TABLE 4.3 Background Lines Observed in Ge-Spectra (This List is Neither Complete nor Should all Lines be Present in Each Spectrum)

γ-line(keV)	Isotope[a]	Reaction[b]	I_γ[c](%)	Remarks
13.26	^{73m}Ge	^{72}Ge(n, γ)^{73m}Ge	0.09	$T_{1/2}=0.5$ s: isomeric transition produced continuously by thermalized neutrons from Cosmic origin (see also 66.7 keV line).
14.41	^{57}Fe	^{57}Fe(p, n)^{57}Co ^{56}Fe(p, γ)^{57}Co ^{56}Fe(d, n)^{57}Co	8.8	EC-decay ($T_{1/2}=271.3$ d): particles from Cosmic origin.
46.5	^{210}Bi	^{210}Pb	3.65	β^--decay ($T_{1/2}=22.28.3$ h): ^{238}U series
49.9	^{223}Ra	^{227}Th	0.52	α-decay ($T_{1/2}=11.43$ d): ^{235}U series
50.1			7.28	
53.2	^{230}Th	^{234}U	0.12	α-decay ($T_{1/2}=1.47$E5 y): ^{238}U series.
53.4	^{73m}Ge	^{72}Ge(n, γ)^{73m}Ge	10.5	$T_{1/2}=0.5$ s: is produced continuously by thermalized neutrons from cosmic origin.
63.32	^{234}Pa	^{234}Th	4.49	β^--decay ($T_{1/2}=24.1$ d): ^{238}U series.
66.7	^{73m}Ge	^{72}Ge(n, γ)^{73m}Ge	0.5	$T_{1/2}=0.5$ s: is produced continuously by thermalized neutrons from cosmic origin. Sum peak 53.4 + 13.26 and individual line. As the lines are produced inside the detector, the probability for summation is almost 100%.
67.7	^{226}Ra	^{230}Th	0.38	α-decay ($T_{1/2}=8$E4 y): ^{238}U series.
68.7	^{73}Ge	^{73}Ge(n, n′)^{73}Ge		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin.
72.80 74.97 84.45 84.94 87.3	Pb	Pb X-Ray		Mainly due to external conversion in the Pb-shield.
81.23	^{231}Pa	^{231}Th	0.89	β^--decay ($T_{1/2}=25.5$ h); ^{235}U series.
82.09	^{231}Pa	^{231}Th	0.4	β^--decay ($T_{1/2}=25.5$ h); ^{235}U series.
84.21	^{231}Pa	^{231}Th	6.6	β^--decay ($T_{1/2}=25.5$ h); ^{235}U series.
84.37	^{224}Ra	^{228}Th	1.9	α-decay ($T_{1/2}=1.91$ y); ^{232}Th series.
92.6	^{234}Pa	^{234}Th	5.16	β^--decay ($T_{1/2}=24.1$ d): ^{238}U series.
93.32	^{67}Zn	^{65}Cu(α, 2n)^{67}Ga	48.0	EC-decay ($T_{1/2}=78.3$ h): α-particles from Cosmic origin. See also 184.5 and 194.25 keV lines
99.6	^{228}Th	^{228}Ac	1.37	β^--decay ($T_{1/2}=6.15$ h); ^{232}Th series.
109.89	^{19}F	^{19}F(n, n′)^{19}F		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin.
122.4	^{57}Fe	^{57}Fe(p, n)^{57}Co ^{56}Fe(d, n)^{57}Co ^{56}Fe(p, γ)^{57}Co ^{57}Co(n, n′)^{57}Co		EC-decay ($T_{1/2}=271.3$ d): particles from Cosmic origin.
122.4	^{219}Rn	^{223}Ra	1.19	α-decay ($T_{1/2}=11.43$ d): ^{235}U series.

