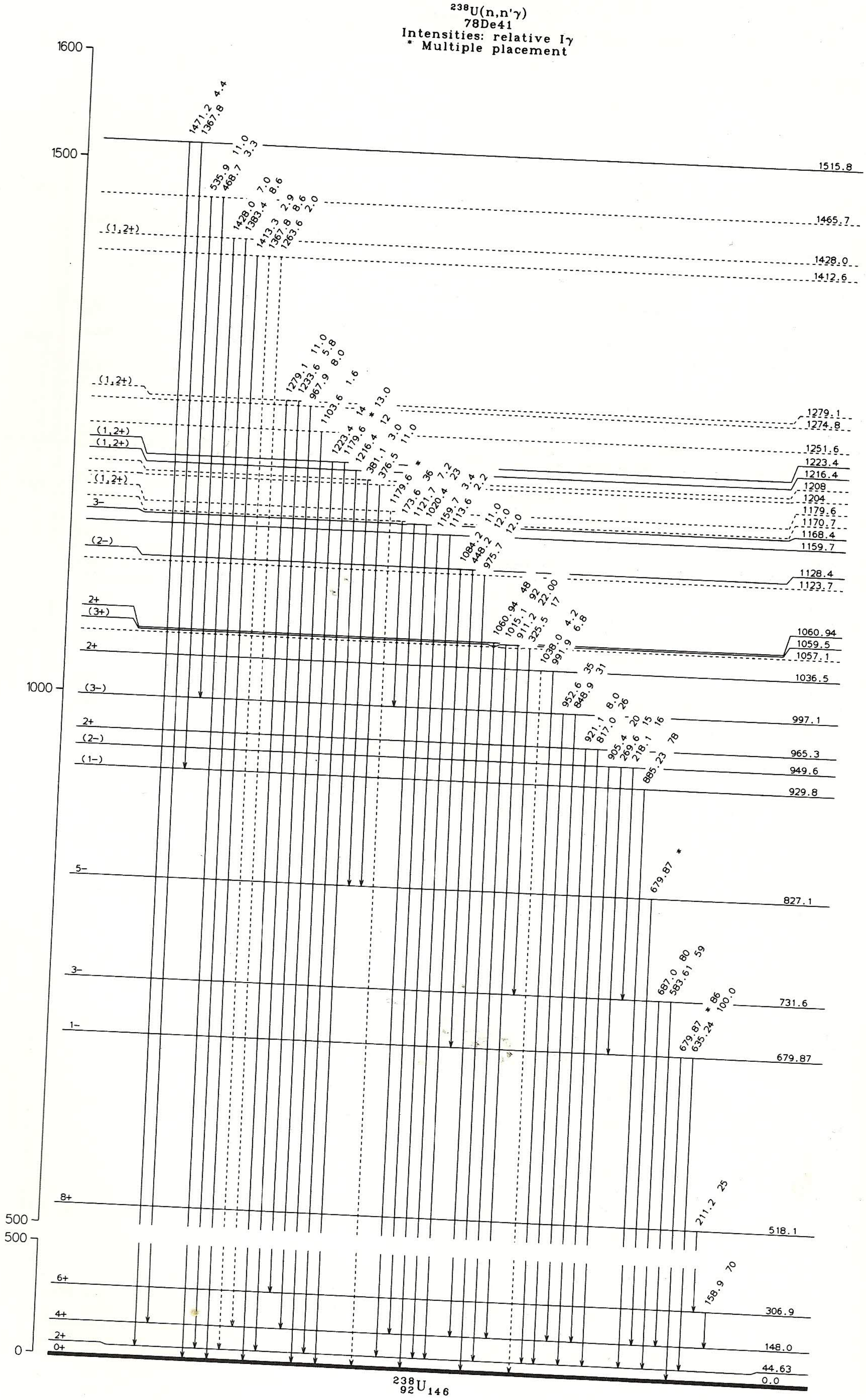
