Superallowed β-decay branching ratio measurement of ^{26}Si

M. Bencomo, J.C. Hardy, V.E. Iacob, H.I. Park, L. Chen, V. Horvat, N. Nica, B.T. Roeder,
A. Saastamoinen, and I.S. Towner

We have measured the branching ratios for the superallowed $0^+ \rightarrow 0^+$ β^+ emitter ^{26}Si (Fig. 1). Since the Q_{EC} value[1] and half-life [2] have already been measured, the branching ratio for the superallowed transition allows us to determine the *ft* value. This completes the second pair of mirror superallowed transitions between T = 1 states, ^{26}Si → ^{26m}Al and ^{26m}Al → ^{26}Mg. Previous measurements of the *A*=38 mirror transitions, ^{38}Ca → ^{38m}K and ^{38m}K → ^{38}Ar, showed that the ratio of mirror *ft* values is very sensitive to the model used to calculate the small isospin symmetry-breaking corrections required to extract V_{ud}. In calculating this correction both Woods-Saxon (WS) and Hartree-Fock (HF) radial wave functions have been used, with the experimental results from the first pair favoring the Woods-Saxon option [3]. In an effort to determine if this preference can be generalized, we extended our measurements to ^{26}Si.

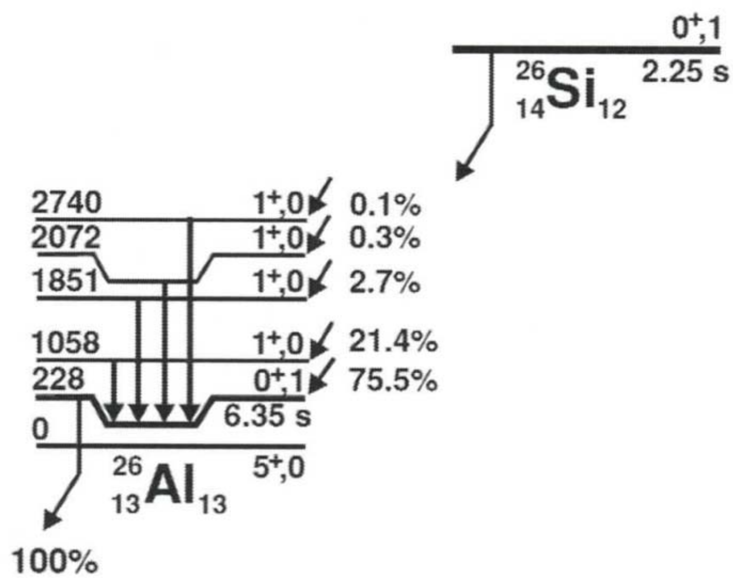

FIG. 1. Decay scheme of ^{26}Si showing only those features of relevance to the superallowed β decay. All energies are in keV. The data are taken from Ref. [4] and show the branching ratios as known before our current work.

Previously, we reported the experimental measurement of ^{26}Si as well as the procedure for analysis and a preliminary result [5]. Most of the experimental corrections needed to determine a branching ratio to the superallowed branch with a precision comparable to those of the half-life and Q_{EC} value were also reported. The analysis for the branching-ratio measurement has now been finalized. The correction for the detection of γ rays in the β detector was the last one to be determined. This correction is very small, of the order of 0.0012%, and does not have a large impact on the results but it still needs to be taken into account for a high-precision measurement.

We have now checked all corrections using different techniques and have confirmed our previous results. With all these corrections taken into account, the branching ratio to the 1058 keV state of ^{26m}Al, which leads to emission of an 829-keV γ ray, is determined to be 21.28(12)%. Using the relative intensities of the other weaker γ-ray peaks we determine the total of all Gamow-Teller branches to be 24.28(15)%, and consequently establish the superallowed branch to be 75.72(15)%.

Based on the half-life and Q_{EC} values taken from the most recent survey [6], and making use of the relation

$$t = \frac{t_{1/2}}{R}(1 + P_{EC}),$$

we can determine the *ft* value of ^{26}Si. With the half-life, $t_{1/2}$ = 2245.3(7) ms; the electron-capture fraction, P_{EC} = 0.0638%; the branching ratio, R = 0.7572(15); and *f* = 1028.03(12); the *ft* value of ^{26}Si becomes 3050.3(57) s. The ^{26m}Al *ft* value is known to be 3037.38 ± 0.58 s. Thus the ratio of *ft* values for the *A*=26 pair is:

$$\frac{ft^a}{ft^b} = \frac{3050.3 \pm 5.7}{3037.38 \pm 0.58} = 1.0043(19)$$

As with the *A*=38 pair, this result can be seen to favor the use of Wood-Saxon radial wave functions (see Fig. 2). The result is similar to the one we reported previously [5] but it has smaller uncertainties.

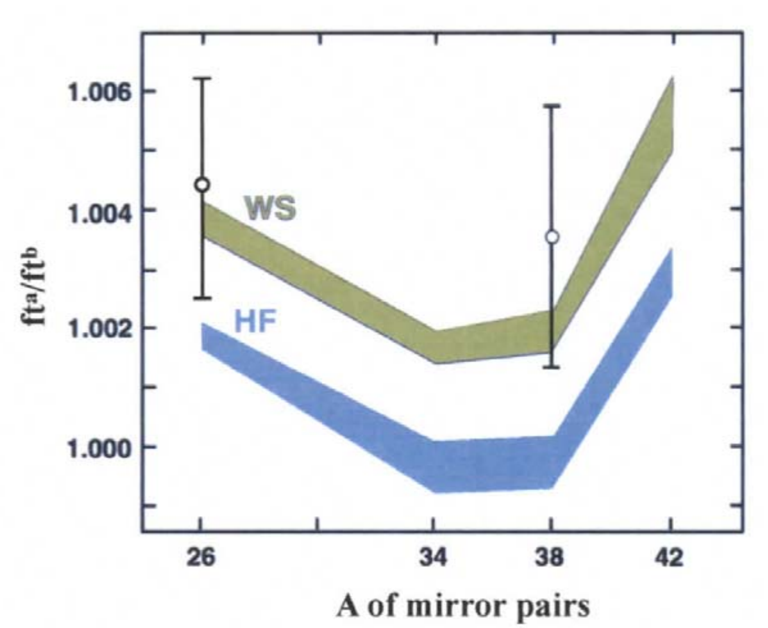

FIG. 2. Result for the ratios of *ft* values for the A = 26 and 38 pairs, compared to theoretical predictions.

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[3] H.I. Park *et al.* , Phys. Rev. Lett. **112**, 102502 (2014).
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[6] J.C. Hardy and I.S. Towner, Phys. Rev. C **91**, 025501 (2015).