Excited states in ^{118}Sn populated by the β^- decay of ^{118}In^g and ^{118}Sb

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The ^{118}In^g activity has been obtained by chemical separation of the parent nucleus ^{118}Cd from a $UO_2(NO_3)_2 \cdot 6H_2O$ sample, irradiated with 25- and 50-MeV bremsstrahlung. Two successive Ge(Li) γ-ray spectra were measured. Several new γ rays were found and the relative intensities of the known γ lines are compared and discussed with respect to the existing data. Levels in ^{118}Sn at 0, 1229.64, 1757.8, 2043.1, 2056.5, 2326.5, 2402.5, and 3137.2 keV were found to be fed in the β^- decay of ^{118}In^g. Based on the measured post-neutron yields of the masses 111, 112, 113, 115, 117, 123, and 125 for the photofission of ^{238}U with 25- and 50-MeV bremsstrahlung, the post-neutron yield of mass 118 was obtained by interpolation, assuming a smooth behavior of the mass distribution in this region. From this the absolute intensity of the observed γ lines could be determined. Intensities for all β branches and corresponding logft values were calculated. The results of this study differ considerably from those known in the literature. The β decay rates for ^{118}In and ^{118}Sb are compared with results of nuclear structure calculations. The systematics of logft values for the $1g_{9/2} \rightleftarrows 1g_{7/2}$ Gamow-Teller β decay is correlated with the filling of the $1g_{7/2}$ neutron single-particle orbit for increasing A.

[RADIOACTIVITY ^{118}In^g [from ^{238}U(γ,f), $E_{\gamma max}$ = 25 and 50 MeV, chemical separation of Cd]. Measured E_γ, I_γ. ^{118}In^g deduced logft, ^{118}Sn deduced levels, J, π.]

I. INTRODUCTION

Although the β decay of the heavy odd-mass In isotopes (A = 115–123) has been extensively studied,[1-6] less information is available concerning the decay of the heavy doubly odd In isotopes.[7-11] This is especially the case for the decay of $I^\pi = 1^+$ states in the odd-odd In isotopes.

For the decay of ^{118}In^g ($T_{1/2}$ = 5.0 s; $I^\pi = 1^+$) the few existing data,[10] used in the catcher foil technique to calculate the total chain yield for mass 118 in the post-neutron mass distribution for spontaneous fission of ^{252}Cf or for the photofission of ^{235}U and ^{238}U with 25- and 50-MeV bremsstrahlung, give rise to yields which are 3 times lower than expected. For this reason we have reinvestigated the decay of the above mentioned In isotopes.

Photofission gives an important yield in the symmetric mass region, including the Cd isotopes, if bremsstrahlung with an end-point energy higher than 10 MeV is used (see Table I). Due to the half-life of ^{118}Cd ($T_{1/2}$ = 50.3 min $I^\pi = 0^+$), and the fact that it is a pure β^- emitter not feeding the ^{118}In^m ($T_{1/2}$ = 4.45 min $I^\pi = 5^+$) isomer, it was very favorable to study the decay of ^{118}In^g, starting from the parent nucleus ^{118}Cd. In addition, we measured the total chain yields for the masses 111, 112, 113, 115, 117, 123, and 125 in the region of symmetric fission for the photofission of ^{238}U with 25- and 50-MeV bremsstrahlung. As in the post-neutron mass distribution for the photofission of ^{238}U, the valley region is flat and is not expected to exhibit significant fine structure[12]; the total chain yields for all the masses in the region of symmetric fission should be nearly equal. This is confirmed by our experiments as can be seen from Table I.

For A = 118, however, a discrepancy of a factor 3 compared to the other mass yields is found. The spectroscopic data needed to calculate mass yields are, for all but mass 118, obtained from Ref. 13. For mass 118 the data of Carlson *et al.*[10] were used. For the following reasons the observed discrepancy must be due entirely to wrong values of the absolute γ-ray intensities or of the half-lives of the considered isotopes:

(i) The fine-structure effects observed in spontaneous fission, particle-induced fission, or photofission[12,14] are at least an order of magnitude smaller than the effect corresponding to the discrepancy mentioned above.

(ii) If one takes into account that the average total number of emitted neutrons $\langle \nu_T \rangle$ = 3.0 in the

TABLE I. Total chain yields $Q(A)$, normalized to a total yield of 200%, as is usual in fission studies, for the photofission of ^{238}U with 25- and 50-MeV bremsstrahlung.

