Shape evolution of ^{106,108,110}Mo in the triaxial degree of freedom†

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The properties of the 2_2^+ band in even-even nuclei are closely connected with the triaxial motion in the direction of the γ degree of freedom, such as the γ-vibration, rigid triaxial rotor,[1)] or γ-unstable rotor.[2)] The lowering of the known 2_2^+-state energy in neutron-rich molybdenum isotopes ($Z = 42$) is interpreted as the development of these triaxial motions associated with the ground-state shape. We studied the neutron-rich ^{106,108,110}Mo isotopes with higher statistics by measuring the β-delayed γ rays.

A neutron-rich cocktail beam was produced from the fragmentation of a 345-MeV/nucleon $^{238}U^{86+}$ beam. The nuclides were separated and identified on the BigRIPS separator and delivered to F11. The ions and β particles were detected by the WAS3ABi active stopper. A high-purity Ge array, EURICA,[3)] and fast-timing $LaBr_3$(Ce) array were used to measure the energy and time of γ rays.

Figure 1 shows $B(E2)$ determined from the lifetime measurement of the 2_1^+ states using the $LaBr_3$(Ce) array. The quadrupole deformation parameters β_2 of ^{106,108,110}Mo were deduced to be 0.349(13), 0.327(10), and 0.305(7), respectively. The results were compared with beyond-mean-field calculations using SLy4 and SLy5+T interactions, for which the predicted ground-state shapes were oblate and prolate, respectively. The prolate shape was indicated because the calculation with the SLy5+T interaction reproduces both $B(E2)$ and the energies of the ground-state band.

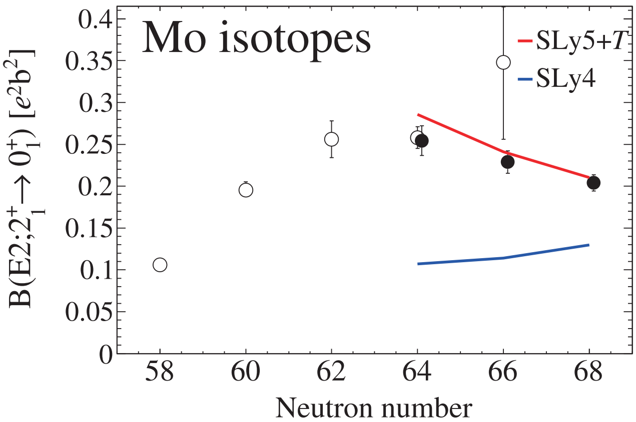

Fig. 1. $B(E2; 2_1^+ \rightarrow 0_1^+)$ of the neutron-rich Mo isotopes. The theoretical results calculated with SLy4 and SLy5+T interactions are shown.

The 2_2^+ band in ^{110}Mo was extended up to the 7^+ state. The energy staggerings of the 2_2^+ bands in ^{106,108,110}Mo are close to that of the axially symmetric rotor of the γ-vibrational state, rather than Davydov's rigid-triaxial rotor model or Wilets-Jean model for γ-unstable nuclei. A candidate of the two-phonon γ vibrational band with $K^\pi = 4^+$, which has not been well established yet, was found in ^{110}Mo. The $K^\pi = 4^+$ band decays only to the γ-vibrational band, and the energy of the $K^\pi = 4^+$ state is 2.5 times larger than that of the 2_2^+ state. Moreover, new 0_2^+ states were assigned in ^{108}Mo and ^{110}Mo.

The spin and parity of parent nuclei were assigned from the log ft values to be 4^- and 2^- for the ground state in ^{106}Nb and ^{108}Nb, respectively. Two β-decaying states were identified in ^{110}Nb, and their spin-parities were asigned as 2^- and 6^-.

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