Fragmentation of ^{137}Cs and ^{90}Sr on proton and deuterium

H. Wang,[*1] H. Otsu,[*1] H. Sakurai,[*1] D. Ahn,[*1] M. Aikawa,[*2] H. Baba,[*1] P. Doornenbal,[*1] T. Fukahori,[*3] N. Fukuda,[*1] T. Isobe,[*1] S. Kawakami,[*4] S. Koyama,[*5] S. Kubono,[*1] G. Lorusso,[*1] Y. Maeda,[*4] A. Makinaga,[*2] S. Momiyama,[*5] M. Niikura,[*5] Y. Shiga,[*1,*6] P.-A. Söderström,[*1] H. Suzuki,[*1] H. Takeda,[*1] S. Takeuchi,[*1] R. Taniuchi,[*1,*5] Ya. Watanabe,[*1] and Yu. Watanabe[*7]

Properties of long-lived fission products (LLFP) have been studied for decades. LLFP nuclei are highly radioactive, although they are close to the line of β stability. These fission products are also of great interest for nuclear engineering as they carry a large weight fraction in the nuclear waste from nuclear reactor systems. Transmutation of the fission products into stable or short-lived isotopes has been suggested. Aiming at investigating the LLFP transmutation, we report on the fragmentation of ^{137}Cs and ^{90}Sr on proton and deuterium in inverse kinematics.

A primary beam U was accelerated to 345 MeV/nucleon, and it bombarded a 1-mm thick Be target located at the object point of the BigRIPS fragment separator. The average beam intensity was about 12 particle nA. Two secondary beam settings were applied and optimized for the ^{137}Cs and ^{90}Sr isotopes. The energies were about 185 MeV/nucleon in front of the secondary targets for both beams. The intensities of the ^{137}Cs and ^{90}Sr beams were 1.2×10^3 and 7.1×10^3 Hz, with purities of 14% and 28%, respectively.

Three targets, 179.2 mg/cm^2 CH_2, 217.8 mg/cm^2 CD_2[1)], and 226.0 mg/cm^2 ^{12}C were used to induce the secondary reactions. Data were also collected using an empty target to obtain the contribution from the beam-line materials. Reaction products were identified by the ZeroDegree spectrometer using the TOF-$B\rho$-ΔE method. A total kinetic energy measurement was performed for identification of the charge states. In order to cover the fragments over a wide range, several settings in ZeroDegree were applied.

The isotopic distributions of the fragmentation cross sections for the ^{137}Cs and ^{90}Sr beams on proton and deuterium are shown in Figs. 1 and 2, respectively. The proton- and deuterium-induced cross sections were deduced from the CH_2 and CD_2 targets, respectively, after subtraction of the carbon contributions by the C target as well as the background contributions by the empty target run. The validation of the cross section values was around 1 mb, as determined by statistics. The results are generally reproduced by PHITS[2)], while EPAX[3)] shows some discrepancies for the multi-nucleon removal channels.

*1 RIKEN Nishina Center
*2 Faculty of Science, Hokkaido University
*3 Japan Atomic Energy Agency
*4 University of Miyazaki
*5 Department of Physics, University of Tokyo
*6 Department of Physics, Rikkyo University
*7 Kyushu University

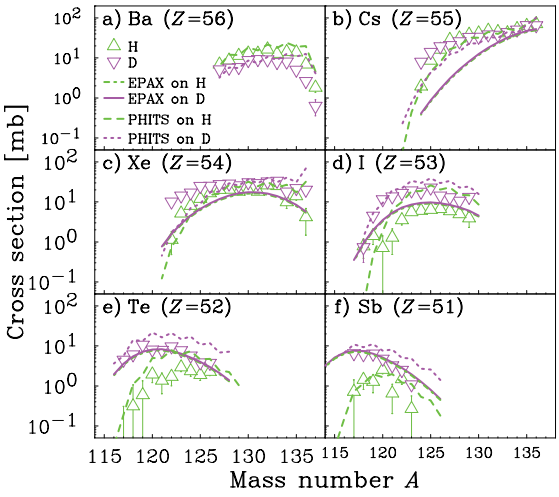

Fig. 1. Measured cross sections presented as isotope distributions for the fragments produced by ^{137}Cs on proton and deuterium. EPAX and PHITS calculations are displayed for comparison.

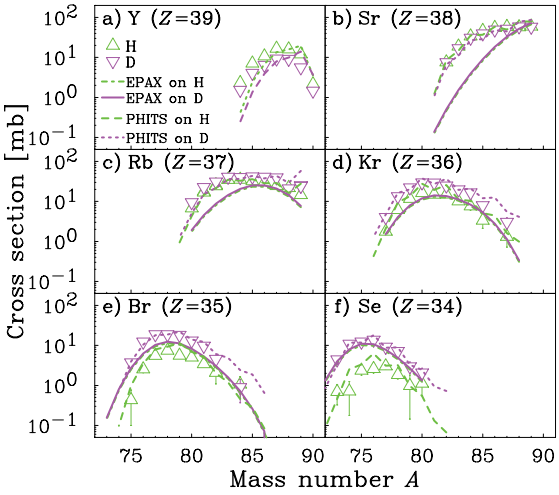

Fig. 2. Same as Fig. 1 but for ^{90}Sr

References
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