(*continued*)

TABLE 4.3 (Continued)

γ-line(keV)	Isotope[a]	Reaction[b]	I_γ[c](%)	Remarks
129.6	^{228}Th	^{228}Ac	2.45	β^--decay ($T_{1/2}=6.15$ h); ^{232}Th series.
131.2	^{234}U	^{234}Pa	20	β^--decay ($T_{1/2}=6.7$ h): ^{238}U series.
136.47	^{57}Fe	^{57}Fe(p, n)^{57}Co ^{56}Fe(d, n)^{57}Co ^{56}Fe(p, γ)^{57}Co ^{57}Co(n, n′)^{57}Co	11.0	EC-decay ($T_{1/2}=271.3$ d): particles from Cosmic origin.
139.7	^{75m}Ge	^{74}Ge(n, γ)^{75m}Ge	39.0	$T_{1/2}=48$ s: isomeric transition produced continuously by thermalized neutrons from Cosmic origin.
143.58	^{57}Fe	^{57}Fe(p, n)^{57}Co ^{56}Fe(d, n)^{57}Co ^{56}Fe(p, γ)^{57}Co ^{57}Co(n, n′)^{57}Co	1.0	See also 14.12, 122.4, and 136.47 eV lines.
143.8	^{231}Th	^{235}U	10.9	α-decay ($T_{1/2}=7.05$E8 y): ^{235}U series.
143.9	^{226}Ra	^{230}Th	0.05	α-decay ($T_{1/2}=8$E4 y): ^{238}U series.
144.2	^{219}Rn	^{223}Ra	3.26	α-decay ($T_{1/2}=11.43$ d): ^{235}U series.
154.1	^{219}Rn	^{223}Ra	3.26	α-decay ($T_{1/2}=11.43$ d): ^{235}U series.
159.7	^{77m}Ge	^{76}Ge(n, γ)^{77m}Ge	11.0	$T_{1/2}=52.9$ s: isomeric transition produced continuously by thermalized neutrons from cosmic origin.
163.3	^{231}Th	^{235}U	5.0	α-decay ($T_{1/2}=7.05$E8 y): ^{235}U series.
174.9	^{71m1}Ge	^{70}Ge(n, γ)^{71m1}Ge	1.0	$T_{1/2}=73$ ns: isomeric transition produced continuously by thermalized neutrons from Cosmic origin.
184.59	^{67}Zn	^{65}Cu(α, 2n)^{67}Ga	62.0	EC-decay ($T_{1/2}=78.3$ h): isomeric transition; α-particles from Cosmic origin. See also 93.32 and 194.24 keV lines.
185.7	^{231}Th	^{235}U	57.5	α-decay ($T_{1/2}=7.05$E8 y): ^{235}U series.
185.91	^{66}Cu	^{65}Cu(n, γ)^{66}Cu		Prompt neutron capture γ-line produced by thermalized neutrons from Cosmic origin.
186.1	^{222}Rn	^{226}Ra	3.57	α-decay ($T_{1/2}=1601$ y): ^{238}U series.
194.25	^{67}Zn	^{65}Cu(α, 2n)^{67}Ga	1.0	β^+-decay ($T_{1/2}=78.3$ h): α-particles from Cosmic origin.
198.4	^{71m2}Ge	^{70}Ge(n, γ)^{71m2}Ge	99.0	$T_{1/2}=22$ ms: is produced continuously by thermal. neutrons from cosmic origin. Sum peak 23.5 + 174
203.1	Cu	^{63}Cu(n, γ)^{64}Cu		Prompt neutron capture γ-ray, $I=6.64$% in nat. isotope-mixture; is produced continuously by thermalized neutrons from cosmic origin.
205.3	^{231}Th	^{235}U	5.0	α-decay ($T_{1/2}=7.05$E8 y): ^{235}U series.
209.3	^{228}Th	^{228}Ac	3.88	β^--decay ($T_{1/2}=6.15$ h); ^{232}Th series.
215.5	^{77}As	^{76}Ge(n, γ)^{77m}Ge	21.0	$T_{1/2}=52.9$ s: β^--decay of isomeric level excited continuously by therm. neutrons from Cosmic origin.

(continued)

TABLE 4.3 (Continued)

