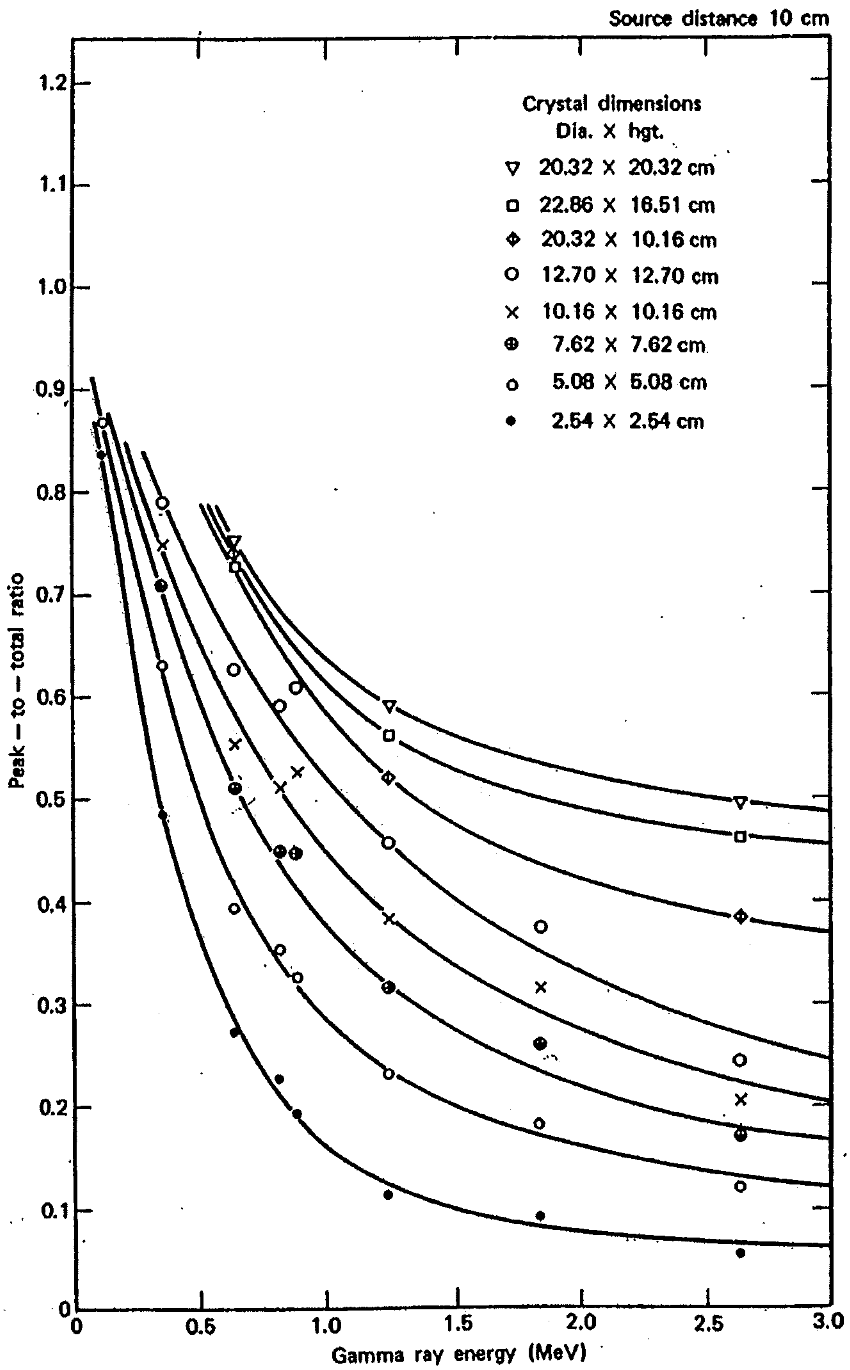


Fig. B4. Peak-to-total ratio (or the photofraction) for various solid cylinders of NaI(Tl) for a point gamma-ray source 10 cm from the scintillator surface. (Courtesy of Harshaw Chemical Company.)