A	$Q(A) E_\gamma^{max}$ = 25 MeV	$Q(A) E_\gamma^{max}$ = 50 MeV
111	0.39 ± 0.05	0.63 ± 0.06
112	0.41 ± 0.03	0.64 ± 0.05
113	0.32 ± 0.04	0.57 ± 0.07
115	0.33 ± 0.03	0.55 ± 0.04
117	0.33 ± 0.04	0.57 ± 0.05
123	0.37 ± 0.05	···
125	0.45 ± 0.03	···

photofission of ^{238}U with 25-MeV bremsstrahlung,[15] the masses 117 and 118 are complementary, which implies that apart from small differences in $\nu(M)$, the number of emitted neutrons as a function of the pre-neutron mass, the yields for both masses should be the same.

The procedure employed to calculate the total chain yield of mass 118 is based on the assumption of a negligible independent fractional yield of ^{118}In. The experiment with 50-MeV bremsstrahlung was performed to check this assumption. Indeed, $dZ_p/dE_c > 0$ (Ref. 16) (with Z_p the most probable charge in a mass chain and E_c the excitation energy of the compound nucleus) means that if there was a small independent yield of ^{118}In for 25-MeV bremsstrahlung induced fission, its value would increase for fission with 50-MeV bremsstrahlung. From our measurements with 25- and 50-MeV bremsstrahlung an upper limit of 10% for the independent yield of ^{118}In is obtained.

In addition, our photofission studies of ^{238}U with 25-MeV bremsstrahlung[15] show for fragment masses in the mass region 128–140 practically the same Z_p values as for ^{235}U(n_{th}, f). Moreover, in calculating the Z_p values for the photofission of ^{238}U with 25-MeV bremsstrahlung, starting from the existing data for thermal-neutron-induced fission of ^{235}U (Ref. 17) and using the relations of Nethaway,[16] values that are close to the Z_p values for ^{235}U(n_{th}, f) are obtained. An independent fractional chain yield for ^{118}In$<0.1\%$ is obtained as well for 25-MeV as for 50-MeV bremsstrahlung-induced fission if this independent yield is calculated based on the Z_p values obtained using the relations of Nethaway.[16]

The total chain yield of mass 118 is determined by measuring the number of ^{118}Cd nuclei, or consequently by measuring the intensity of a given γ ray in the decay of ^{118}In^g for which the absolute intensity is known. On the other hand, assuming that the total chain yield for $A = 118$ is the same as for the adjacent masses, we can deduce the absolute intensity of the γ transitions in ^{118}Sn if the half-lives of ^{118}Cd and ^{118}In^g are known.

Our experimental results for the decay of ^{118}In^g are in good agreement with results for the analogous β decay of ^{116}In and ^{120}In ($I^\pi = 1^+$) (Refs. 9 and 11), but differ substantially from the data of Carlson *et al.*[10] In this paper also the β decay of the adjacent doubly odd nucleus ^{118}Sb (Ref. 18) is discussed in terms of the quasiparticle structure of low-lying levels in the doubly even ^{118}Sn nucleus. In this paper we present the results of extensive unified model calculations for the odd In isotopes and explain qualitatively the β decay to collective excitations in ^{118}Sn. The strong retardation of allowed Gamow-Teller transitions compared to the single-particle strength is also discussed. Finally, the systematics of the $\log ft$ values of the $1^+_{(1)}$ In $\to 0^+_{(1)}$ Sn and $\frac{9}{2}^+_{(1)}$ In $\rightleftarrows \frac{7}{2}^+_{(1)}$ Sn β decay for $111 < A < 125$ are discussed and correlated with the filling of the $1g_{7/2}$ neutron orbit with increasing mass number.

