Gamov-Teller Decay of Nuclei Near ^{100}Sn ◊

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Neutron deficient nuclei near ^{100}Sn have been produced by fragmentation of a 1 A·GeV ^{112}Sn beam in a beryllium target, separated in the FRS and unambiguously identified. The ions were stopped in the center of a stack of highly segmented silicon strip detectors placed at the final focal plane. This 4π implantation detector measured the total energy of emitted β^+-particles with high efficiency. For measuring γ-radiation the implantation detector was surrounded by a 6-fold segmented NaI detector covering 2π and a Germanium clover detector in close geometry. We determined the half-lives and the positron energies for each implanted nuclide with a maximum likelihood method taking into account three decay generations as well as background events during a fixed correlation time after the implantation. Half-life results for $N \approx Z < 50$ nuclei were already reported [1].

During a run of 60 hours a single ^{100}Sn nucleus could be identified resulting in a production cross section of $\sigma = 1.8$ pb. The decay data of this event together with 6 events observed [2] in 1994 (with ^{124}Xe fragmentation) result in a half-life of $T_{1/2} = 1.0^{+0.54}_{-0.26}$ s and a β end-point energy of $E_{\beta_0} = 3.8^{+0.7}_{-0.3}$ MeV. Due to the low statistics a meaningful comparison between the experimental Gamov-Teller strength and theoretical values is not yet possible.

With the implantation of 2800 ^{102}Sn nuclei we were able to study this nuclide in decay spectroscopy for the first time. Analyzing the correlated β-decay events with a maximum likelihood method the ^{102}Sn half-life was determined as $T_{1/2} = 3.8 \pm 0.2$ s. With the knowledge of the half-life it is possible to calculate the probability that an observed event in a decay chain can be assigned to a decay of the mother istope. Using only decay events with a probability $p > 0.70$ for a ^{102}Sn decay, 8 γ-transitions could be identified that follow the ^{102}Sn $\rightarrow$ ^{102}In decay (see Fig. 1). In the case of electron-capture decay it was possible to observe a 150 keV sum line from conversion electrons of the low energy transitions in the silicon detector (Fig. 1). Considering this additional information and guided by theoretical expectations [3] it is possible to construct a decay scheme which is consistent with all experimental observations: the β-decay feeds two 1^+ states at 1598 keV and 1964 keV with an intensity ratio 70:30. From these states γ cascades lead down to the (7^+) ground state.

The measured β^+ spectrum (Fig. 1) was fitted with two components to levels 366 keV apart and with the relative feeding observed in the γ decay. This determined the endpoint energies to these two levels and also the groundstate decay Q-value as $Q_{\mathrm{EC}} = 5760 \pm 90 \pm 50$ keV. The first error is that of the endpoint energy, the second is estimated to take care of the uncertainty in the low energy level scheme of ^{102}In. The summed Gamov-Teller strength of the two individual transitions observed for the ^{102}Sn decay is $B_{\mathrm{GT}} = 4.0 \pm 0.6$. This value is among the largest observed in the nuclear chart. The reference strength value, expected for the $\pi g_{9/2} \rightarrow \nu g_{7/2}$ decay of ^{102}Sn on the basis of the extreme single-particle shell model, is $B^{\mathrm{ref}}_{\mathrm{GT}} = 17.8$, thus leading to a hindrance factor $h = B^{\mathrm{ref}}_{\mathrm{GT}}/B_{\mathrm{GT}} = 4.5$.

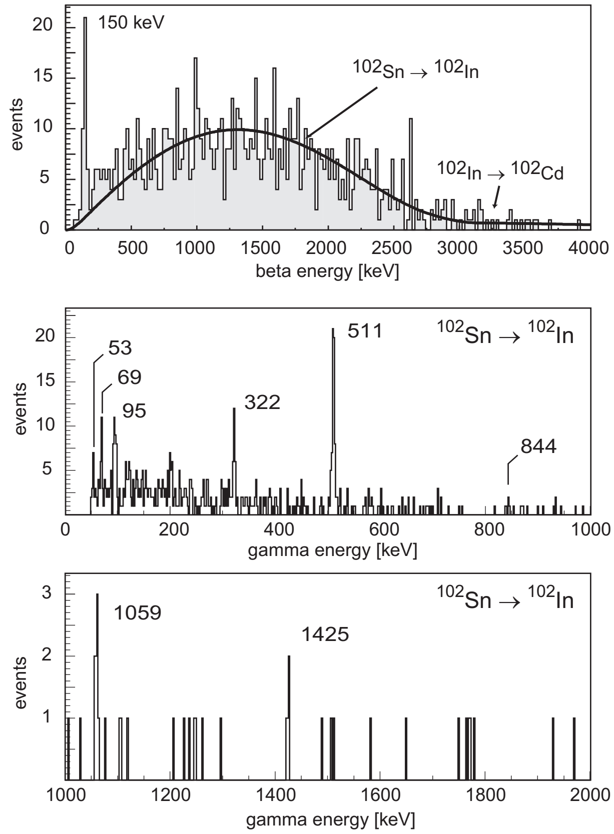

Fig. 1: Measured β and γ spectra for the ^{102}Sn decay. Only decay events wich can be assigned to a decay of ^{102}Sn with a probability $p > 0.7$ are shown. In the β spectrum also a line from conversion electrons shows up.

Using the same experimental techniques it was possible to measure the Q-value of ^{98}Cd with high precision ($Q_{\mathrm{EC}} = 5430 \pm 40$ keV). Together with the already known decay data [4] the summed Gamov-Teller strength for the four observed transitions results in $B_{\mathrm{GT}} = 2.9 \pm 0.2$. This result is in agreement with the published value of $B_{\mathrm{GT}} = 3.5^{+0.8}_{-0.7}$ [4].

References

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