^{79}Se$(n,\gamma)^{80}$Se reaction cross section through ^{77,79}Se$(d,p)^{78,80}$Se reactions

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^{79}Se is one of the long-lived fission products (LLFPs) of nuclear waste. To design a facility to transmute the nucleus, a neutron-capture cross section on the nucleus was conceptualized. However, because both the neutron and LLFPs are unstable, the measurement of neutron-induced cross section is quite challenging. Alternatively, the reaction cross section can be indirectly determined through a surrogate reaction.

It is generally accepted that the (n,γ) cross section is composed of two parts: the formation of a compound state and the subsequent decay. The first term can be calculated using optical-model potentials with global parameter sets. In contrast, theoretical estimates of the second process is quite challenging owing to its high level density and complicated decay scheme, and it needs to be evaluated experimentally.1) The present work aims to determine the γ emission probability, P_γ, as a function of the excitation energy from the unbound states of ^{80}Se populated by the (d,p) reaction. In the surrogate method, the P_γ from the transfer reaction is used to determine the (n,γ) cross section. However, it is known that a mismatch in the angular-momentum transfer between the transfer reaction and capture reaction leads to a large cross section. To compensate for the mismatch, a surrogate ratio method is often used, where the (n,γ) cross section of interest is normalized using a pair of (n,γ) and transfer reactions of the neighboring nucleus. We deduce the ^{79}Se$(n,\gamma)^{80}$Se reaction by employing cross sections of ^{77}Se$(n,\gamma)^{78}$Se2) and ^{77}Se$(d,p)^{78}$Se reaction.

The experiment was performed using the OEDO beam line3) as one of the first physics experiments. ^{77,79}Se beams produced by BigRIPS were energy-degraded at F5, and the beam was spatially focused on a 4-mg/cm^2 thick polyethylene deuteride target by OEDO. The beam energy was adjusted to 20 MeV/nucleon at the target. The recoiled particles were identified by employing a six-SSD-CsI(Tl) array called TiNA, which covered an angular range of 100°–150° in the laboratory frame. The excitation energies of the state populated in ^{78}Se (^{80}Se) were determined using TiNA and the incident beam momentum. The momenta of the outgoing nuclei were analyzed by the first half of the SHARAQ spectrometer.

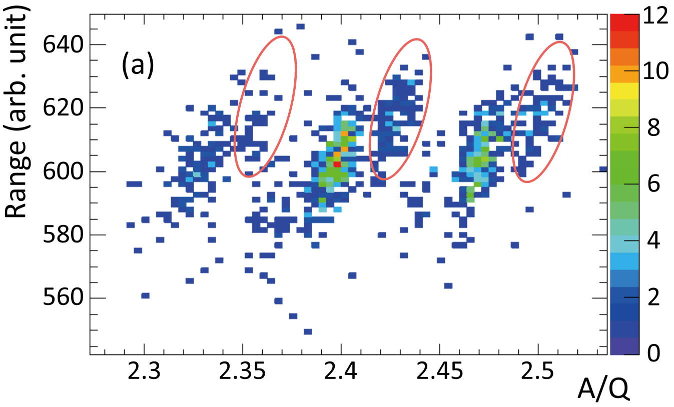

Fig. 1. Mass of the outgoing reaction redisue as a function of their A/Q measured at the S1 focal plane. The events circled were ^{80}Se$^{34+,33+,32+}$, respectively. See the text for details.

In the correlation between the excitation energy and the mass-to-charge ratio (A/Q), which we presented in the last report, ^{80}Se^{33+} ($A/Q = 2.42$) was not clearly separated from ^{78}Se^{32+} ($A/Q = 2.44$). However, in Fig. 1, which presents the mass as a function of the A/Q ratio of ^{80}Se, they are separated well. Here, the mass was deduced from the analysis of the Bragg curve in the ionization chamber installed at the SHARAQ focal plane. Analysis has almost been finalized. The manuscript will be submitted soon.

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