γ-line(keV)	Isotope[a]	Reaction[b]	I_γ[c](%)	Remarks
215.99	^{224}Ra	^{228}Th	0.3	α-decay ($T_{1/2}$ = 1.91 y): ^{232}Th series.
226.4	^{234}U	^{234}Pa	5.9	β^--decay ($T_{1/2}$ = 6.7 h): ^{238}U series.
227.2	^{234}U	^{234}Pa	5.5	β^--decay ($T_{1/2}$ = 6.7 h): ^{238}U series.
236.0	^{223}Ra	^{227}Th	11.2	α-decay ($T_{1/2}$ = 11.43 d): ^{235}U series.
238.6	^{212}Bi	^{212}Pb	43.6	β^--decay ($T_{1/2}$ = 10.64 h); ^{232}Th series.
241.0	^{220}Rn	^{224}Ra	3.97	α-decay ($T_{1/2}$ = 11.43 d): ^{235}U series.
241.98	^{214}Bi	^{214}Pb	7.5	β^--decay ($T_{1/2}$ = 26.8 m): ^{238}U series.
256.0	^{223}Ra	^{227}Th	7.6	α-decay ($T_{1/2}$ = 11.43 d): ^{235}U series.
269.2	^{219}Rn	^{223}Ra	13.6	α-decay ($T_{1/2}$ = 11.43 d): ^{235}U series.
270.2	^{228}Th	^{228}Ac	3.43	β^--decay ($T_{1/2}$ = 6.15 h); ^{232}Th series.
271.2	^{215}Po	^{219}Rn	9.9	α-decay ($T_{1/2}$ = 3.96 s): ^{235}U series.
277.4	^{208}Pb	^{208}Tl	6.31	β^--decay ($T_{1/2}$ = 3.05 m); ^{232}Th series.
278.3	^{64}Cu	^{63}Cu(n, γ)^{64}Cu		Prompt neutron capture γ-ray, I = 30.12% in nat. isotope-mixture; is produced continuously by thermalized neutrons from cosmic origin.
283.7	^{227}Ac	^{231}Pa	1.6	α-decay ($T_{1/2}$ = 4243): ^{235}U series.
288.1	^{208}Tl	^{212}Bi	0.34	α-decay ($T_{1/2}$ = 1.01 h): ^{232}Th series.
295.2	^{214}Bi	^{214}Pb	18.5	β -decay ($T_{1/2}$ = 26.8 m): ^{238}U series.
300.0	^{227}Ac	^{231}Pa	2.39	α-decay ($T_{1/2}$ = 4243 y): ^{235}U series.
300.1	^{212}Bi	^{212}Pb	3.34	β^--decay ($T_{1/2}$ = 10.64 h); ^{232}Th series.
302.7	^{227}Ac	^{231}Pa	2.24	α-decay ($T_{1/2}$ = 4243 y): ^{235}U series.
323.3	^{219}Rn	^{223}Ra	3.9	α-decay ($T_{1/2}$ = 11.43 d): ^{235}U series.
328.3	^{228}Th	^{228}Ac	2.95	β^--decay ($T_{1/2}$ = 6.15 h); ^{232}Th series.
330.1	^{227}Ac	^{231}Pa	1.31	α-decay ($T_{1/2}$ = 4243 y): ^{235}U series.
338.3	^{219}Rn	^{223}Ra	2.789	α-decay ($T_{1/2}$ = 11.43 d): ^{235}U series
338.3	^{228}Th	^{228}Ac	1.25	β -decay ($T_{1/2}$ = 6.15 h); ^{232}Th series.
351.0	^{207}Tl	^{211}Bi	2.76	α-decay ($T_{1/2}$ = 2.14 m): ^{235}U series.
351.92	^{214}Bi	^{214}Pb	38.5	β^--decay ($T_{1/2}$ = 19.9 m): ^{238}U series.
367.94	^{200}Hg	^{199}Hg(n, γ)^{200}Hg		Prompt neutron capture γ-ray, I = 81.35% in nat. isotope-mixture; is produced continuously by thermalized neutrons from cosmic origin. Its observation is mainly due to the high reaction yield and the enormous thermal cross-section of ^{199}Hg of 2000 barn.
401.7	^{215}Po	^{219}Rn	6.64	α-decay ($T_{1/2}$ = 3.96 s): ^{235}U series.
404.8	^{211}Bi	^{211}Pb	3.83	β^--decay ($T_{1/2}$ = 36.1 m: ^{235}U series
409.5	^{228}Th	^{228}Ac	1.94	β^--decay ($T_{1/2}$ = 6.15 h): ^{232}Th series.
426.99	^{211}Bi	^{211}Pb	1.72	β^--decay ($T_{1/2}$ = 36.1 m: ^{235}U series.
427.89	^{125}Te	^{124}Sn(p, γ)^{125}Sb	29.4	β^--decay ($T_{1/2}$ = 2.77 a): protons from Cosmic origin.

