$0^+ \rightarrow 0^+$ Nuclear β-Decay of ^{62}Ga

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Measuring the *ft* values of superallowed $0^+ \rightarrow 0^+$ nuclear β-decays provides the most accurate values of G_V, the weak vector coupling constant [1]. Knowledge of G_V provides a test of the conserved vector current theory as well as a test of the Standard Model [2]. In determining G_V, it is necessary to apply a charge correction term to account for isospin mixing due to the presence of charge dependent forces. At present the uncertainty of these charge corrections provides the largest uncertainty in the calculation of G_V [3]. It is possible to test the theoretical method of calculation of these charge corrections by determining the branching ratio to excited 0+ states as discussed in Ref. [4]. As such, an experiment has been conducted to measure the branching ratio of the β-decay of ^{62}Ga to the first excited 0^+ state at 2.33 MeV in ^{62}Zn.

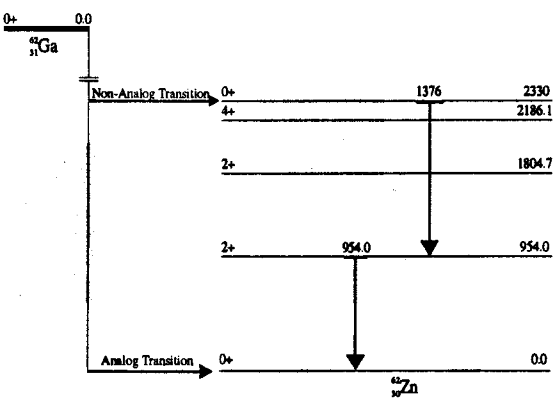

Fig. 1: Decay scheme for the β-decay of ^{62}Ga. Energies are given in units of keV.

This experiment was conducted by producing 62Ga through the reaction $^1H(^{64}Zn, ^{62}Ga)\ 3n$ using a beam of $^{64}Zn^{21+}$ at 41 MeV/nucleon from the Texas A&M K500 cyclotron. MARS was then used to separate the ^{62}Ga from other ions produced in the reaction. A silicon strip detector was first used to determine the incident rate of ^{62}Ga. A β-γ coincidence experiment was then used to determine the amount of β-decay to the excited 0+ state at 2.33 MeV in ^{62}Zn. Details of the experimental procedure have been discussed previously in Ref. [5].

A β-decay to the excited 0+ state at 2.33 MeV will lead to the production of γ-rays with energies 1.376 MeV and 0.954 MeV as shown in the decay scheme in Fig. 1. In order to determine the branching ratio it was first necessary to determine from the γ-ray spectra, the yields of these γ-rays. The peaks corresponding to the 0.954 MeV γ-ray were clearly seen in spectra of each of the three γ-ray detecting Ge detectors. However, the 1.376 MeV γ-ray was not clearly seen in any of the detectors. This suggests that there may be β-decay to higher states that are then populating the 2^+ 0.954 MeV state.

Table I: Branching ratios. Branching ratios are given corresponding to γ-ray energies. Shown are the ratios seen in each detector as well as the total branching ratio, which is the weighted sum of the ratios seen in the individual detectors.

Energy (MeV)	Detector Branching Ratios (%)			Total Branching Ratio (%)
	Ge1	Ge2	Ge3	
0.954	0.118(26)	0.142(40)	0.123(38)	0.120(21)
1.376	0.020(15)	0.040(20)	0.048(21)	0.032(11)
1.386	0.037(15)	0.022(20)	0.000(20)	0.023(10)

Having determined the γ-ray yields, it was also necessary to determine the absolute efficiency of the Ge detectors by conducting a γ-singles experiment with ^{152}Eu source. From this data, efficiency was calculated as a function of energy. It was also necessary to determine the β-ray detector efficiency. This was accomplished with a Monte Carlo simulation. With the rate of ^{62}Ga incident upon the target, it was possible to determine the total number of ^{62}Ga present by recording the total Faraday cup counts from the β-γ coincidence portion of the experiment.

With knowledge of the γ-ray yields, Ge detector efficiency, β-detector efficiency, and total number of ^{62}Ga, it was possible to determine the branching ratio to the first excited 0+ state in ^{62}Zn. Results are shown in Table I. However, the results are inconclusive. This is due to the lack of a definite peak seen in the γ-ray spectra for the 1.38 MeV γ-ray. As mentioned above, the difference in yields between the 1.38 MeV and the 0.954 MeV γ-rays probably indicates β-decay to more energetic states in ^{62}Zn. With an improved reduction in background and with a broader range of γ-ray energies detected, it should be possible to measure the branching ratio more accurately in future studies.

References

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