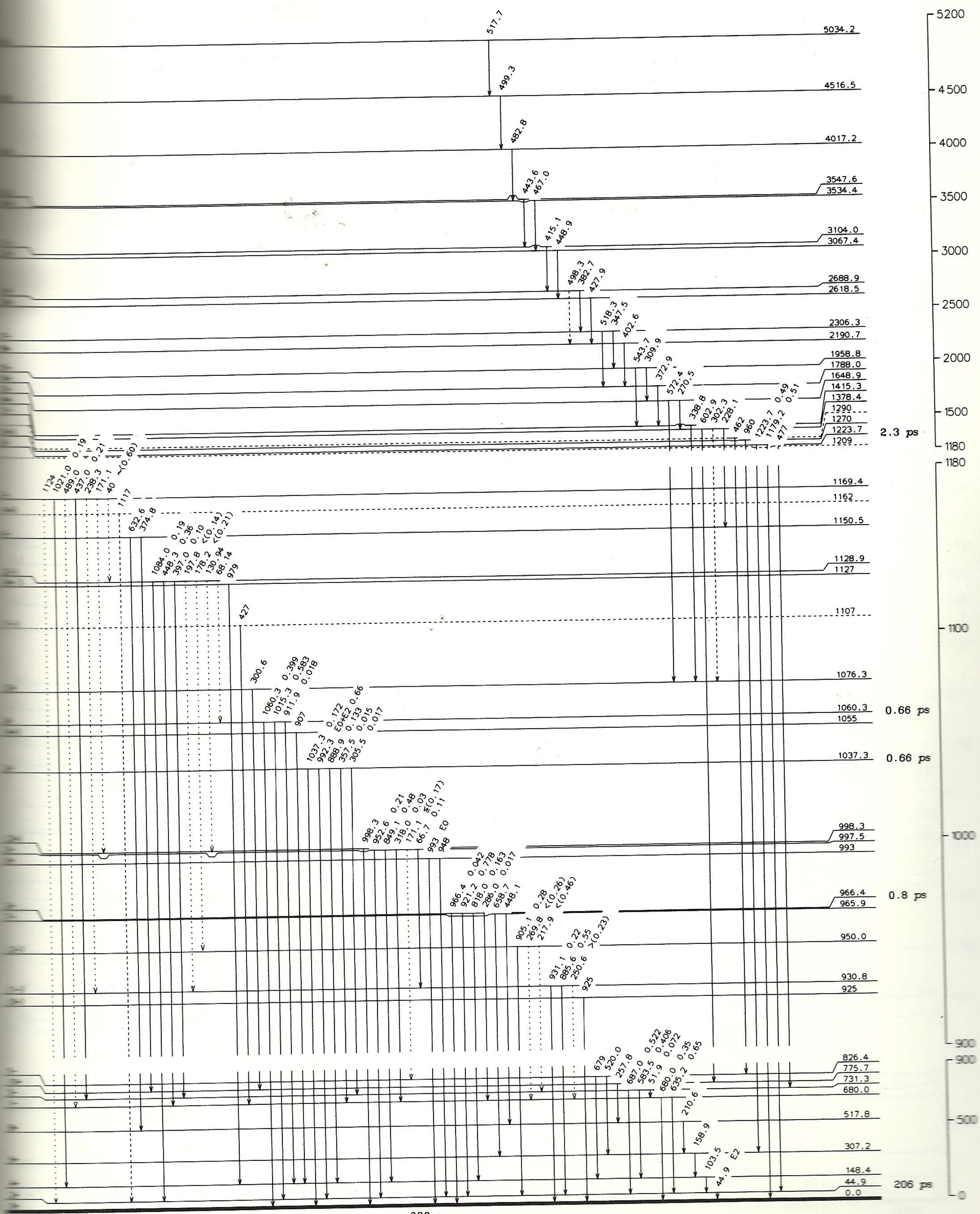

