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One neutron removal cross sections for the 16N isomeric state

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The enhancement of halo neutron removal cross sections in neutron halo nuclei is well known and is one of the evidences for the neutron halo structure. We have measured neutron removal cross sections for several exotic light nuclei to reveal their characteristic neutron-halo-like structures.(M.Fukuda et al, Phys. Lett. B 268, (1991), 339-344)

The difference in the nuclear structure between the ground and the isomeric state of ^{16}N can be explained by the orbitals in which the valence neutron is sitting. Considering the spin and parity, the valence neutron is considered to be mainly occupying in the $1d_{5/2}$ orbital in the ground state and in the $2s_{1/2}$ orbital in the isomeric state. Therefore, the valence neutron in the ^{16}N isomeric state, with effects of $2s_{1/2}$ orbital and its relatively small neutron-separation energy of 2 MeV, can be distributed more broadly in the radial direction. Attachment [1] shows the calculated nucleon density distributions of ^{16}N valence neutrons using the single-particle model. The spread of the density distribution depends on which orbital the valence neutron resides in. Therefore, the ^{16}N isomeric state is a candidate for neutron halo nucleus. The halo nucleus in the excited state has not been observed directly with experimental evidences.

The results of this research can also contribute to astrophysics. One of the nucleosynthesis processes is nuclear reactions in stars. The highest temperature among stars is about 1GK, which corresponds to about 100 keV in energy. This is the same order of magnitude as the excitation energy of ^{16}N isomer(120 keV). This suggests that ^{16}N isomer is existing in stars with a certain probability and may contribute significantly to the synthesis of elements. Therefore, the study of nuclear structure of ^{16}N isomer will be useful for elucidating the mechanism of nucleosynthesis.

In the present study, we measured one neutron removal cross sections using secondary beams of ^{16}N with a mixture of ground and isomeric states. We used two types of primary beams, ^{15}N and ^{18}O, to produce ^{16}N beams with different isomeric ratios, and compared the one neutron removal cross sections measured with each secondary beam. The experiments were carried out at the HIMAC heavy-ion synchrotron facility at National Institute for Radiological Sciences(NIRS), Japan.

The experimental results show that the neutron removal cross section obtained from a ^{16}N beam with a large isomeric ratio, which was produced from ^{18}O, is large compared to that obtained with a ^{16}N beam with a small isomeric ratio produced from ^{15}N. This result suggests that the ^{16}N isomeric state is considered to have a neutron-halo-like structure.

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