α-clustering in heavy nuclei $^{112\text{-}124}$Sn probed with (p,$p\alpha$) reaction

Z. H. Yang[1,2], J. Tanaka[3,4], S. Typel[3,4], T. Aumann[3,4], J. Zenihiro[1], S. Adachi[1], S. Bai[5], P. v. Beek[3], D. Beaumel[6], Y. Fujikawa[7], J. Han[5], S. Heil[3], S. Huang[5], A. Inoue[1], Y. Jiang[5], M. Knösel[3], N. Kobayashi[1], Y. Kubota[2], W. Liu[5], J. Lou[5], Y. Maeda[8], Y. Matsuda[9], K. Miki[10], S. Nakamura[1], K. Ogata[1,11], V. Panin[1], H. Scheit[3], F. Schindler[3], P. Schrock[12], D. Symochko[3], A. Tamii[1], T. Uesaka[2], V. Wagner[3], K. Yoshida[13]

[1]Research Center for Nuclear Physics (RCNP), Osaka University, Ibaraki, Osaka 567-0047, Japan
[2]RIKEN Nishina Center for Accelerator-Based Science, 2-1 Hirosawa, Wako 351-0198, Japan
[3]Institut für Kernphysik, Technische Universität Darmstadt, 64289 Darmstadt, Germany
[4]GSI Helmholtz Center for Heavy Ion Research GmbH, 64291 Darmstadt, Germany
[5]State Key Laboratory of Nuclear Physics and Technology, School of Physics, Peking University, Beijing 100871, China
[6]Institut de Physique Nucléaire Orsay, 15 Rue, Georges, Clemenceau 91400 Orsay, France
[7]Department of Physics, Kyoto University, Kitashirakawa-Oiwake, Sakyo, Kyoto 606-8502, Japan
[8]Faculty of Engineering, University of Miyazaki, 1-1 Gakuen, Miyazaki 889-2192, Japan
[9]Cyclotron and Radioisotope Center, Tohoku University, 6-3 Aoba, Aramaki, Sendai 980-8578, Japan
[10]Department of Physics, Tohoku University, Sendai 980-8578, Japan
[11]Department of Physics, Osaka University, Osaka 558-8585, Japan
[12]Center for Nuclear Study, The University of Tokyo, 2-1 Hirosawa, Wako 351-0198, Japan
[13]Advanced Science Research Center, Japan Atomic Energy Agency, Tokai, Ibaraki 319-1195, Japan

Alpha decay has been known since the very early years of nuclear physics, which is generally described as the quantum tunneling of preformed α particles [1]. Despite the essential role in understanding the α decay process, there is so far no clear experimental evidence reported for the existence of α clusters in heavy nuclei [2]. Recent generalized relativistic density functional (gRDF) calculations suggest that α-clustering occurs at the low-density surface of heavy nuclei, which may explain the origin of α particles in the alpha decay process [3,4]. According to the gRDF calculation, there is also close correlation between surface α-clustering and neutron-skin thickness in heavy nuclei and as a consequence the α-clustering strength in tin isotopes ($^{112\text{-}124}$Sn) decreases monotonically with increase of the neutron number [4]. If confirmed, this will further impact our understanding of the density dependence of the symmetry energy in the nuclear equation of state [3,4].

We recently carried out direct measurements on α-clustering strength at the surface of tin isotopes ^{112,116,120,124}Sn by using quasi-free (p,$p\alpha$) reaction at the WS beam line of RCNP, Osaka. The scattered protons and alpha particles were recorded in coincidence by the Grand Raiden and LAS spectrometers. The α-clustering strengths were then deduced from the measured (p,$p\alpha$) cross sections. In this talk, the results of the experiment will be presented.

[1] G. Gamow, Z. Phys. 51(1928) 204.
[2] C. Qi, Prog. Part. Nucl. Phys. 105 (2019) 214.
[3] S. Typel, et al., Rev. C 81 (2010) 015803.
[4] S. Typel, Phys. Rev. C 89 (2014) 064321.