Search for High-Spin Isomers in $N = 51$ Isotones

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High-spin isomers are systematically studied in $N = 83$ isotones [1]. The neutron number is the magic number 82 plus one and proton numbers are close to 64 sub-magic number. The spins and parities of these isomers are $49/2^+$ and 27^+ for odd and odd-odd nuclei, respectively, in $N = 83$ isotones with $60 \leqq Z \leqq 66$. Configurations of these high-spin isomers are stretch coupled $[\nu(f_{7/2}h_{9/2}i_{13/2})\pi {h_{11/2}}^2]_{49/2^+}$ for odd nuclei and $[\nu(f_{7/2}h_{9/2}i_{13/2})\pi({h_{11/2}}^2 {d_{5/2}}^{-1})]_{27^+}$ for odd-odd nuclei. Large overlap of wave functions of the valence nucleons with high-j and high-Ω is explained to change the nuclear shape to be oblate. The high-spin isomer of ^{147}Gd was experimentally determined to have an oblate shape [1]. The high-spin isomers are caused by the sudden shape change from oblate to near spherical shape.

The high-spin isomers originated from the same type of isomerism are expected to be found in $N = 51$ isotones. Their neutron number is the magic number 50 plus one and the proton numbers are close to 40 sub-magic number. Configurations of high-spin isomers in $N = 51$ isotones are expected to be $[\nu(d_{5/2}g_{7/2}h_{11/2})\pi {g_{9/2}}^2]_{39/2^-}$ for odd nuclei and $[\nu(d_{5/2}g_{7/2}h_{11/2})\pi({g_{9/2}}^2 {p_{1/2}}^{-1})]_{20^+}$ for odd-odd nuclei. Recently, a high-spin isomer with life time of 1.1 μs was observed in ^{93}Mo [2] for the first time in $N = 51$ isotones.

The experiment to search for other high-spin isomers in $N = 51$ was carried out at EN course [3] in Research Center for Nuclear Physics (RCNP). The ^{40}Ar beam with average intensity of 0.2 pnA and energy of 197 MeV was provided by the AVF cyclotron. The beam bombarded a ^{nat}Zn target of 1.9 mg/cm^2 with a lead backing which was used to collect the reaction products at the target position. The γ-rays emitted from the reaction products were detected by using 5 Ge detectors. These detectors are placed at $\theta = 30°$, $60°$, $90°$, $120°$ and $150°$ with respect to the beam axis to measure the γ-ray angular distribution for the determination of the spins of the excited states. The prompt- and delayed-$\gamma\gamma$ coincidence measurements were performed in order to construct the level schemes and to search for the isomers. Coincidence events of 2.1×10^8 in total were recorded.

Figure 1 shows the projection spectra of $\gamma\gamma$-coincidence measurements. The upper and lower spectra were obtained by setting gates on the prompt ($\pm$ 240 ns) and the delayed (240 $\sim$ 600 ns from the prompt peak) in time difference spectrum. In the upper spectrum, the γ-rays were assigned to be those of 18 reaction products. In the lower spectrum, delayed transitions can be observed. The γ-rays in the lower spectrum are assigned to be those deexciting the known isomers in ^{90}Mo, ^{92}Mo, ^{94}Mo and ^{90}Nb with life times of 1.12 μs, 190 ns, 98 ns and 470 ns, respectively.

By the good S/N ratio of the γ-rays in the lower spectrum, this delayed-$\gamma\gamma$ coincidence method enables to search for isomers which exist in the reaction products that have small populations of a few mb such as ^{90}Mo and ^{90}Nb. In the lower spectrum, there are several unknown γ-rays which indicate the existences of new isomers. The analyses are in progress.

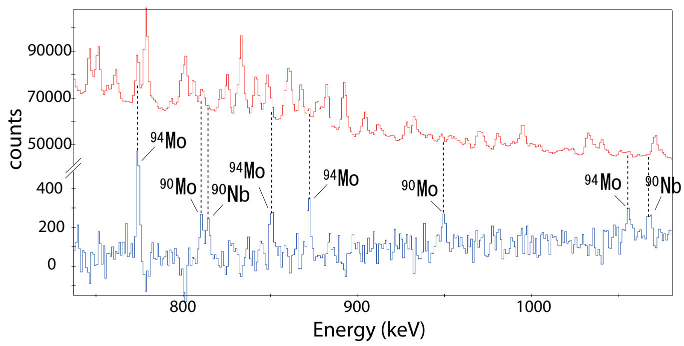

Figure 1: Projection spectra of $\gamma\gamma$ coincidence in the prompt ($\pm$ 240 ns) and the delayed (240 ns - 600 ns) time coincidence region are shown in the upper and lower parts, respectively.

References

[1] Y.Gono et al., Eur. Phys. A **13**, 5 (2002) and references therein.
[2] T.Fukuchi et al., Eur. Phys. J. A **24**, 249 (2005).
[3] T.Shimoda et al., NIM B **70**, 320 (1992).