II. EXPERIMENTAL TECHNIQUES

For the photofission of ^{238}U with 25- and 50-MeV bremsstrahlung, the post-neutron mass yields for several masses in the symmetric region were measured using the catcher foil method, described in detail in Refs. 13 and 15. For the determination of the ratios $Q(A=118)/Q(A=117)/Q(A=115)$ chemically separated samples were used. $Q(A=118)$, $Q(A=117)$, and $Q(A=115)$ stand for the yields of mass 118, 117, and 115, respectively, in the photofission of ^{238}U. Samples of 0.5 g natural uranium [$UO_2(NO_3)_2 \cdot 6H_2O$] were irradiated with 25- or 50-MeV bremsstrahlung from the nonanalyzed beam of the Linac of the Nuclear Physics Laboratory. The bremsstrahlung was produced in a 0.5-mm thick tungsten target, followed by 10 cm carbon to stop the electrons. The irradiation time was 90 min. After a cooling time of 15 min the Cd fraction was extracted using the method of Gleit and Coryell.[19] For the determination of $Q(A=117)/Q(A=115)$ these times were respectively 5 h and 3 h. The efficiency of the chemical separation was $(75 \pm 4)\%$. As tracer, ^{109}Cd was used. Starting 45 min after the end of the irradiation two successive γ-ray spectra of 1 h each were taken in order to check the half-life of the observed γ rays. The apparatus was the same as described in a previous paper.[13] Due to the low intensity of the observed γ rays no coincidence measurements were performed.

III. EXPERIMENTAL RESULTS

Part of the γ-ray spectrum of the Cd fraction extracted from uranyl nitrate, irradiated with 25-MeV bremsstrahlung, is shown in Fig. 1. Energies and relative intensities of the γ transitions belonging to the decay of ^{118}In^g were determined. They are given in Table II. The results of the irradiations with 25- and 50-MeV bremsstrahlung are in very good agreement with each other. The available β decay energy for ^{118}Cd, erroneously given in the Nuclear Data Sheets[10] to be 7400 keV, is 740 keV.[21] For the 1229.7-keV γ ray a decay period of 50 ± 2 min is observed. This is in good agreement with the known half-life of ^{118}Cd (50.3 min)[10] and the very short ^{118}In half-life (5.0 sec).[10]

