TRIUMF : Precise half-life measurement of the superallowed β^+ emitter $^{38}K^m$

J. C. Hardy and V. E. Iacob

Some years ago we participated in a collaborative experiment to measure the half-life of the superallowed β^+ emitter $^{38}K^m$ at the Isotope Separator and Accelerator (ISAC) facility at TRIUMF in Vancouver, Canada. The result has now been published [1].

A radioactive beam of ~5×10^5 ions/s of mixed ^{38}K and $^{38}K^m$ was obtained from a production target combined with a surface-ionization ion source. By pulsing the TRIUMF proton beam and collecting samples for only 0.3 s we could favor $^{38}K^m$ ($t_{1/2}$ = 924 ms) over ^{38}K ($t_{1/2}$ = 7.6 min) by a factor of 60-80. We performed the experiment by implanting this 29-keV radioactive beam into the aluminized Mylar tape of a fast tape-transport system. After the 0.3-s collection time, the beam was interrupted and the sample was moved out of the vacuum chamber through two stages of differential pumping, finally being positioned at the center of a 4π continuous-gas-flow proportional β counter. This counter and the subsequent electronics were very similar to the system we routinely use at the Texas A&M cyclotron (for example, see Ref. [2]). The data were analyzed in parallel at both TRIUMF and Texas A&M. The two results were in good agreement.

There have been five previous measurements of the half-life of $^{38}K^m$ that have been quoted with uncertainties within a factor of ten of the present measurement [3-7]. As can be seen in Figure 1, our result is a factor of two more precise than any of the previous ones. The weighted average of all six measurements is 924.33 ± 0.12 ms but with an unsatisfactory reduced χ^2 of 4.83. As is the usual practice

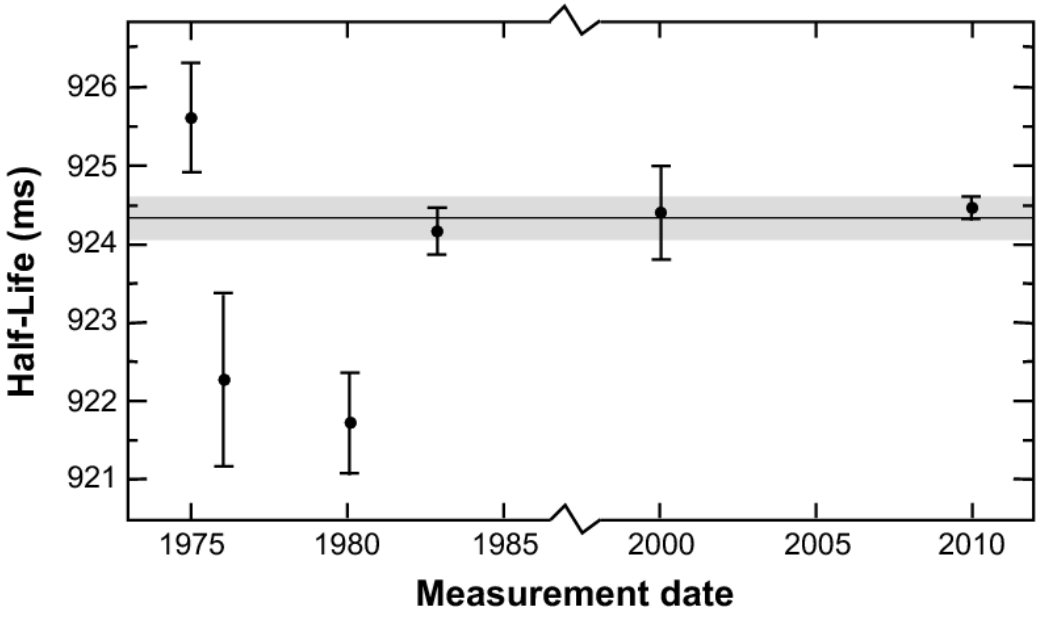

FIG. 1. The data points represent all published measurements of the $^{38}K^m$ half-life with quoted uncertainties that are within a factor of 10 of the present measurement. The results are plotted in chronological order from left to right, with measurement 6 being the present result. The weighted average, 924.33 ms, is given by the horizontal line, with its scaled uncertainty, ± 0.27 ms, represented by the grey band. Note that the uncertainty on the average has been increased by a scale factor equal to the square root of the reduced χ^2 for all six results, which is 4.83.

in the periodic surveys of superallowed β decay (for example, Ref. [8]), we follow the method of the Particle Data Group and inflate the uncertainty quoted on the average by a "scale factor," which is essentially equal to the square root of the reduced χ^2. This result for the average, 924.33 ± 0.27 ms, is the one shown as a horizontal band in the figure.

From the figure it can also be seen that the three most recent measurements are in excellent agreement with one another, while the two Wilkinson measurements [5,6] are significantly below the average, the most recent of the two being four of its standard deviations from the average. Although there is no obvious reason from the original papers to disregard these two measurements, it can be noted that if they are removed from the averaging process, the weighted average becomes 924.44 ± 0.14 ms with a scale factor of 1.1. This observation may perhaps provide some motivation for attempting in the future and even more precise measurement of the $^{38}K^{m}$ half-life with the goal of making the suspect Wilkinson measurements statistically irrelevant.

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