# $^{7}$Be - Comments on Evaluation of Decay Data
# by R. G. Helmer

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## 1. Decay Scheme

This decay scheme is complete since the only levels in $^{7}$Li below the decay energy are populated.

## 2. Nuclear Data

The Q value is from the mass evaluation in 1995Au04.

The adopted half-life is 53.22 (6) days.

The $^{7}$Be half-life has been observed to vary depending on the chemical form of the $^{7}$Be. Some of these measured variations are:

| Reference | Chemical forms compared | $(\Delta T_{½} \times 10^{4})/T_{½}$ |
|---|---|---|
| 1949Se20 | Be - BeO | 1.5 (9) |
| 1953Kr16 | Be - BeO | 1.3 (5) |
| | BeO- $BeF_2$ | 6.1 (6) |
| | Be - $BeF_2$ | 7.4 (5) |
| 1956Bo36 | Be - $BeF_2$ | 12 (1) |
| 1970Jo21 | BeO- $BeF_2$ | 11.3 (6) |
| | BeO - $BeBr_2$ | 14.7 (6) |
| | BeO- $Be_4O(CH_3COO)_6$ | -7.2 (6) |
| | BeO- $Be(C_5H_5)_2$ | 8.0 (7) |
| | BeO- $Be(OH_2)_4$ | -3.7 (8) |
| | $BeF_2$- $Be_4O(CH_3COO)_6$ | -18.5 (8) |
| | $Be(C_5H_5)_2$- $Be(OH_2)_4$ | -11.7 (11) |
| 1999Hu20 | BeO - $Be(OH)_2$ | -149. |
| | BeO - $Be^{2+}(OH_2)_4$ | -98. |
| 1999Ra12 | Be in Au - Be in $Al_2O_3$ | 72 (7) |

Excluding the much larger changes reported by 1999Hu20 and 1999Ra12, these measured changes range from 0.01% to 0.2%, or from 0.005 to 0.10 days, or 0.08 days, if the organic compounds are also omitted.

The adopted value of 53.22 (6) is from Limitation of Relative Statistical Weight (LRSW) (1985ZiZY, 1992Ra09) analysis of 53 (2) (1940Hi01), 52.93 (22) (1949Se20), 53.61 (17) (1953Kr16), 53.0 (4) (1956Bo36), 53.5 (2) (1957Wr37), 53.1 (3) (1965En01), 53.52 (10) (1970Jo21), 53.0 (3) (1974Cr05), 53.17 (2) (1975La16), 53.16 (1) (1982ChZF), 53.284 (4) (1982RuZV), and 53.12 (7) (1996Ja10). In this analysis the uncertainty of 1982RuZV value was increased from 0.004 to 0.0088 so that its relative

weight was reduced from 83 % to 50 %. The weighted average of these values is 53.225 with an internal uncertainty of 0.006, a reduced-$\chi^2$ of 10.5, and an external uncertainty of 0.020. This uncertainty is increased by the LRSW method to 0.06 so that the most precise value of 53.284 is included; this uncertainty also includes the next most precise value of 53.16.

The chemical forms of the samples for which these half-lives were determined are: 1949Se20 Be metal or BeO and difference is not significant, 1953Kr16 Be metal, 1956Bo36 Be metal or $BeF_2$ and difference is not significant, 1970Jo21 average of data for $BeF_2$, BeO, and $Be(C_5H_5)_2$, and 1975La16 isolated Be atoms in aluminum matrix.

The adopted half-life is dominated by the values of 1975La16, 1982ChZF, and 1982RuZV which contribute 10 %, 39 %, and 50 % of the relative weight, respectively. The values of 1982ChZF and 1982RuZV differ by ~ 10$\sigma$ and contribute 3.8 and 4.1 to the reduced-$\chi^2$ value of 10.5. Since these three values differ by 0.12 days and the chemical forms in the latter two cases are not known, the chemical variation data in the above table suggest that some of this difference may be due to chemical effects. This suggests that the adopted uncertainty of 0.06 days is reasonable for general use. In any case, the data on the chemical effects indicate that the adopted value can certainly be used for Be and BeO sources.

Values not used are 54.5 (J. F. Bonner as quoted in 1953Kr16, no uncertainty); and 54.3 (5) (1947BoAA as quoted in 1953Kr16, superseded by value of 1956Bo36); and 53.694 (6), 53.416 (6), and 54.226 (6) (1999Hu20). The values of 1999Hu20 have very small uncertainties and have very large variations, up to 1.5%, with chemical form which need to be confirmed. If this large shift and that of 1999Ra12 are correct, they would invalidate the uncertainty of our adopted value.

Also, the results of 2000Hu20 and 2000Li21 were obtained after this evaluation was completed, but these results would not change the adopted value.

Recent experiments have shown that the half-life of 7Be increases as much as 0.7% by imbedding this radionuclide in different matrices. The recommended value presented in this evaluation should be adequate for Be and BeO samples.

## 2.1 Electron-capture transitions

The adopted value for the electron capture to the 477-keV level is $P_\varepsilon(477)$ = 10.44 % (4). This value is a weighted average of 10 (+20-7) (1938RuAA), 10.7 (20) (1949Wi13), 11.8 (12) (1949Tu06), 12.3 (6) (1951Di12), 10.35 (8) (1969TaZX), 10.47 (20) (1970MuZU), 10.42 (18) (1973Po10), 10.35 (8) (1974Go26), 10.10 (45) (1983Ba15), 10.61 (23) (1983Da14), 10.6 (5) (1983Do07), 10.9 (11) (1983Kn10), 10.7 (2) (1983Ma34), 9.8 (5) (1983No03), 11.4 (7) (1984Ev01), 10.61 (17) (1984Fi10), and 10.49 (7) (1984Sk01). This weighted average has an internal uncertainty of 0.039, a reduced-$\chi^2$ of 1.35, and an external uncertainty of 0.045. The adopted value is dominated by the values of 1969TaZX, 1974Go24, and 1984Sk01 which contribute 23 %, 23 %, and 30 % of the relative weight, respectively. The largest contribution to the reduced-$\chi^2$ is 0.6 from 1951Di12.

Values not used are 10.32 (16) (1962Ta11, superseded by 1969TaZX) and 10.5 (2) (W. Poenitz, 1966, superseded by 1973Po10).

The $P_K$ and $P_L$ values of 0.908 (12) and 0.092 (12) were calculated from the tables in 1998Sc28. The values from the LOGFT code are 0.97 and 0.03, which are different.

### 2.2 Gamma-ray transition

The γ-ray transition energy is computed from the γ-ray energy.

The internal-conversion coefficient is the measured value of 1964Kr04 and the mixing ratio was also determined by 1964Kr04. The theoretical values interpolated from the tables of 1976Ba63 are $7.73 \times 10^{-7}$ for M1 and $2.96 \times 10^{-6}$ for E2.

The gamma transition probability is :
Within its uncertainty, $P_\gamma(477) = I_\gamma(477) \times (1.0+\alpha) = P_\varepsilon(477)$
With $I_\gamma(477) = 10.44\ (4)$ % (c.f. § 2.1)

## 3. Atomic Data

The fluorescence yield is from the compilation of 1994Hu23.

## 4. Radiations

The conversion electron emission intensity is computed from $P_\gamma(477)$ and $\alpha_K$.

The γ-ray energy is from the evaluation of 2000He14.

## 5. Main Production Modes

$^{6}$Li(d,n), $^{10}$B(p,α), and $^{12}$C($^{3}$He,2α)

## 6. References


| | |
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