In Table II our results are compared with the

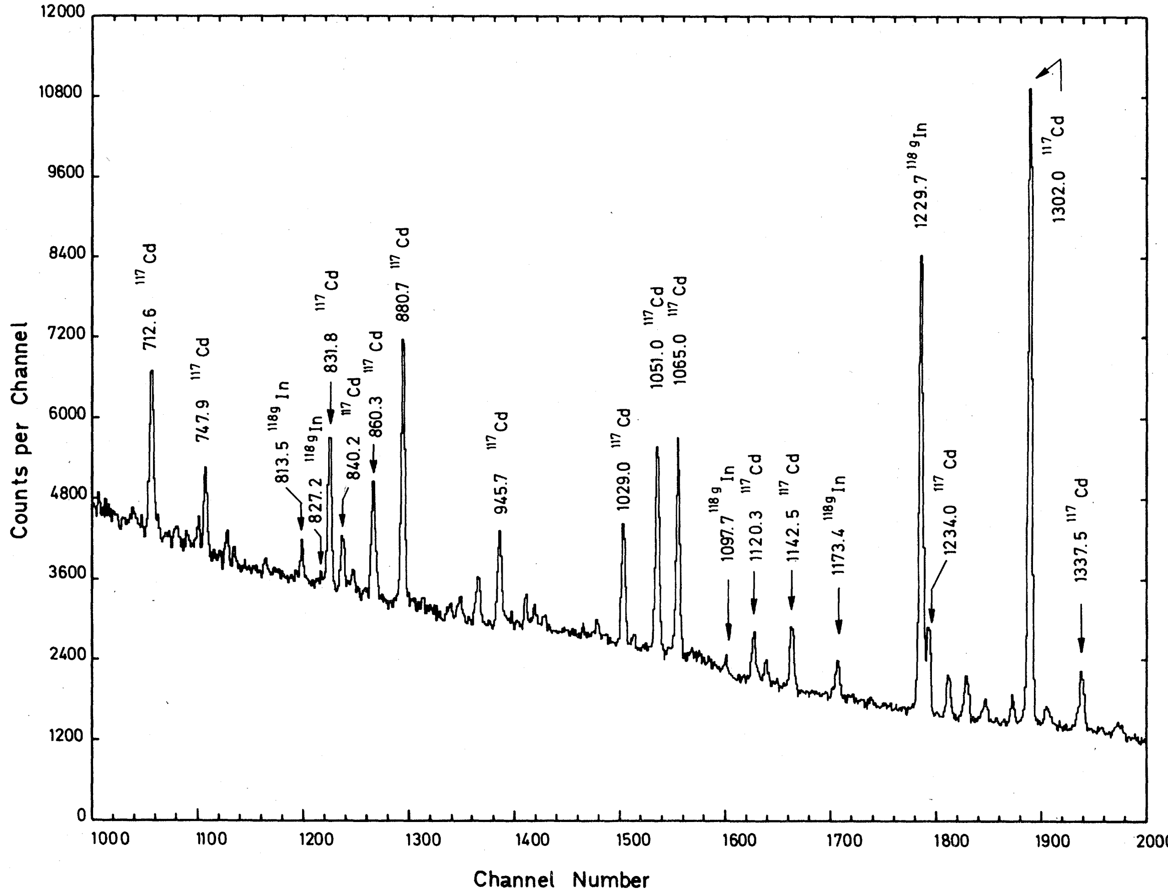

FIG. 1. Part of the γ-ray spectrum of the Cd fraction extracted from uranylnitrate, irradiated with 25-MeV bremsstrahlung. Only the most intense background lines are indicated in this spectrum.

older data of Schwarzbach and Münzel[22] and the more recent Ge(Li) measurements of Hattula, Luikkonen, and Kantele.[18] The agreement between the older NaI(Tl) data of Schwarzbach and Münzel and our results, at least for the most prominent

TABLE II. Energies and relative intensities of the γ rays from the decay of $^{118}\mathrm{In}^{g}$.

E_γ (keV)	I_γ^{rel} (%) Schwarzbach and Münzel (Ref. 22)	Hattula *et al.* (Ref. 18)	This work
528.0	14	36	14±2
813.0	6	···	3.9±0.8
827.0		8.3	0.7±0.3
1097.0	···	···	2.0±0.7
1173.4	···	···	8.6±1.7
1229.7	100	100	100
1680	3	···	···
1880	3	···	···
1908.2	···	···	2.6±0.6
2043.2	···	···	2.1±0.6

lines, is very good. On the other hand, the differences between the results of Hattula *et al.*[18] (concerning the relative intensities of the observed γ rays) and our results are very important. These discrepancies can probably be explained by noting the method of studying the decay of $^{118}\mathrm{In}^{g}$ followed by Hattula *et al.*[18] To produce $^{118}\mathrm{In}^{g}$ the $^{118}\mathrm{Sn}^{g}(n_{14\,\mathrm{MeV}}, p)^{118}\mathrm{In}$ reaction was used. Large contamination from the $^{118}\mathrm{In}^{m}(T_{1/2} = 4.45$ min; $I^{\pi} = 5^{+})$ decay cannot be avoided and a separation of the $^{118}\mathrm{In}^{g}$ and $^{118}\mathrm{In}^{m}$ decays becomes almost impossible, as the most intense γ rays are common to both decays.

A decay scheme, based on the present experimental results and taking into account reaction data and information obtained from the decay of $^{118}\mathrm{Sb}$ concerning the excited states of $^{118}\mathrm{Sn}$ (Ref. 10), is given in Fig. 2. Also, the intensities of the different β branches and the corresponding $\log ft$ values for the β decay of $^{118}\mathrm{Sb}$ are given in the figure and will be discussed.

From the value of $Q(A = 118)$, obtained as the

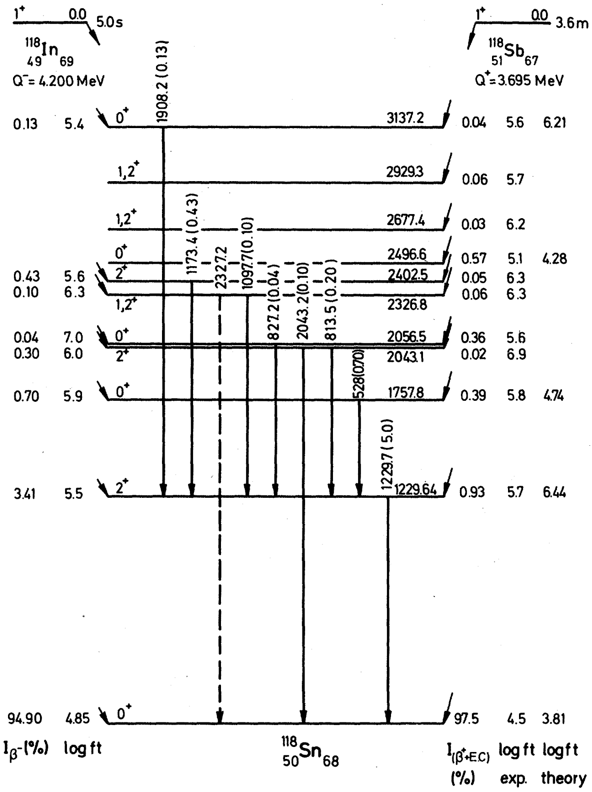

FIG. 2. Decay scheme of $^{118}In^g$. The γ-ray intensities are given per hundred $^{118}In^g$ decays. The level energies (in keV), the I^π values, and the β-decay data for ^{118}Sb are taken from Ref. 10.

