^{129}I - Comments on evaluation of decay data by V. P. Chechev and V. O. Sergeev

1- Decay Scheme

The 2nd unique forbidden β^--transition to the 1/2$^+$ ground state of ^{129}Xe was not observed. In 1954 Der Matiosian and Wu (1954De17) showed experimentally that this β^--branch intensity did not exceed 1 %. This limit gives a log $f_{2u}t \geq 14.9$ (or log $f_0t \geq 15.8$), which is consistent with the log $f_{2u}t$ values of 14.6 – 15.8 tallied in 1998Si17 for ten cases from A=22 to A=138, excluding ^{10}Be, with 13.8, and ^{209}Po, with 14.36. The highest value of 15.8 corresponds to 0.13 % for the transition considered.

Therefore, we have adopted the probability of the 2nd unique forbidden β^--transition to the 1/2$^+$ ground state of ^{129}Xe $P(\beta^-_{0,0})$ = 0.5 (5) % with the uncertainty which provides the limits from 0 to 1 % according to 1954De17.

2- Nuclear Data

The Q value has been computed on the basis of the spectrometric measurement of the $\beta^-_{0,1}$ energy by N. Coursol (1979CoZG) and the evaluated gamma-ray energy. This measurement gives a more accurate Q value than 194 (3) keV, presented in the atomic mass evaluation (1995Au04).

The following four experimental values for the ^{129}I half-life are available (in units of 10^7 years).

1.72 (9)	1951 Ka16
1.56 (6)	1957Ru65
1.57 (4)	1972Em01
1.97 (14)	1973Ku17

Use of the LRSW method leads to a higher uncertainty (0.047) in 1972Em01. Our recommended value has been obtained as the weighted mean with the external uncertainty 0.06 expanded due to the Student's factor (or MBAYS uncertainty): 1.61 (7). Thus our recommended value for the ^{129}I half-life is 1.61 (7) $\times 10^7$ years.

2.1. β^--Transitions

The energy of the $\beta^-_{0,1}$ transition has been adopted from 1979CoZG (Coursol). For the probabilities $P(\beta^-_{0,1})$ and $P(\beta^-_{0,0})$ see discussion in sect.1.Decay Scheme.

2.2. Gamma-ray Transitions and Internal Conversion Coefficients

The correction for recoil has not changed the γ-ray transition energy.

The emission probability of the γ-ray transition (photons + electrons) has been adopted as 99.5 (5) %.(see discussion in sect.1).

The multipolarity of the γ-ray transition was measured in 1965Ge04 (M1) and 1974Ra26 (M1 + 0.073 (27) % E2).

ICC's have been interpolated from theoretical values of 1978Ro22 for the adopted multipolarity of M1 + 0.07 (3) % E2. The uncertainties in the theoretical values are as follows: 1 % for α_K and 3 % for α_L, α_M, α_{NO}. The ratio α_{NO}/α_M has been taken from 1971Dr11. The ICC interpolated from other tables (1968Ha53, 1969Ha61, 1978Band) agree with the adopted values within the limits of the stated uncertainties.

The interpolated value α_K^{theory} = 10.59 (11) can be compared with the following experimental values: 10.6 (1968ReZY), 9.8 (9) (1970Gy01), 10.2 (4) (1970SaZI), 10.2 (5) (1977Ra23), and 10.6 (4) (1985Ba73), which have an unweighted average of 10.3.

3. Atomic Data

3.1. Fluorescence yields

The fluorescence yields have been taken from 1996Sc06 (Schönfeld and Janβen).

3.2. X rays

X-ray energies are based on the wavelengths given in the compilation of 1967Be65 (Bearden).

The relative K x-ray emission probabilities have been taken from 1996Sc06 and 1999Schönfeld.

3.3. Auger Electrons

The energies of Auger electrons are from 1977La19 (Larkins) and 1998Schönfeld.

The ratios P(KLX)/P(KLL) and P(KXY)/P(KLL) have been taken from 1996Sc06.

4. Electron emissions

The energies of the conversion electrons have been calculated from the γ-ray transition energy given in sect. 2.2 and the electron binding energies. Their absolute emission probabilities have been calculated using the conversion coefficients given in 2.2 and the absolute γ-ray emission probability.

For the L-shell the ratios L_1:L_2:L_3 = 100 : 8.9 (4) : 3.13 (14) obtained from theoretical conversion coefficients can be compared with the experimental L_1:L_2:L_3 = 100 : 10.0 (4) : 3.1 (3) from $^{129}Cs \rightarrow {}^{129}Xe$ decay (1965Ge04).

Values of the emission probabilities of K-Auger electrons have been calculated using our recommended P(ceK) and P(ceL) values and atomic data given in 3.1.

The maximum energy of β^- particles with energy of 151 keV has been taken from 1979CoZG (Coursol). The average energy of β^- particles calculated with the LOGFT program, which uses an allowed spectral shape, is 40.6 (3) keV. The SPEBETA program gives a different value of 37 keV (2001 Be). In 2001Be the shape factor $C(W) = q^2 + (0.10 \pm 0.01)\, p^2$ was used that given by E. der Matiosian and C. S. Wu (1953DE10) (measurement with a magnetic spectrometer). The value of 37 keV is supported also by the calculation of Kolobachkin et.al. (See the book "Beta emissions of fission products", authors: V. M. Kolobachkin, P. M. Rubtsov, V. G. Alexankin and P. A. Ruzhanskiy. – Moscow, Atomizdat, 1978, p.189. In Russian). They found 36 keV for the average energy of β^- particles of ^{129}I. So we adopt 37 (1) keV as the recommended value.

5. Photon Emissions

5.1 X-Ray Emissions

Our recommended value for the total K x-ray absolute emission intensity has been calculated as $P_{XK}^{eval.} = \omega_K \alpha_K P_\gamma(39.6) = 69.8\,(11)$ %, based on the adopted value of ω_K, a theoretical value of α_K, and our recommended value of $P_\gamma(39.6) = 7.42\,(8)$ %. This K x-ray emission probability agrees well with the result of the measurement $P_{XK}^{exp.} = 70.2\,(8)$ % in 1985Ba73, relative to P_γ (39.6) = 7.46 % (or 69.8 (8) %, relative to P_γ (39.6) = 7.42 %), and it also agrees with the less accurate experimental result from 1977Ra23: 73 (6) %.

The absolute emission probabilities of the K x-ray components have been deduced from the total P_{XK} using the relative probabilities from sect. 3.2.

The total absolute emission probability of L x-rays has been deduced using the adopted values of ϖ_L and n_{KL} and the recommended values of $P(ce_K)$ =78.6 (12) and $P(ce_L)$ = 10.8 (4) %.

5.2. Gamma Emissions

A γ-ray energy of 39.578 (4) keV has been adopted from 1985Ba73 from an accurate measurement made with a planar HPGe detector. The adopted value coincides with 39.578 (2) keV for the energy of the first excited level in ^{129}Xe (1996Te01), deduced from the decay of ^{129}Cs.

Other less accurate experimental values of $E(\gamma_{1,0})$ are (in keV): 39.58 (3) (1965Ge04), 39.6 (2) (1966Re10), 39.4 (3) (1967Gr05), 39.58 (5) (1972Ta15), and 39.581 (15) (1976Me16).

The absolute γ-ray emission probability (P_γ) has been computed as $P(\beta_{1,0})/(1+\alpha_T)$. The uncertainty in P_γ includes the uncertainty of 0.5 % in $P(\beta_{1,0})$, and 1 % in α_T.

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