(continued)

TABLE 4.3 (Continued)

γ-line(keV)	Isotope[a]	Reaction[b]	I_{γ}[c](%)	Remarks
444.9	^{219}Rn	^{223}Ra	1.27	α-decay ($T_{1/2} = 11.43$ d): ^{235}U series.
452.83	^{208}Tl	^{212}Bi	0.31	α-decay ($T_{1/2} = 1.01$ h): ^{232}Th series.
463.0	^{228}Th	^{228}Ac	4.44	β^--decay ($T_{1/2} = 6.15$ h): ^{232}Th series.
463.38	^{125}Te	$^{124}Sn(p,\gamma)^{125}Sb$	0.15	β^--decay ($T_{1/2} = 2.77$ a): protons from Cosmic origin.
510.8	^{208}Pb	^{208}Tl	22.6	β^--decay ($T_{1/2} = 3.05$ m); ^{232}Th series.
511.0	Anni.			This very common Doppler broadened line finds its origin in the annihilation of β^+-particles occurring in the β^+-decay or the pair production process induced by high energy γ-rays ($E_{\gamma} > 1022$ keV) of Cosmic origin and/or due to nuclear decay or various nuclear reactions. The many possible origins allow no prediction of its intensity. It may not be used to estimate the intensity of a β^+-decay branching. Is also produced by muon-induced pair production.
549.7	^{216}Po	^{220}Rn	0.1	α-decay ($T_{1/2} = 55.6$ s): ^{232}Th series.
558.2	^{114}Cd	$^{113}Cd(n,\gamma)^{114}Cd$		Prompt neutron capture γ-ray, $I = 79.71\%$ in nat. isotope-mixture; is produced continuously by thermalised neutrons of Cosmic origin.
562.9	^{76}Ge	$^{76}Ge(n,n')^{76}Ge$		Prompt γ-line produced by inelastic scattering of fast neutrons from Cosmic origin. Right asymmetric line-shape due to recoil of the Ge-atoms induced by (n, n′) reaction.
563.3	^{134}Ba	$^{133}Cs(n,\gamma)^{134}Cs$	8.38	β^--decay ($T_{1/2} = 2.06$ a). This isotope is found in reactor waste (Chernobyl fallout) but not in the fall-out of bomb testing. This is due to the fact that it is no fission product, as it is screened by the stable ^{134}Xe. It is however found among the reactor fission products, as ^{133}Cs is the stable end product of the A = 133 fission chain having a yield of 7.87%.
568.7	^{234}U	^{234}Pa	3.3	β^--decay ($T_{1/2} = 6.7$ h): ^{238}U series.
569.5	^{234}U	^{234}Pa	10.0	β^--decay ($T_{1/2} = 6.7$ h): ^{238}U series.
569.79	^{207}Pb	$^{207}Pb(n,n')^{207}Pb$ $^{206}Pb(n,\gamma)^{207}Pb$		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin or by thermal neutron capture.
583.2	^{208}Pb	^{208}Tl	84.5	β^--decay ($T_{1/2} = 3.05$ m); ^{232}Th series.

(continued)

TABLE 4.3 (Continued)

