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Study of heavy-ion fusion reactions in inverse kinematic systems using low-energy ^{136}Xe beam

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Although currently extended to element 118, the periodic table of the elements is still far from reaching the end. Search for the Island of Stability has been one of the most attractive problems. The existence of the Island of Stability is predicted based on the Shell Model lighter than Pb, thus energies of single-particle levels require further confirmation when extrapolating to the Super Heavy (SH) region. However, nuclear structure information in the region between Pb and SH region, namely Very Heavy (VH) region, is lack exploration.
The heavy-ion fusion-evaporation reaction is a powerful tool in expanding the chart of nuclides as well as probing the nuclear structure beyond Pb. To design the experiments to study VH/SH nuclei and towards the Island of Stability, we need a reaction model that can precisely give the cross sections, while the fusion dynamics have not been established yet. In particular, the so-called "fusion hindrance"effect caused by Quasi-Fission has not been understood quantitively. Therefore, a series of experiments have been designed to evaluate the fusion hindrance effect quantitively.
To commission the experimental setup, a fusion reaction using the low-energy ^{136}Xe beam to bombard the ^{nat}Zn target was performed in July 2022 at HIMAC. Two-newly developed detectors were applied in the experiment. A ToF spectrometer based on Micro Channel Plate was applied to measure the ToF of the beam, and thus the beam energy can be determined. A position-sensitive mosaic-type detector consisting of 128 Si PIN Photo-Diodes was used to measure the decayed alpha particles from Evaporation Residues (ERs). Partial ERs were identified by the in-beam alpha measurement and off-beam activation measurement, independently. Experimental spectra were compared with realistic Monte-Carlo simulations. Cross sections of partial ERs were extracted and compared with the calculations of the statistical models. The introduction of the experimental setups and the results of the analysis will be given in detail.

Experimental study on nuclear physics

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