$^{238}U(n,n'\gamma)$
78De41
Intensities: relative Iγ
* Multiple placement
1600
1500
1000
500
500
0
1515.8
(1,2+)
1465.7
1428.0
1412.6
(1,2+)
1279.1
1274.8
(1,2+)
(1,2+)
1251.6
1223.4
1216.4
(1,2+)
1208
1204
3−
1179.6
1170.7
1168.4
(2−)
1159.7
1128.4
1123.7
2+
(3+)
1060.94
1059.5
2+
1057.1
(3−)
1036.5
2+
997.1
(2−)
965.3
(1−)
949.6
929.8
5−
827.1
3−
731.6
1−
679.87
8+
518.1
6+
306.9
4+
148.0
2+
44.63
0+
0.0
$^{238}_{92}U_{146}$

Coulomb Excitation
Intensities: relative I(γ+ce) from each level



^{238}U Adopted Levels

Q(β−)=−146.2 *14*; S(n)=6153.3 *5*; S(p)=7621 *50*; Q(α)=4269 *6* 82WaZZ.
Energies of vibrational states (K=0+,2+,4+,1−,2−,3−) were calculated by 65So04, 70Ne08, 71Ko31, 69Bl13, 74Du09, 75IvZZ, 75LeZR.

E(level)	Jπ	$T_{1/2}$	Comments
0.0[†]	0+	4.468×10^9 y *3*	%SF=5.07×10^{-5} *23*; %α=100. $T_{1/2}$: 4.49×10^9 y *1* (49Ki26), 4.507×10^9 y *9* (55Ko13), 4.51×10^9 y (57Cl16), 4.56×10^9 y *3* (57Le21), 4.46×10^9 y *1* (59St45), 4.4683×10^9 y *24* (71Ja07). $T_{1/2}$(SF)=9.86×10^{15} y *15* (68Ro15), 8.1×10^{15} y *3* (52Se67), 7.19×10^{15} y *4* (67Is04), 8.23×10^{15} y *10* (67Sp12), 8.19×10^{15} y *6* (70Ga27), 11×10^{15} y *2* (71Co35), 10.2×10^{15} y *9* (71Kl14), 9.50×10^{15} y *21* (71Le11), 8.7×10^{15} y *10* (71Sa08), 8.0×10^{15} y *4* (71Th17), 9.9×10^{15} y *5* (72Ni19), 10.2×10^{15} y *8* (73Kh10), 9.73×10^{15} y *44* (74Iv04), 9.6×10^{15} y *3* (75Em03), 8.0×10^{15} y *6* (75Wa37), 8.09×10^{15} y *40* (76Th12), 8.43×10^{15} y *21* (78Ka40), 6.77×10^{15} y *15* (78Ri07), 8.8×10^{15} y *4* (80Po09). For calculated $T_{1/2}$(SF), see 76Ra02. Earlier measurements: 66Ra25, 64Fl07, 63Me14, 59Ku81, 59Ge30. The effects of boron and lithium on the ratio of induced to spontaneous fission in natural uranium were measured by 79At01. 78Ge10 measured isotope shift and deduced Q=13.9 *20*.
44.91[†] *3*	2+	225 ps *20*	$T_{1/2}$: from (α)(ce 45γ)(t) in ^{242}Pu α decay (60Be25). See also ^{238}U.
148.41[†] *5*	4+		
307.21[†] *10*	6+		
517.8[†] *2*	8+		
680.1[‡] *2*	1−		
731.9[‡] *2*	3−		
775.7[†] *4*	10+		
827.1[‡] *5*	5−		
927.0[§] *3*	(0+)		Jπ: Coul. ex.
930.8[&] *3*	(1−)		Jπ: gammas to 0+,2+,1− levels, γ from 3− level.
950.0[&] *4*	(2−)		Jπ: γ decay pattern.
965.9[‡] *5*	7−		
966.3[§] *3*	2+	0.8 ps *4*	B(E2)=0.017 *7*. $T_{1/2}$: from B(E2). Jπ: gammas to 0+,2+,4+ levels; Coul. ex. the ratio of reduced transition intensities of 966, 818 gammas is in better agreement with the Alaga rule for K=0: B(E2); 966γ/B(E2); 818γ=0.12 observed in Coul. ex. =0.389 theory for K=0, =0.875 theory for K=1, =14.0 theory for K=2.
993[#]	0+		Jπ: 993γ is E0.
997.5[&] *3*	3−		Jπ: gammas to 2+,4+,1−,5− levels; Coul. ex.
998.3[c] *5*	(2+)		Jπ: Coul. ex.
1037.3[#] *2*	2+	0.66 ps	B(E2)=0.063 *9*. $T_{1/2}$: from Coul. ex. Jπ: 992.3γ is E0+E2; Coul. ex.
1055[§]	(4+)		Jπ: Coul. ex.
1059.5[b]	(3+)		Jπ: gammas to 2+,4+ levels; γ feeding from 2− level; 3+, configuration=((ν,1/2[631])(ν,5/2[622]) proposed by 70HeZX.
1060.3[@] *2*	2+	0.66 ps *5*	B(E2)=0.127 *9*. $T_{1/2}$: from B(E2). Jπ: gammas to 0+,2+,4+ levels.
1076.5[†] *5*	12+		
1105.6[@]	(3+)		Jπ: γ decay pattern.
1107?[c]			J=1−, K=1 assignment was made by 67Di07 in Coul. ex.
1127[#]	(4+)		Jπ: Coul. ex.
1128.7[a] *3*	(2−)		Jπ: gammas to 2+,1−,3− levels.
1150.3[‡] *6*	9−		
1167.7[@]	(4+)		Jπ: γ decay pattern.
1169.1[a] *3*	3−		Jπ: Coul. ex.
1209?[c]			J=4−,K=1 assignment was made by 67Di07 in Coul. ex.
1223.9[c] *3*	2+	2.3 ps *14*	B(E2)=0.022 *13*. $T_{1/2}$: from B(E2). Jπ: Coul. ex.
1231[c]			
1242.9?[a]	(4−)		Jπ: β-decay ^{238}Pa.

