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Short note

Lifetime measurement of the $(\frac{11}{2}^-)$ isomer in ^{125}Cs

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Abstract. The lifetime of the $(\frac{11}{2}^-)$ state at 267keV in ^{125}Cs was measured. A Ge detector with the transistor reset preamplifier(TRP Ge) was used to measure delayed γ-rays under an intense prompt background. The B(M2) value deduced from the lifetime was found to be consistent with the Weisskopf estimate.

PACS. 21.10.Tg Lifetimes – 23.20.Js Multipole matrix elements – 27.60.+j $90 \leq A \leq 149$

In Cs isotopes the $\pi h_{11/2}$ single-particle state appears at low excitation energy as an isomeric state of relatively long lifetime. For example, in ^{123}Cs the $(\frac{11}{2})^-$ state at 157keV with a half-life of 1.64s decays mainly to the $(\frac{5}{2})^+$ state at 95keV through the 62keV E3 transition, while in ^{127}Cs the $(\frac{11}{2}^-)$ state at 452keV with a half-life of 55μs decays to the $(\frac{7}{2}^+)$ state at 273keV via the 179keV M2 transition by 80% and to the $\frac{5}{2}^{(+)}$ state at 66keV via the 386keV E3 transition by 20%. In ^{125}Cs, although the $(\frac{11}{2}^-)$ state is known at 267keV and is supposed to decay mainly to the $(\frac{7}{2}^+)$ state at 254keV via the 13keV M2 transition, neither the lifetime nor the E3 branch to the $(\frac{5}{2}^+)$ state at 85keV has been measured so far [1].

The isomeric state in ^{125}Cs was populated with the fusion-evaporation reaction ^{110}Pd(^{20}Ne,p4n) at a beam energy of 120MeV. A self-supporting ^{110}Pd foil of 10mg/cm^2 was bombarded by a ^{20}Ne beam from the injector of the Heavy Ion Medical Accelerator in Chiba (HIMAC) at the National Institute of Radiological Sciences (NIRS).

The HIMAC injector is pulse-operated with a typical repetition rate of 2Hz; the beam-pulse duration can be varied between 1 and 700μs. The time structure of the beam pulses is suited for lifetime measurements on the order of a few hundred μs or longer. Unfortunately, high-peak intensity required for obtaining enough yields completely disturbs the function of a normal-type Ge detector, mainly a function of the preamplifier. As a result, we found that a huge amount of prompt γ-rays prevented measurements during an order of a few ms after a beam pulse, except for when the beam intensity was reduced unjustifiably low. We have overcome this difficulty by employing a Ge detector with a transisitor reset preamplifier (TRP Ge) with a reset time of 5μs. A limiting factor was the recovery of a spectroscopy amplifier, not a preamplifier; it was found that measurements could be carried out within several tens of μs after a beam pulse.

The γ-rays from the isomer were measured by the TRP Ge placed at a distance of 7cm from the target. The width and the intensity of the beam pulse used here were 100μs and 1μA, respectively. The data, consisting of E_γ and $t_{beam-\gamma}$, were recorded event by event onto the DAT during 20ms after the beam pulse, and subsequently sorted off-line to produce the time spectrum of the specific γ-ray.

Figure 1 shows an example of the γ-ray spectra taken for 20ms after the beam pulse. We can see two parallel cascades below the isomer clearly, one of which is the sequence of 176 and 78keV; the other is 169 and 85keV. The time spectrum gated on both the 176 and 169keV transitions is shown in Fig.2. The half-life of the $(\frac{11}{2}^-)$ was obtained to be 0.90 ± 0.03 ms from the slope of the time spectrum.

There was a discrepancy in the spin-parity assignment to the 78keV state between the previous studies [2,3,4]. U. Garg et al. [2] and J. R. Hughes et al. [4] assigned $\frac{5}{2}^+$ based on the angular distribution of the populating transition of 176keV, while K.Fransson et al. [3] assigned $\frac{3}{2}^+$ based on the K/(L,M,N) ratio of the conversion electron for the 78keV transition. We could deduce the relative

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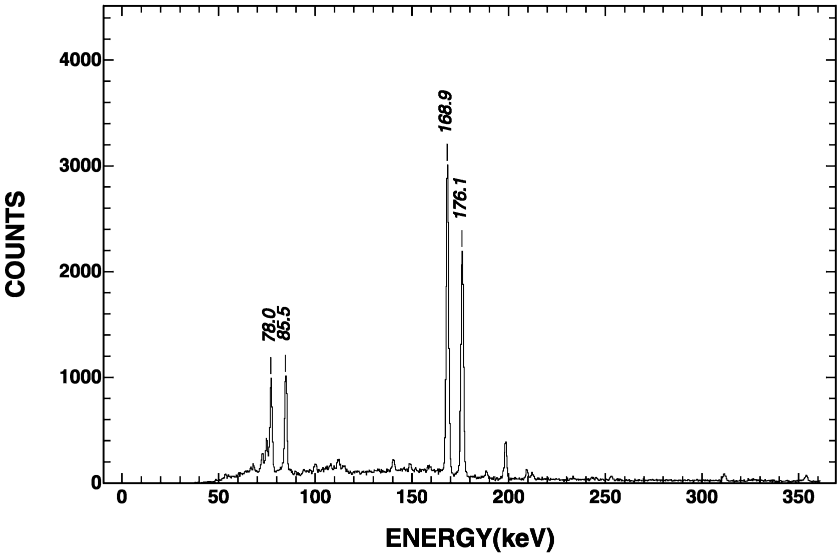