average value of $Q(A=113)$, $Q(A=115)$, and $Q(A=117)$, the absolute intensity of the 1229.7-keV γ line was calculated to be $(5\pm2)\%$. The uncertainty can be separated into two different contributions: (i) 0.5% due to the statistical error on the results and the uncertainty on the efficiency of the Ge(Li) detector; (ii) The remaining 1.5% takes into account the possible uncertainties in the values of the absolute intensities of the reference γ rays, a very improbable 10% independent chain yield of ^{118}In and fine structure effects of maximum 30% in the mass distribution in the symmetric region for the photofission of ^{238}U. These fine structure effects are not expected to be present in the photofission of ^{238}U, and they have never been observed. However, for the photofission of ^{235}U with 14-MeV bremsstrahlung such an effect was reported.[23]

This value of the absolute intensity of the 1229.7-keV γ ray and the deduced summed absolute intensity of the β transitions to all the excited states in ^{118}Sn ($\sum I_\beta^{exc}$), differs considerably from earlier results, as can be seen in Table III. However, when there is a strong ground state β transition, it is very difficult to determine with good accuracy the intensities of the remaining β transitions using the classical Kurie-plot analysis of the measured β spectra. Table IV compares the intensities of the different β branches in the decay of $^{118}In^g$ together with the corresponding logft values with the results of Carlson, Talbert, and Raman.[10]

IV. DISCUSSION

By studying experimentally the β^- decay of the $I^\pi=1^+$ ^{118}In ground state and by comparing the results with the known β^+ decay of the $I^\pi=1^+$ ^{118}Sb ground state[18] to the same final states in ^{118}Sn (having $I^\pi=0^+$, 1^+, or 2^+), information concerning the wave functions in both initial and final states can be obtained.

A. Gamow-Teller decay from ^{118}Sb

Let us first consider the Gamow-Teller (GT) decay from ^{118}Sb($I^\pi=1^+_{g.s.}$) to $I^\pi=0^+$ and 2^+ levels in ^{118}Sn. The wave functions for these particular excited states in the final nucleus are known from two quasiparticle (2QP) calculations.[24-26] We expect the $[c^\dagger_{2d_{5/2}}(\pi)\otimes a^\dagger_{2d_{3/2}}(\nu)]_{1^+}|\tilde{0}\rangle$ configuration to be the most important configuration in the wave function of the $I^\pi=1^+$ initial state.[27] ($c^\dagger_\alpha$ and $a^\dagger_\alpha$

TABLE III. Comparison of the $\sum I_\beta^{exc}$ values for the β decay of $^{118}In^g$.

Method of production of $^{118}In^g$	Method for the determination of $\sum I_\beta^{exc}$	$\sum I_\beta^{exc}$ (%)
^{238}U($d_{14\,MeV}$, f) followed by chemical separation of Cd	β-γ coincidences (Ref. 19)	15^{+10}_{-5}
^{118}Sn($n_{14\,MeV}$, p)^{118}In	Comparison of β and γ spectra of In($I^\pi=1^+, 5^+$) (Ref. 20)	10–20
^{238}U($d_{50\,MeV}$, f) followed by mass spectroscopic separation of Cd	Comparison of the bremsstrahlung continuum and the total γ intensity (Ref. 22)	20
^{238}U(γ,f) followed by chemical separation of Cd	Determination of $\sum I_\beta^{exc}$ from assumed post-neutron total chain yield of mass 118 in the photofission of ^{238}U (this experiment)	5 ± 2

TABLE IV. Energies, intensities, and corresponding $\log ft$ values for the β decay of $^{118}\mathrm{In}^{g}$.