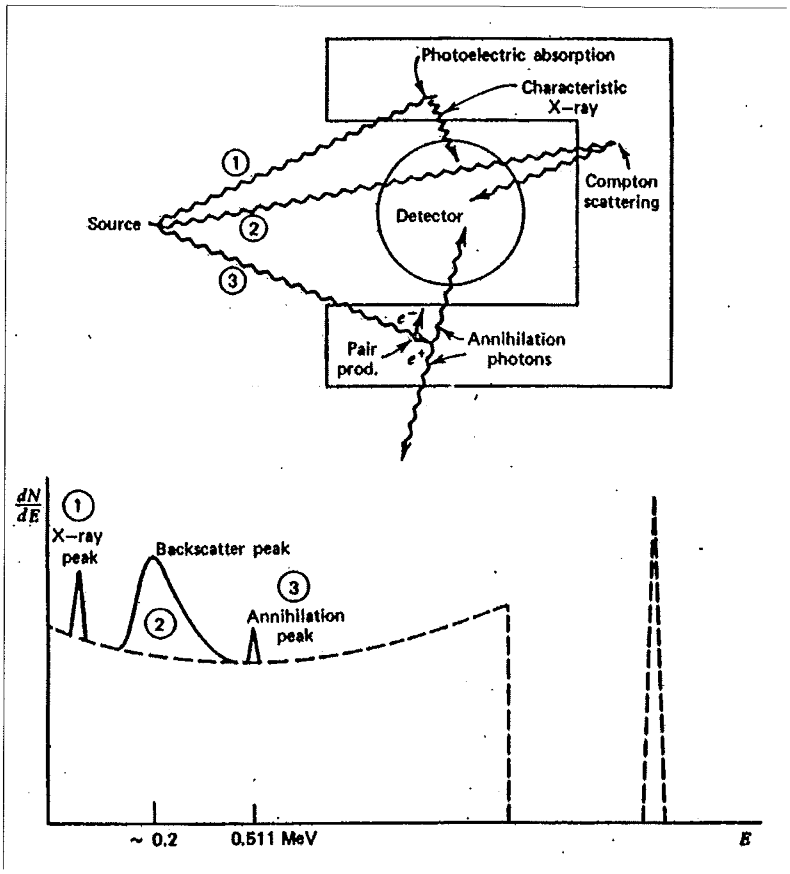


Fig. B5. Influence of surrounding materials on detector response. In addition to the expected spectrum (shown as a dashed line), the representative histories shown at the top, lead to the indicated corresponding features in the response function.