Fig. 1. An example of γ-ray spectra measured during 20ms after the beam pulse

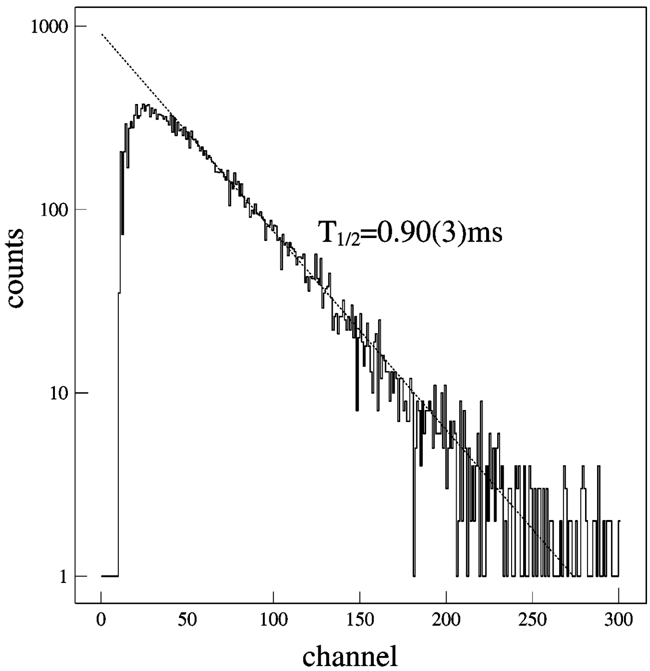

Fig. 2. Time spectrum gated on both the 169 and 176 keV transitions. Each channel corresponds to 0.032ms

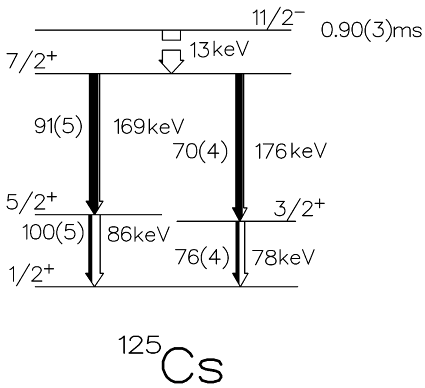

Fig. 3. Decay scheme of the ($\frac{11}{2}^-$) isomer in ^{125}Cs in which the transition intensities deduced in this experiment are shown

Table 1. Transition intensities of the cascade of 176 and 78 KeV assuming either the spin-parity assignment in ref. [2,4] (denoted by $I_t^{(1)}$) or in [3] (denoted by $I_t^{(2)}$)

E_γ(keV)	$I_t^{(1)}$	$I_t^{(2)}$
176.1	66(3)(M1)	70(4)(E2)
78.0	149(8)(E2)	76(4)(M1)

intensities of the cascade transitions of 176 and 78keV assuming either the spin-parity assignments mentioned above, as shown in Table 1, which supported the latter assignment. Based on these intensity arguments we have proposed the decay scheme of the $\frac{11}{2}^-$ isomer, as shown in Fig. 3, in which the transition intensities are also indicated. In this experiment we could observe neither the E3 branch of 182keV nor the M4 branch of 189keV reported by U. Garg et al. [2].

In Table 2 $B(\sigma L)$ of the decaying transitions from the $\frac{11}{2}^-$ isomers in Cs isotopes are compared with the Weisskopf estimates. It can be seen that the half-life of 0.90(3)ms in ^{125}Cs is consistent with the M2 transition of 13keV, although B(M2) in ^{125}Cs is five-times faster than that in ^{127}Cs.

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Table 2. Partial half-lives and $B(\sigma L)$ of the decaying transitions from the $\frac{11}{2}^-$ isomers in Cs isotopes. The data in ^{123}Cs and ^{127}Cs is taken from [1]

Nucleus	$I_i \rightarrow I_f$	σL	$t_{1/2}$	$B(\sigma L)$(W.u.)
^{123}Cs	$\frac{11}{2}^- \rightarrow \frac{5}{2}^+$	E3	1.64(12)s	0.82(6)
^{125}Cs	$\frac{11}{2}^- \rightarrow \frac{7}{2}^+$	M2	0.90(3)ms	0.216(7)
^{127}Cs	$\frac{11}{2}^- \rightarrow \frac{5}{2}^+$	E3	284(16)μs	3.28(18)
	$\frac{11}{2}^- \rightarrow \frac{7}{2}^+$	M2	68(4)μs	0.046(3)

References

1. Table of Isotopes, 8E edited by Richard B. Firestone and Virginia S. Shirley, 1996
2. U. Garg, T. P. Sjoreen, and D. B. Fossan: Phys. Rev. **C19**, 217 (1979)
3. K. Fransson, J. Oms, M. C. Abreu, and The ISOCELE Collaboration: Nucl. Phys. **A469**, 323 (1987)
4. J. R. Hughes, D. B. Fossan, D. R. LaFosse, Y. Liang, P. Vaska, and M. P. Waring: Phys. Rev. **C44**, 2390 (1991)