	I_β (%)		$\log ft$	
E_β (keV)	Carlson *et al.* (Ref. 10)	This experiment	Carlson *et al.* (Ref. 10)	This experiment
4200	85	94.9	4.7	4.85
2971	9	3.41	5.1	5.5
2442	5	0.70	5.0	5.9
2157	1	0.30	5.4	6.0
2143	⋯	0.035	⋯	7.0
1873	⋯	0.10	⋯	6.3
1797	⋯	0.43	⋯	5.6
1162	⋯	0.13	⋯	5.4

denote the single-particle and quasiparticle creation operators in a state α. The ground state of $^{118}\mathrm{Sn}$ is denoted by $|\tilde{0}\rangle$.) This is further supported by examining the ground state spin of the odd-mass nuclei $^{117}\mathrm{Sb}$ and $^{119}\mathrm{Sb}$ (nearly pure $2d_{5/2}$ proton single-particle states[29]), the very low-lying $I^\pi = \frac{3}{2}^+$ level (neutron $1QP$ excitation) in $^{117}\mathrm{Sn}$ and $^{119}\mathrm{Sn}$ (Ref. 27), and recent calculations of the doubly odd $^{112,114,116,122}\mathrm{Sb}$ isotopes in a particle–one-quasiparticle (number projected) calculation.[27]

The subsequent GT transition probabilities become

$$B(\mathrm{GT};1^+_{\mathrm{g.s.}} \to 0^+_{\mathrm{g.s.}}) = \tfrac{1}{3} v_{2d_{3/2}}{}^2 \langle 2d_{5/2} \| \vec{\sigma} \| 2d_{3/2} \rangle^2 , \tag{4.1}$$

$$B(\mathrm{GT};1^+_{\mathrm{g.s.}} \to I^\pi) = \tfrac{1}{3}(2I+1) \left| \sum_{a,b} \Psi(ab;I) \begin{Bmatrix} I & 1 & 1 \\ \frac{5}{2} & a & b \end{Bmatrix} [(-1)^{j_a + j_b - I} \delta_{b,2d_{3/2}} u_a \langle 2d_{5/2} \| \vec{\sigma} \| a \rangle - \delta_{a,2d_{3/2}} u_b \langle 2d_{5/2} \| \vec{\sigma} \| b \rangle] (1+\delta_{a,b})^{-1/2} \right|^2 , \tag{4.2}$$

with $\Psi(ab;I)$ denoting the expansion coefficients of the $2QP$ states I^π in $^{118}\mathrm{Sn}$.

The resulting $\log ft$ values, calculated with the Arvieu wave functions,[24] are indicated in Fig. 2. A retardation of the experimental $1^+_{\mathrm{g.s.}} \to 0^+$ $\log ft$ values compared to the calculated values by $\Delta \log ft \simeq 0.7$ is observed. This strong retardation effect of the GT single-particle transition strength has been discussed extensively.[28,30–33] It is due to core polarization effects, concentrating most of the single-particle GT strength in a coherent, highly excited "giant resonance like" $I^\pi = 1^+$, $T = 1$ vibration.

B. β^- decay of $^{118}\mathrm{In}^{g}$ to $I^\pi = 0^+, 2^+$ levels in $^{118}\mathrm{Sn}$

The wave function describing the $I^\pi = 1^+$ $^{118}\mathrm{In}$ ground state is assumed to be[34]

$$[c_{1g_{9/2}}(\pi) \otimes a^\dagger_{1g_{7/2}}(\nu)]_{1^+} |\tilde{0}\rangle . \tag{4.3}$$

This assumption is strengthened by examining the ground state spin of the odd-mass $^{117,119}\mathrm{In}$ nuclei (nearly a pure $1g_{9/2}$ single-hole state[35]), the lowest $\frac{7}{2}^+$ excitation in $^{117,119}\mathrm{Sn}$ which is a rather pure $1QP$ excitation,[36] and recent calculations of the doubly odd $^{114}\mathrm{In}$, $^{116}\mathrm{In}$ isotopes in a hole–one-quasiparticle (number projected) calculation.[27]

