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An Abrupt Shape Transition between 84Mo and 86Mo: a New Island of Inversion at N = Z

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The shell structure of nuclei is the backbone of the nuclear theory. A large energy gap with the completely filled spherical orbitals defines shell closure and magic number. One of the intriguing experimental findings is the disappearance of shell closure at certain N and Z, which is not predicted from the classical shell model. This Island of Inversion (IOI) has been successfully explained through the shell model with variants of dynamical SU(3) symmetry. The present work focused on the N = Z nucleus ^{84}Mo in which we probed unexpected large deformation.
We measured the lifetime of the first 2^+ states in ^{84}Mo and ^{86}Mo using the plunger setup. The experiment was performed at the NSCL, Michigan State University. A 140-MeV/u ^{92}Mo beam bombarded a 235-mg/cm2 ^{9}Be target to produce an ^{86}Mo secondary beam. The HPGe tracking array GRETINA and the TRIPLEX plunger were used to measure the first 2^+ state lifetimes. The extracted B(E2; $2^+_1 \to 0^+_1$) shows a salient difference between ^{84}Mo and ^{86}Mo, which departs from the similar B(E2; $2^+_1 \to 0^+_1$) trends between other N = Z and N = Z+2 nuclides. DNO-SM and several theoretical approaches were employed to understand the behavior in the proton-rich Mo isotopes. The study revealed that the abrupt shape transition between ^{84}Mo and ^{86}Mo is due to the increase of energy gap between $g_{9/2}$ and $d_{5/2}$ orbitals, leading to different particle-hole configurations. The results can be interpreted as a fingerprint of the 3N nuclear force. The experimental finding and the interpretation set the boundary of IOI on the proton-rich side for the first time.

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