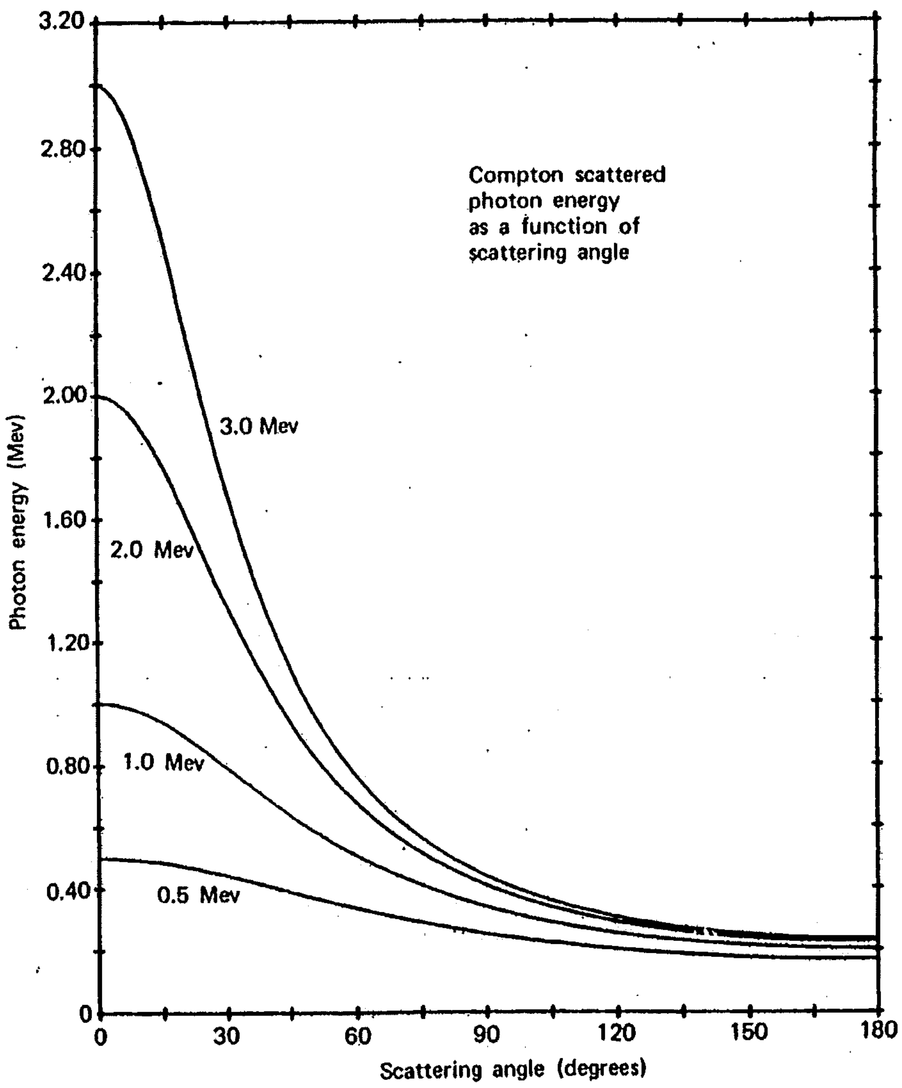


Fig. B6. Variation of scattered gamma-ray energy with scattering angle.

Tabell T1

Table 10. K x-rays: energies, relative intensities, and fluorescence yields

The most prominent K x-ray components are designated

	Classical designation (Siegbahn notation)	Transition energy (see Table 9 for binding energies)
	$K_{\alpha 1}$	BE(K)−BE(L_3)
	$K_{\alpha 2}$	BE(K)−BE(L_2)
$K_{\beta 1}'$	$K_{\beta 1}$	BE(K)−BE(M_3)
	$K_{\beta 2}$	BE(K)−BE(N_{2+3})
	$K_{\beta 3}$	BE(K)−BE(M_2)
$K_{\beta 2}'$	$K_{\beta 4}$	BE(K)−BE(N_{4+5})
	$K_{\beta 5}$	BE(K)−BE(M_{4+5})
		BE(K)−BE(O+...)

Columns 2–5 of Table 10 give the energies (in keV) and relative intensities of the $K_{\alpha 2}$, $K_{\alpha 1}$, $K_{\beta 1}'$, and $K_{\beta 2}'$ lines. Energies are given in boldface type, followed by intensities normalized to 100 for the $K_{\alpha 1}$ line. The energies of the $K_{\alpha 2}$ and $K_{\alpha 1}$ lines are taken from the tables of Bearden.[1] They have been rounded so that the uncertainty in the last digit is ≤5 units. The energies of the complex $K_{\beta 1}'$ and $K_{\beta 2}'$ lines are approximate weighted averages of the components, which can be separated only by instruments of high resolving power. For Z≥93 the energies given are binding energy differences from Table 9.

The relative intensities are adjusted experimental values (and interpolations) from the tables of Salem, et al.[2] $K_{\alpha 2}/K_{\alpha 1}$ values appear to be uncertain by <1% at Z = 20, increasing to ≈2% for high Z; $K_{\beta 1}'/K_{\alpha 1}$ values appear to be uncertain by about 5% (slightly more for Z<20); $K_{\beta 3}/K_{\beta 1}$ values are apparently accurate to ≈5%.