The odd-mass In isotopes have been extensively discussed in the framework of unified model calculations,[35] so that $\log ft$ values can be calculated for β transitions to the 0^+ ground state ($0^+_{\mathrm{g.s.}}$), the 2^+ one-phonon state ($2^+_{1\mathrm{ph}}$), and 0^+, 2^+, and 4^+ two-phonon states ($0^+_{2\mathrm{ph}}$, $2^+_{2\mathrm{ph}}$, $4^+_{2\mathrm{ph}}$). The most important component of the wave function describing the $\frac{9}{2}^+$ ground state of $^{117}\mathrm{In}$ is

$$|\tfrac{9}{2}^+_{(1)}\rangle = 0.887 c_{1g_{9/2}} |\tilde{0}\rangle + 0.409 (c_{1g_{9/2}} \otimes 2^+_{1\mathrm{ph}})_{9/2^+} |\tilde{0}\rangle + 0.067 (c_{1g_{9/2}} \otimes 0^+_{2\mathrm{ph}})_{9/2^+} |\tilde{0}\rangle - 0.052 (c_{1g_{9/2}} \otimes 2^+_{2\mathrm{ph}})_{9/2^+} |\tilde{0}\rangle + \cdots . \tag{4.4}$$

The transition probabilities for the GT β decay from the $I^\pi = 1^+$ $^{118}\mathrm{In}$ ground state to the $I^\pi = 0^+$, 2^+ states in $^{118}\mathrm{Sn}$ are given by

$$B(\mathrm{GT};1^+_{\mathrm{g.s.}} \to R) = 10 \begin{Bmatrix} R & 1 & 1 \\ \frac{7}{2} & \frac{9}{2} & \frac{9}{2} \end{Bmatrix}^2 u_{1g_{7/2}}{}^2 \phi(1g_{9/2}R; \tfrac{9}{2}^+)^2 \langle 1g_{7/2} \| \vec{\sigma} \| 1g_{9/2} \rangle^2 . \tag{4.5}$$

The collective angular momentum is denoted by R; ϕ denotes the amplitude of the configuration $(1g_{9/2}\otimes R)_{9/2^+}|\tilde{0}\rangle$ as given in Eq. (4.4). Also, admixtures of one-phonon and two-phonon states in the $\frac{9}{2}^+_{(1)}$ level are considered in the construction of the wave function of the ground state ($I^\pi=1^+$) of ^{118}In.

For the logft values of the different GT β^- transitions we obtain

$1^+_{\rm g.s.}\to 0^+_{\rm g.s.}$ transition, $\log ft=3.95$;

$1^+_{\rm g.s.}\to 2^+_{\rm 1ph}$ transition, $\log ft=5.38$;

$1^+_{\rm g.s.}\to 0^+_{\rm 2ph}$ transition, $\log ft=6.19$;

$1^+_{\rm g.s.}\to 2^+_{\rm 2ph}$ transition; $\log ft=7.17$.

Again as in the ^{118}Sb to ^{118}Sn $1^+_{\rm g.s.}\to 0^+$ β decay, the GT single-particle strength is strongly reduced compared to the theoretical values.[28,30-33] If, however, we take as the renormalized GT single-particle matrix element the experimental result from the ^{119}In $(\frac{9}{2}^+_{\rm g.s.})\to{}^{119}Sn(\frac{7}{2}^+_{(1)})$ β^- decay,[3,4] we obtain

$$\frac{B({\rm GT};{}^{118}{\rm In}(1^+_{\rm g.s.})\to{}^{118}{\rm Sn}(0^+_{\rm g.s.}))}{B({\rm GT};{}^{119}{\rm In}(\frac{9}{2}^+_{\rm g.s.})\to{}^{119}{\rm Sn}(\frac{7}{2}^+_{(1)}))}=\frac{u_{1g_{7/2}}{}^2}{v_{1g_{7/2}}{}^2}\,\frac{10}{3}\,, \tag{4.6}$$

resulting in a logft of 4.83 for the ^{118}In ground state $\to$ ^{118}Sn ground state β decay. Experimentally, this logft is equal to 4.85, as can be seen in Table IV. To obtain this ratio, the occupation probabilities as calculated by Arvieu[24] are taken.

The fact that two low-lying (< 2.1 MeV) $I^\pi=0^+$ excited states occur has always put stringent problems on the $2QP$ description of the doubly even Sn nuclei.[37,38] Up to $E_{\rm exc}$ = 2.1 MeV only one $I^\pi=0^+$ state is reproduced.[24-26] By means of the residual nucleon-nucleon interactions, a coherent combination of neutron $4QP$ and proton 2p-2h excitations can probably form a collective 0^+ two-quadrupole phonon state[25,39] and lower its unperturbed energy considerably (at twice the energy of the one-quadrupole phonon state in the harmonic approach, i.e., at $\simeq$ 2.4 MeV). The logft value of the β transition to the 2056.5-MeV level, calculated assuming that this level is mainly a two-quadrupole phonon state, supports this explanation.

