Mapping of a new deformation region around ^{62}Ti[†]

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The mass of atomic nuclei is a fundamental quantity as it reflects the sum of all interactions within the nucleus, which is a quantum many-body system comprised of two kinds of fermions, protons and neutrons. Changes in the shell structures of nuclei far from stability can be directly probed by mass measurements.

In the neutron-rich Cr and Ti region, the shell evolution around the ls-closed neutron number of 40 has attracted considerable attention in recent years. The onset of island of inversion (IoI), which was discovered around ^{32}Mg[1)] for the first time, was theoretically predicted along the $N = 40$ isotones.[2)] The IoI is well characterized by the emergence of the Jahn-Teller (JT) stabilization,[3,4)] which is promoted by configuration mixing on the Fermi surface. The goal of the present experiment was to confirm the presence or absence of this effect through the first mass measurements of neutron-rich Ti isotopes around $N = 40$.

The experiment was performed at the RI Beam Factory (RIBF) at RIKEN, which is operated by RIKEN Nishina Center and Center for Nuclear Study, University of Tokyo. The masses were measured directly by using the TOF-$B\rho$ technique. Neutron-rich isotopes were produced by fragmentation of a ^{70}Zn primary beam at 345 MeV/nucleon in a ^{9}Be target. The fragments were separated by the BigRIPS separator,[5)] and transported in the High-Resolution Beamline to the SHARAQ spectrometer.[6)]

Figure 1 shows the present results of the two-neutron separation energy (S_{2n}) of Sc, Ti, and V isotopes, together with theoretical S_{2n} systematics obtained from the macroscopic-microscopic Weizsäcker-Skyrme-type formula with treatments of two radial basis functions corrections (LZU).[9)] This model largely reproduces the S_{2n} trends including the present results. However, it is obvious that the model underestimates the S_{2n} values in ^{61,62}Ti isotopes. The results, therefore, confirm that ^{62}Ti becomes very stable.

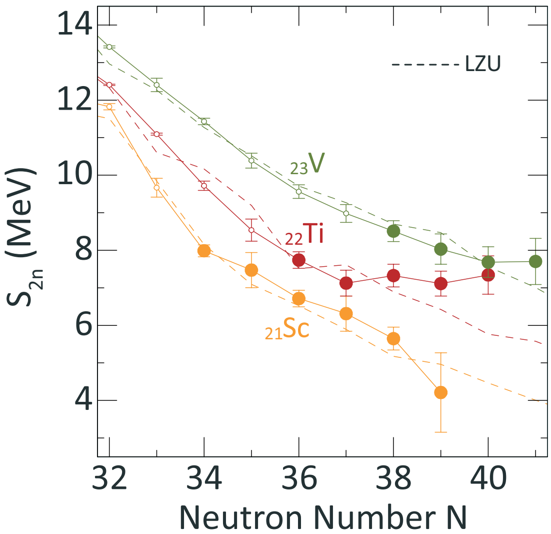

Fig. 1. Two-neutron separation energies (S_{2n}) of Sc, Ti, and V isotopes around $N = 40$. Closed symbols indicate values determined from the present experimental masses, and open symbols are literature values.[7,8)]. Solid lines connect isotopes, and dashed lines show theoretical predictions by the LZU model.[9)]

Since the behavior of the mass surface is similar to that in the $N = 20$ IoI, it is reasonably demonstrated that the JT stabilization arises in the vicinity of ^{62}Ti. The theory[4)] suggests that this enhancement of the JT stabilization around ^{62}Ti is caused by configuration mixing among neutron $fpgd$ orbitals enhanced by the degeneracy of the neutron orbitals.

[†] Condensed from the article in Phys. Rev. Lett. **125**, 122501 (2020)

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