γ-line(keV)	Isotope[a]	Reaction[b]	I_γ[c](%)	Remarks
595.9	^{74}Ge	$^{73}Ge(n,\gamma)^{74}Ge$ $^{74}Ge(n,n')^{74}Ge$		Prompt neutron capture γ-ray, $I = 34.65\%$ in nat. isotope-mixture; is produced continuously by thermalized neutrons from cosmic origin. Prompt γ-line produced by inelastic scattering of fast neutrons from Cosmic origin. Right asymmetric line-shape due to recoil of the Ge-atoms induced by (n, n')-reaction.
604.7	^{134}Ba	$^{133}Cs(n,\gamma)^{134}Cs$	97.6	See comments 563.3 keV line.
651.0	^{114}Cd	$^{113}Cd(n,\gamma)^{114}Cd$		Prompt neutron capture γ-ray, $I = 15.23\%$ in nat. isotope-mixture; is produced continuously by thermalized neutrons from cosmic origin.
600.55		$^{124}Sn(p,\gamma)^{125}Sb$	17.78	β^--decay ($T_{1/2} = 2.77$ y): protons from Cosmic origin.
606.64	^{125}Te	$^{124}Sn(p,\gamma)$	5.02	β^--decay ($T_{1/2} = 2.77$ y): protons from Cosmic origin
609.3	^{214}Po	^{214}Bi	44.8	β^-decay ($T_{1/2} = 19.9$ m): ^{238}U series.
635.9	^{125}Te	$^{124}Sn(p,\gamma)^{125}Sb$	11.32	β^--decay ($T_{1/2} = 2.77$ y): protons from Cosmic origin.
661.66	^{137m}Ba	^{137}Cs	85.0	Fission isotope β^--decay ($T_{1/2} = 30.17$ y): bomb testing + Chernobyl fallout.
669.6	^{63}Cu	$^{63}Cu(n,n')^{63}Cu$		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin
671.40	^{125}Te	$^{124}Sn(p,\gamma)^{125}Sb$	1.8	β^--decay ($T_{1/2} = 2.77$ y): protons from Cosmic origin.
691.0	^{72}Ge	$^{72}Ge(n,n')^{72}Ge$		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin. This line is a 0^+–0^+ and can thus only take place by internal conversion as electrical monopol transitions are strictly forbidden. The asymmetric rightside shape is due to imperfect transformation of the recoil energy due to the neutron scattering and is observed—in contrary to other (n, n') reactions, due to the fact that the recoil takes place in the Ge and thus inside to the detector.
727.3	^{212}Po	^{212}Bi	6.25	β^--decay ($T_{1/2} = 1.01$ h): ^{232}Th series.
751.8	^{65}Zn	$^{63}Cu(\alpha 2n)^{65}Ga$	50.7	β^+-decay ($T_{1/2} = 15$ m): continuously formed by α-particles from Cosmic origin.
766.0	^{234}U	^{234m}Pa	0.21	β^--decay ($T_{1/2} = 1.17$ m); ^{238}U series.
768.4	^{214}Po	^{214}Bi	4.88	β^--decay ($T_{1/2} = 19.9$ m): ^{238}U series.
769.7	^{73}As	$^{73}Ge(p,n\gamma)^{73}As$		Prompt γ-line produced by p,n-reaction with protons from Cosmic origin.

(continued)

TABLE 4.3 (Continued)

γ-line(keV)	Isotope[a]	Reaction[b]	I_γ[c](%)	Remarks
770.8	^{65}Cu	^{65}Cu(n, n')^{65}Cu		Prompt γ-line produced by inelastic scattering of fast neutrons from Cosmic origin.
772.4	^{228}Th	^{228}Ac	1.58	β^--decay ($T_{1/2} = 6.15$ h): ^{232}Th series.
785.6	^{212}Po	^{212}Bi	1.11	β^--decay ($T_{1/2} = 1.01$ h): ^{232}Th series.
794.9	^{228}Th	^{228}Ac	4.34	β^--decay ($T_{1/2} = 6.15$ h): ^{232}Th series.
795.8	^{134}Ba	^{133}Cs(n, γ^{134}Cs	85.4	See 563.3 keV line.
801.9	^{134}Ba	^{133}Cs(n, γ^{134}Cs	8.73	See 563.3 keV line
803.3	^{206}Pb	^{206}Pb(n, n') ^{206}Pb^{210}Po	0.001	Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin. α-decay ($T_{1/2} = 138.4$ d): ^{238}U series.
805.$^-$	^{114}Cd	^{113}Cd(n, γ)^{114}Cd		Prompt neutron capture γ-ray, $I = 5.1\%$ in nat. isotope-mixture; is produced continuously by thermalized neutrons from cosmic origin.
810.80	^{58}Fe	^{59}Co(γ, n)^{58}Co ^{59}Co(n, 2n)^{58}Co ^{58}Fe(p, n)^{58}Co ^{57}Fe(p, γ)^{58}Co ^{57}Fe(d, n)^{58}Co ^{58}Fe(n, p)^{58}Mn	≈ 100 82.2	β^--decay ($T_{1/2} = 63$ s): is produced continuously by fast γ's and particles of cosmic origin.
831.8	^{211}Bi	^{211}Pb	3.83	β^--decay ($T_{1/2} = 36.1$ m): ^{235}U series.
833.95	^{77}Ge	^{72}Ge(n, n')^{72}Ge		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin. Right asymmetric line-shape due to recoil of the Ge-atoms induced by (n, n')-reaction.
834.6	^{54}Cr	^{54}Cr(p, n)^{54}Mn ^{53}Cr(d, n)^{54}Mn ^{53}Cr(p, γ)^{54}Mn	100	EC-decay ($T_{1/2} = 312.2$ d): protons from cosmic origin.
835.7	^{228}Th	^{228}Ac	1.68	β^--decay ($T_{1/2} = 6.15$ h): ^{232}Th series.
846.8	^{56}Fe	^{56}Fe(n, n')^{76}Fe	19.0	Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin. The absence of the 1,282.6 keV line allows to distinguish it from the same line excited in the decay of ^{56}Co.
846.8	^{56}Fe	^{56}Fe(p, n)^{56}Co		β^+-decay ($T_{1/2} = 78.76$ d): The presence of the 1,238.2 keV line allows to distinguish it from the same line excited in the ^{56}Fe(n,n')^{76}Fe reaction.
860.6	^{208}Pb	^{208}Tl	12.42	β^--decay ($T_{1/2} = 3.05$ m); ^{232}Th series.
868.1	^{73}Ge	^{72}Ge(n, γ)^{73}Ge		Prompt neutron capture γ-ray, $I = 30.12\%$ in nat. isotope-mixture; is produced continuously by thermalized neutrons from cosmic origin.
880.51	^{234}U	^{234}Pa	9	β^--decay ($T_{1/2} = 6.7$ h): ^{238}U series.
883.24	^{234}U	^{234}Pa	15	β^--decay ($T_{1/2} = 6.7$ h): ^{238}U series.
897.6	^{207}Bp	^{207}Tl	0.24	β^--decay ($T_{1/2} = 4.79$ m): ^{235}U series.

