

⁸⁵Sr - Comments on evaluation of decay data by E. Schönfeld, R. Dersch

1 Decay Scheme

The decay scheme is taken from Torti et al. (1972) and Meyer et al. (1980). A level at 951 keV which is depopulated by four gamma transitions (see Section 4.3) was observed by Barnard et al. (1973) in n,γ reactions. An EC transition to this level in the ⁸⁵Sr disintegration would be second forbidden. An upper limit of $3 \cdot 10^{-7}$ was estimated for this transition. The existence of EC transitions to the levels at 281 keV (unique third forbidden) and 151 keV (third forbidden) is also questionable.

Below the Q_{EC} value there are also levels at 919,7 keV (possibly two levels, $1/2^-$ or $3/2^-$ and $5/2^-$, populated in the decay of 68 min ⁸⁵Sr^m and several reactions) and 731,822 keV ($3/2^-$, populated in the decay of 4 h ⁸⁵Kr^m and several reactions). EC transitions from ⁸⁵Sr ground state to these levels would be both 3rd forbidden, γ rays from these levels have not been observed in the decay of ⁸⁵Sr.

The main transitions in the EC decay of ⁸⁵Sr are the EC transition populating the 514 keV level of ⁸⁵Rb and the γ transition of 514 keV depopulating this level. Besides these transitions there is an EC transition to the 869 keV level which is mainly depopulated by 869 keV γ rays.

The half-lives of the excited levels were taken from Sievers (1991). The half-life of the 514 keV level was determined by Siekman (1956), Löbner (1964). Miller *et al.* (1972) and Walz and Weiß (1976). Sievers took the value of Miller et al. which claims to be the most accurate one.

2 Nuclear Data

The following values of the half-life of ⁸⁵Sr have been considered ($T_{1/2}$ in d):

1	66	Dubridge and Marshall (1940)
2	65,0(7)	Herrmann and Strassmann (1956)
3	64,0(2)	Wright et al. (1957)
4	63,9(27)	Sattler (1962)
5	65,19(13)	Anspach et al. (1965)
6	66,6(6)	Grotheer et al. (1969)
7	64,93(22)	Emery et al. (1972)
8	64,68(23)	Lagoutine et al. (1972)
9	65,0(49)	Araminowicz and Dressler (1972)
10	65,0(50)	Vatai et al. (1974)
11	64,84(3)	Merritt and Gibson (1976); replaced by value 13
12	64,84(1)	Thomas (1978)
13	64,845(9)	Rutledge et al. (1980)
14	64,856(7)	Houtermans et al. (1980)
15	64,851(6)	Hoppes et al. (1982); replaced by value 17
16	64,85(14)	Walz et al. (1983)
17	64,8530(81)	Unterweger et al. (1992)
18	64,847(3)	unweighted mean of 12, 13, 14, 16, 17
19	64,850(7)	LWM (0,004 (int), 0,003(ext), reduced χ^2 0,46), uncertainty enlarged to the uncertainty of the most accurate single value for the same five values

Values 1 - 11 are only of historical interest. They were not included in the averaging procedure.

The Q_{EC} value was taken from Audi and Wapstra (1995).

2.1 Electron capture Transitions

The main EC transition $\epsilon_{0,3}$ to the 514 keV level in ⁸⁵Rb is allowed ($\lg ft = 6,2$). A transition leading directly to the ground state ($\epsilon_{0,0}$) is unique 1st forbidden. The transition probability of this transition was estimated by Yoshizawa and Inoue (1991) by using the average $\lg ft$ value (according to Gove and Martin (1971)) of $9,47 \pm 0,17$ for seven neighbouring nuclei with uncertainty of 2σ . Their result is 0,8(4)%. The probability for the EC transition $\epsilon_{0,4}$ is deduced from the probabilities of the depopulating γ ray transitions. Concerning EC transitions $\epsilon_{0,2}$ and $\epsilon_{0,1}$ see Section 1. The data for the population and depopulation of the 151 keV level are discrepant as $P_{\gamma+ce}(4,1) + P_{\gamma+ce}(3,1) + P_{\gamma+ce}(2,1)$ is larger than $P_{\gamma+ce}(1,0)$. This can be explained (for example) by a too small value for $P_{\gamma+ce}(1,0)$. Moreover, it supports the assumption that an EC transition to the first excited level of ⁸⁵Rb at 151 keV does not exist.

Double K shell ionization was found by Schupp and Nagy (1984) $6,0(5) 10^{-5}$ per disintegration.

2.2 Gamma Transitions

The transition probability of 0,8(4)% for the EC transition directly feeding the ground state of ⁸⁵Rb yields for $P_{\gamma+ce}(514 \text{ keV}) = 99,2(4)\%$. Furthermore, with the total conversion coefficient of the 514 keV transition $I_{\gamma}(514) = 98,5(4)\%$. The transition probabilities of the other gamma transitions are derived from the measured emission probabilities (Sect. 4.2).

