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Probing surface α clustering in the ground state of stable heavy nuclei

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George Gamow, about 90 years ago, famously proposed an explanation of α decay phenomena utilizing the quantum tunneling effect of preformed α particles[1]. Since then, α clusters are considered as a prerequisite in heavy nuclei, but the clear experimental evidence of its existence has not been reported until today. Instead, α clustering at the low-density nuclear surface could be one plausible explanation for the origin of preformed α particles[2]. In a recent experiment studying quasi-free α-knockout reactions on tin isotopes - Sn(p, pα), the existence of α particles on the nuclear surface in the ground state of tin isotopes was clarified. The observed reaction cross sections exhibit a monotonous decrease with increasing mass number (A = 112-124), which agrees with the theoretical prediction[3]. This experimental result supports the close correlation between surface α-clustering and neutron-skin thickness in heavy nuclei. This, in turn, calls for a revision of the correlation between the neutron-skin thickness of heavy neutron-rich nuclei, and the density dependence of the symmetry energy in the nuclear equation of state[4], which at present relies on mean-field theories without considering the α- clustering effect. In the presentation, the experimental spectrum for Sn(p, pα) reactions using Grand Raiden[5] and LAS[6] spectrometers at RCNP (Research Center for Nuclear Physics, Osaka University) are shown. We will discuss in details our results and the future experiments using exotic alpha-unstable beams.

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Field of your work

Experiental nuclear physics

Primary author: TANAKA, Junki (Riken, Nishina Center)

Presenter: TANAKA, Junki (Riken, Nishina Center)

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