Superallowed beta decay Q-value of ^{42}Sc

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The $0^+ \rightarrow 0^+$ β decay of ^{42}Sc belongs to the traditional set of well known superallowed beta emitters. Its corrected $\mathcal{F}t$ value is known to better than 0.1 % and has a significant impact on the world average $\mathcal{F}t$ value [1]. Out of the three experimental quantities (half-life, branching ratio and Q_{EC} value) required to determine the $\mathcal{F}t$ value, the uncertainty contribution of the Q_{EC} value is second largest and is due to discrepant measurements. A "scale factor" of 3.0 is needed to account for the discrepancy [2]: Although all four contributing measurements have uncertainties of approximately 200 eV, their average has an uncertainty of 300 eV! The new measurement reported here has an uncertainty of 53 eV, a substantial improvement over all previous measurements, including our own previous measurement from 2006 [3].

We carried out the Q_{EC}-value measurement in the accelerator laboratory of the University of Jyvaskyla, Finland, using the JYFLTRAP Penning trap setup [4], which consists of a radio frequency cooler-buncher and two Penning traps. The first trap is used to prepare clean samples of ^{42}Sc or its co-produced beta-decay daughter ^{42}Ca. The actual mass measurement depended on a determination of the free-space cyclotron frequency for both parent and daughter ions. The Q_{EC} value was then obtained from the frequency ratio of the two. Since the parent-daughter ions have the same A/q, systematic frequency shifts are nearly identical for both ion species and thus do not significantly contribute to the Q_{EC}-value uncertainty [5]. The main difference to our previous measurement in 2006 is that this time we used the Ramsey ion-excitation technique, which gives a significant boost to the precision. In addition, thanks to system improvements, we could use longer ion-excitation times, which also helped to boost the precision.

Finally, the Q_{EC} value was obtained with a ±53 eV uncertainty, which is about four times more precise than our previous result and the three results obtained by others. Before this measurement, the uncertainty contribution to the $\mathcal{F}t$ value from the Q_{EC} value and the half-life were about equal; now the Q_{EC}-value contribution is about a factor of four lower. If the half-life could be measured more precisely, say with a factor of four improvement as well, then ^{42}Sc would have one of the most precise experimental *ft*-value of all measured cases. The paper describing these results [6] was chosen by the editors of Physical Review C as an "editor's suggestion."

[1] J.C. Hardy *et al., Progress in Research,* Cyclotron Institute, Texas A&M University (2016-2017), p. I-1.

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[5] T. Eronen, J.C. Hardy *et al*., Phys. Rev. C **95**, 025501 (2017).