(continued)

TABLE 4.3 (Continued)

γ-line(keV)	Isotope[a]	Reaction[b]	I_γ[c](%)	Remarks
911.2	^{228}Th	^{228}Ac	26.6	β^--decay ($T_{1/2}=6.15$ h): ^{232}Th series.
925.0	^{234}U	^{234}Pa	2.9	β^--decay ($T_{1/2}=6.7$ h): ^{238}U series.
926.0	^{234}U	^{234}Pa	11.0	β^--decay ($T_{1/2}=6.7$ h): ^{238}U series.
927.1	^{234}U	^{234}Pa	11.0	β^--decay ($T_{1/2}=6.7$ h): ^{238}U series.
934.1	^{214}Po	^{214}Bi	3.03	β^--decay ($T_{1/2}=19.9$ m): ^{238}U series.
946.0	^{234}U	^{234}Pa	12	β^--decay ($T_{1/2}=6.7$ h): ^{238}U series.
962.1	^{65}Cu	^{63}Cu(n, n′)^{63}Cu		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin.
964.8	^{228}Th	^{228}Ac	5.11	β^--decay ($T_{1/2}=6.15$ h): ^{232}Ht series.
969.0	^{228}Th	^{228}Ac	16.20	β^--decay ($T_{1/2}=6.15$ h): ^{232}Ht series
1001.0	^{234}U	^{234m}Pa	0.59	β^--decay ($T_{1/2}=1.17$ m); ^{238}U series.
1039.5	^{70}Ge	^{70}Ge(n, n′)^{70}Ge		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin. Right asymmetric line-shape due to recoil of the Ge-atoms induced by (n, n′) reaction.
1063.64	^{207}Pb	^{207}Pb(n, n′)^{207}Pb ^{206}Pb(n, γ)^{207}Pb		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin or by thermal neutron capture. See also 569.79 keV line.
1077.41	^{68}Zn	^{65}Cu(α, n)^{68}Ga	3.0	β^+-decay ($T_{1/2}=68.3$ m): α-particles of Cosmic origin.
1097.3	^{116}Sn	^{115}In(n, γ)^{116m1}	55.7	β^--decay ($T_{1/2}=54.1$ m): formed by thermalized neutrons from cosmic origin.
1115.5	^{65}Cu	^{65}Cu(n, n′)^{65}Cu ^{65}Cu(p, n)^{65}Zn	50.75	Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin. EC + β^+-decay ($T_{1/2}=244$ d) Formed by fast neutrons or protons from cosmic origin.
1120.4	^{214}Po	^{214}Bi	14.8	β^--decay ($T_{1/2}=19.9$ m): ^{238}U series.
1124.51	^{65}Cu	^{70}Ge(n, α2n)^{65}Zn	50.75	EC + β^+-decay ($T_{1/2}=244$ d). Formed by fast neutrons from cosmic origin. Note that it is the same line as the above mentioned 1115.5 keV transition. As the reaction takes place inside the Ge-detector itself, its energy sums up with the Kα–X-ray of Cu. It is thus possible to distinguish the formation reaction of ^{65}Zn.
1173.2	^{60}Ni	^{59}Co(n, γ)^{60}Co	100	β^--decay ($T_{1/2}=5.172$ y): This isotope is a common contamination in modern steel and is introduced at the high furnace level.
1204.1	^{74}Ge	^{74}Ge(n, n′)^{74}Ge		Fast neutrons from cosmic origin. Right asymmetric line-shape due to recoil of the Ge-atoms induced by (n, n′) reaction.
1238.26	^{56}Fe	^{56}Fe(p, n)^{56}Co	13.4	β^+-decay ($T_{1/2}=78.76$ d): See 846.8 keV line.
1238.8	^{214}Po	^{214}Bi	5.86	β^--decay ($T_{1/2}=19.9$ m): ^{238}U series.

