

Excitation energy of the β -decaying 9^+ isomer in ^{70}Br

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The properties of the self-conjugate $N=Z=35$ ^{70}Br nucleus have been studied so far by in-beam [1, 2] and β -decay experiments (see [3, 4]). This nucleus has a 0^+ ground-state β -decaying with the half-life ($T_{1/2}$) of 78.54(59) ms, and a more long-lived 9^+ isomeric state with $T_{1/2}=2.19(9)$ s. The isomer energy had been unknown until recently when two groups reported evidence for the 9^+ state in their in-beam data. In the work of *de Angelis et al.* [1], the excitation energy of the 9^+ isomer was reported to be 1214 keV while *Jenkins et al.* [2] place the 9^+ state at an excitation energy of 2293 keV. The large discrepancies of the 9^+ isomer energies reported by different groups was the motivation to undertake a measurement of this quantity by means of a different technique. The method applied involves the determination of the Q_{EC} value for the decay of the isomer and a comparison to the Q_{EC} value of the ground-state decay.

The ^{70m}Br activity was produced in $^{40}\text{Ca}(^{36}\text{Ar},\alpha p n)^{70}\text{Br}$ reactions by using a 4 MeV/u ^{36}Ar beam, and a 3.2 mg/cm² thick CaO target. The Q_{EC} value for the decay of the 9^+ isomer of ^{70}Br was determined by using the Total Absorption Spectrometer (TAS) coupled to the on-line mass separator with the upper silicon detector together with the Ge detector serving as a ΔE -E telescope for β particles [5]. Figure 1 displays the β^+ component of the total TAS spectrum of mass $A=70$, where one can clearly identify contributions from ^{70}Se (peaks around 1 MeV) and ^{70}As (structure around 4 MeV). The decay of the 9^+ isomer of ^{70}Br is characterized by a dominant population of the 4605 keV level in ^{70}Se . The corresponding 4605+1022 keV peak can be seen in Fig. 1. The dash-dotted lines in Fig. 1 mark the limits of the TAS energy window used as a coincidence condition in creating the positron spectrum of the 9^+ isomer decay to the 4.6 MeV excited level in ^{70}Se (see fig. 2). Figure 2 shows also the theoretical β spectrum, folded with the response function and fitted to the experimental spectrum as well as a background spectrum used during fitting. The fit yielded a β end-point energy of 6.59(8) MeV. This corresponds to the Q_{EC} value of 6.59(8)+4.605+1.022=12.22(8) MeV for the β decay of the 9^+ isomer of ^{70}Br . As mentioned at the beginning the knowledge of the Q_{EC} value of the ^{70}Br ground-state decay is essential for determining the excitation energy of the 9^+ isomer. The experimental result of 9.97(17) MeV, has a relatively large uncertainty, therefore we preferred to use an average of two independent and more accurate estimates of the Q_{EC} value of the ^{70}Br ground-state decay. First estimate is based on the accurately measured $\mathcal{F}t$ values for a series of super-allowed $0^+ \rightarrow 0^+$ Fermi decays [6], and yields Q_{EC} value of ^{70}Br to be 9.96(5) MeV. Second estimate based on the interpolation of the Q_{EC} values of the $N=Z$ odd-odd nuclei from the

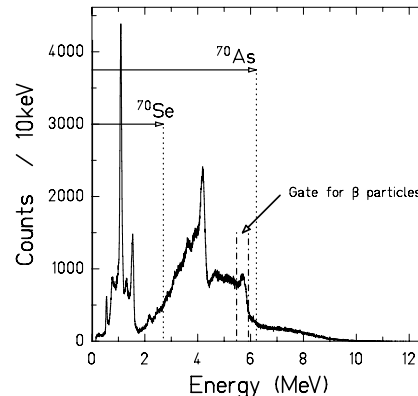


Figure 1: Experimental TAS spectrum related to the β^+ component of the decay of $A=70$. Arrows show the Q_{EC} range for the lower- Z (^{70}Se and ^{70}As) isobars of ^{70}Br .

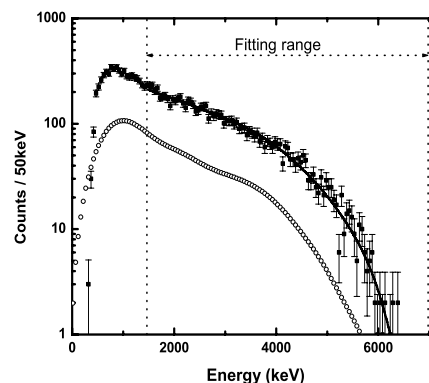


Figure 2: Experimental positron energy spectrum (full circles with error bars) for the 9^+ isomer decay to 4.6 MeV level in ^{70}Se together with fitted theoretical spectrum (solid-line). The normalized and smoothed background spectrum used during the fitting procedure is given by open circles.

vicinity of ^{70}Br gives $Q_{EC}=9.96(10)$. As both methods yield consistent results, we use their weighted average of 9.96(6) MeV for the Q_{EC} of the ^{70}Br ground-state.

The Q_{EC} value measured for the 9^+ isomer of ^{70}Br together with that estimated for the ^{70}Br (0^+) ground-state allows us to determine the excitation energy of the isomer to be 12.22(8) - 9.96(6) = 2.26(10) MeV. When compared to data obtained by in-beam spectroscopy, our result confirms the isomer energy of 2.293 MeV suggested by *Jenkins et al.* [2] but is in striking disagreement with that of 1.214 MeV given by *de Angelis et al.* [1].

References

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