Continued on next page (footnotes at end of table)

^{238}U Band Structure

K=0 ground-state band. A=7.5, B=−0.004

For calculated rotational level energies, see 76Az01, 76Ra04, 68Ho28, 78BeYR, 78To13, 78Ba46 for example. High-spin rotational states were calculated by 77Ma23. Jπ: Coulomb excitation. Assignments of the excited states are based on comparing measured E2-matrix elements with the rigid rotor predictions.

E(level)	Jπ	$T_{1/2}$	Comments
0.0	0+	4.468×10^{9} y *3*	%SF=5.07×10^{-5} *23*; %α=100.
44.91 *3*	2+	225 ps *20*	
148.41 *5*	4+		
307.21 *10*	6+		
517.8 *2*	8+		
775.7 *4*	10+		
1076.5 *5*	12+		
1415.3 *6*	14+		
1788.2 *8*	16+		
2190.7 *13*	18+		
2618.7 *16*	20+		
3067.2 *20*	22+		
3534.5 *15*	24+		
4017.3 *18*	26+		
4516.5 *21*	28+		
5034.3 *23*	30+		

K=0 octupole-vibrational band. A=5.1, B=0.0036

Ratios of reduced transition intensities are in agreement with Alaga rule for K=0:

B(E1);680γ/B(E1);635γ	=0.44	observed in Coul. ex.
	=0.68	observed in ^{238}Pa decay
	=0.54	observed in (n,n'γ)
	=0.50	theory for K=0
	=2.0	theory for K=1.
B(E1);687γ/B(E1);583γ	=0.75	observed in Coul. ex.
	=0.81	observed in ^{238}Pa decay
	=0.78	observed in (n,n'γ)
	=0.75	theory for K=0
	=1.33	theory for K=1.

Negative-parity yrast states were calculated by 76Vo01. The states with low spin were interpreted as octupole states, but the higher spin states become two-quasiparticle, decoupled states. Octupole-vibrational states were calculated by 78Ko03. Levels in yrast-band were calculated by 77Ra25. Jπ: Coul. ex. assignments of the excited states in this band are from comparing measured E2-matrix elements with the rigid-rotor predictions.

E(level)	Jπ	E(level)	Jπ
680.1 *2*	1−	1648.9 *8*	13−
731.9 *2*	3−	1958.6 *8*	15−
827.1 *5*	5−	2305.9 *10*	17−
965.9 *5*	7−	2687.2 *14*	19−
1150.3 *6*	9−	3104.2 *14*	21−
1378.4 *6*	11−	3547.8 *18*	23−

^{238}U Band Structure (continued)

K=0 band. A=6.5, if B=0

E(level)	Jπ	$T_{1/2}$	Comments
927.0 *3*	(0+)		
966.3 *3*	2+	0.8 ps *4*	B(E2)=0.017 *7*.
1055	(4+)		

K=0 β-vibrational band A=7.7, B=-0.05 (A=7.4 if B=0)

E(level)	Jπ	$T_{1/2}$	Comments
993	0+		
1037.3 *2*	2+	0.66 ps	B(E2)=0.063 *9*.
1127	(4+)		
1270	(6+)		

K=2 γ-vibrational band

E(level)	Jπ	$T_{1/2}$	Comments
1060.3 *2*	2+	0.66 ps *5*	B(E2)=0.127 *9*.
1105.6	(3+)		
1167.7	(4+)		

K=1?

May possibly be an octupole band. See 74Mc15, 75Gr23 for discussions.

E(level)	Jπ
930.8 *3*	(1-)
950.0 *4*	(2-)
997.5 *3*	3-

K=2?

E(level)	Jπ
1128.7 *3*	(2-)
1169.1 *3*	3-
1242.9?	(4-)

K=3 ν 1/2[631]+ν 5/2[622]

E(level)	Jπ
1059.5	(3+)

α-radiations from ^{238}U α Decay

αγ(t): (α)(ce 48γ)(t) $T_{1/2}$=0.37 ns *3* 60Be25.

Eα‡	E(level)	Iα†§	HF
4039 *5*	160	0.23 *7*	14
4147 *5*	49.55	23 *4*	1.3
4196 *5*	0.0	77 *4*	1.0

† For α intensity per 100 decays, multiply by 1.0.
‡ From 57Ha08 (ic), 61Ko11 (ic), 59Ko58 (ic). Original energies of 57Ha08 and 60Vo05 have been increased by 5 keV and 2 keV, respectively, because of calibration. Other measurements: 47Al06, 55Va20, 57Bo98, 57Cl17.
§ From 59Ko58.