Beta Decay of ^{62}Ga

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During the past year, we performed two different measurements to investigate the beta decay of ^{62}Ga, one to observe decay branches to excited states in the daughter ^{62}Zn and the other to measure its half-life. The dominant decay mode of ^{62}Ga is the superallowed 0^+ to 0^+ decay to its analog, the ^{62}Zn ground state. The Coulomb correction, $*_c$, to the *ft*-value of this transition is expected to be particularly large, ~2%, making it a good candidate to test the theoretical calculations of these Coulomb corrections. It will likely be several years before the masses of ^{62}Ga and ^{62}Zn have been determined with sufficient precision to determine the *ft*-value to ~0.1%. But improvements are also needed in our knowledge of the ^{62}Ga branching ratios and half-life to reach this goal. Furthermore, ^{62}Zn has an excited 0^+ state at an excitation energy of 2.33 MeV that can provide a different test of the Coulomb calculations [1,2].

Several years ago we performed a preliminary search for ^{62}Ga decay to the 2.33 MeV state in ^{62}Zn [3]. In that experiment, ^{62}Ga was produced in the reaction ^{1}H(^{64}Zn,^{62}Ga)3*n*, then separated from the other reaction products with MARS. The ^{62}Ga was stopped in a 0.6 mm thick Al foil at the MARS focal plane. The stopping foil was observed by four thin plastic scintillator beta detectors and three Ge detectors. No clear evidence for population of the 2.33 MeV state was observed, but the 954 keV 2^+ first-excited state of ^{62}Zn was seen, with an intensity equivalent to a branching ratio of 0.12%. If this originated from ^{62}Ga ground-state beta decay, it implies the existence of Gamow-Teller transitions to (currently unknown) 1^+ excited states in ^{62}Zn, since a direct transition to the ^{62}Zn first-excited state would be second-forbidden and, thus, much weaker. However, we were unable to ensure that the 954 keV gamma ray originated from decay of the ^{62}Ga ground state. No lifetime information was obtained during that measurement, making it possible that we were observing the decay of an isomeric state, instead.

We searched for ^{62}Ga decays to excited states in ^{62}Zn using a set-up similar to that we used to measure the ^{22}Mg branching ratios [4], with one exception. The short half-life of ^{62}Ga (116 ms) dictated a total irradiation-transport-count cycle period of less than 1 s. This made the standard tape-transport configuration, with feed and take-up reels, impractical due to the need for frequent rewinds. We replaced the standard reel tape with a circular tape, run in a closed-loop configuration. This eliminated the need for tape rewinds, but the tape loops needed to be replaced approximately twice a day due to the heavy wear. This measurement had two significant advantages compared to the previous one, both associated with the use of the tape-transport system. We were able to measure the lifetime of the gamma rays that we observed. This allowed us to associate the 954 keV gamma ray unambiguously with ^{62}Ga ground state beta decay. The measured branching ratio was consistent with our previous result. We found no evidence for population of the 2.33 MeV 0^+ excited state in ^{62}Zn. Meanwhile, the

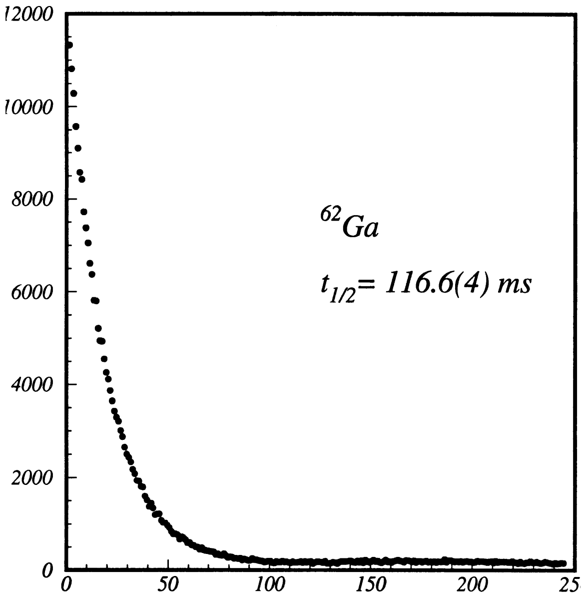

Figure 1: ^{62}Ga decay spectrum, showing beta decay events vs. time channel.

background due to decay of other *N*=*Z* nuclei, which was present in the previous experiment, was eliminated by selecting degrader thicknesses so that the lower *A* nuclei passed through the tape without stopping. But the short lifetime of ^{62}Ga implied most of the nuclei that we produced decayed before we were able to observe them, so this experiment had lower statistical precision than the previous one.

In a second experiment, we performed a preliminary measurement the half-life of ^{62}Ga, using the same set-up that we used to measure the half-life of ^{22}Mg [5]. This is the first time the half-life of ^{62}Ga has been measured with a mass-separated source. Data were taken in several different configurations, including changes in the high voltage of the proportional counter and the discriminator threshold. Consistent results were found throughout. Figure 1 shows the decay curve that we obtained. We find the half-life of ^{62}Ga is 116.6 ± 0.4 ms, in good agreement with the best previous measurement, 116.34 ± 0.35 ms [6]. A follow-up experiment has been scheduled, during which we expect to reduce the uncertainty in the life-time by a factor of at least 3.

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