TRIUMF E-823: Tests of the Standard Model from Nuclear Beta-Decay Studies at ISAC

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The goal of the E-823 experimental program is to measure precise half-lives and branching ratios for superallowed 0^+-to-0^+ beta emitters in medium-mass (A > 60) nuclei produced by the new ISAC radioactive-beam facility at TRIUMF. This is an important adjunct to our program at the Cyclotron Institute to probe CKM unitarity via superallowed beta decay [1]. In addition to the TAMU participants, the E-823 collaboration includes members from TRIUMF, Simon Fraser University, Lawrence Berkeley National Laboratory, Queen's University and Argonne National Laboratory.

The focus of the collaboration for this past year has continued to be the decay of ^{74}Rb. The ISAC facility produces a separated ^{74}Rb beam of ~4000 ions/s, which is well suited to the requirements of precision measurements. During the year, we completed our half-life measurement (see [2]) and published the results [3]; in fact, this was the first publication from the new ISAC facility. The experiment used a tape-transport system, and a 4π proportional gas counter similar to the one we use at the Cyclotron Institute (see, for example, [4]). For control of systematic errors, the data were independently analyzed at TRIUMF and by us at TAMU with the software that we have developed for our measurements here [2]. The final result for the half-life of ^{74}Rb is 64.761 ± 0.031 ms.

We have now begun the measurement of branching ratios in the beta decay of ^{74}Rb. Since the superallowed branch feeds the ground state of ^{74}Kr directly, to determine its branching ratio requires careful measurement of the other non-analog and Gamow-Teller branches from ^{74}Rb. Previously, none had been observed. First, in a search for beta-delayed gamma rays from ^{74}Rb we observed two weak γ rays of 456 and 1198 keV. The energy of the former corresponds to the excitation energy of the first excited 2^+ state known in ^{74}Kr. However, the 2^+ state cannot be fed directly by allowed beta decay, so it is clear that it must be fed by gamma rays from higher lying states of spin 1^+ (or possibly 0^+), which are themselves fed by allowed beta decay. The 1198 keV gamma ray is possibly one of those feeding the 2^+ state but it does not correspond with any known states in ^{74}Kr.

In order to help clarify this situation we have performed a second experiment, this time to study the conversion-electron spectrum that follows the beta decay of ^{74}Rb. In that experiment, we observed a line at 495 keV, which corresponds to the emission of K-conversion electrons from the decay of the known excited 0^+ state at 508 keV in ^{74}Kr.

Table 1: Observed beta-delayed transitions from the decay of ^{74}Rb.

Energy (keV)	**type**	**Intensity (per ^{74}Rb decay)**	**assign-ment**
495(1)	e^-	$4.9(10) \times 10^{-4}$	$0^+_2 \rightarrow 0^+_1$
456(1)	γ	$2.0(3) \times 10^{-3}$	$2^+_1 \rightarrow 0^+_1$
1198(2)	γ	$\sim 1 \times 10^{-3}$	?

Our inventory of beta-delayed transitions observed to date in ^{74}Kr is given in the table. Evidently, we have not yet detected sufficient transitions to explain the observed intensity of the 2^+-to-0^+ gamma-ray intensity. This may well be because ^{74}Rb decays to several excited states that de-excite via a number of transitions, each one too weak to be observed directly. This Pandemonium effect [5] would not be unexpected in a decay such as that of ^{74}Rb, which has Q_β of more than 10 MeV. This work is continuing.

References

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[5] J. C. Hardy *et al.,* Phys. Lett. **71B**, 307 (1977).