For Z≥82 the $K_{\beta 1}$ and $K_{\beta 3}$ components of $K_{\beta 1}'$ are given separately. The weak $K_{\beta 5}$ component (not included) is about 1.5% of the total K_{β} intensity for Pb (Z=82) and 8% for U (Z=92). The weak, forbidden component $K_{\alpha 3}$ (K−L_1) is likewise not given; its intensity varies from 0.01% of $K_{\alpha 1}$ for Nd (Z=60) to 0.2% for U (Z=92).

The last column of Table 10 gives the K-fluorescence yield, ω_K. These data were calculated by Bambynek, et al.[3] from a semi-empirical formula. Uncertainties in ω_K vary from ≈25% for the lightest elements to ≈5% at Z=25 and ≈1−2% for the heaviest elements.

Z	El	$K_{\alpha 2}$	$K_{\alpha 1}$	$K_{\beta 1}'$	$K_{\beta 2}'$	ω_K
3	Li	0.0543				
4	Be	0.108				
5	B	0.183				
6	C	0.277				
7	N	0.392				
8	O	0.525				
9	F	0.677				
10	Ne	0.8486				
11	Na	1.0410				
12	Mg	1.25360 (150)		1.302 1.9		
13	Al	1.48627 (150)	1.48670	1.5574 2.8		0.0357
14	Si	1.73938 (150)	1.73998	1.8359 4.0		0.0470
15	P	2.0127 (150)	2.0137	2.139 5.9		0.0604
16	S	2.30664 (150)	2.30784	2.464 8.8		0.0761
17	Cl	2.6208 (150)	2.6224	2.816 12.0		0.0942
18	Ar	2.95563 (150)	2.95770	3.191 15.8		0.115
19	K	3.3111 (150)	3.3138	3.590 17.9		0.138
20	Ca	3.68809 50.2	3.69168 (100)	4.013 19.2		0.163
21	Sc	4.0861 50.3	4.0906 (100)	4.46 19.7		0.190
22	Ti	4.50486 50.3	4.51084 (100)	4.93 20.1		0.219
23	Va	4.94464 50.3	4.95220 (100)	5.43 20.2		0.250
24	Cr	5.40551 50.4	5.41472 (100)	5.95 20.3		0.282
25	Mn	5.88765 50.5	5.89875 (100)	6.49 20.3		0.314
26	Fe	6.39084 50.6	6.40384 (100)	7.06 20.3		0.347
27	Co	6.91530 50.7	6.93032 (100)	7.65 20.3		0.381
28	Ni	7.46089 50.8	7.47815 (100)	8.26 20.4		0.414
29	Cu	8.02783 50.9	8.04778 (100)	8.91 20.6		0.445
30	Zn	8.61578 51.0	8.63886 (100)	9.57 20.8	9.66	0.479
31	Ga	9.2248 51.1	9.2577 (100)	10.26 21.5	10.37	0.510
32	Ge	9.8553 51.3	9.8864 (100)	10.98 22.2	11.10	0.540
33	As	10.5080 51.4	10.5437 (100)	11.72 23.0	11.86	0.567
34	Se	11.1814 51.5	11.2224 (100)	12.49 23.8	12.65	0.596
35	Br	11.8776 51.6	11.9242 (100)	13.29 24.0	13.47	0.622
36	Kr	12.598 51.7	12.649 (100)	14.11 24.2	14.32 1.9	0.646
37	Rb	13.3358 51.9	13.3953 (100)	14.96 24.3	15.19 2.5	0.669
38	Sr	14.0979 52.0	14.1650 (100)	15.83 24.4	16.06 3.0	0.691
39	Y	14.8829 52.1	14.9584 (100)	16.73 24.8	17.02 3.4	0.711
40	Zr	15.6909 52.3	15.7751 (100)	17.66 25.2	17.97 3.7	0.730
41	Nb	16.5210 52.4	16.6151 (100)	18.62 25.6	18.95 3.9	0.748
42	Mo	17.3743 52.5	17.47934 (100)	19.60 25.9	19.97 4.1	0.764
43	Tc	18.251 52.6	18.367 (100)	20.61 26.3	21.01 4.3	0.779
44	Ru	19.1504 52.7	19.2792 (100)	21.65 26.7	22.07 4.5	0.793
45	Rh	20.0737 52.8	20.2161 (100)	22.72 27.0	23.17 4.6	0.807
46	Pd	21.0201 52.9	21.1771 (100)	23.81 27.3	24.30 4.8	0.819
47	Ag	21.9903 53.0	22.16292 (100)	24.93 27.3	25.46 5.0	0.830
48	Cd	22.9841 53.2	23.1736 (100)	26.09 27.3	26.64 5.3	0.840
49	In	24.0020 53.3	24.2097 (100)	27.27 27.8	27.86 5.4	0.850
50	Sn	25.0440 53.4	25.2713 (100)	28.48 28.2	29.11 5.5	0.859
51	Sb	26.1108 53.6	26.3591 (100)	29.7 28.5	30.4 5.6	0.867
52	Te	27.2017 53.7	27.4723 (100)	31.0 28.8	31.7 5.8	0.875
53	I	28.3172 53.8	28.6120 (100)	32.3 29.0	33.0 6.1	0.882
54	Xe	29.458 53.9	29.779 (100)	33.6 29.3	34.4 6.4	0.889
55	Cs	30.6251 54.1	30.9728 (100)	35.0 29.5	35.8 6.7	0.895
56	Ba	31.8171 54.3	32.1936 (100)	36.4 29.6	37.3 7.0	0.901
57	La	33.0341 54.4	33.4418 (100)	37.8 29.7	38.7 7.3	0.906

