Differential cross section of proton elastic scattering from neutron-rich ^{6}He at 200 *A* MeV and high momentum transfers

S. Chebotaryov,[*1,*2] S. Sakaguchi,[*3] T. Uesaka,[*1] W. Kim[*2]
on behalf of the SAMURAI13 collaboration

Recently, an experiment on p–^{6}He elastic scattering at 200 *A* MeV was carried out at the RIKEN RI-beam factory (RIBF) by using the SAMURAI spectrometer.[1)] Details of the experimental setup and data analysis procedure were described in previous reports.[2,3)] In this report, the measured differential cross sections are presented. The main distinguishing feature of the obtained p–^{6}He cross section data is the highest momentum transfer region covered (q = 1.7–2.8 fm^{-1}), which makes the present data valuable to deduce ^{6}He density distribution in the interior of the nucleus with high precision.

The measured cross sections of p–^{4}He and p–^{6}He elastic scattering are shown in Fig. 1. The data of p–^{4}He elastic scattering were taken to confirm the validity of the experimental setup and data analysis procedure by comparing them to existing data measured in normal kinematics by Moss *et al.*[4)] Good agreement was obtained between the present and existing p–^{4}He data without any normalization. The systematic error was determined to be 9.4% and is the major contribution to the total uncertainty except at the most backward angles, at which statistical error dominates. The slope of the elastic scattering cross section is determined by the matter radius of the probed nucleus. The difference in slopes of the measured p-^{4,6}He cross sections show that the radius of ^{6}He is larger than that of ^{4}He. Such a considerable difference of their magnitudes could also be attributed to the weakly bound nature of the ^{6}He nucleus because scattering at large momentum transfers can easily cause the break-up of ^{6}He, reducing the yield of p–^{6}He elastic scattering events compared to that of p–^{4}He.

Figure 2 shows the obtained data and a summary of theoretical predictions, which were published before the experimental run. The predictions are based on different reaction models and density distributions of ^{6}He. Relativistic impulse approximation (RIA), t- and g-matrix folding models can adequately describe elastic scattering at the incident energy of the present work, making them suitable for the theoretical interpretation of the experimental result. A fit to the present data using one of these reaction models allows us to deduce ^{6}He density, especially in the interior region of the nucleus. The results of such an analysis will be submitted to a journal in the near future.

*1 RIKEN Nishina Center
*2 Department of Physics, Kyungpook National University
*3 Department of Physics, Kyushu University

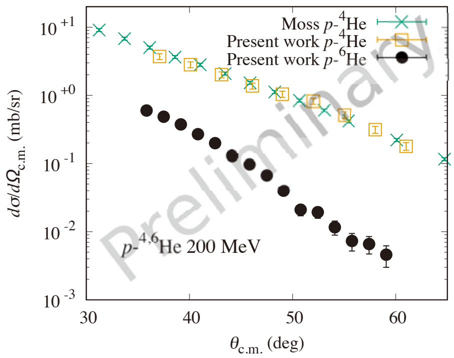

Fig. 1. Measured and existing[4)] differential cross sections of p–^{4}He and p–^{6}He elastic scattering.

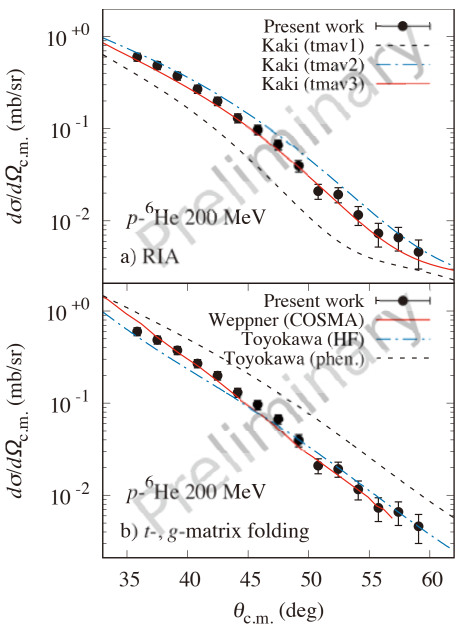

Fig. 2. Comparison of the present experimental result to predictions based on different reaction models.[5–7)]

References

1) T. Kobayashi *et al.*, Nucl. Instrum. Methods Phys. Res. B **317**, 294 (2013).
2) S. Sakaguchi *et al.*, RIKEN Accel. Prog. Rep. **50**, 41 (2017).
3) S. Chebotaryov *et al.*, RIKEN Accel. Prog. Rep. **50**, 42 (2017).
4) G. Moss *et al.*, Phys. Rev. C **21**(5), (1980).
5) K. Kaki, Phys. Rev. C **89**(1), 14620 (2014).
6) M. Toyokawa, Phys. Rev. C **88**(5), 1-14 (2013).
7) S. Weppner, C. Elster, Phys. Rev. C **85**(4), 1-13 (2013).