(continued)

TABLE 4.3 (Continued)

γ-line(keV)	Isotope[a]	Reaction[b]	$I_\gamma{}^c$(%)	Remarks
1291.65	^{59}Co	$^{58}Fe(n,\gamma)^{59}Fe$	57.0	β^--decay ($T_{1/2}=45.1$ d). Is produced continuously by thermalized neutrons of cosmic origin.
1293.5	^{116}Sn	$^{115}In(n,\gamma)^{116m}In$	85.0	In β^--decay ($T_{1/2}=54.1$ m): formed by thermalized neutrons from cosmic origin.
1293.64	^{41}K	$^{40}Ar(n,\gamma)^{41}Ar$	99.16	β^--decay ($T_{1/2}=1.83$ h); is produced continuously by thermalized neutrons from cosmic origin. Is a common B.G. line near air-cooled fission reactors.
1327.0	^{63}Cu	$^{63}Cu(n,n')^{63}Cu$		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin.
1332.5	^{60}Ni	$^{59}Co(n,\gamma)^{60}Co$	100	See 1173.2 keV-line.
1377.6	^{57}Co	$^{58}Ni(\gamma,n)^{57}Ni$ $^{58}Ni(n,2n)^{57}Ni$	30.0	β^+ + EC-decay ($T_{1/2}=36.0$ h)
1377.6	^{214}Po	^{214}Bi	3.92	β^--decay ($T_{1/2}=19.9$ m): ^{238}U series.
1408.0	^{214}Po	^{214}Bi	2.48	β^--decay ($T_{1/2}=19.9$ m): ^{238}U series.
1412.1	^{63}Cu	$^{63}Cu(n,n')^{63}Cu$		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin.
1460.8	^{40}Ar	^{40}K	99.16	EC and β^{+-}decay. ($T_{1/2}=1.277E+8$ y) Widespread natural radioactive isotope. The modal human body contains about 4000 Bq of this isotope.
1481.7	^{65}Cu	$^{65}Cu(n,n')^{65}Cu$		Prompt γ-line produced by inelastic scattering of fast neutrons from Cosmic origin.
1547.0	^{63}Cu	$^{63}Cu(n,n')^{63}Cu$		Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin.
1588.2	^{228}Th	^{228}Ac	3.27	β^--decay ($T_{1/2}=6.15$ h): ^{232}Th series.
1620.6	^{212}Po	^{212}Bi	1.6	β^--decay ($T_{1/2}=1.01$ h): ^{232}Th series.
1729.6	^{214}Po	^{214}Bi	2.88	β^--decay ($T_{1/2}=19.9$ m): ^{238}U series.
1764.5	^{214}Po	^{214}Bi	15.96	β^--decay ($T_{1/2}=19.9$ m): ^{238}U series.
2204.1	^{214}Po	^{214}Bi		β^--decay ($T_{1/2}=19.9$ m): ^{238}U series.
2223.2	^{2}H	$^{1}H(n,\gamma)\,^{2}H$		Prompt neutron capture γ-ray, $I=100\%$ in nat. isotope- mixture; is produced continuously by thermalized neutrons from cosmic origin.
2614.6	^{208}Pb	$^{208}Pb(n,n')$ $^{208}Pb^{208}Tl$	99.2	Prompt γ-line produced by inelastic scattering of fast neutrons from cosmic origin. β^--decay ($T_{1/2}=3.05$ m); ^{232}Th series.

[a] The isotope in which the transition takes place is mentioned. The reaction responsible or the parent nucleus are given in the second column.

[b] The isotopes formed by (n, γ)-reaction can also be formed by (d, p)-reaction or even by n, 2n -reaction if the isotope wit N + 2 neutrons is stable.

[c] Intensity of the γ-line in% and per decay. If possible the intensity of reaction γ's is given in the column reserved for the remarks.