Tabell T2

Table 10. K x-rays: energies, relative intensities, and fluorescence yields (continued)

Z	El	$K_{\alpha 2}$	$K_{\alpha 1}$	$K_{\beta 1}'$	$K_{\beta 2}'$	ω_K
58	Ce	34.2789	34.7197	39.2	40.2	0.911
		54.6	(100)	29.8	7.6	
59	Pr	35.5502	36.0263	40.7	41.8	0.915
		54.8	(100)	29.9	7.9	
60	Nd	36.8474	37.3610	42.2	43.3	0.920
		54.9	(100)	30.0	8.3	
61	Pm	38.1712	38.7247	43.8	44.9	0.924
		55.1	(100)	30.1	8.4	
62	Sm	39.5224	40.1181	45.4	46.6	0.928
		55.2	(100)	30.2	8.6	
63	Eu	40.9019	41.5422	47.0	48.3	0.931
		55.4	(100)	30.5	8.7	
64	Gd	42.3089	42.9962	48.7	50.0	0.934
		55.6	(100)	30.8	8.9	
65	Tb	43.7441	44.4816	50.3	51.7	0.937
		55.8	(100)	31.0	8.9	
66	Dy	45.2078	45.9984	52.1	53.5	0.940
		56.0	(100)	31.2	8.9	
	Ho	46.6997	47.5467	53.8	55.3	0.943
		56.2	(100)	31.5	8.8	
68	Er	48.2211	49.1277	55.6	57.2	0.945
		56.4	(100)	31.9	8.8	
69	Tm	49.7726	50.7416	57.5	59.1	0.948
		56.6	(100)	32.3	8.7	
70	Yb	51.3540	52.3889	59.3	61.0	0.950
		56.7	(100)	32.7	8.7	
71	Lu	52.9650	54.0698	61.2	63.0	0.952
		57.0	(100)	33.1	8.6	
72	Hf	54.611	55.790	63.2	65.0	0.954
		57.2	(100)	33.5	8.5	
73	Ta	56.277	57.532	65.2	67.0	0.956
		57.4	(100)	33.7	8.5	
74	W	57.9817	59.3182	67.2	69.1	0.957
		57.6	(100)	33.8	8.6	
75	Re	59.7179	61.140	69.2	71.2	0.959
		57.8	(100)	34.1	8.6	
76	Os	61.487	63.000	71.3	73.4	0.961
		58.0	(100)	34.4	8.7	
77	Ir	63.287	64.896	73.5	75.6	0.962
		58.1	(100)	34.4	8.9	
78	Pt	65.122	66.832	75.7	77.9	0.963
		58.3	(100)	34.4	9.1	
79	Au	66.989	68.804	77.9	80.2	0.964
		58.6	(100)	34.5	9.4	
80	Hg	68.895	70.819	80.2	82.5	0.966
		58.8	(100)	34.5	9.6	
81	Tl	70.832	72.872	82.5	84.9	0.967
		59.0	(100)	34.6	9.9	

