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Experimental investigation on the γ-emission probability of the unbound states in 131Sn through 130Sn(d,p)131Sn reaction measurement for understanding r-process

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The rapid neutron capture process, r-process, is responsible for the production of more than half of the elements heavier than iron. However, the physical conditions and astronomical sites of the r-process have not yet been determined. One key issue is the lack of experimental data on the properties of involved exotic nuclei, partly due to the difficulty of measuring neutron capture reactions for short-lived nuclei.
One of the critical isotopic regions in r-process is the area near ^{132}Sn, which has the neutron magicity with 82 neutrons. A drastic decrease in the neutron capture rate when crossing the neutron magic number is expected for the compound neutron capture due to the large energy gap after the shell closure. Due to a lack of experimental data, there are large uncertainties in neutron capture rates, which result in the large ambiguity in r-process conditions and make the calculation of final elemental abundance of r-process undetermined.
The neutron capture rates can usually be determined with the knowledge of γ-emission probabilities of the neutron unbound states. However, the low γ-emission probabilities and usually low γ-ray detection efficiency have been the experimental obstacles. At the OEDO-SHARAQ beamline in RIKEN RIBF, an alternative method to identify experimental γ-emission probability was developed, in which the heavy reaction residues are identified with the SHARAQ spectrometer, and the γ-emission probability can be obtained based on the number of heavy residues with increased neutron number. A ^{130}Sn(d,p) experiment was conducted with this method to identify the γ-emission probabilities of the neutron unbound states in ^{131}Sn. The kinetic energy of ^{130}Sn beam was degraded to about 20 MeV/u for the one neutron transfer reaction at OEDO beamline. We identified Sn isotopes with A = 129, 130, and 131, which correspond to two, one, and zero neutron emissions after the reaction, respectively, and the γ-emission probability near the one-neutron separation energy of ^{131}Sn was explored. The features and preliminary results of this experiment will be presented.

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