^{22}Na - Comments on evaluation of decay data by R. G. Helmer and E. Schönfeld.

1 Decay Scheme

This evaluation was originally completed in September 1996 with minor editing in January 1997 and post-review editing in January 1998. The literature available by June 1996 was included.

The decay scheme is complete since the only excited level in ^{22}Ne below the decay energy is populated. Also, there is excellent agreement between the total decay energy of 2842.2(18) keV computed for this decay scheme by RADLST and the Q value of 2842.2(4) keV.

The J^{π} and the half-life of the excited level are from 78En04 and 90En08 evaluations.

2 Nuclear Data

Q value is from Audi and Wapstra 1995 (95Au04).

The available half-life data, in days, are as follows (values quoted in years have been converted to days):

957	(7)	61Wy01	
946.3	(11)	65An07	
954	(4)	65An07	
950.7	(4)	65An07	
950	(4)	65An07	
950.34	(13)	80Ho17	
950.25	(11)	80RuZX,	replaced by 82RuZV
951.71	(11)	82HoZJ,	replaced by 92Un01
950.30	(25)	82RuZV,	
950.97	(12)	92Un01,	
950.62	(35)	or 2.6027 (10) years	Adopted value

Since the value of 92Un01 is inconsistent with the other recent values of 80Ho17 and 82RuZV and the value of 946.3(11) is inconsistent with all of the other values, it is expected that the adopted value will depend somewhat on the method of analysis. Another question is whether to include the values from 1961 and 1965.

The weighted average of all eight unreplaced values is 950.62, with an internal uncertainty of 0.08, an external uncertainty of 0.17, and a reduced-χ^2 of 4.55. About 50% of the χ^2 value is from the 1st value of 65An07 and 25% is from the value of 92Un01. For the three unreplaced values after 1970, the weighted average is 950.64, with an internal uncertainty of 0.08, an external uncertainty of 0.23, and a reduced-χ^2 of 7.4. The Limitation of Relative Statistical Weight analysis does not change the input uncertainties because no value has a relative weight of more than 50%, but does increase the final uncertainty, from 0.23 to 0.33 in the latter case, to include the most precise value of 950.97.

The Normalized Residual method (92Ja06) increases the uncertainties of the most discrepant values. With all eight unreplaced values included, the uncertainties of two values are increased, namely to 946.3(17) and 950.97 (23). The weighted average is then 950.46(10).

The RAJEVAL method (92Ra08) also increases the uncertainties for the discrepant values. If all eight unreplaced values are used, this method increases the uncertainties of four values, namely to 946.3(27), 950.34 (31), 950.30(34), and 950.97(29). The weighted average is then 950.58(16). If only the three values from after 1970 are used, this method increases the uncertainty of the 92Un01 value from 0.12 to 0.65 and gives a weighted average of 950.35(11).

In summary, we have the following weighted averages

Method	8 input values	3 input values
LRSW	950.62 (35)	950.64 (33)
Norm Res	950.46 (10)	
RAJEVAL	950.58 (16)	950.35 (11)

The uncertainties for the two LRSW values have been inflated, from the external values of 0.17 and 0.23, to include the most precise value of 950.97.

It is interesting that none of the three values reported since 1970 are within the 1σ ranges of the results for any of the three methods when all eight values are included (before the LRSW uncertainties are inflated). If one considers the value of 92Un01 to be discrepant because it differs from the two other post-1970 values, one would be justified in using the Normalized Residual or RAJEVAL methods and adopting a value such as 950.58(16). However, with only two other post-1970 values to compare with, the more conservative LRSW value has been adopted.

2.1 Electron Capture Transitions

The $P_{\beta+}$ and P_ε values are derived as follows. From the LOGFT program (theory), the ε/β^+ ratios are 0.1125 (12) for the 1274 level and 0.01786(18) for the ground state. The measured β^+ intensity ratio (53Wr13) is $P_{\beta+}(1274)/P_{\beta+}(0)$ = 1600(400).

Inserting these ratios into the relationship 1.0 = $P_{\beta+}(1274)$ + $P_\varepsilon(1274)$ + $P_{\beta+}(0)$ + $P_\varepsilon(0)$, one has 1.0 = $P_{\beta+}(1274)$ + 0.1125(12) $P_{\beta+}(1274)$ + $P_{\beta+}(1274)/1600(400)$ + 0.01786(18) $P_{\beta+}(1274)/1600(400)$. This gives $P_{\beta+}(1274)$ = 0.89836(10) and then from the above ratios $P_\varepsilon(1274)$ = 0.1011(11), $P_{\beta+}(0)$ = 0.00056(14), and $P_\varepsilon(0)$ = 0.000010(3). From the latter two values, the ground-state feeding is 0.00057(14) and then the 1274-level feeding is 0.99943(14). From this feeding of the 1274-keV level and $P_{\beta+}(1274)$ = 0.89836(10), one can deduce a more precise value of $P_\varepsilon(1274)$, namely, 0.10107(17).

The measured ε/β^+ ratios are 0.104 to 0.113 (67Le07, 71Me , 76Ma38, 77Bo10, and 83Ba41) which agree with the theoretical value of 0.1125(12) to the 1274 level (the contribution from the branch to the ground state will be negligible).

2.2 Positron Transitions

See sec. 2.1.

2.3 Gamma Transitions

The internal-conversion coefficient, α, of 6.8(4) $\times 10^{-6}$ is from the analysis of the experimental data in 85HaZA. The theoretical value of 6.84 x 10^{-6}, interpolated from the tables of 76Ba63, agrees.

From the theoretical tables of 79Sc31, the internal-pair-formation coefficient, α_π, is interpolated for this E2 transition to be 2.1(3) x 10^{-5}.

For the 1274-keV γ-ray, the transition probability is $P_{\varepsilon+\beta+}(1274)$ or 0.99943(14).

3 Atomic Data (Ne, Z=10)

The ω_K is from 96Sc06, but due to the low Z it depends on the chemical state.

3.1 X Radiation, 3.2 Auger Electrons

Calculated from data in 95SCZY and 96SC06.

4 Radiation Emissions

4.1 Electron Emission

The β^+ are discussed above. The other data are from Schönfeld.

4.2 Photon Emissions

The γ-ray energy is from 97HeZZ.
From the data in sect. 2.3, $P_\gamma(1274) = 0.99943(14)$ / $[1+0.000028(3)]$ =0.99940(14). The annihilation radiation emission probability is taken to 2.0 times $P_{\beta+}$, or 1.7978(4) and the 511-keV photon probability is smaller by a factor of 0.990(3) due to the annihilation-in-flight. The latter factor should be accurate for annihilation in any material with Z from 6 to 82.

6 References

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