Z	El	$K_{\alpha 2}$	$K_{\alpha 1}$	$K_{\beta 3}$	$K_{\beta 1}$	$K_{\beta 2}'$	ω_K
82	Pb	72.804	74.969	84.450	84.936	87.3	0.968
		59.3	(100)	11.6	22.2	10.2	
83	Bi	74.815	77.108	86.834	87.343	89.8	0.969
		59.5	(100)	11.6	22.1	10.5	
84	Po	76.862	79.290	89.25	89.80	92.4	0.970
		59.7	(100)	11.6	22.1	10.8	
85	At	78.95	81.52	91.72	92.30	95.0	0.971
		60.0	(100)	11.6	22.1	11.0	
86	Rn	81.07	83.78	94.24	94.87	97.6	0.972
		60.2	(100)	11.6	22.2	11.3	
87	Fr	83.23	86.10	96.81	97.47	100.3	0.972
		60.5	(100)	11.6	22.1	11.5	
88	Ra	85.43	88.47	99.43	100.13	103.0	0.973
		60.8	(100)	11.6	22.1	11.7	
89	Ac	87.67	90.884	102.10	102.85	105.8	0.974
		61.1	(100)	11.6	22.1	11.9	
90	Th	89.953	93.350	104.831	105.61	108.6	0.975
		61.3	(100)	11.6	22.1	12.0	
91	Pa	92.29	95.868	107.60	108.43	111.5	0.975
		61.6	(100)	11.6	22.0	12.1	
92	U	94.665	98.439	110.406	111.300	114.5	0.976
		61.9	(100)	11.6	22.0	12.3	
93	Np	97.08	101.07	113.31	114.24	117.5	0.977
		62.2	(100)	11.6	22.1	12.4	
94	Pu	99.55	103.76	116.27	117.26	120.6	0.977
		62.5	(100)	11.7	22.2	12.5	
95	Am	102.08	106.52	119.32	120.36	123.8	0.978
		62.8	(100)	11.7	22.2	12.7	
96	Cm	104.44	109.29	122.32	123.42	127.0	0.978
		63.2	(100)	11.8	22.3	12.8	
97	Bk	107.21	112.14	125.44	126.61	130.3	0.979
		63.7	(100)	11.8	22.3	13.0	
98	Cf	110.71	116.03	129.60	130.85	134.6	0.979
		64.2	(100)	11.9	22.4	13.2	
99	Es	113.47	119.08	132.92	134.24	138.1	0.980
		64.5	(100)	11.9	22.4	13.4	
100	Fm	116.28	122.19	136.30	137.69	141.7	0.980
		64.8	(100)	12.0	22.5	13.5	

1) J.A. Bearden, RMP 39 78(67)
2) S.I. Salem, S.L. Panossian, and R.A. Krause, ANDT 14 91(74)
3) W. Bambynek, B. Crasemann, R.W. Fink, H.-U. Freund, H. Mark, C.D. Swift, R.E. Price, and P.V. Rao, RMP 44 716(72)