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Level lifetime measurements in neutron-rich Zr and Mo isotopes around A = 110 through in-beam gamma-ray spectroscopy

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Isotopes of zirconium (Zr) with semi-magic atomic number 40 represent one of the most interesting cases of shape evolution in nuclei. The collective behavior of Zr nuclides is very much suppressed at neutron number 50, where ^{90}Zr exhibits properties of a doubly-magic nucleus. On the other hand, a sudden onset of nuclear deformation appears at $N = 40$ and 60 due to the strong proton-neutron interaction between the overlapping partner $\pi 1g_{9/2}$ and $\nu 1g_{9/2}$ ($\nu 1g_{7/2}$) intruder orbitals. The strong shape transition at $N = 60$ happens in Zr ($Z = 40$) and Sr ($Z = 38$) nuclei which are located at the mid-shell between $N = 50$ to 82. The abrupt shape transition is limited to the Sr and Zr nuclei, while the neighboring Kr ($Z = 36$) and Mo ($Z = 42$) show a smooth shape evolution pattern in terms of the quadrupole deformation.
Among Zr isotopes, ^{110}Zr with $Z = 40$ and $N = 70$ shell closures of the harmonic oscillator potential could be another quasi doubly-magic nucleus. However, a previous SEASTAR experiment at the Radioactive Isotope Beam Factory (RIBF) provided evidence for rather well-deformed nature in this isotope by measuring the energy of the first excited state through in-beam gamma-ray spectroscopy [1]. Several questions then remain open, such as the possibility of shape coexistence or triaxial deformation in this ^{110}Zr isotope as predicted by different theoretical models [2-4].
A high-resolution in-beam gamma-ray spectroscopy study of nuclei around ^{110}Zr was performed within the HiCARI (High-resolution Cluster Array at RIBF) campaign at the RIBF to measure the level lifetimes [5]. The HiCARI array was comprised of several different types of high-purity germanium detectors, which were six Miniball triple clusters from the Miniball collaboration [6], four 4-fold segmented Clover detectors from the IMP [7], a quad-type 36-fold segmented tracking detector from the RCNP [8], and a triple 36-fold segmented tracking detector P3 from the LBNL [9]. This large array was installed at the F8 focus which is located between the BigRIPS and Zero Degree Spectrometer at the RIBF facility. From this experiment, ^{110}Zr was populated through proton knockout reactions from ^{111}Nb and ^{112}Mo. In addition, states in ^{110}Mo and ^{112}Mo could be studied with significantly more statistics
In this talk, preliminary experimental results will be represented. Lifetimes of specific levels in ^{110}Zr, ^{110}Mo, and ^{112}Mo are analyzed based on the line-shape method [10]. These experimental results will allow to distinguish between predictions of different nuclear models concerning the shape of ^{110}Zr, the key isotope for the evolution of collective properties along the $N = 70$ isotones.

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