β-decay of the $21/2^+$ isomer in ^{93}Mo and level structure of ^{93}Nb

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The $21/2^+$ spin-gap isomer is known to compete the electron capture as well as the E4 γ decays with life time of 6.58 hour [1]. The experimental g-factor of this isomer suggested a fully aligned configuration of $[\pi(g_{9/2})^2\nu(d_{5/2})]_{21/2}+$ [1]. This state lower the excitation energy, because of the combination of attractive residual two-body interactions. Small β-decay branches to the 2.180 and 2.753 MeV levels in ^{93}Nb were reported with intensities of 0.04 and 0.08%, respectively [1]. Spin-parities were assigned to be $(19/2^+)$ and $21/2^+$, respectively [1]. However, recent study based on the in-beam γ-ray spectroscopy using the ^{82}Se(^{16}O,p4n)^{93}Nb reaction made different spin-parity assignment of $(17/2^-)$ at 2.180 MeV [2]. In order to precisely investigate the β-decay process, the experiment was carried out combined with a recoil catcher method using EN course, which is RCNP secondary beam line.

The $21/2^+$ isomer in ^{93}Mo was produced by the reaction of ^{13}C(^{86}Kr, 6n) at primary target position (F0) of EN course. The 7.4 MeV/u ^{86}Kr^{21+} beam, which was delivered directly from the AVF cyclotron with the beam intensity of 7 pnA, bombarded a ^{13}C target with 1.0 mg/cm^2 thickness and 99% enrichment. The momentum selection was made for ^{93}Mo^{35+} with momentum acceptance of $\Delta(B\rho)/B\rho$=5.8%. Primary beam was stopped inside the first dipole magnet and at slits of the dispersive focus of F1. The nucleus ^{93}Mo^{35+} recoiled out and was transported to a 42 mg/cm^2 Pb catcher foil at the achromatic focus of F2, which locates 16.3 m downstream from F0. As the flight time was ~520 ns, γ rays emitted after the isomer and β decays were effectively observed. The acceptance between F0 and F2 for ^{93}Mo was estimated to be 3.8%. Gamma rays were measured by 14 high-purity germanium (Ge) detectors. The total detection efficiency was 1.8% for 1.3 MeV γ ray. The total $\gamma\gamma$-coincidence events of 7.6×10^8 were obtained for 120 hours.

Transitions attributed to the β decay of the $21/2^+$ isomer of ^{93}Mo were observed in the total projection spectrum of $\gamma\gamma$ coincidence. New transition of 1262 keV was found with the intensity of 0.033% normalized to that of the 685 keV γ ray in ^{93}Mo. This transition was assigned as that between 2.753 and 1.491 MeV levels in ^{93}Nb based on the γ-ray coincidence relations. Accurate γ-ray intensity balances have determined the β-decay intensity of 0.120% to the 2.753 MeV level with logft=4.97(3) and no appreciable intensity for the previously proposed β-decay branching to the 2.180 MeV level. This supports the assignment of $17/2^-$ to the 2.180 MeV level. Based on the γ-ray intensities deexciting the 2.753 MeV level, spin-parity of the 2.753 MeV level was assigned to be $19/2^+$. The revised decay scheme of the $21/2^+$ isomer of ^{93}Mo is shown in Figure 1. The observed levels of ^{93}Nb and ^{93}Mo as well as the logft value deduced by the Gamow-Teller β decay from $\pi(g_{9/2})$ to $\nu(g_{7/2})$ were well reproduced by the j-j coupling shell model calculations.

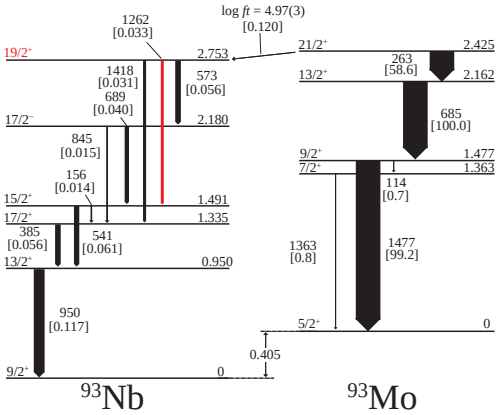

Figure 1: Decay scheme of the $21/2^+$ isomer in ^{93}Mo proposed in this work.

References

[1] R.A. Meyer *et al.*, Phys. Rev. C **15**, 390 (1977) and references therein.
[2] Y. Wakabayashi *et al.*, J. Phys. Soc. Jpn. **76**, 114202 (2007).