The conversion coefficients are interpolated from the tables of Rösler et al. (1978). The main transition $\gamma_{3,0}$ is assumed to have pure M2 multipolarity. The conversion coefficients of the other transitions have little influence on the balancing procedure because the emission probabilities of the assigned transitions are very small.

3 Atomic data

The atomic data are taken from Schönfeld and Janßen (1996).

3.1 X Radiation

The energies are based on the wavelengths of Bearden (1967). The relative probabilities are taken from Schönfeld and Janßen (1996).

3.2 Auger electrons

The energies are taken mainly from Larkins (1977). The relative probabilities are taken from Schönfeld and Janßen (1996).

4 Radiation Emission

4.1 Electron emission

The energies of the Auger electrons are the same as above. The energies of the conversion electrons are calculated from the transition energy and the binding energies. The number of Auger electrons per disintegration are calculated using the above mentioned atomic shell data and the program EMISSION. The number of conversion electrons related to the 514 keV γ -transition are calculated from the transition probability and the conversion coefficients.

4.1 X-ray emission

For the total K X-ray emission intensity, it was found three measured values :

1	59,59(35)	Grotheer et al. (1969)
2	58,6(3)	Bambynek and Reher (1970)
3	58,66(47)	Thomas (1978)
4	59,04(34)	Weighted mean
5	58,95(32)	Unweighted mean
6	59,2 (6)	calculated from P_e , P_K , ω_K , P_{g+ce} This is the adopted value.

4.2 Photon Emission

The accuracy of the γ ray energy of the main line has improved during the last years, in keV :

1	514,0	Sattler (1962), Vartanov (1966)
2	513,98(3)	Legrand et al. (1968)
3	513,998	Ragaini et al (1972), Meyer et al. (1980)
4	514,009(12)	Helmer et al. (1978)
5	514,0076(22)	Kumahora et al. (1983)
6	514,00492(50)	Chang et al. (1993)
7	514,0048(22)	Helmer and van der Leun (2000), evaluation

The γ ray energies of the other transitions are taken from Sievers (1991).

From the balance of the decay scheme $P_{\gamma+ce}$ (514 keV) is calculated to be 99,2(4)%.

The ratio of the emission probabilities of the 869 keV and the 514 keV transitions were determined to be:

1	$1,7 \cdot 10^{-4}$	Sattler (1962)
2	$1,0(2) \cdot 10^{-4}$	Vartanov et al. (1966)
3	$1,4(2) \cdot 10^{-4}$	Vatai et al. (1974)
4	$1,154(63) \cdot 10^{-4}$	Pratt (1977)
5	$1,25(5) \cdot 10^{-4}$	Thomas (1978)
6	$1,25(5) \cdot 10^{-4}$	Meyer et al. (1980)
7	$1,23(3) \cdot 10^{-4}$	LWM of values 2 - 6

With the above-mentioned $I_\gamma(514) = 98,5(4) \%$ this yields $I_\gamma(869) = 0,0121(4) \%$.

Barnard *et al.* (1973) have observed in (n,n' γ) measurements a level at 951,3 keV in ^{85}Rb which is depopulated by the following gamma transitions: 951,3 keV (86 %), 800,2 keV (9 %), 670,3 keV (4 %) and 437,7 keV (1 %). If this level with the populated in the ^{85}Sr decay, the corresponding EC transition is second forbidden ($9/2+ \rightarrow 5/2+$; $\lg ft > 11,2$; transition energy 114(4) keV). Meyer *et al.* (1980) observed a 951 keV gamma ray in two spectra with high counting statistics and estimated an upper limit of $3 \cdot 10^{-7}$ for the emission probability of these gamma rays.

Levels at 731,9 keV ($3/2-$) and 921 keV ($1/2-$, $3/2-$) in ^{85}Rb have not been found to be populated in the studies of the ^{85}Sr decay carried out by Meyer *et al.* (1980).

A level in ^{85}Rb at 281 keV, found by Barnard *et al.* (1973), is depopulated according to Meyer *et al.* (1980) by 129,8 keV gamma rays with an emission probability of $< 5 \cdot 10^{-3}$. As this is an upper limit the existence of this transition is not sure. Therefore, the population and depopulation of this level is given in the above decay scheme by dashed lines.

The gamma ray emission intensities in Table 5.2 and the corresponding values of the transition probabilities $P_{\gamma+ce}$ given in Table 2.2 are from Meyer *et al.* (1980) (129,8/151,1/355,0/362,8 keV) whereas the value for the 717,8 keV gamma rays is from Jerbic-Zorc (1990). The origin of the values for the 514 keV and 869 keV gamma rays were already explained above.

5 Main Production Modes

The main production modes are taken from Sievers (1991).

6 References

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For other references see Chapter “References” in the Table Part.