The 1.757-MeV level is then described as mainly a neutron $2QP$ state. The calculation of logft for the β^- decay to this level, assumed to proceed mainly via the

$$[c_{1g_{9/2}}(\pi)\otimes a^\dagger_{1g_{7/2}}(\nu)]_{1^+}\to[a^\dagger_{1g_{7/2}}(\nu)\otimes a^\dagger_{1g_{7/2}}(\nu)]_{0^+}$$

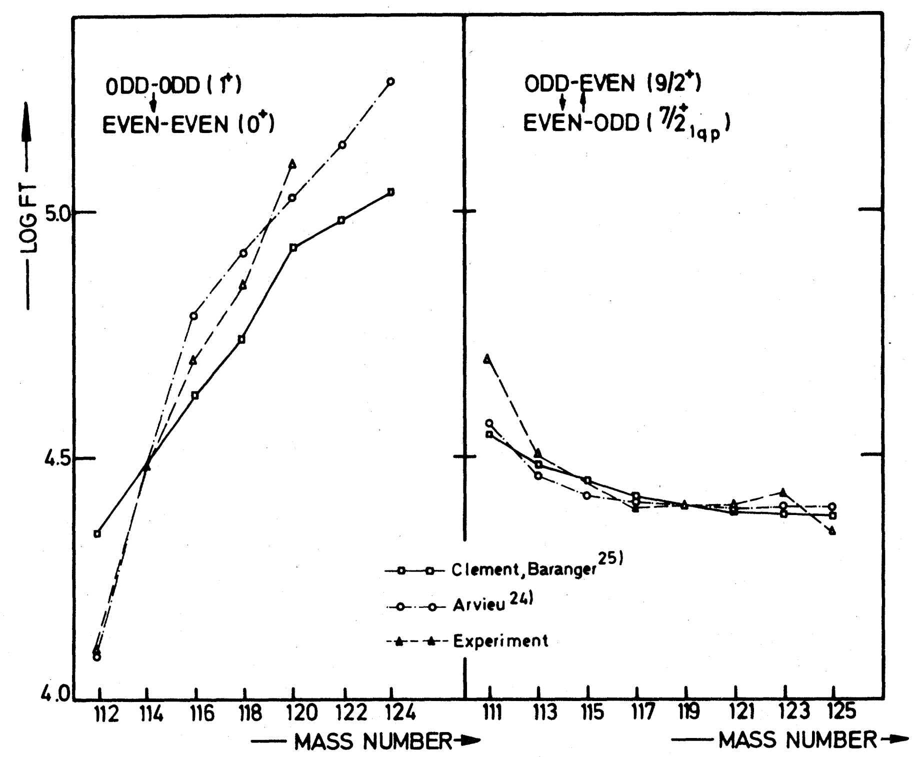

FIG. 3. Comparison of theoretically calculated logft values with experimental results for the $1g_{7/2}\rightleftarrows 1g_{9/2}$ GT β transitions between the different In isotopes and the corresponding Sn isotopes. The experimental results are taken from Refs. 1–11.

transition, results in a value of 5.58, if the wave functions of Clement and Baranger are used.[25] Although the amplitude $\Psi(1g_{7/2}{}^2; 0^+)$ is small and not well determined (Arvieu[24] gives a much smaller value), logft values in the region 5.5–6.0 are expected.

C. Systematics of In ⇌ Sn β transitions

As already indicated by Eq. (4.6), a remarkable correlation with the occupation probabilities exists for the known logft values of different doubly odd In(1^+) to doubly even Sn(0^+) and even-odd In($\frac{9}{2}^+$) to odd-even Sn($\frac{7}{2}^+$; $1QP$) GT transitions. The theoretical and experimental results are indicated in Fig. 3. The theoretical logft values are normalized for the ^{114}In → ^{114}Sn and ^{119}In → ^{119}Sn β^- transitions. They are obtained by using the occupation probabilities as calculated by Arvieu[24] and Clement and Baranger.[25,40] The agreement is very good. Also, the large difference of the even-mass chain logft values compared to the odd-mass chain β^- decay logft values becomes apparent and reflects the filling of the $1g_{7/2}$ neutron single-particle orbit when A increases. The saturation of $v_{1g_{7/2}}{}^2$ shows up in the near constancy of the logft values in the odd-mass chain for $A \geq 113$.

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